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COLORADO RIVER BASIN PROJECT
PART II

HEARINGS

BEFORE THE

SUBCOMMITTEE ON IRRIGATION AND RECLAMATION

OF THE

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS HOUSE OF REPRESENTATIVES

NINETIETH CONGRESS

SECOND SESSION

ON

H.R. 3300

TO AUTHORIZE THE CONSTRUCTION, OPERATION, AND MAINTENANCE OF THE COLORADO RIVER BASIN PROJECT, AND FOR OTHER PURPOSES

S. 1004

TO AUTHORIZE THE CONSTRUCTION, OPERATION, AND MAINTENANCE OF THE CENTRAL ARIZONA PROJECT, ARIZONA-NEW MEXICO, AND FOR OTHER PURPOSES

JANUARY 30, FEBRUARY 1 AND 2, 1968

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NOTE.—The chairman, Hon. Wayne N. Aspinall, and the ranking minority member, Hon. John P. Saylor, are ex officio members of each subcommittee.

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COLORADO RIVER BASIN PROJECT
Part II

TUESDAY, JANUARY 30, 1968

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON IRRIGATION AND RECLAMATION
OF THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:50 a.m., in room 1324, Longworth House Office Building, Hon. Harold T. Johnson (chairman of the subcommittee) presiding.

Mr. JOHNSON. The Subcommittee on Irrigation and Reclamation will come to order.

The purpose of our hearing this morning is to hold further hearings on H.R. 3300, by Mr. Aspinall and others, to authorize construction, operation, and maintenance of the Colorado River Basin project, and for other purposes. S. 1004 passed the Senate on August 7, 1967.

Hearings were held in the subcommittee both morning and afternoon, March 13, 14, 16, and 17, 1967. Printed hearings are before each member of the committee.

The hearing today has been scheduled to hear the Secretary of the Interior in response to the committee's request by letter of December 29 for specific information. The hearing will be confined to that and to matters that are of interest to members of the committee and to the Secretary and his staff.

Since that time, I do want to mention that California has introduced a new bill, H.R. 14834 and H.R. 14835, which was coauthored by most all of our delegation. The matter has not been assigned to a committee.

Our first witness this morning will be the Secretary of the Interior, who will give us the necessary information that was requested in the letter of December 29, by the chairman of the full committee.

Mr. SAYLOR. Mr. Chairman, before we proceed any further——

Mr. ASPINALL. Mr. Chairman?

Mr. JOHNSON. The Chair recognizes Mr. Aspinall, the chairman of the full committee.

Mr. ASPINALL. I think it very appropriate that the letter to the Secretary of the Interior be made a part of the record at this point so that it will appear in the record preceding the Secretary's testimony. I ask unanimous consent that it be done.

Mr. JOHNSON. Any objection?

Mr. SAYLOR. Reserving the right to object, Mr. Chairman, all I wanted was to get the letter of the Secretary into the record. The Secretary has been called up here to testify, and I want to be sure the

record is complete and so that we know what the Secretary has been asked to testify to.

I withdraw my reservation.

Mr. JOHNSON. I want to say if I had had a copy of it I would have placed it in the record. Having received a copy, it is now placed in the record.

(The material referred to follows:)

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
OFFICE OF THE CHAIRMAN,
Washington, D.C., December 29, 1967.

Hon. STEWART L. UDALL,
Secretary of the Interior,
Department of the Interior,
Washington, D.C.

DEAR MR. SECRETARY: The Irrigation and Reclamation Subcommittee is resuming its consideration of the Colorado River Basin project legislation on January 30 and the remainder of that week.

As you know, the Committee has completed public hearings on this legislation. However, because of events that have taken place since these hearings, there are several matters on which the Committee needs additional or up-to-date information as well as the Department's position. A few of these matters are discussed hereinafter.

I hope that you can be present on January 30 along with members of your staff to furnish the Committee the required information and answer the Committee's questions.

The one really new matter on which the Committee has received no testimony is your Department's proposal for prepurchase of a block of thermal generating capacity to meet the pumping requirements of the Central Arizona Project. The Committee will need a full statement on this proposal, showing its advantages over other means of supplying the necessary power and energy, and outlining the Department's plan for marketing energy which is in excess of the needs for project pumping.

In view of the likelihood that both of the Colorado River dams will be eliminated from the legislation, the Committee needs information on the financial assistance that might be available from a Lower Colorado River Basin Development Fund which is accumulated from other sources. The Department's statement on this matter should include the Department's recommendations as to what other sources should be considered and what part of the fund, if any, should be available for assistance to the Central Arizona Project.

As you know, Mr. Secretary, there has been considerable disagreement on the water supply that will be available for the Central Arizona Project and other Lower Basin projects from the Colorado River. Several Members of the Committee have indicated that they are somewhat confused because of the different figures that have been given them. Since there is no appreciable differences of opinion with respect to the physical data for the River System, and the differences in the water supply figures given are primarily the result of assumptions made in various operation studies, there is no reason why the Committee should not have a clear understanding of the Colorado River water situation and what factors cause the difference in the figures. Thus, it is important that you have your best water experts at the forthcoming meetings.

As you know, I believe the Department is being unrealistic in using streamflow records prior to 1922 in estimating the availability of water from the River. The Department itself has conceded this in the past.

Also, in my opinion, the Department study showing that a major portion of the Central Arizona Project water supply will come from Upper Basin spills is not realistic in view of the fact that the study itself shows that the only spills during the 60-year study were interspersed in the 24 years prior to 1929 and that the study shows no spills during the last 37 years. In addition, the reservoir operating principles that have been agreed upon and included in the legislation would negate to a great extent the use of spilled water.

The other point in connection with water supply which, as you know, I have disagreed with the Department on, has been the rate of Upper Basin development and the corresponding stream depletion. The Bureau's estimate of Upper Basin

stream depletion for 1975 is about 4.2 million acre-feet and for the year 2030 is 5.8 million acre-feet. In comparison, the Upper Colorado River Commission records indicate that the Bureau's 1975 depletion figure will be exceeded by about 400,000 acre-feet as soon as presently authorized projects are completed and by about 800,000 acre-feet if the Upper Basin projects in this bill are authorized. The addition of non-Federal projects under active consideration could cause Upper Basin depletions to exceed the Bureau's estimate by more than 1,000,000 acre-feet in 1975.

The Department's position and reply to these questions relating to water supply will be among those sought during the forthcoming hearings.

Other information which the Committee would like to have relates to the amount of water which might be made available through conservation programs and improved uses of existing supplies within the Basin.

Also, the Committee needs to have the latest thinking of the Department with respect to studies for augmentation of the water supplies of the Colorado River. In this connection, we would like to be brought up to date on the studies which the Department has been conducting with respect to augmentation by desalination and weather modification.

Water quality in the Colorado River Basin is another matter we are interested in, particularly in view of the recent announcement by your Water Pollution Control Administration on water quality standards in the Colorado River Basin. Someone of your staff should discuss these standards in relationship to future development in the Basin.

The Committee would like to be brought up to date on any promising power developments incorporating pumped-back storage. We would also like to have a discussion of the Indian rights under the Supreme Court decree, Arizona vs. California, including the amounts of water involved for each State and the Department's responsibility for protecting the Indian water rights.

Lastly, we would like to have a statement of the Department's interpretation of its responsibilities under the authority and direction given in this legislation for operating all of the facilities on the River. I am referring, of course, to the criteria which must be established by the Secretary, in consultation with the States, in accordance with the specific requirements set out in the legislation.

There may, of course, be additional requests for information before or during the Subcommittee meetings.

With best wishes for the New Year, I am

Sincerely,

WAYNE N. ASPINALL,
Chairman.

Mr. JOHNSON. We are ready to hear from the Secretary.

STATEMENT OF HON. STEWART L. UDALL, SECRETARY OF THE DEPARTMENT OF THE INTERIOR; ACCOMPANIED BY KENNETH HOLUM, ASSISTANT SECRETARY FOR WATER AND POWER, AND FLOYD E. DOMINY, COMMISSIONER, BUREAU OF RECLAMATION

Secretary UDALL. Thank you, Mr. Chairman.

I think the record should show that we are using the 3–3–3 defense here this morning.

I would also like to say before beginning my statement that Chairman Aspinall's letter, as far as I am concerned, covered the waterfront, raised all the issues, and we have tried to be responsive to it. I can assure you we have spent a great deal of time preparing this statement for today.

In the interest of saving time, I am going to read the first 17 or 18 pages. I do not plan to read the entire statement—I will summarize highlights with regard to the final phase of this statement, if that is satisfactory with the committee. But I, of course, would like it to appear in the record in its entirety.

In our report of February 15, 1967, and in our testimony of March 14, 1967, before this subcommittee, we presented in detail our position with respect to H.R. 3300 and other pending Colorado River Basin project legislation. Our basic position as presented last year remains unchanged. I shall, therefore, limit my prepared statement to the information and discussions requested by Chairman Aspinall in his letter to me of December 29, 1967.

Before responding to the specific items mentioned in that letter, I would like to point out two recent changes we have made in our analyses of the Colorado River Basin project.

The first concerns the basic period of record of Colorado River runoff. Last year our testimony was based on the 60-year period 1906 through 1965. Since 1965 the Colorado River has experienced 2 years of runoff averaging about 25 percent below the average for that 60-year period. Consistent with our position of using the longest period of hydrologic record as the basis for our analyses, we have brought our previous studies up to date by extension of the runoff record through the 1967 water year. The estimated average annual virgin runoff at Lee Ferry, based on the 62-year period of record ending in 1967 is 14,963,000 acre-feet as compared with the estimated average of 15,063,000 acre-feet for the 60-year period ending in 1965, a reduction of seven-tenths of 1 percent.

The second change concerns the projected initial date of operation of the central Arizona project. Heretofore we have anticipated that Colorado River water would first be diverted to the central Arizona area in 1975. This date no longer appears realistic. Our present projection anticipates start of construction in fiscal year 1970 and initial delivery of water in fiscal year 1979.

The physical effect of these two changes is to decrease slightly the estimated average water supply available to the central Arizona project over its payout period. The effect of the changes on financial payout, however, is insignificant. Under our analysis, the central Arizona project retains its strong justification, both economically and financially.

Unless indicated otherwise, our most recent figures are used in the remainder of my statement. Because of those adjustments, they will differ slightly from comparative figures given in previous testimony.

Turning now to the information requested, the first item concerns our proposal for prepayment arrangements to secure a block of thermal generating capacity and energy to meet the pumping requirements of the central Arizona project.

The studies for the central Arizona project plan which we presented in February of 1967 indicate that 400,000 kilowatts of capacity would be required for project pumping with the Granite Reef aqueduct sized at 2,500 cubic feet per second as we proposed. For a 3,000-cubic-feet-per-second aqueduct, as called for in S. 1004 as passed by the Senate last session, the amount would be increased to 470,000 kilowatts.

Under our proposal the Secretary of the Interior would make arrangements with non-Federal interests to acquire the right to a portion of capacity and associated energy from the output of a large thermal generating powerplant in the amount to serve required project pumping purposes.

The Government would acquire the capacity entitlement by advancing funds to the plant owners from time to time during the construction period in a ratio not to exceed the ratio of the Federal capacity entitlement acquired to the total plant capacity.

In addition to the payments associated with construction, the Government would also pay annually a commensurate portion of the operation and maintenance costs, including such items as advances for working capital, and replacement costs as they occur. The United States would not participate in such costs as interest, financing charges, property taxes, franchise fees, or other similar items.

Transmission of power and energy to points of project use would be provided both by Federal construction of some of the transmission lines and by prepayment for capacity in lines jointly used by the plant owners and the Government, through the Government advancing a portion of the costs of such dual-use lines, again in a ratio not exceeding the ratio of the capacity requirement of the Government to the total capacity of such facilities.

The agreement between the Government and the non-Federal interests would be drawn, of course, to provide security for the Government's investment. In addition, there would need to be contractual arrangements for exchanges of power to assure backup and continuation of essential pumping during periods of equipment outages.

By means of the proposed prepayment arrangement, the project would obtain assured power for pumping at low cost reflecting the economy of large thermal electric powerplants; shared economical, high-capacity, extra-high-voltage transmission facilities; and the benefits of Federal financing. The Federal costs would become costs of the central Arizona project to be repaid by the project beneficiaries as are other reimbursable costs, following long-established reclamation policies.

On the basis of our discussions, I anticipate no difficulty in negotiating arrangements consistent with these principles with the members of the WEST planning group that are prospective participants in the project. Members of the WEST group are currently planning a large thermal powerplant in the vicinity of Page, Ariz., the location which was used as a basis for estimating costs for the report which we presented to the committee last session.

We estimate that through prepayment arrangements power will be made available for central Arizona project for project pumping at a rate of 3 mills per kilowatt-hour for irrigation water—reflecting the interest-free financing provisions of reclamation law—and 5 mills per kilowatt-hour for municipal and industrial water. The average cost of power and energy delivered to the loads over the repayment period is about 3.5 mills per kilowatt-hour.

Capacity and energy sufficient for project pumping when a full water supply is available will be acquired. The central Arizona project pumping requirements will be irregular and dependent on water conditions during a particular year or series of years. On the other hand, the 400-megawatt output available to the central Arizona project from the Page plant will be dependable throughout the year and the full output will be present at least 85 percent of the time regardless of water conditions.

Even during the earlier years when project pumping is heavy, it is expected that there will be dry periods when low river flow will decrease the pumping requirements. We plan to balance this supply against the requirements through banking arrangements—this, of course, is a common and very excellent working arrangement that has been tested and tried in other areas—with other entities which have need for additional power during the same dry periods and are willing to return the power at such times as the respective needs of the central Arizona project have increased. The banking arrangement would be particularly feasible in the Arizona area, since, to the extent the central Arizona project pumping requirement decreases due to low river flow, the deep well irrigation pumping will tend to increase, and vice versa. The exchange arrangement would include suitable compensation for transmission services and losses, of course.

In the event the river's flows are not augmented, as we remain confident they will be, the average water supply for the central Arizona project will decrease due to the increased upstream depletions. In that event power excess to project needs would become available for other disposition, in gradually increasing amounts, although in relatively small quantities, particularly before 1990. Of course, diminution in overall water will also reduce hydrogeneration at the main stem plants, while ground water pumping requirements are increasing. The Salt River project, one of the prospective participants in the Page plant and a public agency, has already indicated that it could utilize such excess power in the event the central Arizona project pumping requirements are diminished. Any excess energy can, of course, be used in periods of low water flow to support capacity of the Upper Basin hydroelectric plants. Any such use would aid the upper basin development fund through a savings in the cost of purchased power.

With regard to the possible alternative means of obtaining pumping power for the project, the most obvious would be direct purchase of commercial power on the open market. We have previously presented testimony in which we stated that such power could be expected to cost an average of 6.5 mills per kilowatt-hour, as compared with the figures I gave a moment ago. This rate estimate is based upon the Bureau of Reclamation's experience in purchasing power in the Pacific Southwest with appropriate adjustments for anticipated reductions in rates in the future.

The higher cost of power purchased from utilities in the commercial market compared to power obtained under prepayment arrangements is the result of three major factors.

First, utility rates are based upon overall costs of the utility system which include a number of older, less efficient plants.

Second, such rates reflect the amortization of capital investments at interest rates higher than those of Federal financing. And third, private utility charges include allowances for profit and for Federal and State taxes.

Another alternative to prepayment would be contract arrangements to obtain power from a specific powerplant built for others with capacity included for this specific purpose. This type of arrangement would permit the Government to obtain the economic advantage of a modern, efficient, large size powerplant. Unlike the proposed prepayment plan, however, the rates in such a case would reflect costs of

non-Federal financing, taxes, insurance, and an increment of costs due to capital risk.

We have estimated the results of obtaining pumping power for the central Arizona project if we entered into such an agreement with the non-Federal utilities planning to construct a thermal electric powerplant at Page, Ariz. If the Page plant were financed entirely by non-Federal, publicly owned utilities, the average cost of energy to the central Arizona project would be increased about 30 percent over the cost under the prepayment plan. If such arrangements were made for a plant entirely financed by private utilities, the average cost would be increased about 60 percent over the cost under prepayment.

LOWER COLORADO RIVER BASIN DEVELOPMENT FUND

In our current proposal for the central Arizona project, involving the prepaid power arrangements I have just discussed, repayment of project costs is predicated on the use of project revenues only. As we reported last year, payout assistance from a development fund would not be necessary under our proposal. This is still our position. Should the Congress desire to establish a Lower Colorado River Basin development fund to provide financial assistance for future water projects, the administration offers no objections. Appropriate sources of revenue for such a development fund would include the following:

Source	*Average annual contribution*
Hoover-Parker-Davis power revenues after payout	$14,500,000
Revenues from the Arizona-Nevada portion of the Pacific Northwest-Southwest Intertie after payout	5,200,000
Central Arizona project revenues after payout ($56 M. & I. water)	18,300,000
Total average annual contributions	$38,000,000

Based on these contributions, surplus revenues that would accumulate in a development fund by the year 2029 are estimated as $597 million and by the year 2050 as $1,384 million.

ESTIMATE OF WATER SUPPLY

Estimates of future water supply available to the lower basin are influenced by three basic assumptions, each a matter of judgment. The first relates to the magnitude of virgin runoff that will occur in the future. The second concerns the rate of increase and the ultimate magnitude of Upper Basin depletions. The third involves the magnitude of future net losses along the Lower Colorado River.

Let us discuss all three of these items.

The traditional method of forecasting future runoff is to base the estimate on past records. The question posed in the Colorado Basin is what period of past runoff should be taken as most representative of the future. The following three periods represent typical variations involved:

[In thousands of acre-feet]

Period	Characteristic	Average virgin runoff at Lee Ferry
1931 to 1967	Critical period	12,990
1922 to 1967	Actual record at Lee Ferry	13,750
1906 to 1957	Longest reliable period of record on Colorado River	14,960

The larger estimate of future virgin runoff at Lee Ferry, the larger will be the estimate of water supply for the lower basin, although not in direct proportion. With a 4.4 million acre-foot California priority the magnitude of the central Arizona project water supply is more sensitive to the estimate of future virgin flow at Lee Ferry.

I would like to discuss the proposal that we ignore the streamflow records of the Colorado River prior to 1922 as a basis for water supply projections. Our understanding of the basis for this proposal is that the earlier records are unrealistic and that actual recorded runoff at Lee Ferry has been measured only since 1922.

Our projections of virgin runoff of the Colorado River consistently have been based on the longest period of runoff record on the Colorado River which we have identified as starting in 1906 and continuing through today.

Continuous records since 1906 are available at points upstream from Lee Ferry which measure over 70 percent of the runoff which reaches Lee Ferry, and continuous records since 1906 are available at points downstream from Lee Ferry which reflect primarily the runoff at Lee Ferry. By correlating the actual flows at Lee Ferry during the period 1922 to date with these other records, the unmeasured flow at Lee Ferry for the period 1906 to 1922 can be estimated with confidence. Thus, based on reliable records, we believe there can be no serious question that the average virgin runoff of the Colorado River during the period 1906–22 was significantly higher than in the period since 1922.

The purpose of selecting any period of record as the basis of analysis is to guide the projection of the water supply available to a project during its effective life. All reliable data available are normally used for making this projection. There is no more justification for casting out high years because they occurred early in a period than there would be for ignoring low years for the same reason. Rejection of any part of a long-term record would be justified only if there were a question of its accuracy or if there were an identifiable change in conditions that rendered it no longer appropriate.

It is obvious that the runoff of the Colorado River has been less since 1930 than in the preceding 25 years. We do not know the reason. However, changes in runoff sequences have occurred frequently in the past. The available runoff records of the Colorado River show that generally drought conditions prevailed during the year 1896–1903, inclusive, and that this was followed by a major wet cycle from 1904 to 1930, inclusive. Since 1930, the 37 years have been generally ones of drought. The question naturally arises: how long will this major drought last?

On October 1, 1963, Mr. Samuel F. Turner, consulting geologist and engineer, Phoenix, Ariz., presented to the Senate Subcommittee on Irrigation and Reclamation an interesting chart entitled "Accumulated Departure From Average Growth as Indicated by Tree Rings in Colorado River Basin Above Lee Ferry." This chart extended back through the year 1250. For the years prior to 1904, Mr. Turner identified on the chart five major drought cycles, which had durations varying from 48 years (the great drought of Hohokam time) to 24 years. The average length of the five major droughts prior to 1904 identified on Mr. Turner's chart was about 34 years.

The chart also shows that major droughts in the past always have been followed by major wet cycles. For the years prior to 1904, the

chart by Mr. Turner identified six major wet cycles. The average length of these major wet cycles was about 24 years.

In addition to major wet and dry cycles, the chart prepared by Mr. Turner shows a large number of minor wet and dry cycles. The chart also shows the current drought starting in 1930. The major conclusion that can be drawn from Mr. Turner's chart is that major droughts in the past have averaged about the length of our present drought and have been followed by major wet cycles.

A study of the runoff since 1906 of other major rivers in the West—the Missouri, Columbia, and Sacramento—indicates no general or unusual trends or reasons for discarding the period of record from 1906 to 1922. The chart back here shows the trends in these basins and in the Colorado and I think it is interesting that the dips and the bends are similar.

In our analyses of lower basin water supply, the abnormally high releases from Glen Canyon during the high runoff periods are, for the most part, stored and regulated in Lake Mead for use in the lower basin. A significant part of the water supply we have projected for the central Arizona project is derived from these abnormally high releases, or upper basin spills. The availability of such spills would not be affected by the reservoir operating criteria included in H.R. 3300 and in S. 1004 as passed by the Senate.

All of our reservoir operation studies have followed closely the principles of these criteria, differing only in minor details which have but an inconsequential effect in estimating water supplies.

We believe that to base water supply projections for the Lower Basin on the longest period of runoff record is not only technically correct but also the most logical and defensible procedure.

Mr. HOSMER. Mr. Chairman, are you working on the 14.9 assumption, figure?

Secretary UDALL. This is our current figure, brought up to date.

Mr. HOSMER. That is the one you are discussing here and the one on which the document is based?

Secretary UDALL. That is so.

There appears to be substantial agreement as to the extent of present upper basin depletions. There is disagreement, however, as to the rate at which future upper basin depletions will occur. There is disagreement as to the extent of responsibility, if any, of the upper basin to meet a part of the Mexican water treaty obligations.

The basic differences in projection of upper basin depletions are as follows:

[In thousands of acre-feet]

Year	Bureau of Reclamation estimate	Tipton report estimate
1965	2,787	2,777
1975	4,220	4,513
1990	5,100	[1] 6,342
2000	5,430	[1] 7,351
2030	5,800	[1] 7,891

[1] Tipton report demonstrates that upper basin's art. III(d), Colorado River compact obligation, limits assured supply for upper basin to 6,300,000 acre-feet annually, exclusive of its Mexican treaty obligation, if any.

We agree that land and other resources in the upper basin could be physically developed to deplete water at the rate the upper basin estimates. However, it does not appear likely in the judgment of our

experts that projections which would completely dedicate the upper basin's total remaining unused Colorado River water supplies to specific areas or uses would be developed at rates commensurate with upper basin projections.

It seems more likely that some reserves will be withheld for future municipal and industrial growth. Also influencing our judgment is the uncertainty as to whether the upper basin is obligated to meet part of any Mexican water treaty deficiencies. Until that issue is resolved, we doubt that projects dependent on the contested water supply, as a practical matter, would be authorized or undertaken.

To the extent that weather modification, desalting, or other measures provide water for additional use, we would expect that the rate of future upper basin depletions would increase accordingly. In the interim, we believe that our estimates of future upper basin depletions are realistic.

NET WATER LOSSES ALONG LOWER COLORADO RIVER

The third broad category where projection or assumption is necessary to estimate future lower basin water supply involves estimating the future net water losses along the Lower Colorado River. Our proposal for the Colorado River Basin project include works to salvage some 680,000 acre-feet of Colorado River water that have constituted river losses in the past. With these salvage works in operation, we estimate that there will remain some 590,000 acre-feet of net losses along the lower river, primarily from evaporation and evapotranspiration from nonbeneficial vegetation. For comparative purposes, other estimates of future net losses are as follows:

Source	*Estimate, acre-feet*
Bureau of Reclamation	590,000
Upper Basin (Tipton)	810,000
Colorado River Board of California	1,000,000

The magnitude of the future losses would affect significantly the residual water supply for the central Arizona project.

Again, we believe our estimates are realistic. Senator Wash Reservoir is now in operation and preventing overdeliveries to Mexico. We are confident that water losses can be reduced through eradication and control of phreatophytes and through further channelization. We know that we can salvage water through ground-water recovery.

WATER SUPPLY FOR THE CENTRAL ARIZONA PROJECT

The effect of varying assumption in the three broad aspects of water supply I have just discussed—virgin runoff, upper basin depletions, and lower river losses—is as follows and as shown graphically on the chart before you.

(The material referred to follows:)

WATER FOR CENTRAL ARIZONA PROJECT[1]

[In thousand acre-feet]

Condition	Year 1979	Year 1990	Year 2000	Year 2030	Average 50-year period
USBR projections:					
60-year period, 1906–65	1,650	1,255	1,026	676	1,045
62-year period, 1906–67	1,650	1,239	1,005	626	1,019
46-year period, 1922–67: USBR projections of upper basin depletions	1,650	900	430	284	622
46-year period 1922–67: Tipton projections of upper basin depletions[2]	1,105	500	360	284	450
46-year period 1922–67: Tipton projections of upper basin depletions; Tipton estimate of lower basin salvage[2]	890	285	145	77	237

[1] Aqueduct capacity, 2,500 c.f.s.; 4.4 m.a.f. priority for California.
[2] Tipton projections on basis that upper basin would be required to provide ½ of Mexican water delivery. If upper basin were not so required, water supply for CAP would drop to zero about 1985 on basis of Tipton projections.

Secretary UDALL. Only time will tell which assumptions are the more nearly correct. There is no way of guaranteeing or proving with certainty any given assumption today. The only positive solution, therefore, lies in programs which will supplement Colorado River runoff at least sufficiently to guarantee 7.5 million acre-feet for consumptive use by the lower basin States. If this is accomplished, the assumptions as to virgin flow, upper basin depletions, and river losses become academic insofar as lower basin water supply is concerned.

Mr. Chairman, the remaining portion of the statement, again responsive to the chairman's letter, as responsive as we can make it, covers things I am going to discuss briefly rather than read my prepared statement, if I may, in order to save time.

Mr. JOHNSON. I might say, Mr. Secretary, your complete statement will appear in the record.

Secretary UDALL. The remainder of my statement covers water supplies which we think can be made available through water conservation programs. I think I can say to the committee that we have made some significant progress on this front in the last 2 or 3 years, particularly since the very low water year we had, I believe in 1964, when the Imperial Irrigation District was very cooperative and instituted water saving programs.

We also cover in the statement the current studies on desalting and its potential. We also bring the committee up to date on the work that is presently being done on the foreseeable potential of weather modification as we see it now.

We also have a section in the statement which discusses the Indian water rights on the river in response to the questions of the chairman.

We have outlined for you what I would describe as a preliminary reconnaissance study showing what the prospects are with regard to pumped storage projects along the Colorado.

We also conclude the statement with a section that concerns the operation of the River and the associated problems.

I should like to add, Mr. Chairman, if I may, mention of one other problem that is not in the statement. I apologize to the committee for this and I take personal responsibility for our tardiness in acting on this problem.

There is one additional problem that I hope we can resolve within the administration and can present language to you which will achieve the desired end. The reason that we did not get this problem in sharp focus until very late in our preparations is that there has been uncertainty with regard to the Orme Reservoir damsite which is the proposed small regulating reservoir near Phoenix where the water will be pumped and stored before it goes out into the irrigation systems. This reservoir, if located at the site we anticipate, would have a very beneficial impact on one Indian reservation and a very harmful one on a second Indian reservation.

The latter is the Fort McDowell Mohave-Apache Indian community. This is a small Indian group, one of the few I know that does not have a lawyer. When they do not have a lawyer, I end up as their lawyer and I am afraid that up to the moment, I have not done my job right—I want to be frank with the committee about it. This tribe is interested in the same thing that other Indian tribes are interested in under like circumstances. This reservoir would take nearly two-thirds of the land of the Indian reservation.

Mr. HALEY. Mr. Secretary, would you share some of that responsibility with the junior Senator from New York? I have noticed recently he has become quite interested in the Indian problems.

Secretary UDALL. We have a lot of help these days, Mr. Chairman.

The problem is a simple one. I am not throwing this at the committee as some new idea. In the earlier bills that had the Hualapai Dam in it there were three pages of language to cover the rights of the Hualapai Indians. These Indians would like to have some additional land. They want to keep their land base. I think this can be worked out.

I spent a substantial part of yesterday with the Department of Agriculture people, with the Bureau of Land Management people, and with the Bureau of the Budget people. I think we can work up an amendment that although it will not enable them to retain the same land base, it will provide, by exchange, an appropriate Indian reservation land base. We also would propose the same thing that we did at Yellowtail and which was proposed for Hualapai—to give recreational development rights to the Indians whose land is being taken.

So we are working on this. I would hope, Mr. Chairman, that by the time the subcommittee gets to markup, we can present an administration amendment that we are all agreed upon. If we are not able for any reason to do that, I think we all ought to agree that the Indian Affairs Subcommittee in due course can handle this matter and that we can get satisfactory legislation.

So I want to make it plain that this is not a controversial matter that I am raising. I think it is a matter for us to decide on an appropriate amendment and then submit it to the committee and the committee can give it its usual attention. This committee has been, and I think very wisely, generous with Indian tribes in all parts of the country when their land was taken, when their damsites were taken. The proposals in the earlier bills with regard to Hualapai Reservations I think were very generous and I think appropriately so. So I think in this pattern, we can work something out and we will be working very strenuously on it in the next few days.

Mr. JOHNSON. Could you give us an idea of the size of the reservoir and the amount of land that is involved?

Secretary UDALL. The amount of land that would be taken is about 15,000 acres, which is about two-thirds of the reservation. They would like to have possibly 5,000 additional acres to keep their reservation of substantial size. I think this can be worked out on the basis of our discussions yesterday with all parties concerned.

That, Mr. Chairman, completes my statement.

(The unread portion of Secretary Udall's statement follows:)

WATER AVAILABLE THROUGH WATER CONSERVATION PROGRAMS

Our proposals for the Colorado River Basin Project include measures which we consider will obtain the greatest water salvage practicable along the lower Colorado River. These comprise:

Measure	*Annual water salvage (acre-feet)*
River channelization (underway)	190,000
Senator Wash Reservoir (completed)	170,000
Ground water recovery	220,000
Phreatophyte eradication	100,000
Total	680,000

Extensive canal lining already has been installed in the Central Arizona area and is continuing. Highly efficient irrigation practices are in use. Urban waste from Tucson and Phoenix is being reused for agriculture or is being returned to recharge round water. Watershed treatment practices are common over much of the Salt River watershed. We are confident that there are no major opportunities for water salvage in Arizona that are not now being developed.

Insofar as the Lower Basin is concerned, we believe that our proposals for water salvage along the lower Colorado River, together with advanced conservation practices already under way, constitute the maximum practicable contribution that water salvage can make to the solution of Colorado River water shortages.

The major known opportunities for future salvage of water in the Upper Basin are through the adoption of more efficient irrigation practices. While the Bureau has not made a detailed survey of these possibilities, it is known that opportunities exist. In the report of the Engineering Advisory Committee to the Upper Colorado River Compact Commission dated November 29, 1948, the average annual total consumptive uses at the sites of use were estimated to be about 1,923,000 acre-feet. Of this amount, a total of about 315,000 acre-feet annually was identified as comsumptive use from noncropped areas located adjacent to irrigated cropped lands. As the future demands for water in the Upper Basin become more acute, a considerable percentage of this use by noncropped areas could be salvaged for use on cropped lands or for other beneficial purposes.

DESALTING

The Bureau of Reclamation, assisted by the Atomic Energy Commission and the Office of Saline Water, has just completed a reconnaissance appraisal of the potential for augmenting the runoff of the Colorado River by desalting sea water as requested and financed by the Congress in action on the 1968 Public Works appropriation bill. As the Committee knows, a related study (due to be completed this summer) is being made by the United States and Mexico under the chairmanship of the International Atomic Energy Agency. Data developed in the course of this international study was, of course, available to the Bureau of Reclamation.

The two studies indicate that, as the technology continues to develop, desalting is one of the potential methods of supplementing Lower Basin water that merits careful consideration.

We expect, of course, that the proposed National Water Commission will review these potentials as they consider the problems of the Colorado. Commissioner Dominy is prepared to provide the Committee with detailed information about this reconnaissance study.

ATMOSPHERIC WATER RESOURCES DEVELOPMENT IN THE COLORADO RIVER BASIN

From the onset of the Bureau of Reclamation's research program to increase water supplied by weather modification, the Colorado River Basin has been a major area of research efforts. The very first contract in the program was made with the University of Wyoming to study increasing the water supply by cloud seeding for Reclamation projects in Wyoming. To date, we have invested over one-third of the program funds on research projects for developing precipitation enhancement techniques in the Colorado River Basin.

This year, three major "Project Skywater" field activities are being conducted for the Colorado River Basin. The University of Wyoming is studying methods for obtaining more snowfall from mountain cap clouds. Present experiments are being conducted at Elk Mountain, an isolated peak just outside the Basin drainage. Experimental cloud seeding is being continued in the Park Range by E. Bollay Associates with ground-based generators using silver iodide. Field support for the Park Range experiment is being provided by the Soil Conservation Service, the Geological Survey, and the Forest Service through formal agreements with the Bureau of Reclamation. At Flagstaff, Arizona, Meteorology Research, Inc., is developing modification techniques to increase precipitation from summer cumulus clouds. Techniques perfected at Flagstaff will be particularly significant in enhancing precipitation over the Lower Basin and in the lower elevations of the Upper Basin.

In total, the Bureau of Reclamation has 11 organizations involved in Colorado River precipitation modification research—4 university groups, 2 private research firms, and 5 Federal agencies.

Detailed planning is now beginning for a large-scale pilot operation in the Upper Colorado River Basin. Knowledge gained through our comprehensive efforts and those financed through the National Science Foundation gives a firm basis for planning an undertaking of this magnitude. This first pilot project could be logically initiated as early as 1969 or 1970.

We believe it reasonable to anticipate that within 10 years a firm capability to augment Upper Basin streamflow by about 1,900,000 acre-feet annually could be developed. A justifiable large-scale operation could then be started involving:

Seeding with in well-defined and localized target areas by remote controlled ground-based generators using silver iodide.

Seeding susceptible winter storms at high elevations to increase winter snowpack.

Modification of winter precipitation in lower or middle elevations of the Upper and Lower Basin and summer precipitation throughout the region are further potentials that could be realized by 1985.

Primary target areas for initial large-scale operations can be identified where precipitation and runoff are sufficient to warrant modification and where temperatures are suitably cold during reasonably long periods. With these fundmental considerations, 14,200 square miles of major primary target areas have been tentatively identified. These areas are generally above 9,500 feet where settlement is sparse and, except for the skiing enthusiasts, activity is reduced in the wintertime. The best seeding season will normally be November through April when an average of 19.4 inches of precipitation occurs.

We believe it safe to assume that a 15-percent increase in the average winter precipitation is likely within 10 years. Recognizing that indicated precipitation increases by current cloud seeding operations and experiments are generally in the 10-to-20-percent range and that considerably expanded knowledge and improved systems should be available by the mid-1970's, a 15-percent increase seems conservative.

Although the average annual streamflow augmentation of about 1,900,000 acre-feet will occur during the spring runoff, regulation provided by the large storage capacity built in the Colorado River Basin will make virtually all the increase usable water supply.

The total annual cost of a full-scale cloud seeding operation in the prime target areas is estimated at $2,650,000. This estimate includes amortized initial installation and replacement costs, supplies, maintenance, and a continuing analysis of results and any effects on ecological regimes.

The unit cost of producing 1,900,000 acre-feet of new water by cloud seeding is thus estimated as about $1.50 per acre-foot. The estimated cost is probably on the high side, representing an upper boundary for costs. Once more is known, careful planning may reduce unit costs to as low as $1.00 per acre-foot.

A 9-year, $25 million comprehensive development program will be needed before the large-scale operation described above can begin. Reducing the development time or costs may endanger opportunities to achieve a full success in utilizing such a new and complex technology as weather modification.

The regional research and development effort for the Upper Basin will be the first such undertaking in weather modification by the Bureau of Reclamation. Much of what is learned here will aid similar projects for other areas throughout the Nation.

WATER QUALITY STANDARDS

The Colorado River is the only major river of the world that is virtually completely controlled. With the existing system of large storage reservoirs it is possible to plan, for all practical purposes, on complete utilization of the river's runoff with no utilizable water escaping to the sea. This means that the limited water supply in the Colorado River Basin must be used and reused and then used again for a wide variety of purposes. In this complete utilization of runoff, the Colorado Basin is unique.

The River is unique also with respect to the number and extent of the institutional constraints on the division and use of the Basin's water which include an international treaty, two interstate water compacts, Supreme Court decisions, Indian water rights, State water laws, and Federal law.

These two aspects, in turn, make the problem of setting numerical mineral quality standards for the Colorado River not only unique but extremely complicated. Before discussing this problem further, I would like to state that salinity standards will not be established until we have sufficient information to assure that such standards will be equitable, workable, and enforceable.

The principal water uses in the Basin include irrigated agriculture, municipal and industrial water supply, fish and aquatic life, and recreation. Salinity in the Colorado Rver has no significant effect on instream or nonconsumptive water uses such as hydroelectric power generation and water-oriented recreation. However, ever-increasing levels of salinity do have an adverse impact on the consumptive uses of water for both irrigated agriculture and municipal and industrial water supply.

Further development and depletion of water allocated to the Upper Basin States will raise the salinity of water downstream.

Salinity standards must be so framed that they will not impede the growing economy of the Colorado River Basin and yet not permit unwarranted degradation of water quality. This is the hard dilemma which is the core of the problem of establishing equitable salinity standards.

A decision not to set salinity standards at this time does not and will not preclude getting started with programs to study and demonstrate the feasibility of controlling and alleviating the Basin's salinity problem. Promising methods of attacking this problem include (1) control of natural sources by such methods as suppression or diversion of mineral springs; (2) control of municipal and industrial wastes by lagooning or injection into deep geological formations; (3) reduction of salt lodes from irrigated lands by such measures as rejection of areas of saline soils in new developments, improved irrigation practices, and control of drainage water; (4) alleviation of water losses through reduction of evaporation and evapo-transpiration, and control of phreatophytes; and (5) removal of salts by desalting.

Water quality also can be improved by measures to increase water supplies such as weather modification and augmentation by desalted sea water which I have previously discussed. These potentials for improving water quality are being explored. The Colorado River Basin Water Quality Control Project of the Federal Water Pollution Control Administration will complete by the end of 1968 a comprehensive report describing the mineral quality of the Basin's waters, delineating the causes of salinity and future increases thereof, assessing the effects of salinity on beneficial water uses and evaluating the economic impact of existing and future mineral quality. The Bureau of Reclamation, for several years, has been giving greater attention to salinity problems as they are related to and influenced by water resources development. Also, the Bureau has just recently embarked on reconnaissance studies to identify possibilities for controlling salinity and to identify specific studies that should be taken to assess control measures at a few select salinity sources. We hope to expand activities of this type in the years ahead, and in this context I can report that we are moving ahead with programs that we expect will lay the foundation for setting workable salinity standards.

Although the salinity problems of the Colorado River are difficult, I am confident that they can and will be resolved.

INDIAN WATER RIGHTS

In Arizona v. California, 1963 (373 U.S. 546), claims of the United States on behalf of five Indian reservations in Arizona, California, and Nevada, to mainstream Colorado River water were sustained. The Indian reservations are the Chemehuevei, the Cocopah, the Yuma, the Colorado River, and the Fort Mohave. The Supreme Court held that water in quantity sufficient to irrigate all the acreage practicable of irrigation on the reservations was reserved; that the United States had reserved such water rights for the Indians; and that such rights are "present perfected rights" with priorities as of the dates the reservations were established. The Department, by reason of its responsibilities over Indian matters, has the obligation to protect and conserve these Indian water rights, and to aid in their use and development.

Article II of the Decree entered March 9, 1964 (376 U.S. 340), quantified for each Indian reservation both a maximum annual diversion from the main stream and the number of irrigable acres. The Decree provides an annual measure of the rights for each Indian reservation. That measure is the lesser of two alternatives: (1) the diversion quantity specified for the reservation or (2) the amount necessary to supply the consumptive use required for irrigation of the number of acres specified for the reservation plus satisfaction of related uses.

Article VI of the Decree required the three States and the Secretary of the Interior to present to the Court a list of their claims of "present perfected rights" as a preliminary to the determination of such rights either by agreement or by further proceedings. In March of 1967 the Solicitor General of the United States filed the following list of claimed Indian "present perfected rights":

PRESENT PERFECTED RIGHTS FOR INDIAN RESERVATIONS IN WATERS OF THE MAIN STREAM OF THE COLORADO RIVER

Indian reservation	State	Present perfected rights [1]		
		Diversion, acre-feet	Net acres	Priority date
Yuma	California	51,616	7,743	Jan. 9, 1884
Fort Mojave	Arizona	27,969	4,327	Sept. 18, 1890
	do	68,447	10,589	Feb. 2, 1911
	California	13,698	2,119	Sept. 18, 1890
	Nevada	12,534	1,939	Do.
Chemehuevi	California	11,340	1,900	Feb. 2, 1907
Cocopah	Arizona	2,744	431	Sept. 27, 1917
Colorado River	do	358,400	53,768	Mar. 3, 1865
	do	252,016	37,808	Nov. 22, 1873
	do	51,986	7,799	Nov. 16, 1874
	California	10,745	1,612	Nov. 22, 1873
	do	40,241	6,037	Nov. 16, 1874
	do	3,760	564	May 15, 1876
		905,496	136,636	

[1] According to the terms of the decree, the quantity of water in each instance is measured by (i) diversions or (ii) consumptive use required for irrigation of the respective acreage, and for satisfaction of related uses, whichever of (i) or (ii) is less.

This list presented in tabular form the Indian water rights as specified in Article II of the Decree.

Since in each case substantial quantities of water diverted from the main stream will be returned to the Colorado River, the controlling figures in determining the amounts of water involved for each State are the "consumptive uses" as that term is defined in the Decree—diversions from the main stream minus return flows available for other consumptive use in the United States or in satisfaction of the Mexican Treaty obligation.

These consumptive uses have been estimated by the Department for planning purposes to be 4 acre-feet per acre for the acreages specified in the Decree. This is a reasonable, rounded figure. On this basis, consumptive uses for the Arizona reservations upon full development are as follows:

Arizona	Acres	Annual consumptive use (acre-feet)
Cocopah Indian Reservation	431	1,724
Colorado River Indian Reservation	99,375	397,500
Fort Mohave Indian Reservation	14,916	59,664
Total	114,722	458,888

The consumptive uses for the Indian lands in California and Nevada, under full development using the same assumption of 4 acre-feet per acre of annual consumptive use, are as follows:

	Acres	Annual consumptive use (acre-feet)
California:		
Yuma Indian Reservation	7,743	30,972
Fort Mohave Indian Reservation	2,119	8,476
Chemehuevi Indian Reservation	1,900	7,600
Colorado River Indian Reservation	8,213	32,852
Total	19,975	79,900
Nevada: Fort Mohave Indian Reservation	1,939	7,756

In summary, of the 905,496 acre-feet of water diversion decreed by the Supreme Court to the various Indian reservations along the Lower Colorado River, a total of about 547,000 acre-feet will be used consumptively under full development of Indian lands, leaving about 358,000 to be returned to the river.

POTENTIAL PUMPED STORAGE HYDROELECTRIC PLANTS

In the course of the reanalysis of the Central Arizona Project, which was performed in late 1966, and other reconnaissance grade investigations, the Bureau of Reclamation has made preliminary examinations of a number of potential pumped storage, hydroelectric plants in Arizona. The plan which appeared most favorable, based upon available data, was the Mohave Pumped Storage plan which is located in Arizona adjacent to Lake Mohave about 21 river miles downstream from Hoover Dam. Lake Mohave would serve as the lower reservoir, and the upper reservoir would be constructed on a high bench called Malpais Mesa.

The Mohave generating facilities could be constructed to a capacity of 5,100 megawatts or more. This would be an offstream plant and would generate no energy exclusive of the pumped storage returns. It, therefore, would provide capacity only for reserves and peaking power.

The capital cost of the pumped storage facilities would be about $664,000,000. Consolidated with a Lower Colorado River Basin Development Fund, and with capacity sold at the rate of $7 per kilowatt per year, the 5,100-megawatt plant could contribute about $100 million by year 2025 and $750 million by year 2047 to the Development Fund.

Other favorable pump storage sites in Arizona identified by the Bureau include the Buckskin-Mesa site on the Bill Williams arm of Lake Havasu, the White Tanks Mountain site adjacent to the Granite Reef Aqueduct in Central Arizona, the Montezuma site southwest of Phoenix, and the Horse Mesa pump storage site adjacent to the Salt River Canyon some 40 miles east of Phoenix, Arizona.

As additional large, efficient, thermal-electric powerplants are added to the power systems of the Pacific Southwest, the need for additional efficient, quick-starting peaking power capacity to meet hourly and daily peak loads will become critical. Pumped storage plans such as the Mohave plan would provide an attractive source of peaking power. If such installations were integrated with the Lower Colorado River Basin Development Fund, the surplus revenues from power sales would improve the financial feasibility of augmentation proposals.

OPERATION OF THE RIVER UNDER SECTION 602, H.R. 3300

The Secretary of the Interior now has the authority to operate the lower Colorado River from Lake Mead downstream and deliver water from the river system to various users under contract with the United States. In the Upper Basin the Secretary is charged with operating and maintaining the Colorado River Storage Project in compliance wtih the Colorado River and Upper Colorado River Basin Compacts. Section 602 of H.R. 3300 and Section 11 of S. 1004 as passed by the Senate establish certain criteria for the operation of reservoirs in both the Upper and Lower Basins.

We believe the language in both instances is generally clear and specific, and we anticipate no great problems in providing criteria to supplement their provisions. In this respect, I refer you to the detailed statement by the Bureau of Reclamation on this subject beginning on page 1358 of the printed record of the hearings in May of 1966 before this subcommittee on H.R. 4671 and similar bills. The criteria which will require the most careful consideration involve the language of Section 602(a)(3) of H.R. 3300 and Section 11(a)(3) of S. 1004, which provides for the storage of water in the Upper Basin to the extent the Secretary shall find to be reasonably necessary to assure deliveries to the Lower Basin without impairment of annual consumptive uses in the Upper Basin pursuant to the Colorado River Compact. The words "reasonably necessary" imply that this is a matter of judgment to be exercised by the Secretary after consultation with the Basin States. Since the Secretary will be involved in and responsible for major developments in both basins, it is our view that the establishment of operating criteria for this purpose will involve extensive consultation and review by all the Basin States to achieve criteria which will adequately protect the interests of both basins and the United States. We believe a reasonable consensus can be achieved in this regard.

We note that both Section 602 of H.R. 3300 and Section 11 of S. 1004 leave open the question of whether the Upper Basin is obligated to meet a portion of any Mexican Treaty deficiency. If and when this becomes an issue affecting the actual operation of the river system, it will, of course, have to be resolved either by agreement or by litigation.

This concludes my prepared statement, which I hope adequately responds to the Chairman's request for information. We will be happy to answer any questions you may have.

Mr. JOHNSON. We want to thank you for being here, Mr. Secretary, and giving us the benefit of your answers to the questions that were raised in the letter of December 29 from the chairman of the full committee.

The chairman of the full committee, Mr. Aspinall, is now recognized.

Mr. ASPINALL. Mr. Chairman, the San Rafael conference report will not be on the floor this afternoon. In consultation with the gentleman from Pennsylvania, Mr. Saylor, we carried it over until next week. Accordingly, we shall try to get permission to sit during debate this afternoon.

Mr. Chairman, I wish to preface my remarks by stating that no one wishes the authorization, construction, and operation of a feasible Colorado River project, including the central Arizona project, any more than the chairman of the full committee, the gentleman from Colorado now speaking. I have lived with this legislation and problems attendant upon it ever since January of 1949. That was the first

month that I was in the Congress. As I question the Secretary and those with him today, I have no intention at all of being argumentative and I shall simply try to write the record so that, when we go to write up this bill, we will have before us different thinking that has to do with the proposed project. The letter to the Secretary was written for the sole purpose of getting the additional information that seemed to me to be necessary after the other body had passed the central Arizona project as such in the form of S. 1004 and because of the additional problems that have arisen since last year.

Mr. Secretary, first I want you to know and those associated with you that I consider your statement this morning to be fully responsive to my letter of December 29. I am particularly pleased that you brought into the discussion this matter of the additional problem that has to do with the Indian reservation. I do, however, have some questions, of course, to clarify the record with respect to the information furnished.

I have already asked of the chairman that the letter be placed in the record.

Mr. Secretary, before asking the questions I have which are directly related to your statement, I have a few general questions which I think are appropriate.

First, Mr. Secretary, do you now support the principles of H.R. 3300?

Secretary UDALL. My answer to your question, Mr. Chairman, is that we support in principle those aspects which are consistent with our report to the committee.

Mr. ASPINALL. What is your present position as it relates to the Senate-passed bill, S. 1004?

Do you support also that bill in its entirety?

Secretary UDALL. Yes. The difficulty is that I do not want to commit myself to every detail, but in principle and with regard to its main provisions, the answer is "Yes," Mr. Chairman.

Mr. ASPINALL. Mr. Secretary, I would like to show the timing of the change of the Department's position with respect to the construction of dams on the Colorado River. I know that you appeared before the committee of the other body in connection with its consideration of a Southwest water plan in support of both dams on the river. When was that?

Secretary UDALL. It was either 1964 or 1965. I think it was the 89th Congress.

Mr. ASPINALL. In the 89th Congress, you appeared before us with a recommendation of only one dam; is that correct?

Secretary UDALL. That is correct.

Mr. ASPINALL. Do you have the date of that appearance before this committee?

Secretary UDALL. August of 1965, I believe, Mr. Chairman.

Mr. ASPINALL. Last year in the 90th Congress, you appeared with a recommendation that there be no dams built at all.

Do you have the date of the adoption of this position by your Department?

Secretary UDALL. This was in mid-March last year.

Mr. ASPINALL. The reason that I ask this, of course, is that I want the record to be perfectly clear that the position of supporting dams on the Colorado River came from the Department. It did not come from any individual of this committee. We accepted the Department's position and tried to further legislation in that respect. It makes no difference to me personally whether or not there are any dams on this river. This is in territory outside of my own personal jurisdiction, or, for that matter, outside of any area where I have any responsibility as far as the Colorado River is concerned.

But there have been a lot of inferences, a lot of things said about dams on the Colorado River and in the Grand Canyon. This was not a matter that was suggested by the members of this committee and it was not suggested by any particular individual of this committee. Some individuals of this committee took umbrage at the fact that these dams were suggested. They had a right to do so. Now, it is clear that there are no dams to be built on the river as far as the present position of the Department and the Administration, as I understand—that is correct, is it not, Mr. Secretary?

Secretary UDALL. Yes; our position has evolved and I think we have to take the responsibility you have suggested.

Mr. ASPINALL. And the position at the present time of the administration is that there will be no dams built?

Secretary UDALL. That is correct.

Mr. ASPINALL. That is all there is to it, as far as that is concerned.

Now, turning for a moment to your proposal for prepurchase of the thermal generating capacity, which is the first matter covered in your statement, there are several points I would like to have clarified.

First, Mr. Secretary, as I understand your proposal, the Federal Government would not actually own a part of the proposed large thermal generating plant but would only aquire the right to the power and energy from a portion of the plant. As I understand it, this proposal was made only after preliminary negotiations with non-Federal interests. I believe you said the WEST planning group; is that correct?

Secretary UDALL. That is correct.

Mr. ASPINALL. Can you advise the committee as to the present status of these negotiations?

Secretary UDALL. Mr. Chairman, we had extensive negotiations about a year ago, prior to our first hearing. We have, of course, touched all of our bases since then. This project is needed in the region. I think it will move forward on schedule—in other words, it will be one of the early projects, large thermal projects to be built. The main entities that are interested include such private power companies as Southern California Edison and the Arizona Public Service Co., and such public power companies as Salt River project. They maintain the position they did previously, that they would construct and own the plant. You are quite right, we do not propose to own any part of the plant.

Mr. ASPINALL. And you have included all non-Federal entities that are involved in your negotiations so far?

Secretary UDALL. That is correct.

Mr. ASPINALL. Have the negotiations included the matter of marketing the excess energy from the Federal capacity; that is, energy which will not be needed for project pumping?

Secretary UDALL. Yes; we have discussed this problem. As I have indicated in the statement, there are two things that we can do. One is this banking arrangement that we think will enable us to preserve our rights to a high degree and to have a flexible arrangement with our partners in this endeavor. With regard to surpluses, the Salt River project, in all likelihood, I am told, will be the operating agent for the plant. That is the way the WEST group operates. One agency is the operator for the group and, in this instance, it could and would use such surpluses as might exist and would agree to do so.

Mr. ASPINALL. In other words, you have answered my next question, which has to do with the disposition of this energy, which would be to the Salt River organization?

Secretary UDALL. That is what we presently contemplate, Mr. Chairman.

Mr. ASPINALL. Would it be on a preference basis?

Secretary UDALL. No; it would be on the basis that the agency which actually constructs and operates the plant, financed in the manner that we have indicated, would, we think, be the logical agency to take care of whatever surpluses there might be, if any. We do not anticipate any large surpluses, as we have indicated.

Mr. ASPINALL. Now, would you explain to some members of this committee who do not know what you meant by the term "the banking operation"?

Some members of this committee, in my mind, do not understand that term as used here.

Secretary UDALL. The banking arrangement, with which the chairman of the subcommittee is most familiar because his own fertile mind has helped devise it for the Central Valley of California, would mean that in those years, particularly the early years, when our power needs would fluctuate and are not even, we would let others use our power when in surplus. That would give us a banking account credit from which we could draw back power in the years when we needed it. This arrangement is very familiar to the electric power industry. It works very well, and it is very practical.

Mr. ASPINALL. I yield to my friend from California now for the purpose of any question he has relative to this particular matter.

Mr. HOSMER. It is as to the economics of banking, rather than attempting to sell the power at a time when it is in excess of project needs. As I understand it, your prepayment into the powerplant comes from money that the Government borrows.

Would it not be better to get revenues for these kilowatts at an earlier stage so that some of this money can be paid back and interest reduced rather than banking the power?

Secretary UDALL. I would think, Congressman, since you bank both ways, you see, there will be some years where we use more power than others, and this is really a kind of way of evening out the peaks and valleys.

Mr. HOSMER. Was your estimate, then, that the surpluses of power might probably occur in the earlier years of the project than in the later years?

Secretary UDALL. It would be the other way around, we think. It would depend on water availability.

I think it is much better and involves much less controversy if we use the banking approach, rather than selling power in the low years and buying it in the high years.

Mr. HOSMER. Are you satisfied from the economic standpoint that this would be more advantageous to the Goverment—that is, banking—than selling and rebuying?

Secretary UDALL. I think we can say that it is our view that it very definitely would be more advantageous.

Mr. HOSMER. Thank you.

Mr. ASPINALL. The present understanding is that there would be both banking arrangements and the selling of surplus energy?

Secretary UDALL. That is correct.

Mr. ASPINALL. Mr. Secretary, before I ask this next question, please accept my own personal opinion.

At the present time, I happen to be one of those who believe that the Bureau of Reclamation should be given some general, perhaps limited, power for the operation of thermal electric plants. Now, I just ask you this question:

I preface it by saying that I have been somewhat bothered by the proposal for prepurchase of the capacity because it looks like a back-door approach to getting the Bureau into the business of constructing and operating thermal electric generating plants.

Would you say this might be the first step in that direction?

Secretary UDALL. I don't see it that way at all, Mr. Chairman. You used the word "constructing." We don't propose to construct anything. You used the word "operating." We don't propose to operate anything.

I agree there are those who hold the view the chairman expressed. However, I think our proposal to obtain central Arizona pumping power is a direct and not a back-door approach.

Mr. ASPINALL. Do you have any instances in Reclamation history which could be considered as a precedent for what you propose in this particular legislation?

Secretary UDALL. None—the commissioner says none that he knows of. The chairman may be interested in knowing where we got the idea. The chairman of the subcommittee is familiar with this. It is similar to the arrangement we worked out with the Canadian Government on the Columbia River. We borrowed the idea from there, thinking that it would be useful here.

Mr. ASPINALL. Of course, that is not Reclamation law. That is all I am trying to show at this time.

Secretary UDALL. That is correct.

Mr. ASPINALL. Mr. Secretary, it is my understanding that the cost of 3 mills per kilowatt-hour for pumping energy under this prepurchase is based upon amortizing the Federal cost on an interest-free basis. Is that correct?

Secretary UDALL. Yes, as far as irrigation is concerned. This is customary.

Mr. ASPINALL. Of course, this is an irrigation proposal as far as this project is concerned.

Secretary UDALL. That is right.

Mr. ASPINALL. Does this cost of 3 mills also take into account repayment assistance from revenues from the marketing of the excess energy?

Mr. DOMINY. To a very minor degree, Mr. Chairman.

Mr. ASPINALL. I do not understand the use of the word "minor" there. It either does or does not. The question is how much excess power there is.

Mr. DOMINY. The rates are different, of course, for the municipal water pumping and the irrigation pumping. This is primarily because interest is charged on that part of the pumping costs related to pumping the M. & I. water. We do not charge interest on those costs associated with pumping irrigation water.

Mr. ASPINALL. Mr. Chairman, if the Department and the Bureau wish to make additional responses to this question, I would like to have unanimous consent that it be placed in the record at this point.

Mr. JOHNSON. Do I hear objection?

(No response.)

Mr. JOHNSON. It is so ordered.

(The material referred to follows:)

Bureau of Reclamation studies show that the rate for irrigation pumping sales which would be required to pay operation and maintenance costs and repay without interest the cost of power facilities associated with irrigation pumping energy would be 3.14 mills/kwh. The proposed rate for irrigation pumping energy is 3 mills/kwh which results in a deficiency in meeting irrigation pumping energy costs of $8,200,000 during the 50-year payout period. This minor deficiency would be made up from M. & I. pumping and commercial energy sales which are at a rate in excess of cost.

Mr. ASPINALL. Mr. Secretary, what is the planned life of the large thermal powerplant in which the Federal Government will participate?

Secretary UDALL. A 50-year-payout basis.

Mr. ASPINALL. What is the plan for meeting the pumping energy needs beyond the life of this particular plant?

Mr. DOMINY. The thermal units, Mr. Chairman, will be replaced about every 35 years. This is characteristic of these high-temperature, high-speed units.

Mr. ASPINALL. Not necessarily in the same location, because if you run out of coal, you have to move your plant.

Mr. DOMINY. As I understand, the coal reserves are adequate.

Mr. ASPINALL. You do not have a complete geological survey on the coal, as to the amount of coal that surrounds this particular plant, do you?

Secretary UDALL. Mr. Chairman, the coal for this would come from the Black Mesa from the Navaho-Hopi Indian Reservation.

Mr. ASPINALL. Mr. Secretary, in your statement you mentioned potential pumped storage hydroelectric plants.

Did you consider this as a possible alternative to your prepurchase proposal?

Secretary UDALL. Mr. Chairman, I think I can say very flatly we do not consider them as an alternative. I think the whole region, with the WEST approach used, is going to need the type of good peaking facilities that nature apparently has provided for us there. This is not a viable alternative for pumping power because we need baseload energy for pumping, not peaking capacity.

Mr. ASPINALL. Then you suggest that it is in addition to the prepurchase plan, is that correct?

Providing it is going to be peaking?

Secretary UDALL. I think when one looks down the road beyond this project to development funds, to augmentation plans, that pump storage facilities might very well enter into the overall plan.

Mr. ASPINALL. Mr. Secretary, assuming that a large thermal power plant is built at Page, Ariz., in the vicinity thereof, in which the Federal Government shares the capacity, is it the Department's understanding that the water for this plant would come from Arizona's 50,000 acre-feet of the upper basin water?

Secretary UDALL. This is what we contemplate.

Mr. ASPINALL. If so, would you expect that such an estimate would result in any controversy or conflict with Indian water rights in Arizona?

Secretary UDALL. I know of none, Mr. Chairman. We went into this rather thoroughly with everyone involved.

Mr. ASPINALL. You do know the provisions of the decree?

Secretary UDALL. Yes.

Mr. ASPINALL. Mr. Secretary, I am interested in your statement that the Department continues to take the position that payout assistance for the central Arizona project from a development fund would not be necessary. This is correct?

Secretary UDALL. This is our firm position.

Mr. ASPINALL. As I remember, in your proposal, this assistance would be given by either increasing the municipal water rate from $50 to $56 an acre-foot or an ad valorem tax?

Secretary UDALL. This is correct.

Mr. ASPINALL. In view of the fact that this was rejected by the other body, I assume it was not well received in Arizona.

Is this a correct assumption on my part?

Secretary UDALL. Mr. Chairman, it is our understanding that the Senate legislation did not accept or reject either. When we get down to working out a repayment contract it is going to be up to the customers, the Arizona people, to decide whether they want to have a high industrial-municipal rate or whether they want to have a medium municipal rate with a small ad valorem tax or a low industrial-municipal rate and a high ad valorem tax. This can be resolved by the people in the State at the time we sit down to get repayment contracts in order.

Mr. ASPINALL. Would it be better if we provided some of the revenue from the Hoover-Davis-Parker complex to which the State of Arizona might be entitled?

Secretary UDALL. Mr. Chairman, we would have no objection to a development fund being established if that were the wisdom of the committee. I do not think this interferes at all. It might be useful. But we feel basically that the central Arizona project is a sound proposal which will carry its own weight.

Mr. ASPINALL. Mr. Secretary, your statement indicates that you take no position whatsoever with respect to establishing a development fund. Yet you have recognized the need for augmenting the flows of the Colorado River. Would you not agree that the establishment of a development fund and provision for dependable sources of revenue is the most important single factor in attaining future augmentation of the river?

Secretary UDALL. I would certainly agree with that statement, yes.

Mr. ASPINALL. I wonder, Mr. Secretary, if the committee could be furnished repayment tables regarding the development contributions set out in your statement?

Secretary UDALL. We would be very happy to do so.

Mr. ASPINALL. Mr. Chairman, I would ask unanimous consent to have that information placed in the record at this place.

Mr. JOHNSON. Is there any objection to the chairman's request?

Hearing none——

Mr. HOSMER. Reserving the right to object, may I understand that the figures requested are those figures which will come into the development fund under the present contracts or is there some other——

Mr. ASPINALL. Not under present contracts, because the present contracts will expire. These will be under new contracts that will be entered into for the sale of power involved.

Mr. HOSMER. And these tables will be broken down by source of revenue?

Mr. ASPINALL. That is right.

Mr. HOSMER. I withdraw my reservation.

Mr. JOHNSON. It is so ordered.

(The material referred to follows:)

ESTIMATED REVENUES AVAILABLE FOR LOWER COLORADO RIVER BASIN DEVELOPMENT FUND, 1991–2050 [1]

Year	Hoover [2]	Parker-Davis	Intertie	CAP [3]	Cumulative balance
1991	12,592				12,592
1992	12,592				25,184
1993	12,592				37,776
1994	12,592				50,368
1995	12,592				62,960
1996	12,592				75,552
1997	12,592				88,144
1998	12,592				100,736
1999	12,592				113,328
2000	12,592				125,920
2001	12,080				138,000
2002	12,080				150,000
2003	12,080				162,160
2004	12,080				174,240
2005	12,080	3,793			190,113
2006	12,080	3,793			205,986
2007	12,080	3,793			221,859
2008	12,080	3,793			237,732
2009	12,080	3,793			253,605
2010	12,080	3,793			269,478
2011	11,740	3,793			285,011
2012	11,740	3,793			300,544
2013	11,740	3,793			316,077
2014	11,740	3,793			331,610
2015	11,740	3,793			347,143
2016	11,740	3,704			362,587
2017	11,740	3,704			378,031
2018	11,740	3,704			393,475
2019	11,740	3,704			408,919
2020	11,740	3,704			424,363
2021	11,420	3,704			439,487
2022	11,420	3,704	5,200		459,811
2023	11,420	3,704	5,200		480,135
2024	11,420	3,704	5,200		500,459
2025	11,420	3,704	5,200		520,783
2026	11,420	3,643	5,200		541,046
2027	11,420	3,643	5,200		561,309
2028	11,420	3,643	5,200		581,572
2029	11,420	3,643	5,200		601,835
Subtotal	466,900	93,335	41,600	0	[4] 601,835
2030	11,260	3,643	5,200	18,300	640,238
2031	11,260	3,643	5,200	18,300	678,641
2032	11,260	3,643	5,200	18,300	717,044
2033	11,260	3,643	5,200	18,300	755,447
2034	11,260	3,643	5,200	18,300	793,850
2035	11,260	3,643	5,200	18,300	832,253
2036	11,260	3,624	5,200	18,300	870,637
2037	11,260	3,624	5,200	18,300	909,021
2038	11,260	3,624	5,200	18,300	947,405
2039	11,260	3,624	5,200	18,300	985,789
2040	11,260	3,624	5,200	18,300	1,024,173
2041	11,260	3,624	5,200	18,300	1,062,557
2042	11,260	3,624	5,200	18,300	1,100,941
2043	11,260	3,624	5,200	18,300	1,139,325
2044	11,260	3,624	5,290	18,300	1,177,709
2045	11,260	3,624	5,200	18,300	1,216,093
2046	11,260	3,624	5,200	18,300	1,254,477
2047	11,260	3,624	0	18,300	1,287,661
2048	11,260	3,624	0	18,300	1,320,845
2049	11,260	3,624	0	18,300	1,354,029
2050	11,260	3,624	0	18,300	1,387,213
Total	703,360	169,553	130,000	384,300	[4] 1,387,213

[1] Based on 1906–65 hydrologic record.
[2] Hoover rate assumed to be 4 mills per kilowatt-hour; $600,000 annual in lieu of taxes payments not deducted.
[3] Assumes no surplus prior to 2030; $56 per acre-foot M. & I. rate after payout.
[4] Differs slightly from figures in text of statement due to using rounded averages in original calculations.

Mr. ASPINALL. Mr. Secretary, what is the interest rate used in your financial studies of the central Arizona project?

Secretary UDALL. 3.225.

Mr. ASPINALL. What is the present interest rate under the interest formula that we have been using for the past several years relative to the acquisition of——

Mr. DOMINY. The present one, Mr. Chairman, that has been certified by the Treasury, is 3.253.

Mr. ASPINALL. Do you not think it would be better to update your studies and bring it in accordance with our present-day interest rates?

Secretary UDALL. I think it would. I am told that this is a new figure and we have not had time, apparently, to update

Mr. ASPINALL. Mr. Secretary, what is the date of the cost estimates you furnished us last year and what has been the increase in costs since those estimates were made?

Mr. DOMINY. October 1963, for the cost estimates that are in the reports we submitted to Congress. We can give you an updated figure.

Mr. ASPINALL. If you do not have it there——

Mr. DOMINY. We will provide it for the record if that is satisfactory.

Mr. ASPINALL. You give me an up-to-date record as of the last possible date of all the projects included in this testimony.

Mr. Chairman, I would ask that it be placed in the record at this point.

Mr. JOHNSON. Do I hear any objection?

Mr. HOSMER. Reserving the right to object, would that require a recomputation of the interest rate?

Mr. DOMINY. As I understand the chairman's request, he merely asks us to update the costs to the current levels.

Mr. HOSMER. I understand, however, that there is no construction contemplated before fiscal year 1970 and the completion of the project is projected for about 1979.

Would not those figures be more pertinent for our purposes than the this-year figures, Mr. Chairman?

Mr. ASPINALL. I cannot figure out 1979. I do not know whether it is going to go up or down. But I do think we ought to have up-to-date figures as far as our present thinking is concerned when we get to mark up this legislation.

Mr. HOSMER. Yes, but I say this project will commence in 1970. That bothers me about the interest rate, too, because we may be at the peak of interest rates at the present time and possibly the projected 1970 rates might be more pertinent than the ones for the current year.

If it is at all possible, I would hope that some explanation or additions to what the chairman has requested would be included to spell out these points.

Secretary UDALL. Congressman, we will give you the very latest figures that we can give you under the procedures we have always followed. We can only give you current data and we cannot project.

Mr. HOSMER. Well, you project the escalation in construction costs. I am sure that the Treasury Department must have some feeling about interest rates and so on. All I was asking is that if there is any elucidating material that might be applied to the actual construction period, it be furnished along with the figures that have been requested.

Secretary UDALL. We will do the best we can.

Mr. HOSMER. With that, I withdraw my reservation.

Mr. JOHNSON. You will furnish that to the committee?

Secretary UDALL. Yes; we will give you the best figures we can.

Mr. SAYLOR. Reserving the right to object, I would like to observe at this point that if we projected into the future and called upon the Department, I do not look for any decrease in interest rates, because anybody familiar with the 15-year formula will realize that the Government borrowed money at some of its lowest rates in 1953, 1954, and 1955 and that the increases which would occur thereafter if we expect to project this will not lower the interest rate on a 15-year average, but will increase it.

I withdraw my reservation.

Mr. HALEY. Reserving the right to object.

Mr. JOHNSON. The gentleman from Florida?

Mr. HALEY. Mr. Secretary, do you not think that in order to give a clear picture of what is involved here, we should have also included in your figures the present interest rate that the Federal Government is paying? After all, putting this over a 15-year period when interest rates were low, we know what they are today and the money you are going to have to borrow somewhere. I never quite understood where you got the figures—rather than figuring the interest on a 15-year security, you do not have the money, you borrow it today so you pay it at the present day's interest rate. I think you ought to have included in these figures, Mr. Chairman, the present interest rate we are paying today.

Secretary UDALL. We will be very happy to provide the latest current figures.

Mr. HALEY. I withdraw my reservation.

(The material referred to follows:)

CONSTRUCTION COSTS FOR POTENTIAL COLORADO PROJECTS INDEXED TO 1967 PRICE LEVELS

[In thousands of dollars]

Project	Construction cost	
	Feasibility report estimate	Indexed to 1967 price levels
Lower basin: Central Arizona project	719,217	779,050
Upper basin:		
Animas-La Plata	109,493	115,880
Dolores	46,643	53,850
San Miguel	67,815	73,140
West Divide	99,800	106,580
Dallas Creek	37,687	42,310

Based on the formula contained in the Water Supply Act of 1958, interest rates for the last five years are as follows:

	Interest rate
1964	3.046
1965	3.137
1966	3.222
1967	3.225
1968	3.253

Such rates have no effect on construction costs but have been used in demonstrating the financial feasibility of recent project proposals. We are unaware of any data that would permit the projection of such rates into the future.

Mr. JOHNSON. The gentleman from Colorado.

Mr. ASPINALL. Now, Mr. Secretary, we come to the hydrologic picture, the matter of water supply for the central Arizona project. That is what your estimate is based upon as far as that is concerned.

As I indicated to you in my letter, members of the committee have been confused by the different figures given them with respect to water supply. As you point out in your statement, these differences come about because of the differences in the three broad judgment assumptions that must be made—the magnitude of the runoff, the schedule of upper basin development, and the water losses along the river.

I think it is important that this record explain the differences in assumptions that make a difference in the central Arizona project water supply so that the members may judge for themselves which assumptions are more appropriate for use in planning additional development in the basin, the Bureau of Reclamation study or the Tipton study, and we have other studies.

As you know, Mr. Secretary, this committee for the past 20 years, since the gentleman from Pennsylvania and I have been members of the committee, has always insisted upon the demonstration of economic and fiscal feasibility for all projects we have approved. This committee has never approved a project where there was a serious question concerning availability of water. If this legislation is to be approved—and I hope it is—and taken to the floor, our most important single requirement is to have a full disclosure of the water supply situation so that our actions may be taken with all the facts in front of us. I am sure that you agree with me.

Secretary UDALL. I could not agree more, Mr. Chairman, with that statement.

Mr. ASPINALL. The use of water from the Colorado River system is governed by an international treaty, by the interstate compacts, by numerous judicial decisions, operating criteria, and agreements. The restrictive legal requirements and severe hydrologic limitations make it imperative that either the use of water be kept within the capability of the river's supply or that proposals for additional development be accompanied by immediate steps to augment the water supply.

Do you agree with this?

Secretary UDALL. I think that is also a fair statement.

Mr. ASPINALL. Before asking several questions with respect to the three assumptions in your statement, I would like to ask two in order to refresh the committee's recollection with respect to the central Arizona water supply.

First, what annual average amount of water is necessary to make the central Arizona project a success during its 50-year repayment period?

Mr. DOMINY. As we have testified previously, Mr. Chairman——

Mr. ASPINALL. I just want the amount.

Mr. DOMINY. It can go down to a very low figure in later years of the payout period when most of it would be used for municipal and industrial purposes. The critical requirement is to not reduce delivery at Lee Ferry below 8¼ million acre-feet per year on the average.

Mr. ASPINALL. Of course, Mr. Dominy, you are not going to get any members of this committee or the Congress by stating you are going to keep from the people of Arizona the amount of water that is necessary and that it is necessary for them to use. That is all I am asking as far as

this particular project is concerned. If you have a table there that you want to put into the record, we will put the table in. I do not want to argue with you. I just want the information in the record.

Secretary UDALL. Mr. Chairman, I think we should submit the information for the record at this point. I think your question is very precise and we will give you as precise an answer as we can.

Mr. ASPINALL. Mr. Chairman, I ask that this information be made a part of the record when it is received and I hope it will be received very soon.

Mr. JOHNSON. Is there objection?

Mr. HOSMER. Reserving the right to object, will that table include case A, B, C, D, and so forth?

Secretary UDALL. Yes, if necessary.

Mr. HOSMER. Depending upon what the changing assumed ratios of M. & I. and agriculture are?

Secretary UDALL. I think we should make it as complete as possible, anticipating the questions that have been foreshadowed here.

Mr. HOSMER. I withdraw my reservation.

Mr. BURTON of Utah. Reserving the right to object, we will not object, but I wonder if the Secretary can give us an indication when we might have this?

Hopefully, we are going to mark this bill up and do something with it this week.

Mr. ASPINALL. Let us refrain from setting any dates. The chairman will take that up later.

Mr. BURTON of Utah. I said "hopefully," Mr. Chairman. But I would like before we advance into the final stages, to have this information available to the committee.

Mr. ASPINALL. That is the reason I asked for it as soon as possible.

Secretary UDALL. If I may respond, our purpose is not to delay the committee in its deliberations in the slightest. We will give this a very high priority.

Mr. BURTON of Utah. I withdraw my reservation.

Mr. JOHNSON. Any other reservations?

You will get that information up so we may have it as soon as possible.

Secretary UDALL. Very shortly.

(The material referred to follows:)

The minimum average annual amount of water necessary to the economic and financial feasibility of the Central Arizona Project is about 450,000 acre-feet. This is the amount of water that would be available based on Colorado River runoff for the 46-year period 1922–1967, based on Mr. Tipton's projection of Upper Basin depletions, and assuming that the Upper Basin would contribute 750,000 acre-feet toward meeting Mexican water deliveries. The average water supply by years would be:

Year:	*Acre-feet (1,000)*
1979	1,105
1990	500
2000	360
2030	284
Average 50-year period	450

A minimum delivery of 8,250,000 acre-feet- annually at Lee Ferry is essential to the feasibility of CAP under the assumption of a 4.4 million acre-foot priority for California.

With the above water supply, the benefit-cost ratio for CAP, based on 100 years and total benefits, would be 1.3 to 1.0. A rate of $63 per acre-foot for M&I water would be necessary without financial assistance from the Development Fund. With financial assistance from the Development Fund limited to Arizona's share, the M&I rate required would be $57 per acre-foot.

Mr. ASPINALL. What average annual amount of water, Mr. Secretary, is necessary from the main stream for all lower basin uses in order to make the central Arizona project a success?

Secretary UDALL. Let us include this in the record rather than try to answer it at this time. We can give you the figure.

Mr. ASPINALL. I would ask unanimous consent to insert it here.

Mr. JOHNSON. It is so ordered.

(The material referred to follows:)

The average annual amount of water and the minimum annual amount of water needed from the main stream for all Lower Basin uses in order to make the Central Arizona Project feasible are both of the same general order of magnitude. At least 8,250,000 acre-feet annualy are required. This amount would serve the following requirements:

Use	*Amount*
Delivery to Mexico	1,500,000
California	4,400,000
Nevada	246,000
Arizona main stem	1,230,000
Central Arizona project	[1] 284,000
Net losses below Hoover Dam	590,000
Total	8,250,000

[1] This plus 50,000 acre-feet of other project water supply developed by CAP would be a firm supply to meet the revenue-producing M. & I. sales.

Inasmuch as net inflow between Lee Ferry and Lake Mead just about equals evaportion from Lake Mead, this means that the minimum regulated flow at Lee Ferry would need to be 8,250,000 acre-feet. With average runoff, the regulated flow at Lee Ferry will exceed 8,250,000 acre-feet for a number of years, at least into the 1980's. Thus, the average Lower Basin water supply would exceed the minimum required by a small amount due to early years of excess.

Mr. ASPINALL. Mr. Secretary, in your statement, you discussed first the matter of virgin runoff, pointing out that your estimates are based on the longest period of runoff on record which you have identified as the period starting in 1906 and continuing through today.

You show the average virgin runoff at Lee Ferry for this period as 14,965,000 acre-feet.

At the same time, you point out that the average virgin flow for the period since the signing of the Colorado River Compact in 1922 to the present time has been only 13,750,000 acre-feet. These figures themselves indicate the period 1906 to 1922 was a period of very high runoff.

Since the assumption you have made to include this period in your operations study is critical to the water supply of the central Arizona project, as I shall bring out later, I believe we need to examine further the Department's decision to include it.

Your statement supports the conclusion only by saying that you normally use the longest period of runoff for which you have records.

As I understand it, your records between 1906 and 1922 are based upon the stations on the San Juan River at Bluff and, on the Green River at Green River, Utah, and on the Colorado someplace around Cisco. Is this correct?

Mr. DOMINY. We have had measurements at Yuma on the lower river since 1903. We have had measurements at the points you mentioned on the upper river since 1906, although they are not continuous at all stations.

Mr. ASPINALL. You also had measurements on the river, did you not, Mr. Dominy, from 1896 to 1906?

Mr. DOMINY. Yes, at various places, but not complete enough, in our judgment, to——

Mr. ASPINALL. The 1906–67 period is not a conservative one. An earlier starting continuous period of greater average flow than the period starting in 1906 and including all following years' record is not to be found. Estimates are available by correlation that would have given an average of 14.8 million acre-feet for the longer 1896–1967 period, which, of course, is less than the average for 1906–67.

The water records for stations upstream from Lee Ferry are not continuous records. Several have been, themselves, derived partially by correlation estimates. For example: U.S. Geological Survey records for the San Juan River near Bluff, Utah, are for years 1915–18 and for 1927–67, and for the Colorado River near Cisco, Utah, only for years 1912–18 and 1923–67. The periods of missing records have been filled by estimates derived from statistical processes. Those partially synthesized records have again been used as sources of data in estimating part of the record of virgin flow at Lee Ferry.

But all of this water, as far as the supply of the river between 1896 and 1922, is based upon the correlated projection that you have made, is it not?

Mr. DOMINY. That is correct in relation to estimates of virgin runoff at Lee Ferry.

Mr. ASPINALL. Do you feel, Mr. Secretary, that the records you have for these early years are dependable?

Secretary UDALL. I think it obvious from the discussion here, that we feel the figures from 1906 are quite reliable, highly reliable. We have some figures for earlier years which we do not think are sufficiently reliable to use. I think that is a good way to put it.

Mr. ASPINALL. Are they as dependable as the records that you have since 1922?

Secretary UDALL. I think we would have to say that they are not.

Mr. ASPINALL. Are they as dependable—is either one of these three—1896 to 1906, 1906 to 1922, 1922 to 1929—are these records as dependable as the records you have since 1929?

Mr. DOMINY. I would like to say this, Mr. Chairman, that since we have definite recordings at Lee Ferry since 1922 and we have been able to go back and collate the old records back to 1906 as compared to the actual records since 1922 at the lower and upper stations, we have enough reliability in the figures from 1906 to 1922 to justify their inclusion in this long-term hydrologic record.

Mr. ASPINALL. According to the Department's 1947 report, "the Colorado River"—and I am placing this in not for argumentative purposes, but just to make a record—I quote from that report:

> For the years 1902 to 1921, inclusive, the estimate (Lee Ferry) considered both tributary flows and flows of downstream gauging stations with due allowance for both measured and unmeasured gains and losses between Lee Ferry and the point of measurement. When basing the estimate on the Yuma records, allowances were made for the flow of the Gila River at its mouth for diversion by the Yuma Project.

That was in 1947.

As far as your memory is concerned, Mr. Dominy, that was the position of the Bureau at that time, was it not?

Mr. DOMINY. Yes, sir.

Mr. ASPINALL. All I am trying to do is get the record. You see, what bothers some of us on the committee, Mr. Secretary, and the members of the committee staff, is that when we begin to talk about a project authorization we also have the best information possible in favor of the project. I want this project to be a success. I want it to serve the area and not disturb other users on the Colorado River in the future. As far as I am concerned, I just want to be sure we know what we are doing.

Mr. Secretary, can you imagine spilling an average of more than a million acre-feet of water annually from a completely full Lake Powell, water which, as I understand your operation study, the upper basin would not get credit for? That in fact is what the summary of your operation study shows, is it not?

This is the guts of this whole matter and I want a straightforward answer. If you want to have permission to change your answer or modify it before the final record is printed, this will be all right with me.

Secretary UDALL. Mr. Chairman, this issue is so important, I would like Mr. Riter, who is one of our specialists, to answer the question. I also would like to put in an explicit and exact answer to this question so that as far as the Department is concerned, there is nothing left uncertain.

Mr. ASPINALL. I would ask unanimous consent that the Secretary's request be granted.

I would also like to hear from Mr. Randy Riter. On the other hand, I want to hear from the Department.

Mr. JOHNSON. Is there objection?

Mr. HOSMER. Reserving the right to object, would the Chairman restate the question so we have it firmly in mind?

Mr. ASPINALL. The question is as follows:

Can you imagine spilling an average of more than a million acre-feet of water annually from a completely full Lake Powell, water which, as I understand the operation study, the upper basin would not get credit for?

In other words, they base the future of the central Arizona project now proposed on the spillage of a million acre-feet of water from Lake Powell starting sometime in the future and continuing annually thereafter. I wanted the answer and we will get it completely as far as that is concerned, with the promise of the Secretary and now from Mr. Riter.

Mr. HOSMER. I withdraw my reservation.

Mr. JOHNSON. The reservation is withdrawn.

Are you ready to testify, Mr. Riter?

Mr. RITER. Yes.

I am quoting from page 236 of the hearings before this subcommittee, dated from August 23 to September 1, 1965. This shows the following average annual spills which are averages for a 60-year period of study.

Mr. ASPINALL. Whose projections are these?

Mr. RITER. These are projections of the Bureau of Reclamation.

Mr. ASPINALL. I just wanted this committee to know that.

Mr. RITER. The table on page 236 of the 1965 hearings shows that the spills from Lake Mead as of year 1975 average 653,000 acre-feet, for the year 1990, the spills from Lake Mead average 269,000 acre-feet per year, for the year 2000, the spills from Lake Mead are shown to be 148,000 acre-feet per year, and for the year 2030, these spills are listed as averaging 158,000 acre-feet per year. These all reflect average conditions.

I would like also to qualify them to this extent: these computations assumed a 60-year runoff cycle—1906 through 1965, inclusive. In each one of these studies, we repeated this hydrologic cycle for the projected level of development of the year involved.

If you examine the details year by year, you will find a good many years when there was no spill. Values shown are averages for a 60-year period.

Mr. ASPINALL. Mr. Chairman, I would ask unanimous consent that complete operation studies be placed in the record at this place.

Mr. BURTON of Utah. May I reserve the right to object, please?

Mr. JOHNSON. The gentleman from Utah.

Mr. BURTON of Utah. The spillage Mr. Riter has told us about is over a 60-year period and embraces a period when by and large, the upper basin projects were not operative.

Is this correct?

Mr. ASPINALL. This is correct.

Mr. BURTON of Utah. So the million acre-feet that is being spilled on a yearly basis would largely be upper basin water.

Is that not a correct assumption?

Mr. ASPINALL. I think this is correct. On the other hand, they will furnish the information for us to take up in committee.

Mr. BURTON of Utah. I just wanted to have that clear in my mind, Mr. Chairman.

Mr. ASPINALL. I think the gentleman is correct.

Mr. BURTON of Utah. I withdraw my reservation.

Mr. HOSMER. Further reserving the right to object, the Secretary introduced a factor of 24- and 48-year historic dry cycle on the river and the historic average of a 24-year wet cycle. If you take the mean 24- and 48-year historic dry cycle at 36 years plus 24 years wet cycle, that gives you a 60-year full cycle. As this averaging has been done on a 60-year cycle, does this take cognizance of these wet and dry cycles in the sense that there might be a better time to start the cycle as an independent calculation, assuming that we are now at some point in the cycle, and work out the years ahead on that basis, rather than just averaging out as you have done?

Secretary UDALL. Congressman, that is an interesting question. The reason we included the tree-ring studies, which I think are considered scientifically sound, is to show what the real long-term trend has been.

The interesting thing about this 60-year period is we have had both an unusually extended dry cycle and a major wet cycle embraced within it.

Now, this does not mean necessarily that we are going into a major wet cycle. We might go into a minor wet cycle, or a minor dry cycle.

Mr. ASPINALL. What I am trying to get at is that there are alternative ways of using this information that could give us comparative figures for different assumptions.

Would that be of any value in trying to estimate this water supply over the particular period of time rather than an arbitrary 60 years that starts some place and ends some place depending on who happened to start keeping records at the particular time in 1922?

Secretary UDALL. You can use any assumptions you want. If one wants to be optimistic, he can use certain assumptions or if he wants to be pessimistic, he can use others. But we have tried in our calculations to stick to the knowns as much as possible in terms of the calculations that we have made.

Mr. ASPINALL. That give you the most optimistic figure possible?

Secretary UDALL. No, I do not think it does. Since we are in the end of a long and severe dry cycle.

Mr. ASPINALL. There is no way to average it any higher than 14.96.

Mr. DOMINY. If you use the whole period of record, that is it. But some people are arguing that we should use records only since 1922 and throw out the period 1906 to 1922, which was the period of high runoff. If you are going to argue that way, why not leave out the last 5 or 6 years that have been a period of low runoff?

Yet we have added in these last years to be consistent. We believe the longest period of major record is the right period to use in projections of stream flow runoff.

Mr. ASPINALL. If it does in fact coincide with these long-range wet and dry cycles.

Mr. HOSMER. I withdraw my reservation.

Mr. JOHNSON. Any further reservations?

(No response.)

Mr. JOHNSON. If not, Mr. Secretary, you will get that to the committee also?

Secretary UDALL. Yes.

(The material referred to follows:)

SUMMARY OF OPERATIONS—LAKE POWELL

1975 CONDITIONS

[Unit—1,000 acre-feet]

Water-year	Inflow		Evaporation	Power releases		Spill	Reservoir content end of year [1]	Water surface elevation end of year (feet)
	Unregulated	Regulated by upstream reservoir		Scheduled	Other			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1906	15,093	14,672	422	9,550	0	0	18,976	3,631
1907	18,837	17,625	547	9,550	0	0	26,504	3,682
1908	9,553	9,557	607	9,550	0	0	25,904	3,678
1909	18,851	18,027	641	9,550	3,178	1,415	29,147	3,698
1910	10,793	10,710	668	9,550	492	0	29,147	3,698
1911	12,362	12,438	670	9,550	1,774	444	29,147	3,698
1912	16,316	15,956	673	9,550	3,178	2,555	29,147	3,698
1913	10,985	10,872	669	9,550	653	0	29,147	3,698
1914	16,952	16,795	674	9,550	3,178	3,393	29,147	3,698
1915	10,582	10,859	668	9,550	641	0	29,147	3,698
1916	15,136	14,598	672	9,550	3,178	1,198	29,147	3,698
1917	19,414	19,292	676	9,550	3,178	5,888	29,147	3,698
1918	11,764	11,606	669	9,550	1,110	277	29,147	3,698
1919	9,233	9,841	662	9,550	0	0	28,776	3,695
1920	17,584	17,169	675	9,550	3,178	3,395	29,147	3,698
1921	18,547	17,989	675	9,550	3,178	4,586	29,147	3,698
1922	14,362	14,261	672	9,550	3,178	861	29,147	3,698
1923	14,328	14,157	672	9,550	3,148	787	29,147	3,698
1924	10,752	10,696	668	9,550	478	0	29,147	3,693
1925	9,722	9,555	660	9,550	0	0	28,492	3,698
1926	12,182	12,320	668	9,550	1,158	289	29,147	3,698
1927	14,614	14,174	672	9,550	3,162	790	29,147	3,698
1928	13,486	13,384	671	9,550	2,530	633	29,147	3,698
1929	17,115	17,080	674	9,550	3,178	3,678	29,147	3,698
1930	11,377	11,137	669	9,550	918	0	29,147	3,698
1931	5,070	6,031	614	9,550	0	0	25,014	3,672
1932	13,428	13,163	618	9,550	0	0	28,009	3,691
1933	8,236	8,573	626	9,550	0	0	26,406	3,682
1934	3,183	4,226	549	9,550	0	0	20,533	3,642
1935	8,429	8,603	478	9,550	0	0	19,108	3,631
1936	10,375	9,710	462	9,550	0	0	18,806	3,630
1937	10,323	10,146	460	9,550	0	0	18,942	3,630
1938	13,702	13,221	500	9,550	0	0	22,113	3,653
1939	7,971	8,005	504	9,550	0	0	20,064	3,638
1940	5,784	6,567	448	9,550	0	0	16,633	3,612
1941	14,234	13,921	459	9,550	0	0	20,545	3,642
1942	15,080	14,779	547	9,550	0	0	25,227	3,673
1943	9,763	9,200	580	9,550	0	0	24,297	3,669
1944	11,606	11,216	584	9,550	0	0	25,379	3,675
1945	10,044	10,074	593	9,550	0	0	25,310	3,674
1946	7,403	7,180	560	9,550	0	0	22,380	3,656
1947	11,877	10,970	543	9,550	0	0	23,257	3,662
1948	11,994	11,922	568	9,550	0	0	25,061	3,672
1949	12,687	12,678	612	9,550	0	0	27,577	3,688
1950	9,599	8,577	618	9,550	0	0	25,986	3,678
1951	8,633	8,476	585	9,550	0	0	24,327	3,669
1952	16,442	16,299	624	9,550	1,044	261	29,147	3,698
1953	7,618	7,825	641	9,550	0	0	26,781	3,684
1954	4,958	5,445	568	9,550	0	0	22,108	3,653
1955	6,314	6,899	489	9,550	0	0	18,968	3,631
1956	7,705	7,343	431	9,550	0	0	16,330	3,610
1957	15,954	15,123	463	9,550	0	0	21,440	3,648
1958	12,743	12,858	542	9,550	0	0	24,206	3,668
1959	5,810	6,161	524	9,550	0	0	20,293	3,640
1960	8,153	8,744	471	9,550	0	0	19,016	3,630
1961	5,670	6,727	427	9,550	0	0	15,766	3,606
1962	13,508	13,041	432	9,550	0	0	18,825	3,630
1963	5,625	6,447	423	9,550	0	0	15,299	3,602
1964	7,169	7,450	360	9,550	0	0	12,839	3,578
1965	13,500	11,333	346	9,550	0	0	14,276	3,593
Total:								
1953–64	101,227	104,063	5,771	114,600	0	0	−16,308	----------
1931–64	327,090	327,600	17,903	324,700	1,044	261	−16,308	----------
1906–65	690,530	683,703	34,543	573,000	45,710	30,450	0	----------
Average:								
1953–64	8,435	8,672	481	9,550	0	0	−1,359	----------
1931–64	9,621	9,634	526	9,550	31	7	−480	----------
1906–65	11,509	11,395	576	9,550	762	507	0	----------

SUMMARY OF OPERATIONS—LAKE POWELL

1990 CONDITIONS

[Unit—1,000 acre-feet]

Water-year	Inflow		Evaporation	Power releases		Spill	Reservoir content end of year [1]	Water surface elevation end of year (feet)
	Unregulated	Regulated by upstream reservoir		Scheduled	Other			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1906	14,108	13,266	419	8,750	0	0	17,380	3,628
1907	17,714	16,607	537	8,750	0	0	24,700	3,682
1908	8,730	8,810	609	8,750	0	0	24,151	3,678
1909	17,765	16,654	641	8,750	3,056	764	27,594	3,698
1910	9,942	9,907	674	8,750	483	0	27,594	3,698
1911	11,455	11,604	674	8,750	1,744	436	27,594	3,698
1912	15,277	14,836	674	8,750	3,553	1,859	27,594	3,698
1913	10,120	9,969	674	8,750	545	0	27,594	3,698
1914	15,894	15,737	674	8,750	3,553	2,760	27,594	3,698
1915	9,731	10,078	674	8,750	654	0	27,594	3,698
1916	14,130	13,522	674	8,750	3,278	820	27,594	3,698
1917	18,266	18,144	674	8,750	3,553	5,167	27,594	3,698
1918	10,876	10,718	674	8,750	1,035	259	27,594	3,698
1919	8,429	9,098	670	8,750	0	0	27,272	3,696
1920	16,502	16,172	670	8,750	3,553	2,877	27,594	3,698
1921	17,431	16,728	674	8,750	3,553	3,751	27,594	3,698
1922	13,380	13,279	674	8,750	3,084	771	27,594	3,698
1923	13,346	13,175	674	8,750	3,001	750	27,594	3,698
1924	9,901	9,923	674	8,750	499	0	27,594	3,698
1925	8,899	8,810	670	8,750	0	0	26,984	3,693
1926	11,275	11,486	670	8,750	1,165	291	27,594	3,698
1927	13,627	13,190	674	8,750	3,013	753	27,594	3,698
1928	12,541	12,232	674	8,750	2,246	562	27,594	3,698
1929	16,053	15,993	674	8,750	3,553	3,016	27,594	3,698
1930	10,497	10,271	674	8,750	847	0	27,594	3,698
1931	4,402	5,424	635	8,750	0	0	23,633	3,674
1932	12,483	12,290	622	8,750	0	0	26,551	3,692
1933	7,455	7,859	639	8,750	0	0	25,021	3,683
1934	2,576	3,807	562	8,750	0	0	19,516	3,645
1935	7,648	7,751	487	8,750	0	0	18,030	3,635
1936	9,528	8,946	468	8,750	0	0	17,758	3,633
1937	9,476	9,375	468	8,750	0	0	17,915	3,635
1938	12,753	12,352	502	8,750	0	0	21,015	3,656
1939	7,204	7,308	495	8,750	0	0	19,078	3,642
1940	5,088	5,972	460	8,750	0	0	15,840	3,618
1941	13,266	12,981	467	8,750	0	0	19,604	3,645
1942	14,074	13,851	552	8,750	0	0	24,153	3,677
1943	8,936	8,261	588	8,750	0	0	23,076	3,670
1944	10,722	10,412	588	8,750	0	0	24,150	3,678
1945	9,334	9,238	600	8,750	0	0	24,038	3,676
1946	6,652	6,631	567	8,750	0	0	21,352	3,659
1947	10,989	10,093	551	8,750	0	0	22,144	3,664
1948	11,092	11,060	579	8,750	0	0	23,875	3,675
1949	11,766	11,632	618	8,750	0	0	26,139	3,689
1950	8,776	7,854	628	8,750	0	0	24,615	3,680
1951	7,882	7,329	592	8,750	0	0	22,602	3,667
1952	15,393	14,912	622	8,750	548	0	27,594	3,698
1953	6,867	7,175	654	8,750	0	0	25,365	3,685
1954	4,290	4,855	580	8,750	0	0	20,890	3,655
1955	5,595	6,256	498	8,750	0	0	17,898	3,634
1956	6,943	6,685	440	8,750	0	0	15,393	3,614
1957	14,914	14,099	466	8,750	0	0	20,276	3,651
1958	11,817	12,005	550	9,750	0	0	22,981	3,670
1959	5,114	5,501	538	8,750	0	0	19,194	3,643
1960	7,372	7,665	480	8,750	0	0	17,629	3,631
1961	4,983	5,903	430	8,750	0	0	14,352	3,605
1962	12,563	11,894	420	8,750	0	0	17,076	3,627
1963	4,938	5,939	420	8,750	0	0	13,845	3,600
1964	6,426	6,901	365	8,750	0	0	11,631	3,577
1965	12,563	10,761	359	8,750	0	0	13,283	3,595
Total:								
1953–64	91,822	94,878	5,841	105,000	0	0	—15,963	----------
1931–64	299,317	300,216	18,131	297,500	548	0	—15,963	----------
1906–65	637,769	631,186	34,834	525,000	46,516	24,836	0	----------
Average:								
1953–64	7,652	7,906	487	8,750	0	0	—1,330	----------
1931–64	8,803	8,830	533	8,750	16	0	—470	----------
1906–65	10,629	10,519	580	8,750	775	414	0	----------

SUMMARY OF OPERATIONS—LAKE POWELL

2000 CONDITIONS

[Unit—1,000 acre-feet]

Water-year	Inflow		Evaporation	Power releases		Spill	Reservoir content end of year [1]	Water surface elevation end of year (feet)
	Unregulated	Regulated by upstream reservoir		Scheduled	Other			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1906	13,723	13,254	361	8,580	0	0	12,224	3,592
1907	17,286	16,205	490	8,580	0	0	19,359	3,652
1908	8,798	8,897	564	8,580	0	0	19,112	3,649
1909	17,350	16,201	628	8,580	0	0	26,105	3,695
1910	9,618	9,651	704	8,580	0	0	26,472	3,697
1911	11,110	11,283	707	8,580	1,527	382	26,559	3,698
1912	14,883	14,470	707	8,580	3,631	1,552	26,559	3,698
1913	9,793	9,443	707	8,580	156	0	26,559	3,698
1914	15,492	15,335	707	8,580	3,631	2,417	26,559	3,698
1915	9,406	9,776	707	8,580	489	0	26,559	3,698
1916	13,748	13,153	707	8,580	3,093	773	26,559	3,698
1917	17,831	17,676	707	8,580	3,631	4,758	26,559	3,698
1918	10,538	10,380	707	8,580	1,000	93	26,559	3,698
1919	8,125	8,809	705	8,580	0	0	26,083	3,695
1920	16,091	15,798	705	8,580	3,631	2,406	26,559	3,698
1921	17,010	16,306	707	8,580	3,631	3,388	26,559	3,698
1922	13,008	12,865	707	8,580	2,862	716	26,559	3,698
1923	12,975	12,804	707	8,580	2,814	703	26,559	3,698
1924	9,576	9,623	707	8,580	336	0	26,559	3,698
1925	8,588	8,519	704	8,580	0	0	25,794	3,694
1926	10,930	11,171	704	8,580	1,000	122	26,559	3,698
1927	13,252	12,793	707	8,580	2,805	701	26,559	3,698
1928	12,183	11,814	707	8,580	2,022	505	26,559	3,698
1929	15,648	15,663	707	8,580	3,631	2,745	26,559	3,698
1930	10,165	9,890	707	8,580	603	0	26,559	3,698
1931	4,149	5,245	660	8,580	0	0	22,564	3,673
1932	12,124	11,891	648	8,580	0	0	25,227	3,689
1933	7,161	7,582	650	8,580	0	0	23,579	3,680
1934	2,345	3,649	587	8,580	0	0	18,061	3,642
1935	7,355	7,414	515	8,580	0	0	16,380	3,629
1936	9,208	8,647	488	8,580	0	0	15,959	3,625
1937	9,155	9,073	497	8,580	0	0	15,955	3,625
1938	12,391	12,010	522	8,580	0	0	18,863	3,648
1939	6,914	6,935	528	8,580	0	0	16,690	3,632
1940	4,823	5,681	470	8,580	0	0	13,321	3,602
1941	12,897	12,471	472	8,580	0	0	16,740	3,632
1942	13,692	13,489	552	8,580	0	0	21,097	3,663
1943	8,622	7,969	586	8,580	0	0	19,900	3,655
1944	10,387	10,097	582	8,580	0	0	20,835	3,662
1945	8,883	8,805	587	8,580	0	0	20,473	3,658
1946	6,366	6,424	557	8,580	0	0	17,760	3,640
1947	10,652	9,940	538	8,580	0	0	18,582	3,645
1948	10,750	10,719	562	8,580	0	0	20,159	3,657
1949	11,417	11,302	595	8,580	0	0	22,286	3,672
1950	8,465	7,621	603	8,580	0	0	20,724	3,661
1951	7,596	7,127	569	8,580	0	0	18,702	3,647
1952	14,992	14,195	594	8,580	0	0	23,723	3,680
1953	6,582	6,968	625	8,580	0	0	21,486	3,666
1954	4,036	4,678	562	8,580	0	0	17,022	3,634
1955	5,324	6,061	480	8,580	0	0	14,023	3,608
1956	6,655	6,478	420	8,580	0	0	11,501	3,585
1957	14,524	13,499	443	8,580	0	0	15,977	3,625
1958	11,465	11,671	518	8,580	0	0	18,550	3,646
1959	4,849	5,313	507	8,580	0	0	14,776	3,615
1960	7,078	7,124	444	8,580	0	0	12,976	3,598
1961	4,722	5,451	382	8,580	0	0	9,365	3,563
1962	12,205	11,351	373	8,580	0	0	11,763	3,588
1963	4,677	5,545	358	8,580	0	0	8,370	3,548
1964	6,144	6,379	291	8,580	0	0	5,878	3,512
1965	12,196	10,890	277	8,580	0	0	7,911	3,542
Total:								
1953–64	88,261	90,518	5,403	102,960	0	0	−17,845	
1931–64	288,605	288,804	17,765	291,720	0	0	−20,681	
1906–65	617,928	611,473	34,919	514,800	40,493	21,261	0	
Average:								
1953–64	7,355	7,543	450	8,580	0	0	−1,487	
1931–64	8,488	8,494	523	8,580	0	0	−609	
1906–65	10,299	10,191	582	8,580	675	354	0	

SUMMARY OF OPERATIONS—LAKE POWELL

2030 CONDITIONS

[Unit—1,000 acre-feet]

Water-year	Inflow		Evaporation	Power releases		Spill	Reservoir content end of year[1]	Water surface elevation end of year (feet)
	Unregulated	Regulated by upstream reservoir		Scheduled	Other			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1906	13,508	12,868	332	8,230	0	0	10,190	3,596
1907	16,816	15,735	483	8,230	0	0	17,212	3,656
1908	8,078	8,177	563	8,230	0	0	06,596	3,650
1909	16,895	15,746	637	8,230	0	0	23,475	3,695
1910	9,261	9,294	717	8,230	115	0	23,707	3,698
1911	10,732	10,905	724	8,230	1,561	390	23,707	3,698
1912	14,449	14,036	724	8,230	3,794	1,288	23,707	3,698
1913	9,432	9,082	724	8,230	128	0	23,707	3,698
1914	15,052	14,895	724	8,230	3,794	2,147	23,707	3,698
1915	9,050	9,420	724	8,230	466	0	23,707	3,698
1916	13,330	12,735	724	8,230	3,015	766	23,707	3,698
1917	13,353	17,198	724	8,230	3,794	4,450	23,707	3,698
1918	10,167	10,009	724	8,230	1,000	55	23,707	3,698
1919	7,791	8,475	712	8,230	0	0	23,240	3,695
1920	15,639	15,346	712	8,230	3,794	2,143	23,707	3,698
1921	16,547	15,843	724	8,230	3,794	3,095	23,707	3,698
1922	12,601	12,458	724	8,230	2,803	701	23,707	3,698
1923	12,567	12,396	724	8,230	2,754	688	23,707	3,698
1924	9,221	9,268	724	8,230	314	0	23,707	3,698
1925	8,247	8,178	708	8,230	0	0	22,947	3,693
1926	10,552	10,793	708	8,230	1,000	95	23,707	3,698
1927	12,841	12,382	724	8,230	2,742	686	23,707	3,698
1928	11,790	11,421	724	8,230	1,874	593	23,707	3,698
1929	15,204	15,219	724	8,230	3,794	2,471	23,707	3,698
1930	9,802	9,527	724	8,230	573	0	23,707	3,698
1931	3,869	5,013	677	8,230	0	0	19,813	3,673
1932	11,732	11,452	663	8,230	0	0	22,372	3,688
1933	6,838	7,259	674	8,230	0	0	20,727	3,679
1934	2,092	3,444	584	8,230	0	0	15,357	3,642
1935	7,031	7,043	503	8,230	0	0	13,667	3,628
1936	8,854	8,293	478	8,230	0	0	13,252	3,625
1937	8,802	8,720	473	8,230	0	0	13,269	3,625
1938	11,995	11,614	506	8,230	0	0	16,147	3,648
1939	6,594	6,615	517	8,230	0	0	14,015	3,630
1940	4,533	5,439	445	8,230	0	0	10,779	3,604
1941	12,494	12,022	447	8,230	0	0	14,124	3,632
1942	13,274	13,071	545	8,230	0	0	18,420	3,664
1943	8,277	7,624	587	8,230	0	0	17,227	3,656
1944	10,020	9,730	582	8,230	0	0	18,145	3,662
1945	8,535	8,457	590	8,230	0	0	17,782	3,660
1946	6,054	6,160	552	8,230	0	0	15,160	3,638
1947	10,280	9,616	531	8,230	0	0	16,015	3,646
1948	10,376	10,251	555	8,230	0	0	17,481	3,657
1949	11,036	10,921	597	8,230	0	0	19,575	3,672
1950	8,124	7,328	604	8,230	0	0	18,069	3,662
1951	7,284	6,863	563	8,230	0	0	16,139	3,648
1952	14,556	13,664	597	8,230	0	0	20,976	3,681
1953	6,269	6,703	629	8,230	0	0	18,820	3,670
1954	3,757	4,447	555	8,230	0	0	14,482	3,633
1955	5,026	5,811	464	8,230	0	0	11,599	3,610
1956	6,339	6,210	395	8,230	0	0	9,184	3,584
1957	14,093	12,882	420	8,230	0	0	13,416	3,626
1958	11,079	11,385	509	8,230	0	0	16,062	3,647
1959	4,559	5,171	498	8,230	0	0	12,505	3,618
1960	6,755	6,854	428	8,230	0	0	10,701	3,601
1961	4,435	5,264	359	8,230	0	0	7,376	3,562
1962	11,812	11,058	348	8,230	0	0	9,856	3,592
1963	4,388	5,404	338	8,230	0	0	6,692	3,551
1964	5,837	6,220	255	8,230	0	0	4,427	3,518
1965	11,804	9,922	235	8,230	0	0	5,884	3,538
Total:								
1953–64	84,349	87,409	5,198	98,760	0	0	−16,549	----------
1931–64	276,999	278,008	17,468	279,820	0	0	−19,280	----------
1906–65	595,728	589,336	34,859	493,800	41,109	19,568	0	----------
Average:								
1953–64	7,029	7,284	433	8,230	0	0	−1,379	----------
1931–64	8,147	8,177	514	8,230	0	0	−567	----------
1906–65	9,929	9,823	582	8,230	685	326	0	----------

[1] Includes 15 percent bank storage but excludes the portion of the original storage capacity impaired by sediment encroachment.

LOWER COLORADO RIVER BASIN OPERATION STUDY

DEVELOPMENT CONDITIONS, 1975

[Period of record, 1906-65. Units, 1,000 acre-feet]

Year	Lake Mead operation							Distribution of scheduled release					
	Glen Canyon release	Net gain, Glen Canyon-Lake Mead	Total inflow, Lake Mead	Evaporation, Lake Mead	Scheduled release, Hoover Dam	Spill, Hoover Dam	End of year content, Lake Mead	Nevada-Mexico losses	California entitlement	Arizona entitlement	Available to CAP	Diversion limited to 1,200	Diversion limited to 2,500
1906	9,550	796	10,350	700	9,650	0	13,630	2,140	4,555	2,955	1,935	1,200	1,935
1907	9,550	796	10,350	700	9,650	0	13,630	2,140	4,555	2,955	1,935	1,200	1,935
1908	9,550	796	10,350	700	9,650	0	13,630	2,140	4,555	2,955	1,935	1,200	1,935
1909	14,143	796	14,940	770	9,650	0	18,150	2,140	4,555	2,955	1,935	1,200	1,935
1910	10,042	796	10,840	840	9,650	0	18,500	2,140	4,555	2,955	1,935	1,200	1,935
1911	11,768	796	12,560	880	9,650	0	20,530	2,140	4,555	2,955	1,935	1,200	1,935
1912	15,283	796	16,080	970	10,780	0	24,860	2,140	5,120	3,520	2,500	1,200	2,500
1913	10,203	796	11,000	1,020	10,780	0	24,060	2,140	5,120	3,520	2,500	1,200	2,500
1914	16,121	2,098	18,220	1,040	10,780	4,560	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1915	10,191	2,588	12,780	1,070	10,780	930	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1916	13,926	1,504	15,430	1,070	10,780	3,580	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1917	18,616	−135	18,480	1,070	10,780	6,630	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1918	10,937	389	11,330	1,060	10,780	0	25,390	2,140	5,120	3,520	2,500	1,200	2,500
1919	9,550	709	10,260	1,030	10,780	0	23,840	2,140	5,120	3,520	2,500	1,200	2,500
1920	16,123	2,397	18,520	1,040	10,780	4,640	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1921	17,314	−377	16,940	1,070	10,780	5,090	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1922	13,589	2,358	15,950	1,070	10,780	4,100	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1923	13,485	1,756	15,240	1,070	10,780	3,390	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1924	10,028	1,663	11,690	1,060	10,780	0	25,750	2,140	5,120	3,520	2,500	1,200	2,500
1925	9,550	629	10,180	1,040	10,780	0	24,110	2,140	5,120	3,520	2,500	1,200	2,500
1926	10,997	560	11,560	1,020	10,780	0	23,870	2,140	5,120	3,520	2,500	1,200	2,500
1927	13,502	778	14,280	1,040	10,780	430	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1928	12,713	367	13,080	1,070	10,780	1,230	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1929	16,406	67	16,470	1,070	10,780	4,620	25,900	2,140	5,120	3,520	2,500	1,200	2,500
1930	10,468	480	10,950	1,060	10,780	0	25,010	2,140	5,120	3,520	2,500	1,200	2,500
Subtotal, 1906–30	313,605	24,199	337,830	24,530	262,720	39,200	11,380	53,500	124,610	84,610	59,110	30,000	59,110
Average 1906–30	12,544	968	13,513	981	10,509	1,568	455	4,360	4,985	3,384	2,364	1,200	2,364
1931	9,550	538	10,090	1,020	10,780	0	23,300	2,140	5,120	3,520	2,500	1,200	2,500
1932	9,550	1,151	10,700	980	10,780	0	22,240	2,140	5,120	3,520	2,500	1,200	2,500

1933	9,550	526	10,080	940	10,780	0	20,600	2,140	5,120	3,520	2,500	1,200	2,500
1934	9,550	576	10,130	900	9,650	0	20,180	2,140	4,555	2,955	1,935	1,200	1,935
1935	9,550	365	9,970	890	9,650	0	19,560	2,140	4,555	2,955	1,935	1,200	1,935
1936	9,550	759	10,310	880	9,650	0	19,340	2,140	4,555	2,955	1,935	1,200	1,935
1937	9,550	1,207	10,760	880	9,650	0	19,570	2,140	4,555	2,955	1,935	1,200	1,935
1938	9,550	1,152	10,700	880	9,650	0	19,740	2,140	4,555	2,955	1,935	1,200	1,935
1939	9,550	708	10,260	880	9,650	0	19,470	2,140	4,555	2,955	1,935	1,200	1,935
1940	9,550	784	10,330	880	9,650	0	19,270	2,140	4,555	2,955	1,935	1,200	1,935
1941	9,550	2,172	11,720	890	9,650	0	20,450	2,140	4,555	2,955	1,935	1,200	1,935
1942	9,550	919	10,550	900	9,650	0	20,450	2,140	4,555	2,955	1,935	1,200	1,935
1943	9,550	614	10,160	900	9,650	0	20,060	2,140	4,555	2,955	1,935	1,200	1,935
1944	9,550	790	10,340	900	9,650	0	19,850	2,140	4,555	2,955	1,935	1,200	1,935
1945	9,550	788	10,340	890	9,650	0	19,650	2,140	4,555	2,955	1,935	1,200	1,935
1946	9,550	379	9,930	880	9,650	0	19,050	2,140	4,555	2,955	1,935	1,200	1,935
1947	9,550	845	10,400	860	9,650	0	18,940	2,140	4,555	2,955	1,935	1,200	1,935
1948	9,550	394	9,940	850	9,650	0	18,370	2,140	4,555	2,955	1,935	1,200	1,935
1949	9,550	564	10,110	840	9,650	0	17,990	2,140	4,555	2,955	1,935	1,200	1,935
1950	9,550	56	9,610	820	9,650	0	17,130	2,140	4,555	2,955	1,935	1,200	1,935
1951	9,550	202	9,750	800	9,650	0	16,430	2,140	4,555	2,955	1,935	1,200	1,935
1952	10,855	999	11,850	810	9,650	0	17,320	2,140	4,555	2,955	1,935	1,200	1,935
1953	9,550	98	9,650	820	9,650	0	17,000	2,140	4,555	2,955	1,935	1,200	1,935
1954	9,550	67	9,620	790	9,650	0	16,180	2,140	4,555	2,955	1,935	1,200	1,935
1955	9,550	745	10,300	780	9,650	0	16,050	2,140	4,555	2,955	1,935	1,200	1,935
1956	9,550	483	10,030	770	9,650	0	15,660	2,140	4,555	2,955	1,935	1,200	1,935
1957	9,550	1,271	10,820	770	9,650	0	16,060	2,140	4,555	2,955	1,935	1,200	1,935
1958	9,550	994	10,540	780	9,650	0	16,170	2,140	4,555	2,955	1,935	1,200	1,935
1959	9,550	171	9,720	770	9,650	0	15,470	2,140	4,555	2,955	1,935	1,200	1,935
1960	9,550	784	10,330	760	9,650	0	15,570	2,140	4,555	2,955	1,935	1,200	1,935
1961	9,550	510	10,060	750	9,650	0	15,050	2,140	4,555	2,955	1,935	1,200	1,935
1962	9,550	724	10,270	740	9,650	0	14,930	2,140	4,555	2,955	1,935	1,200	1,935
1963	9,550	108	9,660	730	9,650	0	14,210	2,140	4,555	2,955	1,935	1,200	1,935
1964	9,550	−29	9,520	710	9,650	0	13,370	2,140	4,555	2,955	1,935	1,200	1,935
1965	9,550	1,058	10,610	700	9,650	0	13,630	2,140	4,555	2,955	1,935	1,200	1,935
Subtotal, 1931–65	335,555	23,552	359,110	29,350	341,140	0	−11,380	74,900	161,120	105,120	69,420	42,000	69,420
Average, 1931–65	9,587	673	10,260	838	9,747	0	−325	2,140	4,604	3,003	1,938	1,200	1,983
Grand total, 1906–65	649,160	47,751	696,940	53,880	603,860	39,200	0	128,400	285,730	189,730	128,530	72,000	128,530
Average, 1906–65	10,819	796	11,615	898	10,064	653	0	2,140	4,762	3,162	2,142	1,200	2,142

Note: Scheduled release: Minimum 9,650, maximum 10,780; to maximize yield from Lake Mead for a 2,500 diversion to central Arizona project. Distribution: Losses, 540; Mexico, 1,500; Nevada, 100; California, 4,400 plus ½ surplus; Arizona, 2,800 plus ½ surplus; and CAP, Arizona less 1,020 mainstream uses.

LOWER COLORADO RIVER BASIN OPERATION STUDY

DEVELOPMENT CONDITIONS, 1990

[Period of record, 1906–65. Units: 1,000 acre-feet]

Year	Lake Mead operation							Distribution of scheduled release					
	Glen Canyon release	Net gain, Glen Canyon-Lake Mead	Total inflow, Lake Mead	Evaporation, Lake Mead	Scheduled release, Hoover Dam	Spill, Hoover Dam	End of year contest, Lake Mead	Nevada-Mexico losses	California entitlement	Arizona entitlement	Available to CAP	Diversion limited to 1,500	Diversion limited to 2,500
							13,300						
1906	8,750	776	9,530	700	8,800	0	13,330	2,190	4,400	2,210	1,050	1,050	1,050
1907	8,750	----------	9,530	700	8,800	0	13,360	2,190	4,400	2,210	1,050	1,050	1,050
1908	8,750	----------	9,530	700	8,800	0	13,390	2,190	4,400	2,210	1,050	1,050	1,050
1909	12,570	----------	13,350	760	8,800	0	17,180	2,190	4,400	2,210	1,050	1,050	1,050
1910	9,233	----------	10,010	820	8,800	0	17,570	2,190	4,400	2,210	1,050	1,050	1,050
1911	10,930	----------	11,710	860	8,800	0	19,620	2,190	4,400	2,210	1,050	1,050	1,050
1912	14,162	----------	14,940	930	11,110	0	22,520	2,190	5,260	3,660	2,500	1,200	2,500
1913	9,295	776	10,070	940	11,110	0	20,540	2,190	5,260	3,660	2,500	1,200	2,500
1914	15,063	2,078	17,140	990	11,110	0	25,580	2,190	5,260	3,660	2,500	1,200	2,500
1915	9,404	2,568	11,970	1,060	11,110	0	25,380	2,190	5,260	3,660	2,500	1,200	2,500
1916	12,848	1,484	14,330	1,060	11,110	1,640	25,900	2,190	5,260	3,660	2,500	1,200	2,500
1917	17,470	−155	17,320	1,070	11,110	5,140	25,900	2,190	5,260	3,660	2,500	1,200	2,500
1918	10,044	369	10,410	1,040	11,110	0	24,160	2,190	5,260	3,660	2,500	1,200	2,500
1919	8,750	689	9,440	980	11,110	0	21,510	2,190	5,260	3,660	2,500	1,200	2,500
1920	15,180	2,377	17,560	1,000	11,110	1,060	25,900	2,190	5,260	3,660	2,500	1,200	2,500
1921	16,054	−397	15,660	1,070	11,110	3,480	25,900	2,190	5,260	3,660	2,500	1,200	2,500
1922	12,605	2,338	14,940	1,070	11,110	2,760	25,900	2,190	5,260	3,660	2,500	1,200	2,500
1923	12,501	1,736	14,240	1,070	11,110	2,060	25,900	2,190	5,260	3,660	2,500	1,200	2,500
1924	9,249	1,643	10,890	1,050	11,110	0	24,630	2,190	5,260	3,660	2,500	1,200	2,500
1925	8,750	609	9,360	990	11,110	0	21,890	2,190	5,260	3,660	2,500	1,200	2,500
1926	10,206	540	10,750	930	11,110	0	20,600	2,190	5,260	3,660	2,500	1,200	2,500
1927	12,516	758	13,270	930	11,110	0	21,830	2,190	5,260	3,660	2,500	1,200	2,500
1928	11,558	347	11,900	940	11,110	0	21,680	2,190	5,260	3,660	2,500	1,200	2,500
1929	15,319	47	15,370	990	11,110	0	24,950	2,190	5,260	3,660	2,500	1,200	2,500
1930	9,597	460	10,060	1,010	11,110	0	22,890	2,190	5,260	3,660	2,500	1,200	2,500
Subtotal, 1906–30	289,554	23,699	313,280	23,660	263,890	16,140	9,590	54,750	126,340	82,800	53,800	29,100	53,800
Average, 1906–30	11,582	948	12,531	946	10,556	646	383	2,190	5,054	3,312	2,152	1,164	2,152
1931	8,750	518	9,270	940	11,110	0	20,110	2,190	5,260	3,660	2,500	1,200	2,500
1932	8,750	1,131	9,830	890	9,100	0	20,000	2,190	4,400	2,510	1,350	1,200	1,350

1933	8,750	506	9,260	890	8,800	0	19,570	2,190	4,400	2,210	1,050	1,050	1,050
1934	8,750	556	9,310	880	8,800	0	19,200	2,190	4,400	2,210	1,050	1,050	1,050
1935	8,750	345	9,100	860	8,800	0	18,640	2,190	4,400	2,210	1,050	1,050	1,050
1936	8,750	739	9,490	850	8,800	0	18,480	2,190	4,400	2,210	1,050	1,050	1,050
1937	8,750	1,187	9,940	860	8,800	0	18,760	2,190	4,400	2,210	1,050	1,050	1,050
1938	8,750	1,132	9,880	860	8,800	0	18,980	2,190	4,400	2,210	1,050	1,050	1,050
1939	8,750	688	9,440	860	8,800	0	18,760	2,190	4,400	2,210	1,050	1,050	1,050
1940	8,750	764	9,510	860	8,800	0	18,610	2,190	4,400	2,210	1,050	1,050	1,050
1941	8,750	2,152	10,900	880	8,800	0	19,830	2,190	4,400	2,210	1,050	1,050	1,050
1942	8,750	979	9,730	890	8,800	0	19,870	2,190	4,400	2,210	1,050	1,050	1,050
1943	8,750	594	9,340	890	8,800	0	19,520	2,190	4,400	2,210	1,050	1,050	1,050
1944	8,750	770	9,520	880	8,800	0	19,360	2,190	4,400	2,210	1,050	1,050	1,050
1945	8,750	768	9,520	880	8,800	0	19,200	2,190	4,400	2,210	1,050	1,050	1,050
1946	8,750	359	9,110	860	8,800	0	18,650	2,190	4,400	2,210	1,050	1,050	1,050
1947	8,750	825	9,580	860	8,800	0	18,570	2,190	4,400	2,210	1,050	1,050	1,050
1948	8,750	374	9,120	840	8,800	0	18,050	2,190	4,400	2,210	1,050	1,050	1,050
1949	8,750	544	9,290	830	8,800	0	17,710	2,190	4,400	2,210	1,050	1,050	1,050
1950	8,750	36	8,790	820	8,800	0	16,880	2,190	4,400	2,210	1,050	1,050	1,050
1951	8,750	182	8,930	800	8,800	0	16,210	2,190	4,400	2,210	1,050	1,050	1,050
1952	9,298	979	10,280	800	8,800	0	16,890	2,190	4,400	2,210	1,050	1,050	1,050
1953	8,750	78	8,830	790	8,800	0	16,130	2,190	4,400	2,210	1,050	1,050	1,050
1954	8,750	47	8,800	770	8,800	0	15,360	2,190	4,400	2,210	1,050	1,050	1,050
1955	8,750	725	9,480	760	8,800	0	15,280	2,190	4,400	2,210	1,050	1,050	1,050
1956	8,750	463	9,210	750	8,800	0	14,940	2,190	4,400	2,210	1,050	1,050	1,050
1957	8,750	1,251	10,000	750	8,800	0	15,390	2,190	4,400	2,210	1,050	1,050	1,050
1958	8,750	974	9,720	760	8,800	0	15,550	2,190	4,400	2,210	1,050	1,050	1,050
1959	8,750	151	8,900	760	8,800	0	14,890	2,190	4,400	2,210	1,050	1,050	1,050
1960	8,750	764	9,510	740	8,800	0	14,860	2,190	4,400	2,210	1,050	1,050	1,050
1961	8,750	490	9,240	740	8,800	0	14,560	2,190	4,400	2,210	1,050	1,050	1,050
1962	8,750	704	9,450	730	8,800	0	14,480	2,190	4,400	2,210	1,050	1,050	1,050
1963	8,750	88	8,840	720	8,800	0	13,800	2,190	4,400	2,210	1,050	1,050	1,050
1964	8,750	−49	8,700	700	8,800	0	13,000	2,190	4,400	2,210	1,050	1,050	1,050
1965	8,750	1,038	9,790	690	8,800	0	13,300	2,190	4,400	2,210	1,050	1,050	1,050
Subtotal, 1931–65	306,798	22,852	329,660	28,640	310,610	0	−9,590	76,650	154,860	79,100	38,500	37,050	38,500
Average, 1931–65	8,766	653	9,419	818	8,875	0	−274	2,190	4,425	2,260	1,100	1,059	1,100
Grand total, 1906–65	596,352	46,551	642,940	52,300	574,500	16,140	0	131,400	281,200	161,900	92,300	66,150	92,300
Average 1906–65	9,940	776	10,716	872	9,575	269	0	2,190	4,687	2,698	1,538	1,102	1,538

Note: Scheduled release: Minimum 8,800, maximum 11,110; to maximize yield from Lake Mead for a 2,500 diversion to central Arizona project. Distribution: Losses, 540; Mexico, 1,500; Nevada, 150; California, 4,400 plus ½ surplus; Arizona, 2,800 plus ½ surplus (assumes total deficiency if 2,800 not available); CAP, Arizona less 1,160 mainstream uses.

LOWER COLORADO RIVER BASIN OPERATION STUDY

DEVELOPMENT CONDITIONS, 2000

[Period of record, 1906–65. Units, 1,000 acre-feet]

Year	Lake Mead operation							Distribution of scheduled release					
	Glen Canyon release	Net gain, Glen Canyon-Lake Mead	Total inflow Lake Mead	Evaporation, Lake Mead	Scheduled release, Hoover Dam	Spill, Hoover Dam	End of year contest, Lake Mead	Nevada-Mexico losses	California entitlement	Arizona entitlement	Available to CAP	Diversion limited to 1,500	Diversion limited to 2,500
1906	8,580	756	9,340	660	8,650	0	12,130	2,240	4,400	2,010	780	780	780
1907	8,580	756	9,340	660	8,650	0	12,160	2,240	4,400	2,010	780	780	780
1908	8,580	756	9,340	660	8,650	0	12,190	2,240	4,400	2,010	780	780	780
1909	8,580	756	9,340	660	8,650	0	12,220	2,240	4,400	2,010	780	780	780
1910	8,580	756	9,340	660	8,650	0	12,250	2,240	4,400	2,010	780	780	780
1911	10,489	756	11,240	690	8,650	0	14,150	2,240	4,400	2,010	780	780	780
1912	13,763	756	14,520	800	8,650	0	19,220	2,240	4,400	2,010	780	780	780
1913	8,736	756	9,490	870	8,650	0	19,190	2,240	4,400	2,010	780	780	780
1914	14,628	2,058	16,690	940	11,300	0	23,640	2,240	5,300	3,730	2,500	1,200	2,500
1915	9,069	2,548	11,620	990	11,300	0	22,970	2,240	5,300	3,730	2,500	1,200	2,500
1916	12,446	1,464	13,910	1,000	11,300	0	24,580	2,240	5,300	3,730	2,500	1,200	2,500
1917	16,969	−175	16,790	1,050	11,300	3,120	25,900	2,240	5,300	3,730	2,500	1,200	2,500
1918	9,673	349	10,020	1,020	11,300	0	23,590	2,240	5,300	3,730	2,500	1,200	2,500
1919	8,580	669	9,250	960	11,300	0	20,580	2,240	5,300	3,730	2,500	1,200	2,500
1920	14,617	2,357	16,970	980	11,300	0	25,270	2,240	5,300	3,730	2,500	1,200	2,500
1921	15,599	−417	15,180	1,060	11,300	2,190	25,900	2,240	5,300	3,730	2,500	1,200	2,500
1922	12,158	2,318	14,480	1,070	11,300	2,110	25,900	2,240	5,300	3,730	2,500	1,200	2,500
1923	12,097	1,716	13,810	1,070	11,300	1,440	25,900	2,240	5,300	3,730	2,500	1,200	2,500
1924	8,916	1,623	10,540	1,040	11,300	0	24,100	2,240	5,300	3,730	2,500	1,200	2,500
1925	8,580	589	9,170	970	11,300	0	21,000	2,240	5,330	3,730	2,500	1,200	2,500
1926	9,702	520	10,220	910	10,310	0	20,000	2,240	4,835	3,235	2,005	1,200	2,005
1927	12,086	738	12,820	900	11,300	0	20,620	2,240	5,330	3,730	2,500	1,200	2,500
1928	11,107	327	11,430	900	11,150	0	20,000	2,240	5,255	3,655	2,425	1,200	2,425
1929	14,956	27	14,980	930	11,300	0	22,750	2,240	5,330	3,730	2,500	1,200	2,500
1930	9,183	440	9,620	940	11,300	0	20,130	2,240	5,330	3,730	2,500	1,200	2,500
Subtotal, 1906–30	276,254	23,199	299,450	22,400	260,160	8,860	8,030	56,000	125,240	78,920	48,170	26,640	48,170
Average, 1906–30	11,050	928	11,978	896	10,406	355	321	2,240	5,009	3,157	1,927	1,066	1,927
1931	8,580	498	9,080	890	8,650	0	19,670	2,240	4,400	2,010	780	780	780
1932	8,580	1,111	9,690	880	8,650	0	19,830	2,240	4,400	2,010	780	780	780

1933	8,580	486	9,070	880	8,650	0	19,370	2,240	4,400	2,010	780	780	780
1934	8,580	536	9,120	870	8,650	0	18,970	2,240	4,400	2,010	780	780	780
1935	8,580	325	8,900	850	8,650	0	18,370	2,240	4,400	2,010	780	780	780
1936	8,580	719	9,300	840	8,650	0	18,180	2,240	4,400	2,010	780	780	780
1937	8,580	1,167	9,750	840	8,650	0	18,440	2,240	4,400	2,010	780	780	780
1938	8,580	1,112	9,690	850	8,650	0	18,630	2,240	4,400	2,010	780	780	780
1939	8,580	668	9,250	850	8,650	0	18,380	2,240	4,400	2,010	780	780	780
1940	8,580	744	9,320	840	8,650	0	18,210	2,240	4,400	2,010	780	780	780
1941	8,580	2,132	10,710	860	8,650	0	19,410	2,240	4,400	2,010	780	780	780
1942	8,580	959	9,540	880	8,650	0	19,420	2,240	4,400	2,010	780	780	780
1943	8,580	574	9,150	870	8,650	0	19,050	2,240	4,400	2,010	780	780	780
1944	8,580	750	9,330	860	8,650	0	18,870	2,240	4,400	2,010	780	780	780
1945	8,580	748	9,330	850	8,650	0	18,700	2,240	4,400	2,010	780	780	780
1946	8,580	339	8,920	840	8,650	0	18,130	2,240	4,400	2,010	780	780	780
1947	8,580	805	9,380	840	8,650	0	18,020	2,240	4,400	2,010	780	780	780
1948	8,580	354	8,930	830	8,650	0	17,470	2,240	4,400	2,010	780	780	780
1949	8,580	524	9,100	810	8,650	0	17,110	2,240	4,400	2,010	780	780	780
1950	8,580	16	8,600	800	8,650	0	16,260	2,240	4,400	2,010	780	780	780
1951	8,580	162	8,740	770	8,650	0	15,580	2,240	4,400	2,010	780	780	780
1952	8,580	959	9,540	760	8,650	0	15,710	2,240	4,400	2,010	780	780	780
1953	8,580	58	8,640	750	8,650	0	14,950	2,240	4,400	2,010	780	780	780
1954	8,580	27	8,610	730	8,650	0	14,180	2,240	4,400	2,010	780	780	780
1955	8,580	705	9,280	720	8,650	0	14,090	2,240	4,400	2,010	780	780	780
1956	8,580	443	9,020	710	8,650	0	13,750	2,240	4,400	2,010	780	780	780
1957	8,580	1,231	9,810	710	8,650	0	14,200	2,240	4,400	2,010	780	780	780
1958	8,580	954	9,530	720	8,650	0	14,360	2,240	4,400	2,010	780	780	780
1959	8,580	131	8,710	720	8,650	0	13,700	2,240	4,400	2,010	780	780	780
1960	8,580	744	9,320	710	8,650	0	13,660	2,240	4,400	2,010	780	780	780
1961	8,580	470	9,050	700	8,650	0	13,360	2,240	4,400	2,010	780	780	780
1962	8,580	684	9,260	690	8,650	0	13,280	2,240	4,400	2,010	780	780	780
1963	8,580	68	8,650	680	8,650	0	12,600	2,240	4,400	2,010	780	780	780
1964	8,580	—69	8,510	660	8,650	0	11,800	2,240	4,400	2,010	780	780	780
1965	8,580	1,018	9,600	650	8,650	0	12,100	2,240	4,400	2,010	780	780	780
Subtotal, 1931–65	300,300	22,152	322,430	27,710	302,750	0	—8,030	78,400	154,000	70,350	27,300	27,300	27,300
Average, 1931–65	8,580	633	9,213	792	8,650	0	—229	2,240	4,400	2,010	780	780	780
Grand total, 1906–65	576,554	45,351	621,880	50,110	562,910	8,860	0	134,400	279,240	149,270	75,470	53,940	75,470
Average, 1906–65	9,609	756	10,365	835	9,382	148	0	2,240	4,654	2,488	1,258	899	1,258

Note: Scheduled release: Minimum 8,650, maximum 11,300; to maximize yield from Lake Mead for a 2,500 diversion to central Arizona project. Distribution: Losses, 540; Mexico, 1,500; Nevada, 200; California, 4,400 plus ½ surplus; Arizona, 2,800 plus ½ surplus (assumes total deficiency if 2,800 not available); CAP, Arizona less 1,230 mainstream uses.

LOWER COLORADO RIVER BASIN OPERATION STUDY

DEVELOPMENT CONDITIONS, 2030

[Period of record, 1906–65. Units, 1,000 acre-feet]

Year	Lake Mead operation							Distribution of scheduled release					
	Glen Canyon release	Net gain, GlenCanyon-Lake Mead	Total inflow, Lake Mead	Evaporation, Lake Mead	Scheduled release, Hoover Dam	Spill, Hoover Dam	End of year content, Lake Mead	Nevada-Mexico losses	California entitlement	Arizona entitlement	Available to CAP	Diversion limited to 1,200	Diversion limited to 2,500
							11,320						
1906	8,230	726	8,960	630	8,350	0	11,300	2,340	4,400	1,610	380	380	380
1907	8,230	726	8,960	630	8,350	0	11,280	2,340	4,400	1,610	380	380	380
1908	8,230	726	8,960	630	8,350	0	11,260	2,340	4,400	1,610	380	380	380
1909	8,230	726	8,960	630	8,350	0	11,240	2,340	4,400	1,610	380	380	380
1910	8,345	726	9,070	640	8,350	0	11,320	2,340	4,400	1,610	380	380	380
1911	10,181	726	10,910	67	8,350	0	13,210	2,340	4,400	1,610	380	380	380
1912	13,312	726	14,040	770	8,350	0	18,130	2,340	4,400	1,610	380	380	380
1913	8,358	726	9,080	840	8,350	0	18,020	2,340	4,400	1,610	380	380	380
1914	14,171	2,028	16,200	910	10,310	0	23,000	2,340	4,785	3,185	1,955	1,200	1,955
1915	8,696	2,518	11,210	980	10,230	0	23,000	2,340	4,745	3,145	1,915	1,200	1,915
1916	12,011	1,434	13,440	1,000	11,400	0	24,040	2,340	5,330	3,730	2,500	1,200	2,500
1917	16,474	−205	16,270	1,040	11,400	2,970	24,900	2,340	5,330	3,730	2,500	1,200	2,500
1918	9,285	319	9,600	1,040	10,460	0	23,000	2,340	4,860	3,260	2,030	1,200	2,030
1919	8,230	639	8,870	980	8,350	0	22,540	2,340	4,400	1,610	380	380	380
1920	14,167	2,327	16,500	1,040	11,400	1,700	24,900	2,340	5,330	3,730	2,500	1,200	2,500
1921	15,119	−447	14,670	1,070	11,400	2,200	24,900	2,340	5,330	3,730	2,500	1,200	2,500
1922	11,734	2,288	14,020	1,070	11,400	1,550	24,900	2,340	5,330	3,730	2,500	1,200	2,500
1923	11,672	1,686	13,360	1,070	11,400	890	24,900	2,340	5,330	3,730	2,500	1,200	2,500
1924	8,544	1,593	10,140	1,050	10,990	0	23,000	2,340	5,125	3,525	2,295	1,200	2,295
1925	8,230	559	8,790	980	8,350	0	22,460	2,340	4,400	1,610	380	380	380
1926	9,325	490	9,810	980	8,350	0	22,940	2,340	4,400	1,610	380	380	380
1927	11,658	708	12,370	980	11,330	0	23,000	2,340	5,295	3,695	2,465	1,200	2,465
1928	10,697	297	10,990	980	10,010	0	23,000	2,340	4,635	3,035	1,805	1,200	1,805
1929	14,495	−3	14,490	1,020	11,400	170	24,900	2,340	5,330	3,730	2,500	1,200	2,500
1930	8,803	410	9,210	1,010	10,100	0	23,000	2,340	4,680	3,080	1,850	1,200	1,850
Subtotal, 1906–30	266,427	22,449	288,880	22,640	245,080	9,480	11,680	58,500	119,835	66,745	35,995	20,980	35,995
Average, 1906–30	10,657	898	11,555	906	9,803	379	467	2,340	4,793	2,670	1,440	839	1,440
1931	8,230	468	8,770	970	8,350	0	22,380	2,340	4,400	1,610	380	380	380
1932	8,230	1,081	9,310	960	8,350	0	22,380	2,340	4,400	1,610	308	380	380

1933	8,230	456	8,690	940	8,350	0	21,780	2,340	4,400	1,610	380	380	380
1934	8,230	506	8,740	940	8,350	0	21,230	2,340	4,400	1,610	380	380	380
1935	8,230	295	8,520	920	8,350	0	20,480	2,340	4,400	1,610	380	380	380
1936	8,230	689	8,920	900	8,350	0	20,150	2,340	4,400	1,610	380	380	380
1937	8,230	1,137	9,370	900	8,350	0	20,270	2,340	4,400	1,610	380	380	380
1938	8,230	1,082	9,310	900	8,350	0	20,330	2,340	4,400	1,610	308	380	380
1939	8,230	638	8,870	890	8,350	0	19,960	2,340	4,400	1,610	380	380	380
1940	8,230	714	8,940	890	8,350	0	19,660	2,340	4,400	1,610	380	380	380
1941	8,230	2,102	10,330	900	8,350	0	20,740	2,340	4,400	1,610	380	380	380
1942	8,230	929	9,160	920	8,350	0	20,630	2,340	4,400	1,610	380	380	380
1943	8,230	544	8,770	900	8,350	0	20,150	2,340	4,400	1,610	380	380	380
1944	8,230	720	8,950	890	8,350	0	19,860	2,340	4,400	1,610	380	380	380
1945	8,230	718	8,950	880	8,350	0	19,580	2,340	4,400	1,610	380	380	380
1946	8,230	309	8,540	870	8,350	0	18,900	2,340	4,400	1,610	380	380	380
1947	8,230	775	9,000	860	8,350	0	18,690	2,340	4,400	1,610	380	380	380
1948	8,230	324	8,550	840	8,350	0	18,050	2,340	4,400	1,610	380	380	380
1949	8,230	494	8,720	830	8,350	0	17,590	2,340	4,400	1,610	380	380	380
1950	8,230	−14	8,220	810	8,350	0	16,650	2,340	4,400	1,610	380	380	380
1951	8,230	132	8,360	790	8,350	0	15,870	2,340	4,400	1,610	380	380	380
1952	8,230	929	9,160	770	8,350	0	15,910	2,340	4,400	1,610	380	380	380
1953	8,230	28	8,260	760	8,350	0	15,060	2,340	4,400	1,610	380	380	380
1954	8,230	−3	8,230	740	8,350	0	14,200	2,340	4,400	1,610	380	380	380
1955	8,230	675	8,900	720	8,350	0	14,030	2,340	4,400	1,610	380	380	380
1956	8,230	413	8,640	710	8,350	0	13,610	2,340	4,400	1,610	380	380	380
1957	8,230	1,201	9,430	710	8,350	0	13,980	2,340	4,400	1,610	380	380	380
1958	8,230	924	9,150	720	8,350	0	14,060	2,340	4,400	1,610	380	380	380
1959	8,230	101	8,330	710	8,350	0	13,330	2,240	4,400	1,610	380	380	380
1960	8,230	714	8,940	700	8,350	0	13,220	2,340	4,400	1,610	380	380	380
1961	8,230	440	8,670	690	8,350	0	12,850	2,340	4,400	1,600	380	380	380
1962	8,230	654	8,880	680	8,350	0	12,700	2,340	4,400	1,610	380	380	380
1963	8,230	38	8,270	670	8,350	0	11,950	2,340	4,400	0,600	380	380	380
1964	8,230	−99	8,130	640	8,350	0	11,090	2,340	4,400	1,610	380	380	380
1965	8,230	988	9,220	640	8,350	0	11,320	2,340	4,400	1,610	380	380	380
Subtotal, 1931–65	288,050	21,102	309,130	28,560	292,250	0	−11,680	81,900	154,000	56,350	13,300	13,300	13,300
Average, 1931–65	8,230	603	8,833	816	8,350	0	−333	2,340	4,400	1,610	380	380	380
Grand total, 1906–65	554,477	43,551	598,010	51,200	537,330	9,480	0	140,400	273,835	123,095	49,295	34,280	49,296
Average, 1906–65	9,241	726	9,967	853	8,956	158	0	2,340	4,564	2,052	822	571	822

Note: Scheduled release: Minimum, 8,350; maximum, 11,400; to maximum yield from Lake Mead for a 2,500 diversion to central Arizona project. Distribution: Losses, 540; Mexico, 1,500; Nevada, 300; California, 4,400 plus ½ surplus; Arizona, 2,800 plus ½ surplus (assumes total deficiency if 2,800 not available); CAP, Arizona less 1,230 mainstream uses.

Mr. ASPINALL. I wish to state that some members of the committee disagree with the Secretary on the flow of the Colorado River. With respect to the chart shown a few minutes ago, it is the only one that has shown a continuous downward trend. The other rivers show an up-and-down flow record. The Colorado has never been able to come back to any extent. But that is neither here nor there.

I want to thank you for having Mr. Riter give that information. I want the members of the committee to understand that these spills are due almost entirely to the assumed inclusion of the 1906–1922 runoff period. In order that the members understand the relationship between the inclusion of the 1906–1922 period and the water supply for the central Arizona project, let me point out that the Bureau shows that the average spill equals 35 percent of the total central Arizona project water supply, and that, under 2030 conditions, the average spills exceeds the total amount of water supplied to central Arizona project from the Colorado River.

I would like to have someone from the Secretary's staff explain this peculiar situation.

Secretary UDALL. Mr. Chairman, I wonder if we could include that answer also. It is related to the questions you asked earlier.

Mr. ASPINALL. I think it is very important.

Mr. JOHNSON. Mr. Secretary, you will furnish that?

Secretary UDALL. Yes, indeed.

Mr. ASPINALL. In other words, it would appear that most of the water from the central Arizona project is supplied from reservoir spills which would not be available if we adopt a period of runoff beginning in 1922, when we entered into the Colorado River Compact.

(The material referred to follows:)

Basically, the Colorado River water supply for the Central Arizona Project will come from two sources: (1) regulated releases from Glen Canyon Dam and (2) spills from Glen Canyon Dam into the Lower Basin. Referring to the water supply analysis for the Central Arizona Project summarized in the table on page 96 of the March 1967 record of hearings on H.R. 3300 and similar bills, the breakdown of the estimated CAP water supply between these two sources is as follows:

[In thousands of acre-fee]

Source	1975	1990	2000	2030
Regulated release	1,650	1,020	730	284
Upper basin spills	0	235	296	392
Total [1]	1,650	1,255	1,026	676

[1] With aqueduct capacity of 2,500 cubic feet per second.

Spills from the Upper Basin would serve other uses than CAP water supply. An approximate accounting of the Upper Basin spills shown on the referenced table is as follows:

[In thousands of acre-feet]

Use	1975	1990	2000	2030
CAP water supply	0	235	296	392
California water supply	247	287	254	164
Unused Arizona entitlement [1]	247	283	232	146
Increased evaporation from Lake Mead	126	119	103	153
Spill to Mexico	653	269	148	158
Total	1,273	1,193	1,033	1,013

[1] Available to Arizona with a larger aqueduct than 2,500 cubic feet per second. If aqueduct is limited to 2,500 cubic feet per second, essentially all of this water would be additional spills to Mexico.

The estimated spills shown above are, of course, averages over the period 1906–1965. During such a cycle actual spills would be limited to a few years. If the runoff period 1922–1965 were used as the basis for analysis, our studies indicate that there would be no spills, either from Glen Canyon or from Hoover, and thus the entire water supply for CAP would come from regulated releases at Glen Canyon.

Mr. ASPINALL. In addition, it is hard for me to see how these spills are made usable to the extent indicated even if the period 1906 to 1967 is used. Where are you going to use this water under the proposals you have in the central Arizona project as such? How are you going to have it used?

You are not going to have it in Lake Mead. You are not going to have it in the rivers below. Are you going to carry it through the aqueduct and store it in central Arizona?

Where are you going to use the water?

Mr. RITER. The numbers I gave you are spills from Lake Mead, These would not be usable, sir.

Maybe you are referring to spills from Lake Powell.

Mr. ASPINALL. I am referring to the spills you suggested are going to be available to take care of the project.

Mr. RITER. The numbers I read to you from the record, the spills from Lake Mead, are nonusable.

Mr. ASPINALL. You don't mean that, because they will surely be picked up by the Yuma project or the California users. Do you mean to say they are going to go into the Gulf of California?

Mr. RITER. Yes, sir; at least into Mexico.

Secretary UDALL. Mr. Chairman, I think it is very clear that we have a big job on our hands to answer clearly, as clearly as we can, the question that you have posed here. We will certainly do so.

Mr. ASPINALL. Primarily, Mr. Secretary, Mr. Dominy, Mr. Riter, what I am trying to find out is what you are going to do with these spills between upper basin, which is Glen Canyon, and the Lake Mead supply. What are you going to do with those waters?

Are they going to be wasted?

Mr. RITER. Congressman Aspinall, the spills from Lake Powell we anticipated will be largely conserved in Lake Mead and used in lower basin projects.

Mr. ASPINALL. Well, if I have your figures correctly as they have been set forth, for the year 1975, you say the upper basin spill will be 1,273,000.

Mr. RITER. That is what our tables show.

Mr. ASPINALL. And the Lake Mead spill will be 653,000?

Mr. RITER. That is right.

Mr. ASPINALL. You have a recovered spill of 620,000. What are you going to do with that water?

Mr. RITER. That will be used in the lower basin, either in central Arizona or some of the lower basin projects.

Mr. ASPINALL. You have a spill in the year 2030 of 1,013,000. You have a Lake Mead spill of 158,000. That leaves a recoverable spill of 855,000. That is 85 percent. What are you going to do with that water?

Mr. RITER. Part of that will be diverted by the central Arizona project. Part of it will be diverted by other projects in the lower basin, sir.

Mr. ASPINALL. Mr. Secretary, before leaving this matter of virgin flow, I want to say I have no confidence in the stream flow records prior to 1922, as you might assume. I believe that my views are shared by most of the experts in this field who have studied this matter, other than the Bureau of Reclamation. In 1953, the State of Colorado hired the firm of Leeds, Hill & Jewett, to report on the availability of water for use in the upper basin and, in 1965, the Upper Colorado River Commission had an exhaustive series of studies made by the internationally recognized engineering firm of Tipton & Kalmbach. It is too bad Mr. Tipton has departed this world. Neither of these firms has agreed with the Bureau of Reclamation in this matter.

It has been 10 years since the progressive 10-year-average virgin flow assumed by the Bureau of Reclamation, and during this 35-year period the trend has been consistently down, as shown by your chart. You will not find this situation in any other river basin in the United States. It seems completely unreasonable to me to attribute this decline in water use entirely to the occurrence of a drought cycle.

Mr. Secretary, do you agree with me that over this period, there have been other scientific reasons for the declining water supply, such things as change in watershed conditions or anything else? What is the opinion of your experts?

Secretary UDALL. I don't think, Mr. Chairman, that we attribute the decline to any major changes in the watershed; watershed conditions that would affect runoff. I think it is our judgment that this is one of the most severe drought cycles in the long history of the Colorado, as indicated by tree-ring records.

Mr. ASPINALL. Mr. Secretary, the second assumption involved in the water supply involves upper basin depletions. In your statement, you point out the differences between the Bureau's estimate and the upper basin estimate of such depletions.

I want the members of the committee to understand how the difference in these estimates could make a big difference in the water availability in the lower basin.

In your statement, by the way, Mr. Secretary, you have taken it upon the Office of the Secretary to determine how these depletions will take place in the upper basin when the use of these waters under the compact are decisions for the upper basin States to make and they have their depletion studies also.

Your statement indicates that, by the year 1990, the Bureau estimates upper basin depletions at only 5,100,000 acre-feet, while the upper basin estimate—this is by the Upper Colorado River Compact Commission—shows 6,342,000 acre-feet. Members of the committee should note that the difference between these two figures is about the same amount as the average annual water supply for the central Arizona project.

I think you would agree to the determination that that is the difference.

Secretary UDALL. I cannot argue with your mathematics, Mr. Chairman; we do have a difference on certain assumptions that are made.

Mr. ASPINALL. Mr. Secretary, who do you think is in the best position to estimate the upper basin development—the Bureau of Reclamation or the States themselves who have a right to this water?

Secretary UDALL. I think we are both in the picture. I cannot argue with you that the States involved have a right to determine the schedule on which they want to make depletions, but because the Bureau of Reclamation will build the projects, because the Federal Government, Federal financing and a schedule of Federal action are involved, I think we are really both in the picture. Obviously we disagree on certain assumptions.

Mr. ASPINALL. We agreed, I think, in this assumption, that we want the river developed and that we want the river developed coordinately for the benefit of all sections of the river. On the other hand, I have heard some statements coming from Arizona to the effect that if they didn't get this project as a Federal project they would go ahead and build it themselves.

If Colorado should assume this same position, the Bureau of Reclamation wouldn't have very much to say about the depletion of the upper basin, would it—or if the State of Wyoming or the State of Utah should take that position? You wouldn't have very much to say about it as far as the representative of Federal Government, would you?

Secretary UDALL. That is an argument that cuts both ways. There are many problems attendant to the State building projects on their own, as I think some of the Arizona people have found out.

But, in a sense, one could make the argument the chairman is making, just as others have made the argument in a similar way.

Mr. ASPINALL. I am not asking for your agreement. What I am trying to say is that it isn't necessarily beholden on the Department of Interior or the Federal Government to determine what the development in the upper basin is going to be.

That is a matter for the States concerned and for the Congress of the United States. Is that not correct?

Secretary UDALL. I think I would have to agree with you in part that we do not have complete control.

Mr. DOMINY. Mr. Chairman, in appearing here in support of the central Arizona project authorization, I think it is proper for us to point out some weaknesses in the projection the upper basin has used. I do not agree with it. I think ours are much more realistic.

For example, Mr. Tipton showed an increase in upper basin depletion of nearly 3 million acre-feet between his study of a couple of years ago and 1985. Now, considering that, over the past 100 years, uses have developed to deplete the upper basin by only 2,800,000 acre-feet, we don't believe it is realistic to show uses developing in the next 17 years that will require depletion in excess of that amount.

Mr. Tipton shows full depletion by 1985, both on the Navajo Indian irrigation project and the Bonneville-central Utah project. I just don't think that this is possible of achievement by a long way. It would involve full development of 110,000 acres and full water depletion of 250,000 acre-feet by 1985 on the Navajo Indian irrigation project and 166,000 acre-feet of depletion by 1985 on the Bonneville unit of the central Utah project. I don't think it can be done.

Mr. Tipton shows full depletion of all five upper basin projects by 1985. Even if they were built concurrently with the central Arizona project, all the lands would not be in production nor would all the

water be depleted by 1985, by even an optimistic estimate. It isn't possible.

Mr. Tipton shows 40,000 acre-feet being used in the four counties area of northeast Colorado by 1975. That use has been in controversy, is still in controversy. If it were resolved today, the projected water use could not be accomplished by 1975. The Seedskadee project, Mr. Tipton shows full depletion by 1980 on that project. That is not possible of achievement.

I defend the project projections the Bureau made. We have been in the business for a long time and we have no special axes to grind.

Mr. ASPINALL. I just want to say Mr. Dominy has defended the projections that the Bureau has made. This is his proposal as far as that is concerned. If it conflicts with the other information, he is certainly of a right to make that statement.

Mr. BURTON of Utah. Before you leave that point, I would like to draw it out a little better on the record.

When Congress seemed unsure of the central Arizona project, there were people in Arizona who said they would go it alone. Nobody in the Federal Government said Arizona did not have the right to go it alone. Is that correct?

Secretary UDALL. I think they have the right to go it alone. I think they can undoubtedly put a project of some kind together. There is no doubt that the water cost would be substantially higher. I think the State has the resources, I think it has the determination that, if once it were made clear there were to be no Federal legislation, you would see quite a movement in the State. That is my own judgment.

Mr. BURTON of Utah. If the gentleman from Colorado would yield further, that is the point, simply to ascertain that the compact rights of the seven States involved are inviolate, as far as I see it, from the Federal standpoint or Department of Interior standpoint.

If I may add this one point, Mr. Chairman, some people have fears in my State that if this project is built the ultimate fate of central Utah may never come to pass.

Because, as you indicated in your statement, Mr. Secretary, I think on page 9, it is unlikely that any Federal developments will be authorized when the river is virtually dry. However, there have been some people in Colorado and in Wyoming and in Utah who have said that, if we are not able to use our entitlement through the benefit of Federal projects, some of the States involved might use this water in the development of oil shale should this resource be developed in the future. I cannot see any reason why Utah or Colorado or Wyoming could not go it alone on certain reclamation projects if they choose or why they could not use the water in oil shale development in future years if they choose, without interference from the Department of the Interior.

Would you agree with that?

Secretary UDALL. I think whatever option Arizona has to go it alone the other States have a similar option. The only other ingredient is their own determination or their own desperation, as it might exist.

I want to add one other comment, though, because we develop quite a pessimistic, gloomy mood when we discuss it this way. I have been an optimist all along about the future of this region. This is one of the fastest growing regions in the country. This country is strong

enough and has the technological capability, I think, in one way or another to augment this river. Rather than talking about us running out of water, I think, if we get this legislation behind us, creative talk can then begin in the whole region about the various means of augmentation. That is the reason that I do not like to think we are heading down the road where a river runs dry. I do not like that kind of speculation.

Mr. BURTON of Utah. I share your optimism, Mr. Secretary, I wish I could get Mr. Wyatt here to join with me.

I thank you gentlemen for yielding.

Mr. UDALL. Would the gentleman yield?

I thoroughly agree with what has been said. Augmentation, as your statement said, makes all these questions academic. But talking about the determination of States to go it alone; there is determination in Arizona and I don't think there is any doubt about it that we are going to go the Federal route.

Mr. ASPINALL. I think my friend from Arizona, he is not speaking about water from the upper basin. The upper basin has control of its own water in the compact.

Mr. JOHNSON. Would the gentleman yield on that point?

Mr. ASPINALL. Yes.

Mr. JOHNSON. I want to say that that is California's real interest in this matter, that we have taken it upon our own and moved over to the river. We want to stay there and receive our share. That is our real interest.

Mr. ASPINALL. Let me get back, Mr. Chairman, to my question.

Let me point out, Mr. Secretary, that if we take the present depletion in the upper basin, and add projects already authorized, the total upper basin depletion will amount to four and a half million acre-feet of water. Do you believe, Mr. Secretary, that between now and 1990 there will be additional development, both Federal and non-Federal, which will result in the depletion of only an additional 600,000 acre-feet of water?

Secretary UDALL. Mr. Chairman, I would really rather provide a written reply, if I may, to that question.

Mr. JOHNSON. All right. I will ask permission to insert it.

The five upper basin projects authorized in this legislation alone involve the depletion of about 400,000 acre-feet of water. The question then is what is the answer on both of these questions.

You will furnish the information and put it in the record at this point.

Secretary UDALL. Yes.

Mr. ASPINALL. I ask unanimous consent.

Mr. JOHNSON. Do I hear objection to the request of the gentleman from Colorado?

Hearing none, it is so ordered.

(The material referred to follows:)

Studies made in 1965 show the "present" depletions in the Upper Colorado River Basin at Lee Ferry to be 2,878,000 acre-feet. The following table lists the estimated ultimate additional depletions from expansions of existing and authorized Federal and non-Federal projects and by the five Upper Basin Federal projects included for authorization in H.R. 3300. The table shows also

the Bureau of Reclamation estimate of the amount of the ultimate additional depletion that would be attained by the year 1990.

[In thousands of acre-feet]

State	Project	Additional depletion	
		Ultimate	By 1990
All	Evaporation, Colorado River storage project	570	570
Arizona	Industrial use	39	39
Colorado	Silt	6	6
Do	Fryingpan-Arkansas	70	70
Do	Independence Pass expansion	14	14
Do	Bostwick Park	3	3
Do	Fruitland Mesa	28	28
Colorado-Wyoming	Savery-Pot Hook	38	38
Colorado	Denver expansion	215	135
Do	Colorado Springs expansion	6	6
Do	Homestake	74	58
Do	Englewood	10	10
Do	Pueblo expansion	3	3
Do	M. & I. from Green Mountain Reservoir	12	12
Do	Expansion, Hayden steamplant	12	8
Colorado-New Mexico	Animas-La Plata	146	79
Colorado	Dolores	87	69
Do	Dallas Creek	37	29
Do	West Divide	76	30
Do	San Miguel	85	40
New Mexico	Farmington M. & I	5	0
Do	Additional use, Hammond	5	5
Do	San Juan-Chama	110	110
Do	Navajo Indian	250	170
Do	Expansion, Hogback	10	10
Do	Additional use, Utah construction	25	25
Do	M. & I. from Navajo Reservoir	[1] 0	100
Utah	Additional use, Vernal unit	2	2
Do	Bonneville unit	166	150
Do	Upalco unit	20	20
Do	Jensen unit	10	10
Do	Emery County	17	17
Do	Industrial Resources, Inc	102	102
Wyoming	Seedskadee	165	145
Do	Lyman	10	10
Do	Additional use, Westvaco, etc	36	36
Do	Cheyenne M. & I	31	26
Total at sites of use		2,495	2,185

[1] Proposed contracts would expire in year 2005.

Without making allowance for future salvage of channel losses between the sites of use and Lee Ferry, these numbers, added to estimated "present" depletions, indicate a total depletion of 4,972,000 acre-feet by the year 1990, or 128,000 acre-feet less than the 1990 depletion projected by the Bureau of Reclamation. Taking into account the salvage potential of 60,000 acre-feet, this would allow for 188,000 acre-feet of additional uses not identified in the above table.

Mr. ASPINALL. On the matter of water loss, I have no real disagreement with the Secretary except to point out that the Bureau's estimate of water losses is based upon having the salvage program and salvage works in operation. They are not computed at the present time and until they are, of course, water losses will naturally be higher.

I would like to have permission, Mr. Chairman, to put in the record at this point the detailed statement that puts in the record my views on the virgin flows and the upper basin depletion of the Colorado River Basin.

Mr. JOHNSON. Is there objection to the chairman's request?

(No response.)

Mr. JOHNSON. Hearing none, is it so ordered.

(The material referred to follows:)

COMMENTS ON WATER SUPPLY BY MR. ASPINALL

Throughout history the Upper Division States (Colorado, New Mexico, Utah and Wyoming) have relied upon the Colorado River Compact of 1922 and the Upper Colorado River Basin Compact of 1948 for their protection. These documents are supposed to protect (1) the right of the Upper Colorado River Basin to develop water apportioned to it as a whole, and (2) the right of each of the Upper Division States to conserve and utilize its share of the Upper Basin water. Their reliance on these documents is still predicated upon confidence in the approval by the Congress of these two keystone documents.

Due to the relatively slower rate of growth of the States of the Upper Basin as compared with the population and economic expansion of the Lower Basin, and political influences beyond their control, the four Upper Division States have had to wait until the Supreme Court resolved differences between Arizona and California before the Upper Basin could move ahead with its water resources program. For instance it was not until the last lawsuit Arizona v. California was well under way that a real Federal program of water development could be initiated in the Upper Basin.

In contrast to the legal entanglements among the Lower Division States the Upper States made their own decisions pertaining to the apportioning of water among themselves by means of the Upper Colorado Basin Compact. By approving this compact for the Upper Basin States the Congress for the second time strongly expressed its intent to preserve and protect the development of the water resources of the Upper Basin until social and economic conditions proved their conservation and utilization to be necessary in the best interests of the region and the Nation.

The Congress approved the Colorado River Storage Project Act in 1956. This Act is a comprehensive basin-wide integrated program of water and related natural resources development for the States of Colorado, New Mexico, Utah and Wyoming. In this Act the Congress for the third time expressed its intent to utilize the waters of the Colorado River system in the Upper Basin for the development of that region.

For the past 20 years this Committee has been subjected to a barrage of conflicting testimony pertaining to the amount of available water in the Colorado River system. Almost every occasion when legislation involving the Colorado River has been considered we have heard testimony indicating wide differences of opinion with regard to the dependability of the water supply actually remaining available for consumptive use. For this reason when H.R. 4671 of the 89th Congress, a predecessor bill to the pending legislation, was before the Committee I requested all of the States of the Colorado River Basin to compile up-to-date water supply analyses and to state their positions in the light of the results. During the course of the hearings on H.R. 4671 the Committee received testimony concerning three detailed analyses of water supply. These analyses were prepared by engineers at the Bureau of Reclamation, by engineers of the States of Arizona, California and Nevada, and by the engineering firm of Tipton and Kalmbach, Inc. (under the auspices of the Upper Colorado River Commission). The three sets of studies were based upon different assumptions as to net channel and evaporation losses, rates of increase of Upper Basin stream depletions and in some instances the periods of stream flow records. The studies of the Upper Colorado River Commission embraced many combinations of these factors.

The most important result of these three analyses is the surprising degree of agreement with respect to the water supply remaining available for development in the Basin. The differences in the final results of the three studies relate only to the expected time when utilization of the entire water resources of the Basin will be accomplished.

The Upper Basin's Colorado River Storage Project is based upon the principle of long-term holdover water storage—the holding of water in reservoirs from good water years to be used in the lean years. In fact, this is the fundamental concept and Congressionally expressed intent of the law under which the Upper Basin's water development program was authorized. Departmental witnesses in 1954 and 1955 told this Committee that it was only under such a long-term, holdover storage principle that the Upper Division States could put to use their

compact-apportioned water supplies without curtailing their uses in lean water years. The Department in its report that it transmitted to the Congress in support of the Colorado River Storage Project stated:

"A capacity of 23 million acre-feet would be reserved in project reservoirs for long-time regulatory storage. The water stored would be released as needed in drought periods to meet the compact obligation at Lee Ferry. The reservoirs would be refilled during years of favorable water supply. In a dry decade such as that of 1931–40, release of the entire 23 million acre-feet would be necessary to meet the Lee Ferry obligation. A storage release in that amount would be necessary even if water uses in the upper basin were naturally curtailed by the drought, resulting in a depletion at Lee Ferry somewhat less than the compact-permitted 7,500,000 acre-feet annually.

"Present flows in the upper basin are adequate to meet the 10-year Lee Ferry obligation. Within 20 or 25 years, however, the depletions are expected to increase to the extent that curtailment of consumptive uses will be necessary in protracted dry periods unless some storage water is available for delivery to the lower basin. If the required storage works are to be available when needed, steps toward construction should be taken immediately. An extended construction period will be required and the reservoirs should be filled initially while unused apportioned water is available."

It is this limited supply of "unused apportioned water" that is the subject of controversy in this legislative effort.

I am sure that the Department still holds the view that its statement of 1954 is correct with respect to this point. I want to remind this Committee that at the time (1954) that the Deparment reported on the Colorado River Storage Project its witnesses were telling us that there was no doubt that there was a water supply available for Upper Basin development under the Colorado River Storage Project. This assertion was true because, at that time the Upper Basin States were using only 2 to 2½ million acre-feet of their compact apportionment of 7½ million acre-feet of consumptive use. I also wish to remind the Committee that in 1954, as mentioned by the Department, a minimum 10-year average of 11.8 million acre-feet of virgin flow at Lee Ferry was behind us. But, also at the same time the river was entering another 10-year period (1954–63) of minimum average virgin flow at Lee Ferry of only 11.8 million acre-feet. This record is now available. It was not in 1954. These two 10-year periods of minimum flows are far below that required to provide full compact-apportionments of 7½ million acre-feet of consumptive use per year to each of the two basins. As a matter of fact, the Department has pointed out that the average virgin flow for the period since the signing of the Colorado River Compact, 1922–1967, has been only 13.7 million acre-feet, and for the 1906–1967 period only 14.9 million acre-feet. Both figures are also below compact apportionments to the Upper and Lower Basins. The Department favors the use of the 1906–1967 period of record only because under that record can the Department find a water supply for the Central Arizona Project by using fairly large amounts of water presently unused by the Upper Basin, but the use of which has been apportioned to the Upper Basin. And let me remind you that this water will be put to use in the Upper Basin States at rates much more rapidly than those assumed by the Department in its studies.

Furthermore, the Department in order to find a water supply for a Central Arizona Project is forced to utilize so-called "spills" from the Upper Basin on an average annual basis. The use of those spills in water supply analysis on an annual basis is certainly open to question for the simple reason that they do not occur in that manner over a 62-year period. In other words, this type of analysis ignores the fact that all of the spills were interspersed in 24 years prior to 1929 and that in the following 36 years only regulated releases would be available for a Central Arizona Project water supply. In view of the present small amounts of water in Lake Powell and Lake Mead, only regulated releases can be anticipated for several more years. The question therefore arises as to the use of spills by the Department in its water supply analysis since past records and present conditions could preclude spills for 40 or more consecutive years. This places the water supply for a Central Arizona Project in a very precarious situation.

On the basis of the 1906–1965 period used by the Department's table in the Senate report on S. 1004, the spills are shown as averaging under 1975 conditions 1,273,000 acre-feet per year for the 60-year period; 653,000 acre-feet as shown as being lost as spill from Lake Mead. The recovered amount—620,000 acre-feet—is a substantial part (35%) of the supply contemplated for a Central Arizona

Project in 1975. It is interesting to note that the proportion of the Central Arizona Project water supply that is expected to be salvaged from Upper Basin reservoir spills is anticipated to increase in subsequent years as follows:

60-YEAR ANNUAL AVERAGE CAP WATER SUPPLY FROM UPPER BASIN SPILLS

[In acre-feet]

Year	Upper basin spill	Less Lake Mead spill	Recovered spill	Total water supplied CAP from Colorado River	Percent of total supplied from recovered spill
1975	1,273,000	653,000	620,000	1,759,000	35
1990	1,193,000	269,000	924,000	1,231,000	75
2000	1,033,000	148,000	885,000	1,011,000	88
2030	1,013,000	158,000	855,000	[1] 673,000	100

[1] The danger of depending upon the recovery of such hypothetical spills is partially recognized in the footnote of the table, which states: "Although the average yield under the year 2030 condition would be 723,000 acre-feet, the assured yield would be less than ½ of this figure * * *."

The Secretary in his statement mentioned that the Bureau of Reclamation in response to my request had estimated the average annual virgin runoff at Lee Ferry on the basis of the 1906–67 records and had found it to be 14,963,000 acre-feet instead of 15,063,000 acre-feet for the period 1906–1965, a reduction of 0.7 percent. The 0.7 percent, although algebraically correct, is misleading unless other factors are taken into consideration. When considered as an effect upon the annual average, it cannot be spread as 6.2 million acre-feet over the entire 62-year period, but only over the 15 years since 1952 because the Upper Basin reservoirs could logically be expected to refill in 1952, if they were ever to fill again. The critical difference would then be 400,000 acre-feet over 15 years instead of 100,000 acre-feet over 60 or 62 years. The important point, however, is that either the 400,000 or the 100,000 acre-feet would, in reality, constitute a serious item in the Central Arizona Project water supply.

I mentioned a moment ago that water remaining to be developed in the Upper Basin will be put to use at rates much more rapidly than those assumed by the Department in its studies. Certainly I believe that I have a sound foundation for assuming that the Department has a major inconsistency in its assumptions pertaining to future stream depletions in the Upper Colorado River Basin. In the Senate Committee report on S. 1004 the Department shows Upper Basin depletions as follows:

Year:	*Depletion (acre-feet)*
1975	4,220,000
1990	5,100,000
2000	5,430,000
2030	5,800,000

According to records submitted to the Senate Committee and to which the four Upper Division States and Upper Colorado River Commission agreed, present and imminent stream depletions in the Upper Basin States amount to 4,392 acre-feet distributed as follows:

[In thousands of acre-feet]

State	Present depletion	Authorized Federal projects	State total
Arizona	11		11
Colorado	1,786	516	2,302
New Mexico	145	444	589
Utah	579	365	944
Wyoming	267	279	546
Total			4,392

To the above total must be added 100,000 acre-feet for municipal and industrial water contracts from Navajo Reservoir in New Mexico, (three contracts to use 51,550 acre-feet of this 100,000 acre-feet are now before this Committee) 20,000 acre-feet for the Unitah Unit of the Central Utah Project and 102,000

acre-feet for the Kaiparowits power development in Utah because these water uses are now in definite planning stages. These additions would bring the total to 4,614,000 acre-feet. If the thermal electric generating plant contemplated in pending legislation is to be constructed, Arizona's additional Upper Basin depletion would raise the total to 4,643,000 acre-feet or 433,000 acre-feet more than the Department allowed for Upper Basin depletions for year 1975. Adding five Upper Basin projects to be authorized in the bills before you would cause the Department's estimate to be short by 824,000 acre-feet annually as of 1975, or between 1975 and 1980, depending upon the time of completion of those projects. In addition, non-Federal projects under active consideration could run this deficit even higher which, if taken into account in the Department's analysis would eliminate a large segment of the water supply contemplated for the Central Arizona Project in years 1975 or 1980, again depending upon the date of completion of the Central Arizona Project and the other projects. You should be reminded that the Department contemplates delivery of water to the Central Arizona Project by not later than the year 1979.

These probable water deficits that I have mentioned are based upon the Department's application of a long-term high-flow water supply assumption to which I also cannot agree. Therefore, it appears quite clearly that the Department's study demonstrates that a water supply can be made available for a Central Arizona Project only by throttling future Upper Basin water uses, unless a Colorado River water supply augmentation is put into effect almost simultaneously with the Central Arizona Project. Apparently the Secretary seems to agree with me because in his statement I notice that he agrees that land and other resources in the Upper Basin could be physically developed to deplete water at the rate the Upper Basin estimates it could be depleted. He then adds that it does not appear likely that projects which would completely dedicate the Upper Basin's total remaining unused Colorado River water supply to specific areas or uses would be developed at rates commensurate with Upper Basin projections. Could it be the intention of the Department to put a brake on the Upper Basin development through enactment of this legislation? Certainly I would have to agree that if water that is apportioned to the Upper Basin is put to use in the Lower Basin the chances of the Upper Basin's ever getting it returned are extremely doubtful. This is especially true, also, without an in facto resolution of the magnitude of the Upper Basin's obligation to deliver water to fulfill the burdens of the Mexican Treaty.

Mr. Chairman, at this point I wish to insert into the record tables showing the present stream depletions, authorized Federal projects, probable future depletions, etc.:

TABLE I.—*Upper Colorado River Basin stream depletions*

COLORADO

	Units: 1,000 acre-feet accumulated
1. Present depletions:	
Yampa and Green Rivers	65
Hayden Steam project	4
White River	34
Gunnison River	407
Smith Fork project	6
Paonia project	10
Colorado River—Main stream	481
Collbran project	7
Pueblo—Eagle River division	8
Colorado—Big Thompson project	260
Small ditches	1
Colorado Springs—Blue River	45
Denver—Blue River	15
Denver—Moffat Tunnel	63
Denver—Williams Fork	10
Busk—Ivanhoe Tunnel	5
Independence Pass Tunnel	38
Grand River ditch	20
San Juan and Dolores Rivers	289
Florida project	16
Total	1,786

TABLE I.—*Upper Colorado River Basin stream depletion*—Continued

	Units: 1,000 acre-feet accumulated
2. Authorized Federal projects:	
Savery—Pot Hook	26
Bostwick Park	4
Fruitland Mesa	28
Fryingpan—Arkansas	70
Ruedi Reservoir, municipal and industrial	6
Silt	6
Mainstream evaporation	342
Total	482
3. Probable future depletions:	
Hayden steam plant	12
Homestake Creek diversion	74
Pueblo—Eagle River	3
Denver—Blue River Denver—Moffat Tunnel Denver—William Fork Denver—Eagle and Piney Rivers	215
Englewood—Moffat Tunnel	10
Independence Pass Tunnel	14
Colorado Springs—Blue River	6
Municipal and industrial from Green Mountain Reservoir	12
Total	346
4. Proposed authorization—H.R. 3300:	
Animas-La Plata	106
Dolores	74
Dallas Creek	37
West Divide	76
San Miguel	85
Total	378
Grand total	2,992
NEW MEXICO	
1. Present depletions:	
Utah construction	15
Navajo Reservoir evaporation	20
Hammond	10
Other existing uses	100
Total	145
2. Authorized Federal projects:	
San Juan-Chama	110
Navajo Indian irrigation	250
Mainstream evaporation	74
Navajo Reservoir evaporation	10
Total	444
3. Probable future depletions:	
Town of Farmington	5
Utah construction	25
Navajo Reservoir contracts	100
Navajo Indian Hogback	10
Total	140

TABLE I.—*Upper Colorado River Basin stream depletion*—Continued

	Units: 1,000 acre-feet accumulated
4. Proposed authorization—H.R. 3300:	
Animas-La Plata	34
Total	34
Grand Total	763
UTAH	
1. Present depletions:	
Depletions as of 1952	407
Subsequent Utah Water and Power Board projects	25
Municipal and industrial uses not included elsewhere	4
Private developments	3
Miscellaneous exports	108
Central Utah project Vernal unit	10
Miscellaneous evaporation	22
Total	579
2. Authorized Federal projects:	
Central Utah project:	
Bonneville unit	166
Upalco unit	20
Jensen unit	10
Emery County project	17
Main stream evaporation	152
Total	365
3. Probable future depletions:	
Uintah Unit central Utah project	20
Kaiparowits power development	102
Total	122
4. Proposed authorizations—H.R. 3300	0
Grand total	1,066
WYOMING	
1. Present depletions	267
Total	267
2. Authorized Federal projects:	
Seedskadee	165
Lyman	10
Savery-Pot Hook	12
Main stream evaporation	92
Total	279
3. Probable future depletions:	
Westvaco Industrial	41
Cheyenne and Laramie Division	30
Total	71
4. Proposed authorizations—H.R. 300	0
Grand total	617

TABLE II.—SUMMARY OF UPPER COLORADO RIVER BASIN DEPLETIONS

[In thousands of acre-feet]

	Arizona	Colorado	New Mexico	Utah	Wyoming	Total
1. Present	11	1,786	145	579	267	2,788
2. Authorized Federal projects		482	444	365	279	1,604
3. Probable future	39	346	140	122	71	758
4. Proposed authorizations, H.R. 3300		378	34			425
Total	50	2,992	763	1,066	617	5,575

TABLE III.—COMPUTED COMPACT ALLOTMENTS BASED ON VARIOUS ASSUMED WATER SUPPLIES

[In thousands of acre-feet]

	Arizona	Colorado	New Mexico	Utah	Wyoming	Total
7,500,000 acre-feet available	50	3,855	838	1,714	1,043	[1] 7,500
6,300,000 acre-feet available	50	3,234	703	1,438	875	[2] 6,300
5,600,000 acre-feet available	50	2,872	624	1,277	777	[3] 5,600
5,800,000 acre-feet available	50	2,976	647	1,322	805	[4] 5,800

[1] Based on full compact amount being available.
[2] Amount from Tipton report limited by historic flow and 7,500,000 acre-foot Lee Ferry delivery.
[3] Amount from Tipton report limited by historic flow and 8,250,000 acre-foot Lee Ferry delivery.
[4] Amount available as estimated by U.S Bureau of Reclamation.

The Secretary, as part of his testimony, included a table purporting to show basic differences in projection of Upper Basin stream depletions using a table of comparison of the Tipton depletions with those assumed by his Department. I wish to point out that the table is not complete. The Tipton report also included studies of the Bureau of Reclamation's assumptions of Upper Basin stream depletions in about half of its operation analyses. The Tipton report used projection of depletions as estimated in 1965. Delays in assumed date of construction of the Central Arizona Project and other reclamation projects would necessarily change these rates of assumed depletions if they were to be made today or as of 1970, for example. The same changing conditions would also affect assumptions of the Department. The Bureau of Reclamation's depletions do not include uses of water by all five Upper Basin projects included for authorization in this legislation.

The three million acre-foot difference between the Bureau's and States' stream depletion estimates includes some 650,000 to 700,000 acre-feet already committed to use in mainstream developments and about 400,000 acre-feet for the five Colorado projects. The rates assumed for depletions by the Central Utah and Navajo Indian Irrigation projects were questioned even though those projects are currently under construction. The fact that they may be completed by 1975–1980 or 1985 is not the real issue. If their rate of construction is slower than earlier anticipated, so will be the rate of construction of other reclamation projects. The Secretary has already extended the time of delivery of Central Arizona Project water several years to 1979. The time element, then becomes only relative. The assumptions with regard to physical factors still remain valid even if modified by a change in time of their application.

We have reached the stage in the Colorado River Basin where we are rapidly developing the last increments of the available water supply. Under these conditions, the risks of over development of the water, or of over estimating the supply and causing serious injury to existing and potential economies become compounded. Certainly anyone would have to agree that during the early 1950s, approximately 15 years ago, when the Colorado River Storage Project was being considering by the Congress, the risks of over estimating the available water supply were minor compared with the adverse effects that could result today. This is true because in the 1950s the Upper Basin States were consuming only 2 to 2½ million acre-feet of water per year contrasted with 4.6 million acre-feet that are and will be consumed by presently constructed and authorized projects. In other words, the amount of water remaining to be developed was much greater in the 1950s that it is today. It is more important today than ever before to avoid the risks associated with possible inaccuracies or over estimation from stream

flow records prior to 1922. The Department itself has pointed out that on the basis of the 1922 to 1967 period for which actual measured records at Lee Ferry are available, the virgin flow is estimated to be 13.7 million acre-feet as contrasted to 14.9 million acre-feet for its so-called long term period of 1906 to 1967.

I do not share the confidence that the Secretary seems to have in the stream flow records prior to 1922 for several reasons. First, the Department itself in its 1954 report in H. Doc. 364 on the Colorado River Storage Project mentioned that inaccuracies are risked with the extension of records prior to 1914. In order to avoid part of these risks the Department in its report on the Colorado River Storage Project extensively used the 1914 to 1947 period of water supply records. Of course, at that time (1954) as I have mentioned above, there was plenty of water available for the Colorado River Storage Project under almost any period of records that might be used.

Second, the Secretary has mentioned that continuous water records since 1906 are available at points upstream from Lee Ferry which measure about 70% of the runoff, and continuous records are available downstream from Lee Ferry since 1906 which can be used by statistical correlation methods to produce estimates of flow at Lee Ferry prior to 1922. Considering the risks involved in a possible over estimation of the water supply, I cannot ignore the advice of eminent hydrologists of the U.S. Geological Survey that data for accurate definition of extremes of stream flows are generally deficient. It should be remembered that the estimates of stream flows prior to 1922 involve a majority of the extremely high flows of the Colorado River. According to the Geological Survey experts:

". . . tests of the performance of the existing streamflow network in furnishing information from which to estimate flow at ungaged points are being carried out by the Geological Survey using multiple regression methods. A sampling of the network—in the Potomac River Basin, the Central Valley of California, Kansas and Louisiana—suggests that it performs well as a base from which to estimate flows in the mediun range (error of estimate ± 20%), but that it is deficient as a base from which to estimate extremes of flow."[1]

In 1968, considering the availability of our present day sophisticated hydrological methods, not much imagination is necessary to raise doubts about the estimates of extremes of the Colorado River flows between 1906 and 1922, or 45 to 61 years ago, when relatively primitive methods of measurement were used at the gaging stations that are now employed to estimate by correlation the synthesized flows at Lee Ferry.

It should be understood by the Committee, after hearing Secretary Udall and Commissioner Dominy and myself on this question of adequacy of a dependable water supply, that my objection, in a critical water supply situation, to the use of estimates (not actual measurements) of certain stream flow records prior to 1922 is based not on their questioned accuracy alone. I also question seriously the actual ability to utilize effectively the extensive spills that result on paper from the inclusion of these early estimates. No matter where the records start, an hydrologist must account for the low flow years following 1930. All of the computed annual reservoir spills cannot be carried over and fully utilized in the dry years following 1930 because of the limitations on reservoir space and the inability of man to forecast anticipated water yields from weather sufficiently far in the future with the required degree of accuracy.

Once the spills from Lake Powell have been stored in Lake Mead, it also fills. This filling is a rapid occurrence under the application of the stream flows in the years following 1906. How can you expect to store more Lake Powell spill water when both reservoirs are full?

Third, I cannot ignore the fact that in the early 1950s the late Silmon Smith, a renowned water attorney from western Colorado, found after extensive study that the ultimate stream depletion available for the Upper Colorado River Basin would be not more than 6.1 million acre-feet annually. This means that the average virgin flow at Lee Ferry would be close to 13.7 million acre-feet. Furthermore, in 1953 the State of Colorado hired the firm of Leeds, Hill and Jewett to report on availability of water for use in the Upper Basin. This report places the limit on stream depletion by the Upper Basin at 6.2 million acre-feet per year. Again, in 1965 the Upper Colorado River Commission had an exhaustive series of studies made by the worldwide engineering firm of Tipton and Kalmbach, Inc. These studies revealed that with presently existing water storage

[1] Bulletin prepared for Advisory Committee on Water Data for Public Use by Office of Water Data Coordination, U.S. Geological Survey, November, 1967.

capacities and assuming curtailment of delivery water to the Lower Basin to an average of 7.5 million acre-feet per year, the stream depletions above Lee Ferry would be limited by nature to 6.3 million acre-feet per year. The net depletion excluding reservoir losses would be 5.6 million acre-feet annually. Thus, due to the vagaries of nature, the Upper Basin States are already suffering curtailment in their total water resource development to an amount 20% under that apportioned to them by the Colorado River Compact. The risks involved in further curtailment of the Upper Basin's social and economic development as the result of further curtailment of their water uses are real, not imaginary.

Fourth, on the basis of the Department's long-term streamflow records at Lee Ferry, not once since 1933—34 consecutive years—has the progressive 10-year average virgin flow exceeded the average virgin flow. During this 34-year period the trend has been consistently downward. It seems unreasonable to attribute this decline in water yield entirely to the occurrence of a "drought" cycle as contrasted to a "wet" cycle. Scientific reasons for this declining water availability do not seem to be fully known or clearly demonstrated. Maybe watershed conditions have changed materially during the past 35 years so that the same runoff does not result from comparable amounts of precipitation as occurred in earlier years. I recently received a memorandum from my esteemed colleague, Honorable Morris K. Udall of Arizona, that may better illustrate this point. This memorandum states:

"The records of this area (13,000 square-mile watershed of Salt River Project in Arizona) indicate that notwithstanding continuation of approximately the same average annual rainfall which existed more than fifty years ago, the runoff from the watershed has decreased by approximately 50 percent—principally by virtue of uneconomic water-wasting growth on the watershed area. What is true of this area must also be true of watersheds throughout the entire Colorado River Basin—and this undoubtedly has played a great part in the dwindling water supply of the Colorado River since adoption of the Colorado River Compact." [2]

Whatever the reason may be for this decline in water yield it is apparently obvious to others besides myself that the long-term reliable runoff of the Colorado River has decreased considerable below the estimates for years prior to 1922.

Fifth, the Secretary mentioned that "time will tell regarding your assumptions" that are used in making stream flow analyses. I agree. Yet it seems glaringly apparent from the testimony and discussion that the Department in its studies used the most optimistic water supply, the most pessimistic Upper Basin projected rates of stream depletions, and the most optimistic recovery of river losses of the several agencies whose estimates were compared by the Committee staff. Inherent risks are built into this type of project water supply justification.

In conclusion, Mr. Chairman, I have presented these facts and views on water supply to the Committee in this manner for three important reasons: First, on any river, whether it be the Colorado River or another, that is subject to both severe hydrologic limitations and restrictive legal requirements it is important that the use of water be kept within the capability of the river supply. Second, during my entire Congressional career, almost one-fifth of a Century, it has been the consistent policy of this Committee to report to the Congress only water resources bills about which there is no question concerning availability of water. I believe that this position has been sound, reasonable and in the Nation's interest. Third, I believe that this Committee and the Congress should have before it as complete a set of facts and figures as possible relating to the water supply of the Colorado River system. With all of the facets of the picture in mind and only on this basis with the serious social and economic implications of the probabilities of overestimating the water supply before it, should the Congress decide the issues of this legislation.

Mr. ASPINALL. Mr. Secretary, I am pleased with your discussion of the water quality standards in relation to the Colorado River Basin. I am particularly pleased with your statement that "salinity standards will not be established until we have sufficient information to

[2] Memorandum dated August 30, 1967, from Hon. Morris K. Udall of Arizona to Hon. Wayne N. Aspinall, Chairman of the Committee on Interior and Insular Affairs, House of Representatives.

assure that such standards will be equitable, workable, and enforceable." The practicable approach set out in your statement will be welcomed by all those throughout the Basin who have been concerned about this problem over the last 2 or 3 years. As you know, many throughout the Basin have been quite upset by statements and positions taken by some of your subordinates.

Now, Mr. Secretary, my only comment on your discussion of the Indian water rights, other than emphasizing to the members of the committee the sizable amounts of water involved and the priority given these rights, has to do with the question of the difference between the diversion amounts and the estimated consumptive use. My concern goes beyond the use of water on the Indian reservations; it goes to the determination of return flow throughout the entire Basin. Your staff has already been alerted as to my request for information on this matter. I hope that someone is in a position to give the committee a brief discussion on how the Bureau makes these determinations.

Are you prepared to do that?

Secretary UDALL. Commissioner Dominy would like to address himself to that.

Mr. DOMINY. Return flows from irrigation developments consist of surface water returns which, when collected in drainage facilities, can be measured. They consist of underground returns which mingle with natural underground flows and can't be positively identified. Thus, it is seldom, if ever, possible to get a complete measurement of all return flows. However, procedures have been developed which, by processes of deduction, give highly reliable estimates of return flows.

The quantity of water diverted for irrigation can be accurately measured and is being accurately measured. The effective rainfall over the growing season can be measured and is being accurately measured, which, together with the diverted water, comprises the water available to grow crops.

A great deal of research, primarily by the Department of Agriculture, has gone into the determination of the consumptive use requirements of various crops under varying soil and climatic conditions. In this research, large tanks are filled with soil. Crops are grown in these tanks under conditions which permit the most precise determination of water application and water use requirements—consumptive requirements of the plant.

Reliable consumptive use figures, not only for crops but for noncrop vegetation, are thus derived for varying climatic conditions and from such research, the widely used Blaney-Criddle method of estimated consumptive use has been developed.

When all estimated consumptive uses are subtracted from the total water available, the remainder must constitute return flow. Some of this return flow which percolates through the ground may take extensive periods to reach the main stream. The theoretical estimates are checked periodically by the Bureau of Reclamation and the most recent studies involved operations on the Rio Grande project in New Mexico and Texas and on the North Platte project in Wyoming and Nebraska, which are two of our oldest projects. The actual measurements of surface return flow at these two projects over several years,

plus considerations of unaccounted subsurface return and peripheral nonbeneficial consumptive uses gave us an excellent check on our estimates of consumptive use and return flow.

So I think, Mr. Chairman, we have established a supportable method for making realistic estimates of consumptive use and return flow.

Mr. ASPINALL. You think you are accurate within one percentage point?

Mr. DOMINY. I would say it is as accurate as man can propound and therefore, it is usable.

Mr. ASPINALL. Of course, Mr. Dominy, we have never had this matter completely determined by any scientific study as such. We have our assumptions. Are you accurate within a 10 percent degree or are you within a 20 percent degree?

Mr. DOMINY. We think we are accurate well within 10 percent, Mr. Chairman.

Mr. ASPINALL. Mr. Chairman, I would ask unanimous consent to place in the record at this place the detailed statement that I have before me of some figures here as to lower basin Indian water users. It is taken from the Secretary's figures.

Mr. JOHNSON. You have heard the request of the gentleman from Colorado.

Is there objection?

Mr. HOSMER. Reserving the right to object, does that conflict with the testimony that has been given?

Mr. ASPINALL. No, it does not. It is just additive to it so you can figure from it.

Mr. HOSMER. As I understand, these have been shown by the Secretary as present perfected rights but he did not estimate what other rights might be of a contingent nature. Is that correct?

Mr. ASPINALL. That is correct.

Mr. HOSMER. Does this paper of yours include contingencies?

Mr. ASPINALL. No.

Mr. HOSMER. I wonder if it would be possible for the chairman to add to his request an estimate from the Bureau of what the range of contingent demands from the Indian tribes might be.

Mr. UDALL. The Supreme Court decision affirmed rights of the Indians to water for the acreages of irrigable land specified in the Court's decree. There were no contingencies provided for. Therefore, the quantity of water involved, is the consumptive use required for the lands.

Mr. HOSMER. I understand there are some 900,000 acre-feet that the Secretary lists. There is some other figure.

Mr. ASPINALL. May the chairman of the full committee state that this information I have here showing that there is an annual consumptive use in 1966 by Indian tribes of approximately 223,566 acre-feet of water on the right they have, and 332,978 acre-feet remaining.

Mr. HOSMER. I thank the gentleman.

I withdraw my reservation.

Mr. JOHNSON. Further objection?

Hearing none, the matter will be placed in the record at this point.

(The material referred to follows:)

LOWER BASIN INDIAN WATER USERS—ARIZONA VERSUS CALIFORNIA

State (Indian reservation)	Acres	Ultimate annual consumptive use at 4 acre-feet per acre	Consumptive use in 1966 (last data available)	Amount remaining (acre-feet annually)
Arizona:				
Fort Mohave	14,916	59,664	0	59,664
Cocopah	431	1,724	1,600	124
Colorado River	99,375	397,500	201,966	195,534
Total, Arizona	114,722	458,888	203,566	255,322
California:				
Yuma	7,743	30,972	20,000	10,972
Fort Mohave	2,119	8,476	0	8,476
Chemehuevi	1,900	7,600	0	7,600
Colorado River	8,213	32,852	0	32,852
Total, California	19,975	79,900	20,000	59,900
Nevada: Fort Mohave	1,939	7,756	0	7,756
Total, lower basin	136,636	546,544	223,566	322,978

Mr. ASPINALL. Mr. Secretary, my only question with respect to pumped hydroelectric plans is whether or not the Department is continuing its studies on this possibility as a means of financing augmentation; if so, what is the present status of those studies?

Mr. DOMINY. We have no concrete proposal on this, Mr. Chairman. We have made some reconnaissance studies of potentials.

The potentials at Lake Mojave appear to be the most promising as a major source of peaking capacity.

Mr. ASPINALL. Mr. Secretary, one reason I wanted a statement from you on the operation of this river under section 602 of the legislation is to determine how important you consider the requirement of consultation and cooperation with the States in establishing the operating criteria and implementing them. It is, after all, the States of the upper basin who have entered into a compact to release certain amounts of water to the lower basin States. The Secretary's responsibility is to operate the works on the river in accordance with this compact and the other compacts, contracts, and so forth, which make up the law of the river.

I feel very strongly that there must be very close consultation with the States and the Upper Colorado River Commission which represents the upper basin States with respect to how the compact provisions and the provisions of section 602 are to be administered.

It is my assumption that the criteria established pursuant to section 602 will go into effect not later than July 1, 1970, the date set out in the bill, and at that time, the filling criteria which are now in effect will be terminated.

Do you agree with this assumption?

Secretary UDALL. Let me say, Mr. Chairman, we are going to need increasingly close consultation on all these matters. We are operating a river which is a life line of the region and which will be governed by criteria and provisions that Congress may write in regard to how we make management decisions. I think we are going to have to have a pattern operation that will involve increasingly close cooperation.

Mr. ASPINALL. Let me say, Mr. Secretary, so that the record will be clear, does the Secretary consider that this is the final determination

of the Secretary as to whether or not—not as to, but whether or not section 602 is part of the legislation?

Secretary UDALL. If section 602 is part of the legislation, we have to implement it and carry it out.

Mr. ASPINALL. You will do your best to carry it out within the time period that I suggested?

Secretary UDALL. That is my statement.

Mr. ASPINALL. Mr. Secretary, I am interested in your estimates of water that can be salvaged through conservation programs.

Does the Department presently have authority to carry out all the measures listed in your statement?

Secretary UDALL. We think that additional, specific authority would be helpful. We would need additional authorization, if, in addition to the items I listed, we are going to line the Imperial Canal. I think we have to be water-saving conscious. I think we can save substantial amounts of water, but there will be major investments and I think we all are going to find that we have an interest in conservation, particularly in the lower basin, where the present losses are high.

Mr. ASPINALL. I think that I would be in agreement with what you state, but of course, we have in H.R. 3300 a provision which would authorize the expenditure of $42 million for this purpose.

That is still your figure; is it not?

Mr. DOMINY. That is substantially right; yes, sir.

Mr. ASPINALL. Do you not think it would be more to the—better for the operation of the Department if we placed this in this bill and came right out in the open and said what we have in mind rather than trying to hide a part of the cost of this project?

Secretary UDALL. I am all for writing a straightforward bill. I am also for water conversation. I do not see any objection to doing what you propose.

Mr. ASPINALL. Mr. Secretary, I have an opportunity to go briefly through the reconnaissance report on augmentation of the Colorado River—by desalting of sea water. And I want to tell you frankly that I have very little confidence in the cost estimate that the Department comes up with in the report. The estimate of 9.8 cents per thousand gallons for desalting, even though the report says that this is based upon 1995 technology, is in my opinion completely unrealistic and without foundation. As far as I know, there is no existing information on desalting technology which will justify this optimistic estimate.

Mr. Chairman, inasmuch as this report has been forwarded to us and it comes about under authority given to the Secretary, I ask that this report be made a part of the record at this place.

Mr. JOHNSON. You have heard the request of the gentleman from Colorado.

Is there objection?

Mr. SAYLOR. Reserving the right to object, Mr. Chairman, I will not object with the understanding that we will be permitted to question the Secretary of the Interior with regard to this report.

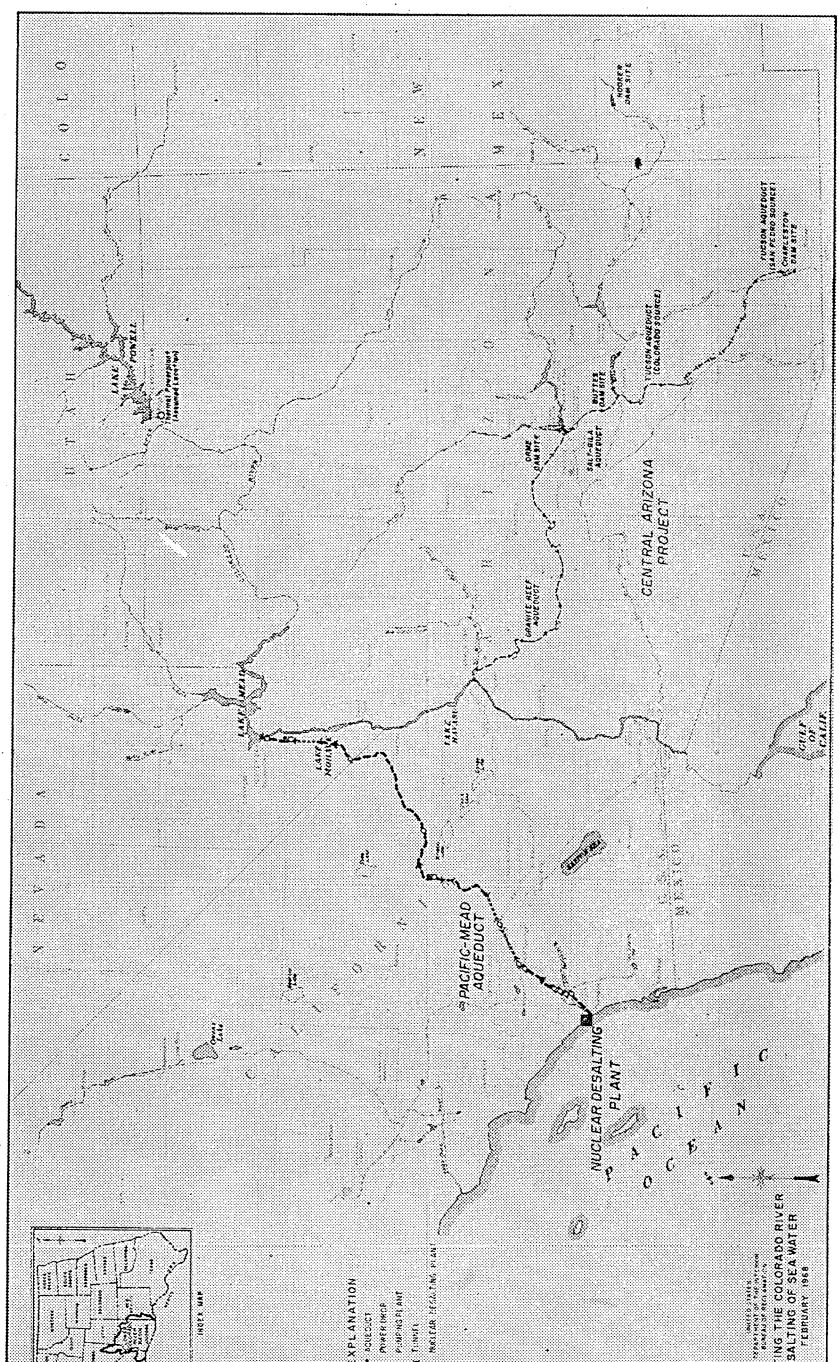
Mr. ASPINALL. I am not going to question the Secretary very much further on this report, but I think my colleagues have that right.

Mr. SAYLOR. I withdraw my reservation.

Mr. JOHNSON. It will be done.

(The material referred to follows:)

U.S. DEPARTMENT OF THE INTERIOR RECONNAISSANCE REPORT: AUGMENTATION OF THE COLORADO RIVER BY DESALTING OF SEA WATER, JANUARY 1968



Summary sheets

COSTS

	Million dollars
Project costs:	
Desalted water	809
Nuclear pumping power	112
Conveyance system	1,863
Total	2,784
Annual operation, maintenance, and replacement costs:	
Desalted water	39.48
Nuclear pumping power	4.11
Conveyance system	5.32
Total	[1] 48.91

[1] Includes sinking fund of $19.6 million for replacing nuclear desalting facilities after 30-year life.

Benefit-cost analysis (100 years at 3¼ percent)

	Annual equivalent benefit, million dollars
Benefits:	
Mexican Water Treaty	120.8
U.S. water supply	11.8
Power	3.0
Total annual benefit	135.6
Costs:	
Total project costs	2,784
Interest during construction	253
Federal investment	3,037
Annual equivalent of investment costs	91.7
Annual equivalent O.M. & R. costs	[1] 39.4
Total annual costs	131.1

Benefit-cost ratio: 100 years at 3¼ percent 1.03 to 1.00

[1] Includes component for plant replacement based on a 30-year sinking fund.

COST ALLOCATION

[In millions of dollars]

Purpose	Construction cost	Interest during construction	Total Federal investment	Annual O.M. & R.
Mexican Water Treaty	2,505	228	2,733	44.02
U.S. water supply:				
Irrigation	237	21	258	4.15
Municipal and industrial	42	4	46	.74
Total	2,784	253	3,037	[1] 48.91

[1] Includes sinking fund of $19,600,000 for replacing nuclear desalting facilities after 30-year life.

REPAYMENT ANALYSIS

[In millions of dollars]

	Construction cost	Interest during construction	Total for repayment
Reimbursable costs:			
U.S. water supply:			
Irrigation	237		237
Municipal and industrial	42	4	46
Subtotal	279	4	283
Nonreimbursable costs: Mexican Water Treaty	2,505		
Total	2,784	4	283

DEVELOPMENT FUND

[In millions of dollars]

	Year 2029	Year 2059
Contributions (cumulative):		
Hoover	486	857
Parker-Davis	101	222
Intertie	42	130
Central Arizona project		918
Total	629	2,127
Development fund: Balance after repayment of augmentation costs	192	1,551

INTRODUCTION

There is universal agreement that the water supply of the Colorado River is inadequate to meet developing demands. There is further widespread agreement that augmentation of the natural flows of the river will be necessary, not only as a solution to the rising water demands, but as a solution also to the controversies involving the disposition and full use of Colorado River runoff.

Of the four principal potentials for augmenting Colorado River water supply—desalting of sea water, surface water imports from basins of surplus water supply, weather modification, and water salvage measures—only the first two offer potentials of the magnitude necessary for adequate long-range solutions. Weather modification and water salvage measures may well provide the cheapest means of producing additional water supplies. As such, these potentials should be fully explored and exploited before more costly augmentation works are undertaken. There are limitations, however, on the amounts of new water available from these sources. Sooner of later, recourse must be made either to the unlimited seas or to surface water imports if the foreseeable water needs of the Colorado River Basin are to be met.

While the physical aspects of surface water imports should pose no exceptional problems, the institutional problems at this time, both national and international, are formidable. There are no bars, however, to the study of augmenting the Colorado River by desalting of sea water. The "Public Works and Atomic Energy Commission Appropriation Act, 1968" provided funds for the Central Arizona Project investigation specifically to include a reconnaissance study of Colorado River augmentation by desalting. This reconnaissance report is prepared pursuant to that provision.

Presented herein is a plan for augmenting the Colorado River water supply by desalting in amounts sufficient to assure the availability of 7.5 million acre-feet of Colorado River water for consumptive use by the Lower Basin States without calling upon the Upper Basin States to assume any portion of the obligation to deliver 1.5 million acre-feet of water annually to Mexico. The time available did not permit studies in sufficient detail to determine that the plan presented is the most economic plan available. To the contrary, there are indications that a better plan from an economic viewpoint would originate on the Gulf of California rather than the Pacific Ocean. Such a plan would require international agreements beyond the purview of a brief reconnaissance appraisal but should be explored thoroughly in any detailed studies of augmenting by desalting. A joint United States-Mexico study group is now making a preliminary assessment of the practicability of dual-purpose nuclear power and desalting plant to serve the general area of southern California, Arizona, Baja California and Sonora.

This reconnaissance report does show that within presently projected techniques for combined nuclear power-desalting plants, and within certain policy guidelines contained in pending legislation, there is sound reason to expect that detailed studies would establish the feasibility of a plan for augmenting the Colorado River to the extent necessary to assure the Lower Basin States 7.5 million acre-feet of Colorado River water annually for consumptive use.

UNDERLYING POLICIES, GUIDELINES, AND ASSUMPTIONS

Augmentation of the Colorado River through desalting of sea water, by increasing the basic water supply of the river, would alter the river's hydrology. The water supply for the Lower Basin, including the Central Arizona Project, would be increased. The controversy over any responsibility for the Upper Basin States to meet a portion of Mexican water deliveries would be settled. Capital and annual costs would be involved, and under Reclamation tradition, provision for return of the reimbursable costs, with interest where appropriate, must be made. As the initial desalting plants will not be required until about 1990, projections of techniques for producing nuclear power and desalting of sea water are required. These aspects give rise to the requirement, for study and report purposes, to establish guidelines, policies, and assumptions. The basic and important ones adopted are discussed in following paragraphs under the three broad headings of "Central Arizona Project," "Hydrology," and "Financial."

Central Arizona Project

The Central Arizona Project (CAP) would be a separate entity, financially self-contained, essentially as described in the Bureau of Reclamation's "Summary Report—Central Arizona Project with Federal Prepayment Power Arrangements" dated February 1967. It is assumed that after payout of project costs, surplus revenues from the CAP would accrue to the Lower Colorado River Basin Development Fund and be available to assist in returning the reimbursable costs of any Colorado River augmentation works. The only effect of CAP on the plan presented herein is thus in the magnitude of Development Fund revenues that would accrue from CAP. With an augmented river, there would be a great deal more water for sale from CAP, both for irrigation and municipal and industrial purposes, and the water marketing presented in the Summary Report would be substantially altered.

With an augmented Colorado River a constant diversion of about 1.6 million acre-feet annually would be assured. In the Summary Report, which reflected natural river conditions, it was projected that prior to 1990 the average water supply available to the CAP would begin to decrease progressively as Upper Basin uses increased, dropping from 1.6 million acre-feet (m.a.f.) to an average diversion of 676,000 acre-feet by the year 2030. Of this average diversion, only a little more than 300,000 acre-feet represented assured project deliveries. Thus, in the Summary Report, sales of water for municipal and industrial (M&I) purposes were limited to assured deliveries of 312,000 acre-feet which accommodated increased M&I demands up to the year 2000. After the year 2000 M&I water deliveries were held constant. With an assured diversion of 1.6 m.a.f. from an augmented Colorado River, increases in M&I demands after the year 2000 would be met from CAP water supplies. By the year 2030 it is projected that 672,000 acre-feet of M&I water demand would be served from CAP water. As part of the increased M&I water supply would be needed to serve Tucson, additional capacity in the Tucson Aqueduct would be required in the future. The CAP revenues to the Development Fund shown in this report take into account the need for repayment of the cost of such additional capacity.

Under the augmented water supply conditions, the CAP would repay all of its costs from project revenues. Assumed water rates at canalside are $10 per acre-foot for irrigation and $56 per acre-foot for M&I water. All capital cost repayment requirements would be met by the year 2033, and thereafter the CAP would contribute about $34,000,000 annually to the Development Fund.

The capacity of the Granite Reef Aqueduct has been assumed as 2,500 cubic feet per second (c.f.s.). However, because CAP is treated as a self-contained financial entity during payout, assumption of a 3,000-c.f.s. aqueduct would have little effect on the augmentation study. Previously, 1975 has been assumed as the initial date of Colorado River diversion for the CAP. This date no longer appears realistic and in this report initial diversion is assumed in 1979.

Since an augmented river would provide California with a minimum of 4.4 m.a.f. for consumptive use at all times, the question of a 4.4-m.a.f. priority for California would automatically be resolved.

Hydrology

In this study the same basic hydrologic and river operation criteria have been retained as used in earlier Bureau of Reclamation studies, modified only to accommodate extension of the runoff record through the year 1967 and the addition of 2.0 to 2.5 m.a.f. of desalted water in Lake Mead annually. Such an addition, however, would have appreciable effects. It would increase the water supply for the Lower Basin and, by eliminating the question of Upper Basin responsibility for a portion of the Mexican Treaty delivery, assure the Upper Basin of a greater water supply. Water quality in the Colorado River below Hoover Dam would be measurably improved.

Lower basin water supply.—Without augmentation and with a regulated delivery of 8,250,000 acre-feet annually at Lee Ferry, it is estimated that the average water supply available for consumptive use in the Lower Basin at Lee Ferry would decrease by the year 2030 to 6,830,000 acre-feet and the assured water supply to 6,310,000 acre-feet. With augmentation and with a regulated delivery at Lee Ferry of 7,500,000 acre-feet annually, comparable figures would be 7,730,000 acre-feet average supply and 7,500,000 acre-feet assured supply.

From these figures, it can be seen that the amount of agumentation needed to assure the Lower Basin of 7.5 m.a.f. of consumptive use in the year 2030 would be 1,940,000 acre-feet annually [(7,500,000—6,310,000) + (8,250,000—7,500,000)]. For the basic study of this report, we have rounded this figure to 2,000,000 acre-feet. It, of course, would not all be needed initially but could be staged. Analysis shows the following staging to be appropriate: year 1990, 1.0 m.a.f.; 2000, 0.5 m.a.f.; and 2010, 0.5 m.a.f.

The derivation of 2,000,000 acre-feet as the required magnitude of augmentation to assure 7.5 m.a.f. to the Lower Basin is based on Bureau of Reclamation estimates of future main-stem losses after realization of salvage potentials along the lower Colorado River. There is not full agreement among other Colorado River experts as to the effectiveness of future water salvage measures, and estimates of the amounts of augmentation water required to assure 7.5 m.a.f. consumptive use in the Lower Basin range up to 2.5 m.a.f. While the Bureau of Reclamation believes that its estimate of 2.0 m.a.f. is adequate, this report also presents an alternative study based on the requirement of 2.5 m.a.f. as the necessary amount of augmentation to assure 7.5 m.a.f. of Colorado River water for the Lower Basin States. Under this alternative the following staging of desalting plants would be appropriate: Year 1985, 0.75 m.a.f.; 1990, 0.5 m.a.f.; 1995, 0.75 m.a.f.; 2010, 0.5 m.a.f.

Upper basin water supply.—Based upon past records of Colorado River runoff and operation of the reservoirs of the Colorado River Storage Project, studies show that with delivery of 75.0 m.a.f. of water at Lee Ferry every 10 consecutive years, there would remain but 6.55 m.a.f. for consumptive use annually in the Upper Basin. If the Upper Basin were required to contribute in addition one-half of the water deliveries to Mexico, or 750,000 acre-feet annually, the amount available for consumptive use annually in the Upper Basin would be 5.8 m.a.f.

In connection with the Colorado River Basin Project, the Bureau of Reclamation has previously projected that consumptive use of Colorado River Basin water by the Upper Basin States would reach 5.8 m.a.f. in the year 2030. The Bureau recognized that the potential for use of water by the Upper Basin States is much greater and could occur at a much earlier date. The projections made were judgment values based on a limited water supply. With augmentation of the Colorado River and consequent assurance that the Upper Basin would not be required to contribute to Mexican water deliveries, it could be expected that expansion of Upper Basin depletions would be faster and to a higher ceiling. To reflect this, new projections were made of Upper Basin depletions for this report which are compared with the projections of the 1967 Summary Report in the following tabulation:

[In millions of acre-feet]

Year	Annual upper basin depletions	
	1967 summary report	This report
1975	4.220	4.220
1990	5.100	5.475
2000	5.430	6.180
2030	5.800	6.550

Should Upper Basin depletions occur at a faster rate than projected, it would be necessary to bring the initial units of the augmenting desalting works into operation at an earlier date. Otherwise there would be no significant effect on the augmentation study.

Water quality.—The introduction of from 2.0 to 2.5 m.a.f. of pure water annually into the lower Colorado River would have a significantly beneficial effect on water quality. The greatest benefits would be obtained by thorough mixing of this pure water with natural river flows above the points of use. In fact, to avoid wide fluctuations in water quality, which could be highly undesirable, it might well be necessary to discharge desalted water into the river upstream from the point of all major Lower Basin uses. For this reason Lake Mead was selected as the point in this study to receive desalted water.

There are other possibilities for obtaining a satisfactory mix of desalted and natural waters. One such scheme would involve construction of a large reservoir on the Bill Williams River which would act as a regulating depository for desalted water to be fed into Lake Havasu at rates necessary to obtain desired mixes. If such a scheme proved feasible, it would reduce the costs of the desalted water conveyance system appreciably, particularly if a route from the Gulf of California proved feasible.

Mexican Treaty delivery obligation.—Legislation is pending which provides that the costs of measures to satisfy the obligations of the Mexican Water Treaty from the Colorado River plus losses of water associated with delivery of water under that treaty woud be treated as a national obligation and be nonreimbursable. The water delivery obligation under the Treaty is 1.5 m.a.f. per year. The losses associated with that delivery are functions of the magnitude of the water losses on the lower river. Based on Bureau of Reclamation estimates, the total net losses on the Colorado River below Lee Ferry after all water salvage measures are in effect will average about 1,550,000 acre-feet per year. The pro rata share of losses associated with the Mexican water delivery, weighted as to point of delivery, is 300,000 acre-feet. Thus, of the 2.0 m.a.f. which the Bureau of Reclamation estimates to be necessary to augment the Colorado River to assure 7.5 m.a.f. for the Lower Basin, 1.8 m.a.f. would be associated with delivery of water to Mexico.

Should the losses prove to be greater and 2.5 m.a.f. augmentation be necessary, the pro rata share associated with the Mexican water delivery would also be greater. In this event, it is estimated the associated losses would be 430,000 acre-feet, for a total of 1.93 m.a.f., identified with the Mexican water delivery.

Financial

The financial feasibility of the augmentation plan presented herein looks, in large measure, to the enactment of provisions in pending Colorado River Basin Project legislation.

Mexican Treaty obligation.—Pending legislation, as embodied in H.R. 3300 and similar bills, declares that the satisfaction of the requirements of the Mexican Water Treaty constitutes a national obligation. Accordingly, such legislation provides that costs of construction, operation, and maintenance allocated to the replenishment of depleted Colorado River flows occasioned by compliance with the Mexican Water Treaty shall be nonreimbursable. The replenishment would include losses in transit, evaporation from regulatory reservoirs, and regulatory losses at the Mexican boundary incurred in the transportation, storage, and delivery of water in discharge of the obligations of that treaty.

As discussed previously, the amount of augmentation necessary to satisfy the Mexican Water Treaty will very with the magnitude of water losses on the lower Colorado River. For the plan requiring 2.0 m.a.f. augmentation, 1.8 m.a.f. is identified with Mexican water deliveries. For the plan requiring 2.5 m.a.f. augmentation, 1.93 m.a.f. is identified with Mexican water deliveries. The costs of the augmentation works are split between reimbursable and nonreimbursable, essentially on a pro rata basis.

Lower Colorado River Basin Development Fund.—Pending legislation (S. 1004, H.R. 3000, and similar bills) provides also for establishment of a Lower Colorado River Basin Development Fund which would be a source of financial assistance to return the reimbursable costs of augmentation works. For the purposes of this report, it is assumed that the following revenues accruing to the Development Fund would be available to apply toward the reimbursable costs of the augmentation plan: (1) the surplus revenues from the operation of the Boulder Canyon and Parker-Davis projects after payout of these projects and after ad-

justments for the in-lieu-of-tax payments to the States of Arizona and Nevada as provided for in section 2(c) of the Boulder Canyon Project Adjustment Act; (2) the surplus Federal revenues from the portion of the Pacific Northwest-Pacific Southwest intertie located in the States of Nevada and Arizona; and (3) excess revenues (gross revenues less annual operation, maintenance, and replacement costs) of the CAP after the project's reimbursable capital costs have been repaid.

Price guarantee.—H.R. 3300 and similar legislation provide that to the extent the main stream of the Colorado River is augmented to satisfy annual consumptive uses of 2.8 m.a.f. in Arizona, 4.4 m.a.f. in California, and 0.3 m.a.f. in Nevada, the Secretary of the Interior shall make such augmented water available to users of main-stream water in those States at the same costs and on the same terms as would be applicable if main-stream water were otherwise available to supply such consumptive use. This provision was adopted for this report and thus there are no revenues deriving directly from the augmentation works. Some funds would accrue to the Development Fund, however, from increased power generation at Hoover and Parker-Davis and from increased water revenues from the Central Arizona Project after payout.

Dual-purpose nuclear desalting power arrangements.—It is assumed that the Federal Government would obtain only desalted water and project pumping power from the dual-purpose nuclear desalting plants and that non-Federal entities would participate to the extent of financing and marketing the commercial power component. It is anticipated that an arrangement would be made whereby the non-Federal entities would construct and own the electric turbine-generator plant. The United States, through prepayment of an appropriate share of the capital costs, would obtain the rights to the electrical capacity and energy necessary for project purposes. Through such an arrangement, the United States would retain the benefits of Federal financing for the prepaid portion of the electrical plant. The commercial power aspects, however, would be divorced from the Federal plan and handled by non-Federal interests.

It is also assumed that there would be cooperative development of the nuclear reactors which will serve as a joint heat source for the desalting and electric power generation facilities. The portion of the reactor costs associated with commercial power generation would be borne by non-Federal interests.

PROJECT DESCRIPTION

Purpose

This potential project would provide 2 million acre-feet of additional water annually for use in the Colorado River Basin. The principal project plan described below was selected to demonstrate the various factors involved in this concept of augmentation by sea water desalting and for preliminary analysis of its feasibility. The physical works include nuclear reactors, thermal electric power generating facilities, desalting plants, power transmission facilities, and conveyance works to transport desalted sea water from the coast of southern California to Lake Mead on the Colorado River.

Dual-purpose nuclear desalting plant

Location.—The nuclear power generation and desalting facilities would be located on the Pacific coast of southern California. For the purposes of estimating costs, this report assumes the site to be within the boundaries of the Camp Joseph C. Pendleton Naval Reservation about seven miles northwest of Oceanside, California. This site is in Federal ownership, would appear to satisfy current reactor siting criteria, and has excellent access from U.S. Highway 101 and the Santa Fe Railroad.

In detailed studies, consideration would also be given to other potential sites along the coast. Studies indicate that there will be one or more suitable land-based sites along the southern California coast which could be used for large-scale nuclear desalting plants after 1980. This conclusion is based upon geologic information, consideration of waste brine disposal problems, projected population distributions, reactor siting criteria, and the assumption that credit can be taken for engineered safeguards.

Particular attention would be directed to the possibility of siting on an offshore, man-made island. Consideration of offshore siting would increase significantly the number of potential sites.

Nuclear Reactors and Turbine-Generators.—The estimates of costs for the nuclear reactors are based upon information provided by the Atomic Energy Commission. The reactor concept used is based upon a projected level of tech-

nology for breeder type reactors for about 1995. The assumed timing of the reactor installations is keyed to the staging of augmentation water deliveries in years 1990, 2000, and 2010. Replacement plants will also be required at the end of the 30-year service life for each dual-purpose plant.

While it is recognized that the full benefits of 1995 technology will not be available for the first-stage installation, the same reactor costs have been used throughout the study period to simplify the analysis. Since two of the three installation stages and all the replacement reactors will be built after 1965 and will have the advantage of further technological improvements, it was considered that the 1995 assumptions adequately represent average conditions over the period. Also, in view of the long-time period and the attending uncertainties involved, further refinements reflecting different levels of technology for various specific installations would not be expected to enhance the accuracy of the projections at this time.

The nuclear reactors are assumed to be of the fast breeder type. This reactor concept is an advanced type and will require further development, testing, and demonstration. The Atomic Energy Commission, American industry, and foreign countries have extensive programs for the development of fast breeder power reactors using various designs. Emphasis is being directed toward development of this type of reactor because it is predicted that its use will be essential to permit the nuclear industry to achieve the expansion projected by the end of this century.

Development of high-grain breeder reactors will increase the efficiency of fuel utilization. This will have the effect of permitting the economic use of lower grade uranium ores, and will thereby extend the available resources. The breeding feature results in very low fuel cycle costs, and hence these reactors have a potential for producing low cost heat and power.

The design used for cost estimates in this report is based upon those developed by the Argonne National Laboratory in 1966 for a sodium-cooled, fast breeder reactor. The Atomic Energy Commission provided base estimates for two 5,000-megawatt thermal (mwt) reactors at a single station. Because of the time period involved, the individual sizes may be smaller or larger. The use of a station with multiple reactors would provide added flexibility of operation. Multiple reactors, also would reduce the hazard to electric systems which rely on the plant for firm power and would have to carry spinning reserves to protect against the possibility of an emergency reactor shutdown. From the base figures, costs were derived for reactor capacities to meet the heat requirements for each stage of desalting plant installation.

In addition to the heat energy required for desalting, the reactors will provide heat for the production of electric power. The power production will exceed the requirements for the pumping of project water in each stage, and, as explained previously, the financing and marketing of power in excess of project needs would be the responsibility of non-Federal entities and are divorced from the financial analysis in this report. Because the reactor concept used in the present study has been developed primarily for commercial power production, large amounts of electric power will be produced. According to recent estimates prepared by the Federal Power Commission, however, approximately 4,500 megawatts (mw) of new generating capacity will be required each year by about 1990 to meet anticipated commercial load growth in southern California, Arizona, and southern Nevada. About one-half of the 4,500-mw load growth, or 2,200 mw, represents the requirement for commercial baseload generating capacity. Furthermore, future technology may yield concepts which could decrease the amounts of electric power produced.

The output of the reactors and turbine generators and uses associated with each stage are as follows:

Stage (year)	Total reactor capacity (megawatt-tons)	Powerplant installed capacity (megawatts)	Auxiliary power in plant (megawatts)	Project pumping (megawatts)	Available for commercial sales (megawatts)
1990	13,050	3,615	452	567	2,596
2000	6,525	1,807	225	283	1,299
2010	6,525	1,807	225	283	1,299
Total	26,100	7,229	902	1,133	5,194

Desalting plant.—The cost estimates in this report for the desalting plant are based upon estimates provided by the Office of Saline Water. The reference plant concept represents 1990–1995 projections and is a combination multi-effect, vertical tube and multistage flash evaporator. Both the vertical tube and horizontal condenser surfaces are shaped to promote high heat transfer rates. The maximum brine temperature is limited to 250 degrees F., with acid pretreatment of feed to reduce scale formation problems in the evaporator.

The reference plant has a capacity of 1 billion gallons per day (bgd) divided into four trains of 250 million gallons per day (mgd) each. The concept includes improvements in plant technology which are currently undergoing laboratory tests.

For purposes of this analysis, plants were sized for each stage to provide the quantity of desalted water desired for delivery at Lake Mead plus the anticipated 5 percent conveyance losses. The capacities of the stages are as follows:

Stage (year)	Plant output (million gallons per day)	Delivery to Lake Mead	
		Million gallons per day	Acre-feet per year
1990	1,044	992	1,000,000
2000	522	496	500,000
2010	522	496	500,000
Total	2,088	1,984	2,000,000

Economic advantages are derived from the dual-purpose design of the nuclear electric power and desalting complex. Both purposes share in the economy of scale of a large reactor and the common site. The turbines operate efficiently with high-temperature, high-pressure steam produced by the reactor while the evaporator makes use of the turbine exhaust steam at lower temperature and pressures and acts as a condenser for the turbines. Possible future modifications of evaporator design to utilize the vapor compression process or increased brine temperatures might result in the production of water with less electric power output.

Conveyance System

Location and general description.—The aqueduct system which would convey the desalted water from the Pacific Coast to Lake Mead will be 313 miles in length. It would consist of 85 miles of pipeline, 77 miles of tunnel, 135 miles of lined canal, and 16 miles of pumping plant discharge and penstock lines. Ten pumping plants would be required to lift product water 4,277 feet, and three power drops would be utilized to recover the energy in 1,682 feet of head. The route is shown on the frontispiece map.

From the desalting complex, product water would be conveyed for regulation and storage to the proposed De Luz site on the Santa Margarita River downstream from De Luz Creek which is at Mile 10 of the aqueduct. The aqueduct would then cross Murrieta Creek in the Temecula Valley about 1 mile southeast of Murrieta, and continue with the aid of a number of pump lifts through pipelines and tunnels to the summit of the San Gorgonio Pass about 1 mile south of Banning. A series of tunnels and pipelines would convey water to the foot of the Little San Bernardino Mountains. At this point a pumping plant would lift water to a gravity tunnel 17.8 miles in length for conveyance under the Little San Bernardino Mountains. From the tunnel outlet portal, about 2 miles east of Joshua Tree, the aqueduct would turn to the north and by means of pipelines, tunnels, and canal would proceed to the east side of El Dorado Valley and through a pass about 2.5 miles east of Boulder City, Nevada, to its terminus in Lake Mead at a point east of Hemenway Wash and about 2 miles west of Hoover Dam in Boulder Basin.

Storage reservoir.—For purposes of this study, the De Luz Dam site was used for regulation. In detailed studies a number of alternative storage sites near the desalting plant would be considered. The dam would be located on the Santa Margarita River immediately downstream from De Luz Creek and about 10

miles northeast of the desalting plant. The dam would be an earthfill structure rising 219 feet above streambed with a crest length of 4,100 feet at elevation 344. The reservoir would provide 40,000 acre-feet of regulatory storage for the conveyance system from a total capacity of 175,000 acre-feet.

Tunnels.—Eighteen gravity flow, horseshoe-section, concrete-lined tunnels would be required. All tunnels would be single-stage construction, would be 17.5 feet in diameter, and would have a capacity of 3,240 c.f.s.

Pipelines.—Pipelines would be required for about 85 miles of the aqueduct system. All pipelines would be double-barreled, precast concrete, gravity-flow sections. Each barrel would be 15 feet in diameter and have a capacity of 1,620 c.f.s. The pipelines would be constructed in two equal stages.

Pumping plants.—Ten pumping plants, constructed in three stages, would be required, ranging in total dynamic head from about 173 to 728 feet. The total capacity of each plant after third-stage construction would be 3,240 c.f.s. and would consist of nine units, including one standby. The total installed electric capacity of the pumping plants would be 1,430 megawatts.

Power drops.—Three power drops would be constructed in three stages to a total hydraulic capacity of 3,240 c.f.s. with eight units. The total installed capacity of the inline powerplants would be 372 megawatts.

Canals.—All open canals would be concrete lined and would be constructed in one stage. The canals would have a capacity of 3,240 c.f.s., a base width of 24 feet, and a water depth of 17.0 feet.

Transmission facilities.—Energy for pumping desalted sea water to Lake Mead would be supplied by the dual-purpose nuclear powerplant on the California coast and by inline hydroelectric powerplants installed at power drops along the conveyance system. The Federal Government would construct the transmission system necessary to serve the pumping plants.

Transmission lines would roughly parallel the conveyance system throughout its length so that power could be furnished to each pumping plant and energy could be recovered from the power drops. Transmission system losses for capacity and energy were assumed to be 5 percent.

The transmission system would be constructed in three stages.

Project costs

Dual-purpose nuclear desalting plant.—The construction and annual operating costs of the nuclear reactor are prorated between the purposes of desalting and electric power generation on the basis of the proportion of the useful heat applied to each process. All of the desalting cost are Federal costs. The electric power costs were prorated between that portion of capacity required for project pumping and the portion of capacity surplus to project needs. The latter portion of the costs would be non-Federal costs and are excluded from this analysis.

Estimates provided by the Atomic Energy Commission and the Office of Saline Water are based upon 1966 price levels and market conditions.

DUAL-PURPOSE NUCLEAR DESALTING PLANT CONSTRUCTION COSTS

[In millions of dollars]

Feature	Stage			
	1990	2000	2010	Total
Nuclear reactor	241	121	121	483
Powerplant	142	71	71	284
Desalting plant	312	179	179	670
Total	695	371	371	1,437
Less non-Federal power costs	258	129	129	516
Federal costs	437	242	242	921
Desalted water	(381)	(214)	(214)	(809)
Nuclear pumping power	(56)	(28)	(28)	(112)

The annual operation, maintenance, and interim replacement costs for the dual-purpose plant at the completion of each stage of installation are as follows:

DUAL-PURPOSE NUCLEAR DESALTING PLANT, ANNUAL O.M. & R. COSTS[1]

[In millions of dollars]

Feature	Stage (cumulative)		
	1990	2000	2010
Nuclear reactor	4.24	6.37	8.50
Thermal powerplant	1.83	2.74	3.65
Waterplant	9.21	14.50	19.79
Total (operation, maintenance, and "interim replacement")	15.28	23.61	31.94
Non-Federal power costs	3.97	5.96	7.95
Federal costs:			
Desalted water	10.45	16.36	22.27
Nuclear pumping power	.86	1.29	1.72
Subtotal	11.31	17.65	23.99
Sinking fund for rebuilding plants	9.32	14.46	19.60
Total	20.63	32.11	43.59

[1] Includes fuel, interim replacements, and for Federal costs an amount for rebuilding the plant at the end of the 30-year service life.

A small amount is included (0.35 percent of capital costs) to provide for interim replacement of minor components within the assumed 30-year life span of the plants. To account for the longer period of analyses for benefit-cost and the payout studies, an annual sinking fund as shown above is included in the Federal operating costs to cover reconstruction of the nuclear desalting complex at the end of the 30-year service life.

The nature of breeder reactors is that they produce more fuel than they consume. The excess fuel produced is sold for use in other reactors. Plutonium credits partly offset the costs of fabrication, processing, and interest charges on investments in fuel inventory. These savings, together with the advantages of Federal financing of the fuel inventory, result in a low fuel cycle cost for the advanced breeder concept.

Conveyance system.—The total estimated construction cost for the conveyance system to Lake Mead based on reconnaissance estimates and unit prices as of October 1967 is $1,863,000,000. The estimates include electrical transmission system; right-of-way acqusition; and engineering, supervision of construction, and other indirect costs. Pumping plants, power drops, and transmission lines would be constructed in three stages for completion in 1990, 2000, and 2010 and pipelines in two stages for completion in 1990 and 2000. Canals, tunnels, and other facilities would be constructed to their ultimate capacity during the first stage.

The construction costs are as follows:

CONVEYANCE SYSTEM CONSTRUCTION COSTS

[In millions of dollars]

Feature	Stage			
	1990	2000	2010	Total
Dam (De Luz site)	24			24
Tunnels	509			509
Canals	137			137
Pipelines	290	236		526
Pumping plants	369	60	60	489
Power drops	65	18	17	100
Transmission system	47	25	3	75
Access roads	3			3
Total	1,444	339	80	1,863

The estimated annual operation, maintenance, and replacement costs after the completion of the three stages of construction are as follows:

CONVEYANCE SYSTEM, ANNUAL O.M. & R. COSTS

[In millions of dollars]

Feature	Stage		
	1990	2000	2010
Aqueduct facilities	3.02	3.46	4.11
Transmission system	.73	1.17	1.21
Total	3.75	4.63	5.32

Summary of Federal project costs.—A summary of the total Federal project costs for augmentation of the Colorado River by 2.0 m.a.f. delivered to Lake Mead follows:

SUMMARY OF TOTAL FEDERAL PROJECT COSTS

[In millions of dollars]

Feature	Stage			
	1990	2000	2010	Total
Construction costs:				
Desalted water	381	214	214	809
Nuclear pumping power	56	28	28	112
Conveyance system	1,444	339	80	1,863
Total	1,881	581	332	2,784
Annual O.M. & R.:[1]				
Desalted water	10.45	16.36	22.27	----------
Nuclear pumping power	.86	1.29	1.72	----------
Sinking fund for rebuilding plants	9.32	14.46	19.60	----------
Conveyance system	3.75	4.63	5.32	----------
Total	24.38	36.74	48.91	----------

[1] Annual O.M. & R. costs are cumulative after completion of each stage.

Cost of pumping power.—The cost of pumping power includes an allocated portion of the capital and OM&R costs of the nuclear powerplant plus costs of the transmission system associated with conveyance works. The amount of pumping power capacity required from the nuclear powerplant was determined by deducting the power available at power drops from the total requirement and adjusting for transmission losses. The cost of thermal pumping power at the dual-purpose plant is 0.9 mills per kilowatt-hour. The average transmission cost is 0.4 mills per kilowatt-hour. These two components plus an adjustment for transmission losses and for plant replacement at the end of 30-year life will result in an average cost for thermal pumping power of about 1.5 mills per kilowatt-hour at the pumps.

ECONOMIC AND FINANCIAL ANALYSIS

The analysis of the economic justification of the augmentation plan does not readily lend itself to the application of typical benefit-cost procedures of conventional Reclamation projects. The primary emphasis of this economic analysis is to define the magnitude of the investment and operating costs involved so that a judgment can be made on the reasonableness of using nuclear desalting of ocean water as a source of augmentation, and to determine whether sufficient revenues are available in the Development Fund to cover reimbursable costs within the general framework of Reclamation financing criteria. Since adequate procedures have not been developed for measuring the benefits associated with meeting the Mexican obligation, somewhat arbitrary benefit estimates were used for this reconnaissance effort.

Economic costs

The derivation of costs can logically be divided between the cost of producing desalted water and pumping power at the dual-purpose desalting complex and the cost of conveying product water to the river.

Dual-purpose nuclear desalting plant.—The financial criteria, the method of allocating joint heat costs of the nuclear reactors between water and electricity, and the plant-loading characteristics play crucial roles in determining the cost of production. The ability to stage the plants to meet future needs as they develop also has an important bearing on overall costs by minimizing the economic costs of unused capacity.

The determination of capital cost for use in the economic studies includes construction cost and interest during construction computed at 3¼ percent. A 30-year service life is assumed for the reactor, thermal powerplant, and water plant. Consistent with Reclamation financing criteria, components for taxes and insurance were not included.

The method adopted for allocating joint nuclear reactor costs follows the use-of-facility concept with use measured in terms of available heat energy consumed in each of the water and power production processes. This approach permits both purposes to share in the advantages of dual-purpose production. Other joint costs resulting from the use of a common site were proportionally distributed on the basis of use. Inasmuch as the reactors, turbine-generators, and the water plant require internal auxiliary electric power, suballocations of electric power costs were made to each plant account in accordance with the capacities required.

It is expected that the dual-purpose installation would operate at full capacity as each stage is placed in service. It is assumed that the plants would operate at an average annual plant capacity factor of 90 percent.

A final division of costs was made between power needed for project pumping and the residual available for commercial sale by non-Federal entities participating in the cooperative venture. Costs were prorated between commercial and pumping power after adjusting for hydroelectric power produced by power drops in the aqueduct system.

The average product costs for the three stages at the plant boundary, before conveyance and transmission losses, are estimated to be 9.8 cents per 1,000 gallons, or $32 per acre-foot, and 0.9 mill per kilowatt-hour for project pumping power. One of the most important factors influencing these costs is the low cost of heat provided by the fast breeder reactors. Prime steam is estimated at 5.1 cents per million BTU and exhaust steam from the turbines for use in the water plant at 1.6 cents per million BTU.

Conveyance costs.—Conventional procedures were followed in deriving the economic costs of the aqueduct system. These facilities are assumed to have a 100-year service life, and a 3¼ percent interest rate is used for purpose of amortization.

Total project costs

Total investment costs for the augmentation plan consist of the estimated construction costs discussed earlier plus interest during the period of construction and are summarized as follows:

FEDERAL INVESTMENT COST

[In millions of dollars]

Feature	Construction cost	Interest during construction	Total
Nuclear desalting facilities (including project pumping power)	921	53	974
Conveyance system	1,863	200	2,063
Total	2,784	253	3,037

Total annual operating costs include operation, maintenance, interim replacements, nuclear fuel, and a sinking fund component to permit rebuilding the

nuclear desalting and project pumping facilities every 30 years through the 100-year period of analysis. These costs are summarized as follows:

FEDERAL ANNUAL O.M. & R. COSTS

[In millions of dollars]

Feature	O.M. & R.	Sinking fund for plant replacement	Total
Nuclear desalting facilities (including project pumping power)	23.99	19.60	43.49
Conveyance system	5.32		5.32
Total	29.31	19.60	48.91

Annual equivalent costs were determined over a 100-year period of analysis beginning with the completion of the first stage in 1990, using a 3¼ percent interest rate. Investment costs and operating costs associated with staged development were appropriately discounted. Total annual economic equivalent costs of investment averages $91.7 million; annual OM&R discounted for time of occurrence averages $39.4 million, making the total annual economic costs $131.1 million. Based on the ultimate annual delivery of 2.0 m.a.f. as scheduled in this study, the economic cost of desalted water conveyed to the Colorado River at Lake Mead averages $81 per acre-foot (25 cents per thousand gallons).

Project benefits

This project will provide a number of tangible and intangible benefits. As a result of the project, the flows of the Colorado River will be augmented by 2.0 m.a.f. annually. Because the treaty with Mexico insures the delivery of water to Mexico whether or not augmentation occurs, the augmented supplies will be utilized within the United States.

The replacement, as a Federal obligation, of the portion of water assigned to Mexico will eliminate much of the long controversy which has impeded orderly development in the Lower Colorado River Basin States and threatens future orderly development in both the Upper and Lower Basins.

Augmentation by desalting will provide opportunities to improve the quality of the water supply provided from the river. The addition of almost pure distilled water will enhance the overall quality of the river downstream from the point of delivery, with attendant benefits to users.

The delivery of additional supplies at Lake Mead will also produce power benefits from increased generation at Hoover and Davis powerplants.

Mexican Water Treaty.—National benefits are associated with discharging the Federal obligation of the Mexican Water Treaty. Because of the difficulties of measuring the intangible values involved, it has been assumed that the benefits of meeting the terms of this international agreement, as a minimum, are equal to the costs of an augmentation plan sized to deliver 1.8 m.a.f. annually to the river. Therefore, an average annual equivalent benefit of $120.8 million has been claimed for this function.

Additional water use in the United States.—The augmentation plan will make available an additional 200,000 acre-feet of water for use in the Lower Basin within the United States over the amount required to provide water to Mexico.

The average annual benefit value, of about $74 per acre-foot, discounted for staged deliveries results in total annual equivalent benefits of about $11.8 million.

Water quality.—The benefits associated with water quality improvements have not been evaluated in this preliminary study but should prove to be significant.

Increased hydroelectric power generation.—Increased generation at Hoover and Davis powerplants will result in increased power sales averaging some $3 million annually in increased revenues.

Total annual benefits.—Total annual benefits evaluated above amount to $135.6 million.

Benefit-cost ratio

Utilizing the benefits which were evaluated above, and excluding any benefit from improved water quality, the project has a ratio of benefits to costs of 1.03 to 1.00 over a 100-year period of analysis at a 3¼ percent interest rate.

The benefit-cost ratio derived from the incremental costs and benefits associated with providing 200,000 acre-feet of water in excess of that required for the replacement of the Mexican Treaty requirements is 1.17 to 1.00.

Cost allocation

Costs of the augmentation plan were first allocated to (1) replacing the requirements of the Mexican Water Treaty and (2) providing additional water for use in the United States. These costs were distributed in proportion to the ultimate supply in each category; i.e., 90 percent to the Mexican Treaty obligation and 10 percent to use in the Lower Basin. The latter assignment was suballocated between purposes now being served in the Lower Basin based on historical use (85 percent irrigation and 15 percent municipal and industrial water). A summary of the cost allocation follows:

SUMMARY OF COST ALLOCATION

[In millions of dollars]

Purpose	Construction cost	Interest during construction	Total Federal investment	Annual O.M. & R.
Mexican Water Treaty	2,505	228	2,733	44.02
U.S. water supply:				
Irrigation	237	21	258	4.15
Municipal and industrial	42	4	46	.74
Total	2,784	253	3,037	[1] 48.91

[1] Includes sinking fund of $19,600,000 for replacing nuclear desalting facilities after 30-year life.

Repayment Analysis

For the purposes of this study, all costs allocated to the Mexican Treaty obligation are considered nonreimbursable; the remainder are treated as reimbursable costs to be returned by the Development Fund. In accordance with Reclamation repayment policy, investment costs allocated to M&I are to be repaid with interest at the current rate of 3.253 percent; construction costs allocated to irrigation are repaid without interest. Repayment of facility costs is to be accomplished within the service life of the facility or 50 years, whichever is shorter, after the completion of each facility. Reimbursable and nonreimbursable costs are shown in the following tabulation.

SUMMARY OF REIMBURSABLE AND NONREIMBURSABLE COSTS

[In millions of dollars]

	Construction cost	Interest during construction (3.253 percent)	Total for repayment
Reimbursable:			
U.S. water supply:			
Irrigation	237		237
Municipal and industrial	42	4	46
Subtotal	279	4	283
Nonreimbursable: Mexican Water Treaty	2,505		
Total	2,784	4	283

Of the total annual operating costs of $48.91 million, $4.89 million is assigned as reimbursable. Included is the sinking fund component required to completely replace the desalting and thermal pumping power facilities throughout the payout period at 30-year intervals. Hydrologic studies of the Colorado River with augmentation show that, on a probability basis, there will be years in which reservoirs will be full and no augmentation water can be beneficially used. Because of the dual-purpose nature of the nuclear complex and the need for continued production of commercial power, discontinuation of operations for extended periods is not economic. The variable operating costs for the desalting plant and the thermal pumping power, excluding all replacement and other fixed charges, represents a small percentage of the total production costs. Consequently, it was assumed that, at a minimum, the operating costs could be returned by interim sales of product water near the site or along the aqueduct. To simplify the repayment analysis, these sales are reflected as a small reduction in the desalting and thermal pumping power portions of the operating costs.

As presented in the detailed payout schedule (Table I), the repayment analysis demonstrates that all reimbursable costs can be returned well within the allowable periods from Development Fund revenues. As indicated earlier, those revenues include surplus power revenues from the Boulder Canyon and Parker-Davis Projects, the portion of Pacific Northwest-Pacific Southwest Intertie located in the States of Nevada and Arizona, and the Central Arizona Project, all after completion of project payout. Revenues accumulated from these sources and the balances remaining in the Development Fund after repayment of augmentation costs are shown below for year 2029, representing 50 years after first year of full operation of the Central Arizona Project, and year 2059, reflecting 50 years after completion of augmentation works.

[In millions of dollars]

	Year 2029	Year 2059
Contributions (cumulative):		
Hoover	486	857
Parker–Davis	101	222
Intertie	42	130
Central Arizona project		918
Total	629	2,127
Development fund balance after repayment of augmentation costs	192	1,551

TABLE I.—AUGMENTATION OF THE COLORADO RIVER BY DESALTING OF SEA WATER
REPAYMENT ANALYSIS—REIMBURSABLE COSTS (2,000,000-ACRE-FOOT PLAN)

[In thousands of dollars]

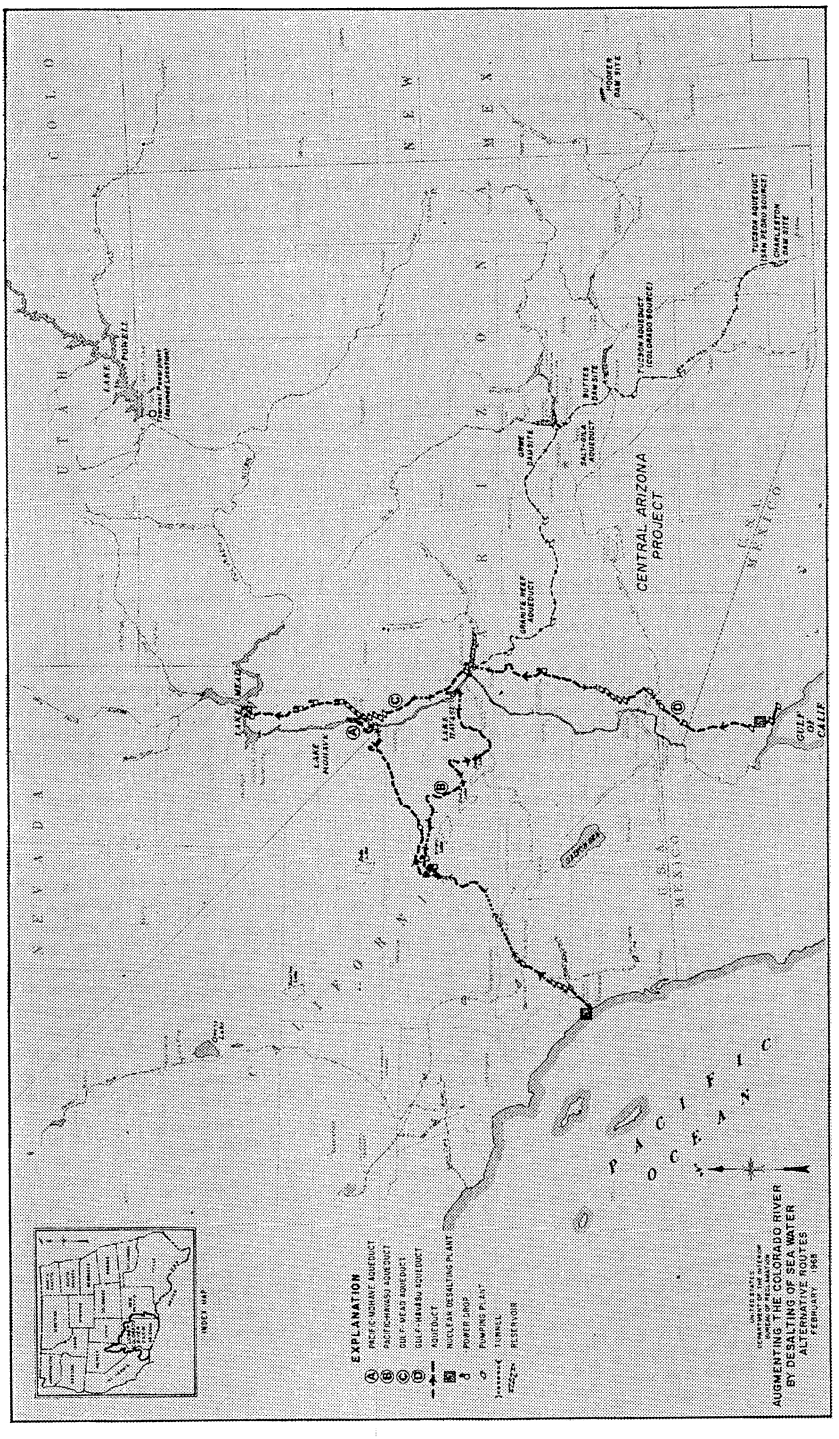
Year	Development fund revenues					O.M. & R.[1]	Development fund less reimbursable O.M. & R.	Repayment					Development fund balance
								Interest bearing			Interest free		
	Hoover	Parker-Davis	Intertie	CAP	Total			Interest at 3.253 percent	Unpaid balance	Plant in service	Unpaid balance	Plant in service	
1989									31,000	31,000	160,000	160,000	
1990						2,320	−2,320	1,008	32,356	31,000	161,972	160,000	
1991	12,691				12,691	2,320	10,371	1,052	23,037	31,000	161,972	160,000	
1992	12,691				12,691	2,320	10,371	749	13,415	31,000	161,972	160,000	
1993	12,691				12,691	2,320	10,371	436	3,480	31,000	161,972	160,000	
1994	12,691				12,691	2,320	10,371	113	0	31,000	155,194	160,000	
1995	12,691				12,691	2,320	10,371	0	0	31,000	144,823	160,000	
1996	12,691				12,691	2,320	10,371	0	0	31,000	134,452	160,000	
1997	12,691				12,691	2,320	10,371	0	0	310,00	124,081	160,000	
1998	12,691				12,691	2,320	10,371	0	0	31,000	113,710	160,000	
1999	12,691				12,691	2,320	10,371	0	0	40,000	162,339	210,000	
2000	12,691				12,691	3,490	9,201	0	0	40,000	153,138	210,000	
2001	12,438				12,438	3,490	8,948	0	0	40,000	144,190	210,000	
2002	12,438				12,438	3,490	8,948	0	0	40,000	135,242	210,000	
2003	12,438				12,438	3,490	8,948	0	0	40,000	126,294	210,000	
2004	12,438				12,438	3,490	8,948	0	0	40,000	117,346	210,000	
2005	12,438	4,046			16,484	3,490	12,994	0	0	40,000	104,352	210,000	
2006	12,438	4,046			16,484	3,490	12,994	0	0	40,000	91,358	210,000	
2007	12,438	4,046			16,484	3,490	12,994	0	0	40,000	78,364	210,000	
2008	12,438	4,046			16,484	3,490	12,994	0	0	40,000	65,370	210,000	
2009	12,438	4,046			16,484	3,490	12,994	0	0	45,000	85,376	238,000	
2010	12,438	4,046			16,484	4,640	11,844	0	0	45,000	73,532	238,000	
2011	12,398	4,046			16,444	4,640	11,804	0	0	45,000	61,728	238,000	
2012	12,398	4,046			16,444	4,600	11,804	0	0	45,000	49,924	238,000	
2013	12,398	4,046			16,444	4,640	11,804	0	0	45,000	38,120	238,000	
2014	12,398	4,046			16,444	4,640	11,804	0	0	45,000	26,316	238,000	
2015	12,398	4,042			16,440	4,640	11,800	0	0	45,000	14,516	238,000	
2016	12,398	4,042			16,440	4,640	11,800	0	0	45,000	2,716	238,000	
2017	12,398	4,042			16,440	4,640	11,800	0	0	45,000	0	238,000	9,084
2018	12,398	4,042			16,440	4,640	11,800	0	0	45,000	0	238,000	20,884
2019	12,398	4,042			16,440	4,640	11,800	0	0	45,000	0	238,000	32,684
2020	12,398	4,042			16,440	4,640	11,800	0	0	45,000	0	238,000	44,484
2021	12,358	4,042			16,400	4,640	11,760	0	0	45,000	0	238,000	56,244
2022	12,358	4,042	5,200		21,600	4,640	16,960	0	0	45,000	0	238,000	73,204
2023	12,358	4,042	5,200		21,600	4,604	16,960	0	0	45,000	0	238,000	90,164

2024	12,358	4,042	5,200	----------	21,600	4,640	16,960	0	0	45,000	0	238,000	107,124
2025	12,358	4,039	5,200	----------	21,597	4,640	16,957	0	0	45,000	0	238,000	124,081
2026	12,358	4,039	5,200	----------	21,597	4,640	16,957	0	0	45,000	0	238,000	141,038
2027	12,358	4,039	5,200	----------	21,597	4,640	16,957	0	0	45,000	0	238,000	157,995
2028	12,358	4,039	5,200	----------	21,597	4,540	16,957	0	0	45,000	0	238,000	174,952
2029	12,358	4,039	5,200	----------	21,597	4,640	16,957	0	0	45,000	0	238,000	191,909
Subtotal	486,492	101,075	41,600	----------	629,167	150,900	478,267	3,358	0	45,000	0	238,000	191,909
2030	12,358	4,039	5,200	5,992	27,589	4,640	22,949	0	0	45,000	0	238,000	214,858
2031	12,340	4,039	5,200	6,048	27,627	4,640	22,987	0	0	45,000	0	238,000	237,845
2032	12,340	4,039	5,200	6,107	27,686	4,640	23,046	0	0	45,000	0	238,000	260,891
2033	12,340	4,039	5,200	15,702	37,281	4,640	32,641	0	0	45,000	0	238,000	293,532
2034	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	344,483
2035	12,340	4,039	5,200	34,013	55,592	4,640	50,952	0	0	45,000	0	238,000	395,435
2036	12,340	4,039	5,200	34,013	55,592	4,640	50,952	0	0	45,000	0	238,000	446,387
2037	12,340	4,039	5,200	34,013	55,592	4,640	50,952	0	0	45,000	0	238,000	497,339
2038	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	548,290
2039	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	599,241
2040	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	650,192
2041	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	701,143
2042	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	752,094
2043	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	803,045
2044	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	853,996
2045	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	904,947
2046	12,340	4,039	5,200	34,012	55,591	4,640	50,951	0	0	45,000	0	238,000	955,898
2047	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,001,649
2048	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,047,400
2049	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,093,151
2050	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,138,902
Subtotal	745,650	185,894	130,000	612,056	1,673,600	248,340	1,425,260	3,358	0	45,000	0	238,000	1,138,902
2051	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,184,653
2052	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,230,404
2053	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,276,155
2054	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,321,906
2055	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,367,657
2056	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,413,408
2057	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,459,159
2058	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,504,910
2059	12,340	4,039	0	34,012	50,391	4,640	45,751	0	0	45,000	0	238,000	1,550,661
Total	856,710	222,245	130,000	918,164	2,127,119	290,100	1,837,019	3,358	0	45,000	0	238,000	1,550,661

[1] Includes sinking fund component for replacement of reimbursable portion of nuclear complex.

ALTERNATIVE PLANS

Preliminary analyses of several alternative plans of development were made in the course of this investigation. The base plan described previously was evaluated at an enlarged size to permit the delivery of 2.5 million acre-feet of water annually to the Colorado River. In addition, preliminary cost estimates were developed for four alternative conveyance routes at both 2 and 2.5 million acre-feet capacities. Two of these alternative routes are associated with desalting facilities on the Gulf of California, rather than on the coast of southern California. (See map.)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CENTRAL ARIZONA PROJECT
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LAKE HAVASU
GULF OF CALIF.
PACIFIC OCEAN
EXPLANATION
PACIFIC-HAVASU AQUEDUCT
PACIFIC-MEAD AQUEDUCT
GULF-MEAD AQUEDUCT
GULF-HAVASU AQUEDUCT
AQUEDUCT
DESALTING PLANT
POWER PLANT
PUMPING PLANT
TUNNEL
RESERVOIR
INDEX MAP
AUGMENTING THE COLORADO RIVER BY DESALTING OF SEA WATER
ALTERNATIVE ROUTES
FEBRUARY 1968

Basic route, 2.5 million acre-feet

Assumptions.—As explained previously, some experts believe that 2.5 m.a.f. of augmentation annually will be required to provide for 7.5 m.a.f. of consumptive use in the Lower Colorado River Basin. The basic physical plan described above was modified to include the additional capacity necessary to meet the 2.5 m.a.f. capacity.

Hydrologic studies, based upon the assumptions inherent in the larger augmentation requirement, indicate that appropriate staging of the project would be as follows:

Stage	Year	Water delivery		Cumulative pumping power (megawatts) [1]
		Each stage (acre-feet per year)	Cumulative (acre-feet per year)	
1	1985	750,000	750,000	425
2	1990	500,000	1,250,000	708
3	1995	750,000	2,000,000	1,133
4	2010	500,000	2,500,000	1,416

[1] Thermal power requirement after deducting power produced at aqueduct power drops.

Costs.—Costs for the dual-purpose nuclear desalting plant were derived as explained in the discussion of the base plan. The summary of costs is as follow:

DUAL-PURPOSE NUCLEAR DESALTING PLANT—CONSTRUCTION AND O.M. & R. COSTS [1]

[In millions of dollars]

	Stage				
	1985	1990	1995	2010	Total
Construction:					
Total	536.00	372.00	536.00	372.00	1,816
Less non-Federal power	194.00	130.00	194.00	130.00	648
Federal	342.00	242.00	324.00	242.00	1,168
Desalted water	(300.00)	(214.00)	(300.00)	(214.00)	(1,028)
Nuclear pumping power	(42.00)	(28.00)	(42.00)	(28.00)	(140)
Annual O.M. & R.: [1]					
Total, operation maintenance, and "interim replacement"	11.87	20.20	32.07	40.40	----------
Non-Federal power	3.00	4.99	7.99	9.98	----------
Federal:					
Desalted water	8.23	14.14	22.37	28.28	----------
Nuclear pumping power	.64	1.07	1.71	2.14	----------
Subtotal	8.87	15.21	24.08	30.42	----------
Sinking fund for rebuilding plants	7.31	12.47	19.78	24.94	----------
Total, Federal O.M. & R.	16.18	27.68	43.86	55.36	----------

[1] Cumulative costs after completion of stage.

Conveyance facilities were increased to 4,050 c.f.s. to accommodate the larger deliveries. The summary of costs of conveyance works is as follows:

CONVEYANCE SYSTEM—CONSTRUCTION AND O.M. & R. COSTS [1]

[In millions of dollars]

Feature	Stage (year)				
	1985	1990	1995	2010	Total
Construction costs:					
Dam (De Luz site)	24.00				24
Tunnels	593.00				593
Canal	153.00				153
Pipeline	333.00		270.00		603
Pumping plants	395.00	56.00	83.00	55.00	589
Power drops	53.00	16.00	24.00	15.00	108
Transmission system	53.00		32.00		85
Access roads	3.00				3
Total	1,607.00	72.00	409.00	70.00	2,158
Annual O.M. & R.:					
Aqueduct facilities	2.98	3.44	4.28	4.80	
Transmission system	1.01	1.01	1.68	1.68	
Total	3.99	4.45	5.96	6.48	

[1] The annual O.M. & R. costs are the total costs after completion of each stage.

Economic and financial analysis.—A benefit-cost analysis of the 2.5-m.a.f. plan would produce results comparable to those of the base plan. The repayment analysis would vary significantly because the revenues accruing to the Development Fund are essentially the same while the costs increase substantially. The payout study indicated that all costs could be repaid within 50 years after the last stage is completed and still leave a substantial balance at year 2059; however, for a period of some 12 years between 2033 and 2046 the revenues do not meet the repayment requirement for each individual stage. A summary of surplus revenues and Development Fund balances for the 2.-m.a.f. plan similar to those presented for the base plan follows:

[In millions of dollars]

	Year 2029	Year 2059
Contribution (cumulative):		
Hoover	514	908
Parker-Davis	109	140
Intertie	42	130
Central Arizona project		918
Total contributions	665	2,196
Development fund balances after repayment of augmentation works	0	436

Note: Details of the repayment schedule are presented in table II.

TABLE II.—AUGMENTATION OF THE COLORADO RIVER BY DESALTING OF SEA WATER
REPAYMENT ANALYSIS—REIMBURSABLE COSTS (2,500,000-ACRE-FOOT PLAN)

[In thousands of dollars]

Year	Development fund revenues					O.M. & R.[1]	Development fund less reimbursable O.M. & R.	Repayment						Development fund balance
								Interest bearing			Interest free			
	Hoover	Parker-Davis	Intertie	CAP	Total			Interest, at 3.253 percent	Unpaid balance	Plant in service	Unpaid balance	Plant in service	Allowable unpaid balance	
1984									74,000	74,000	378,000	378,000	378,000	
1985						4,400	−4,400	2,407	77,067	74,000	381,740	378,000	381,740	
1986						4,400	−4,400	2,507	80,234	74,000	385,480	378,000	385,480	
1987						4,400	−4,400	2,610	83,504	74,000	389,220	378,000	389,220	
1988						4,400	−4,400	2,716	86,880	74,000	392,960	378,000	392,960	
1989						4,400	−4,400	2,826	102,366	86,000	457,700	439,000	457,700	
1990						6,990	−6,990	3,330	106,744	86,000	463,642	439,000	463,642	
1991	13,294				13,294	6,990	6,304	3,472	103,912	86,000	463,642	439,000	463,642	
1992	13,294				13,294	6,990	6,304	3,380	100,988	86,000	463,642	439,000	463,642	
1993	13,294				13,294	6,990	6,304	3,285	97,969	86,000	463,642	439,000	463,642	
1994	13,294				13,294	6,990	6,304	3,187	122,852	114,000	508,642	484,000	508,642	
1995	13,294				13,294	10,820	2,474	3,996	124,374	114,000	508,642	484,000	508,642	
1996	13,294				13,294	10,820	2,474	4,046	125,946	114,000	508,642	484,000	508,642	
1997	13,294				13,294	10,820	2,474	4,097	127,569	114,000	508,642	484,000	508,642	
1998	13,294				13,294	10,820	2,474	4,150	129,245	114,000	508,642	484,000	508,642	
1999	13,294				13,294	10,820	2,474	4,204	130,975	114,000	508,642	484,000	508,642	
2000	13,294				13,294	10,820	2,474	4,261	132,762	114,000	508,642	484,000	508,642	
2001	13,166				13,166	10,820	2,346	4,319	134,735	114,000	508,642	484,000	508,642	
2002	13,166				13,166	10,820	2,346	4,383	136,772	114,000	508,642	484,000	508,642	
2003	13,166				13,166	10,820	2,346	4,449	138,875	114,000	508,642	484,000	508,642	
2004	13,166				13,166	10,820	2,346	4,518	141,047	114,000	508,642	484,000	508,642	
2005	13,166	4,437			17,603	10,820	6,783	4,588	138,852	114,000	508,642	484,000	508,642	
2006	13,166	4,437			17,603	10,820	6,783	4,517	136,586	114,000	508,642	484,000	508,642	
2007	13,166	4,437			17,603	10,820	6,783	4,443	134,246	114,000	508,642	484,000	508,642	
2008	13,166	4,437			17,603	10,820	6,783	4,367	131,830	114,000	508,642	484,000	508,642	
2009	13,166	4,437			17,603	10,820	6,783	4,288	141,335	126,000	569,642	545,000	569,642	
2010	13,166	4,437			17,603	13,420	4,183	4,598	141,750	126,000	569,642	545,000	569,642	
2011	13,153	4,437			17,590	13,420	4,170	4,611	142,191	126,000	569,642	545,000	569,642	
2012	13,153	4,437			17,590	13,420	4,170	4,625	142,646	126,000	569,642	545,000	569,642	
2013	13,153	4,437			17,590	13,420	4,170	4,640	143,116	126,000	569,642	545,000	569,642	
2014	13,153	4,437			17,590	13,420	4,170	4,656	143,602	126,000	569,642	545,000	569,642	
2015	13,153	4,342			17,495	13,420	4,075	4,671	144,198	126,000	569,642	545,000	569,642	
2016	13,153	4,342			17,495	13,420	4,075	4,691	144,814	126,000	569,642	545,000	569,642	
2017	13,153	4,342			17,495	13,420	4,075	4,711	145,450	126,000	569,642	545,000	569,642	
2018	13,153	4,342			17,495	13,420	4,075	4,731	146,106	126,000	569,642	545,000	569,642	
2019	13,153	4,342			17,495	13,420	4,075	4,753	146,784	126,000	569,642	545,000	569,642	

2020	13,153	4,342			17,495	13,420	4,075	4,775	147,484	126,000	569,642	545,000	569,642
2021	13,139	4,342			17,481	13,420	4,061	4,798	148,221	126,000	569,642	545,000	569,642
2022	13,139	4,342	5,200		22,681	13,420	9,261	4,822	143,782	126,000	569,642	545,000	569,642
2023	13,139	4,342	5,200		22,681	13,420	9,261	4,677	139,198	126,000	569,642	545,000	569,642
2024	13,139	4,342	5,200		22,681	13,420	9,261	4,528	134,465	126,000	569,642	545,000	569,642
2025	13,139	4,339	5,200		22,678	13,420	9,258	4,374	129,581	126,000	569,642	545,000	569,642
2026	13,139	4,339	5,200		22,678	13,420	9,258	4,215	124,538	126,000	569,642	545,000	569,642
2027	13,139	4,339	5,200		22,678	13,420	9,258	4,051	119,331	126,000	569,642	545,000	569,642
2028	13,139	4,339	5,200		22,678	13,420	9,258	3,882	113,955	126,000	569,642	545,000	569,642
2029	13,139	4,339	5,200		22,678	13,420	9,258	3,707	108,404	126,000	569,642	545,000	569,642
Subtotal	514,381	109,485	41,600		665,466	487,650	177,816	184,862	108,404	126,000	569,642	545,000	569,642
2030	13,139	4,339	5,200	5,992	28,670	13,420	15,250	3,526	96,680	126,000	569,642	545,000	569,642
2031	13,132	4,335	5,200	6,048	28,715	13,420	15,295	3,145	84,530	126,000	569,642	545,000	
2032	13,132	4,335	5,200	6,107	28,774	13,420	15,354	2,750	71,926	126,000	569,642	545,000	
2033	13,132	4,335	5,200	15,702	38,369	13,420	24,949	2,340	49,317	126,000	569,642	545,000	569,642
2034	13,132	4,335	5,200	34,012	56,679	13,420	43,259	1,604	7,662	126,000	569,642	545,000	191,642
2035	13,132	4,335	5,200	34,013	56,680	13,420	43,260	249	0	126,000	534,293	545,000	187,902
2036	13,132	4,335	5,200	34,013	56,680	13,420	43,260	0	0	126,000	491,033	545,000	184,162
2037	13,132	4,335	5,200	34,013	56,680	13,420	43,260	0	0	126,000	447,773	545,000	180,422
2038	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	404,514	545,000	176,682
2039	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	361,255	545,000	111,942
2040	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	317,996	545,000	106,000
2041	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	274,737	545,000	106,000
2042	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	231,478	545,000	106,000
2043	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	188,219	545,000	106,000
2044	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	144,960	545,000	61,000
2045	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	101,701	545,000	61,000
2046	13,132	4,335	5,200	34,012	56,679	13,420	43,259	0	0	126,000	58,442	545,000	61,000
2047	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	20,383	545,000	61,000
2048	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2049	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2050	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
Subtotal	790,160	200,524	130,000	612,056	1,732,740	769,470	963,270	198,476	0	126,000	0	545,000	61,000
2051	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2052	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2053	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2054	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2055	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2056	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2057	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	61,000
2058	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	0
2059	13,132	4,335	0	34,012	51,479	13,420	38,059	0	0	126,000	0	545,000	0
Total	908,348	239,539	130,000	918,164	2,196,051	890,250	1,305,801	198,476	0	126,000	0	545,000	0

2020	17,676
2021	55,735
2022	93,794
2023	131,853
2024	169,912
2025	207,971
2026	246,030
2027	284,089
2028	322,148
2029	360,207
2030	398,266
2031	436,325
2032	
2033	
2034	
2035	
2036	
2037	
2038	
2039	
2040	
2041	
2042	
2043	
2044	
2045	
2046	
2047	
2048	
2049	
2050	
Subtotal	93,794
2051	131,853
2052	169,912
2053	207,971
2054	246,030
2055	284,089
2056	322,148
2057	360,207
2058	398,266
2059	436,325
Total	436,325

[1] Includes sinking fund component for replacement of reimbursable portion of nuclear complex.

Alternative routes

Four alternative routes for conveyance of desalted sea water to the Colorado River were examined for purposes of comparison to the base plan. For each alternative route, costs were estimated for the provision of 2 m.a.f. and 2.5 m.a.f. of augmentation supplies. (See map of alternative routes.)

Those alternative plans which involve the delivery of desalted water into the Colorado River downstream of Hoover Dam (plans A, B, and D) would not have the use of storage capacity of Lake Mead for regulation. As a result, preliminary studies indicate that these plans would require additional regulatory storage as a feature of the augmentation plan.

Such storage near the terminal point of the conveyance works would also provide an opportunity to mix the very high quality desalted water with the natural river water. It appears that provisions for adequate mixing will be essential to optimize the benefit from use of the desalted water to reduce the river's salinity, as well as to avoid the problems associated with delivering water of widely varying quality to users.

Cost estimates for plans A, B, and D include the costs of a regulatory reservoir on the Bill Williams River arm of Lake Havasu located approximately 2 miles upstream from Parker Dam. The Bill Williams Reservoir would have a storage capacity of about 800,000 acre-feet, and the estimates include provisions for pumping from Lake Havasu into the reservoir. It would provide sufficient storage capacity to accommodate hydraulic mixing as well as regulatory storage to maintain efficient operation of the river.

The estimates for plans C and D incorporate dual-purpose nuclear desalting complexes situated at El Golfo de Santa Clara on the Gulf of California. As discussed later, siting of the plants in Mexico would involve international agreements. A joint study group formed by the Governments of the United States of America and Mexico and the International Atomic Energy Agency is currently conducting an assessment which will serve to define these considerations.

Summary tabulations of the costs and physical features of the alternative routes follow:

ALTERNATIVE IMPORT ROUTES (2,000,000 ACRE-FEET)

	Pacific-Mohave (A)	Pacific-Havasu (B)	Gulf-Mead (C)	Gulf-Havasu (D)
Construction cost (million dollars):				
Nuclear desalting facilities [1]	904	899	931	854
Conveyance system	1,837	1,868	2,357	1,199
Total	2,741	2,767	3,288	2,053
Annual costs, O.M. & R.[2] (million dollars):				
Nuclear desalting facilities	42.8	42.5	43.8	41.2
Conveyance system	4.6	4.2	8.3	4.2
Total	47.4	46.7	52.1	45.4
Physical features (miles):				
Tunnels	66	94	38	27
Pipeline	87	77	130	27
Canal	101	122	184	138
Penstocks and discharge lines	13	10	17	11
Total	267	303	369	203
Pumping plants:				
Number of plants	9	8	19	10
Total dynamic head (feet)	4,105	3,381	5,045	5,154
Installed capacity (mw.)	1,357	1,117	1,667	1,650
Power drops:				
Number of drops	4	3	6	2
Design head (feet)	2,114	1,418	2,315	451
Installed capacity (mw.)	481	323	527	94

[1] Includes allocated power costs for project pumping.
[2] Includes fuel costs, interim replacements, and sinking fund to rebuild at the end of 30-year service life.

ALTERNATIVE IMPORT ROUTES (2,500,000 ACRE-FEET)

	Pacific-Mohave (A)	Pacific-Havasu (B)	Gulf-Mead (C)	Gulf-Havasu (D)
Construction cost (in millions of dollars):				
Nuclear desalting facilities [1]	1,140	1,134	1,174	1,085
Conveyance system	2,113	2,149	2,672	1,360
Total	3,253	3,283	3,846	2,445
Annual costs—O.M. & R.[2] (in millions of dollars):				
Nuclear desalting facilities	54.4	54.0	54.7	52.0
Conveyance system	5.5	5.1	9.6	4.7
Total	59.9	59.1	64.3	56.7
Physical features (miles):				
Tunnels	66	94	83	27
Pipeline	87	77	130	27
Canal	101	122	184	138
Penstocks and/discharge lines	13	10	17	11
Total	267	303	369	203
Pumping plants:				
Number of plants	9	8	19	10
Total dynamic head (feet)	4,105	3,381	5,045	1,650
Installed capacity (megawatts)	1,696	1,397	1,992	651
Power drops:				
Number of drops	4	3	6	2
Design head (feet)	2,114	1,418	2,315	415
Installed capacity (megawatts)	601	403	629	113

[1] Includes allocated power costs for project pumping.
[2] Includes fuel costs, interim replacements, and sinking fund to rebuild at the end of 30-year service life.

CONSIDERATIONS FOR FEASIBILITY STUDIES

The objective of this study was to explore, based upon reconnaissance level data, the possibilities of augmenting the water supply of the Colorado River by desalting of sea water. The plan presented herein has been selected in order to demonstrate the various factors involved in the concept of augmentation by desalting of sea water without introducing unnecessary complications. In the course of study, a number of potential alternative or modified courses of action were taken into consideration. Because of limitations on the time and scope of the study, it was not possible to explore in detail all of the potential opportunities to improve the plan. A number of these possibilities appear to be of significant potential advantage, however, and should be considered in detail when feasibility studies are undertaken. The following discussion concerns the most important of these possibilities.

Coordination with Mexico-United States of America desalting proposal studies

A joint study group has been formed by the Government of Mexico, the Government of the United States of America, and the International Atomic Energy Agency to make a preliminary assessment of the technical and economic practicability of a dual-purpose nuclear power and desalting plant which would serve the general areas of California, Arizona, Baja California, and Sonora. The work on this assessment is presently under way.

It is certain that long-range provisions for additional augmentation of the Colorado River will be necessary to support the continued economic and sociological development of the Pacific Southwest. The assessment being made by the joint study group is giving consideration to providing for such long-range needs.

If agreement is reached among the parties and plans to proceed with this joint venture materialize, an opportunity might exist to obtain the augmentation water from this source at a significant saving, particularly in conveyance costs.

Consolidation of these two proposals would impart the advantages of financing

associated with the augmentation to a portion of the joint venture, and important advantages might be provided the augmentation effort by plant siting in Mexico.

Because of the obvious uncertainties of international agreements and timing associated with siting of the plant in Mexico, this reconnaissance report has been based upon a plan which is located entirely within the United States. If feasibility studies are undertaken, however, further attention should be given to the progress of the study group's efforts and economic analyses made of the alternative of utilizing the joint venture as a source of augmentation water.

National Water Commission

Congressional action is well advanced on pending legislation to establish a National Water Commission. If established, it is anticipated that the commission will address itself to the problems of water supply in the Pacific Southwest at an early date. Among the factors which should be considered by the commission is the practicability of augmenting the Colorado River by desalting of sea water. To meet the objectives outlined in this report, it will not be necessary to initiate construction of desalting facilities until after 1980. The National Water Commission's recommendations will be available well in advance of the need to make a final decision to proceed with construction.

Need for additional augumentation

This reconnaissance study has been directed toward the provision of sufficient water to prevent shortages in the 7.5 m.a.f. of annual consumptive use apportioned among the State of the Lower Colorado River Basin. The provision of this quantity of water would, of course, not supply adequately the potential uses of the Pacific Southwest. California uses from the river presently exceed 5.0 m.a.f. annually and would, with this augmentation in effect, be reduced to an assured 4.4 m.a.f. Estimates of Arizona's present ground-water overdraft made for earlier reports are 2.2 m.a.f. annually as compared to about 1.5 m.a.f. which would be supplied from the Central Arizona Project. Nevada's allocation has been estimated to be adequate to provide for municipal and industrial growth of the Las Vegas metropolitan area until 2020, but population growth is exceeding the projections annually in this area. One potential source for provision of water would be by desalting, as is being studied by the joint committee discussed above. The ability to provide staged construction of desalting facilities has the advantages of flexibility in timing capacity to meet needs, spreading the time of construction investment, and maximizing the use of advancing technology. Future studies of desalting facilities should include consideration of additional capacity for long-range needs. If such capacity can be shown to be desirable, plans should include provisions which would facilitate future stages.

The Upper Basin has committed the major portion of its available water supply. Large population centers within and adjacent to the Upper Basin will remain dependent on the Colorado River for the development of increased supplies of municipal water. Mineral resources of phosphates, oil and gas, coal, trona, uranium, and oil shale exist extensively in the Upper Basin and would depend on a supply of additional water for development. Agricultural opportunities also exist which could use additional water.

Potential pumped storage

In the course of the reanalysis of the Central Arizona Project, which was performed in late 1966, and other reconnaissance-grade investigations, the Bureau of Reclamation has made preliminary examinations of a number of potential pumped storage, hydroelectric plants in Arizona. The plan which appeared most favorable, based upon available data, was the Mohave pumped storage plan which is located in Arizona adjacent to Lake Mohave about 21 river miles downstream from Hoover Dam.

The existing Lake Mohave, the reservoir formed by Davis Dam, would serve as the lower reservoir for the installation. Low cost thermal electric power from plants of power systems in the Southwest would be used at times of low power demand to pump water, using reversible pump-generators, to an upper reservoir. The 49,000-acre-foot upper reservoir would be formed by excavation and damming of a natural depression on Malpais Mesa almost 1,400 feet above Lake Mohave.

During periods of peak power demand or at times of sudden loads on the integrated power systems, water would be released from the upper reservoir back into Lake Mohave, providing a source of quickly available, high value peaking power.

The plant could be built to a capacity of 5,100 megawatts or larger, and could be integrated with baseload steamplants of the electric utility systems in the area to provide sources of low cost pumping energy. The nuclear powerplants associated with the dual-purpose desalting facilities would be another potential source of off-peak energy. Although the Mohave pumped storage would produce no net energy, the facility would make substantial contributions to a development fund through the sale of peaking capacity if an appropriate source of pumping energy were available.

Other favorable pump storage sites in Arizona identified by the Bureau include the Buckskin Mesa site on the Bill Williams arm of Lake Havasu, the White Tanks Mountain site adjacent to the Granite Reef aqueduct in central Arizona, the Montezuma site southwest of Phoenix, Arizona, and the Horse Mesa pump storage site adjacent to the Salt River Canyon some 40 miles east of Phoenix.

As additional large, efficient thermal electric powerplants are added to the power systems of the Pacific Southwest, the need for additional efficient, quick-starting peaking capacity to meet hourly and daily peak loads will become critical. Pumped storage plants such as the Mohave plan would provide an attractive source of peaking power. If such installations were integrated with the Lower Colorado River Basin Development Fund, the surplus revenues from power sales would improve the financial feasibility of augmentation proposals.

Impact of weather modification

Recent scientific and technical advances in the field of weather modification have shown that practical applications of this knowledge to increase streamflows in a significant scale may be imminent. The Department of the Interior's current atmospheric water resources program includes projects aimed at developing the capability to increase the yield of water from the atmosphere in specific localities and regions.

Operational capability to increase streamflow will first be achieved in areas where significant amounts of data and experience have been accumulated from experiments now in progress. Initial effects of the program may become evident in the Colorado Basin by the early 1970's.

If weather modification proves to be successful in increasing precipitation in the basin, the effect will be to postpone, but not replace, the need for augmentation measures. Before any construction need be initiated on desalting works, it is expected that the results of weather modification will be apparent. To the extent that construction of desalting units is delayed, technological advances in desalting techniques may be expected to improve the financial feasibility of the plan.

Impact of water salvage measures

The plan proposed for the Central Arizona Project includes water salvage measures along the lower Colorado River consisting of ground-water recovery in the Yuma area and phreatophyte clearing along the lower reaches of the River. It is anticipated that these undertakings will yield 320,000 acre-feet of water annually for use. The benefit of this salvage is incorporated in the hydrologic assumptions underlying the studies in this report.

Accomplishment of the above measures, along with the recently completed Senator Wash reservoir and channel alignment work presently under way, will substantially exhaust the opportunities for increasing the yield of the river by salvage along the main stem. There might remain some possibility of decreasing the evaporation losses in the major reservoirs, and the Bureau is conducting studies of evaporation suppression at the present time. However, no practical method of suppressing evaporation on large reservoirs has yet been developed.

In the course of detailed augmentation studies, the results of water salvage activities will, of course, be taken into account. The timing of initiation of augmentation can be adjusted as necessary to accommodate the actual future conditions; but it does not appear that water salvage activities will have appreciable influence on the feasibility of the desalting project.

CONCLUSIONS

Based on the analysis presented herein it is concluded that there is reasonable expectation that detailed studies will establish the feasibility of augmenting the Colorado River by the amount of 2 to 2.5 million acre-feet annually by desalting of sea water. The validity of this conclusion rests principally on three future developments; (1) the realization, at least in part, of projected tech-

niques for combined nuclear-desalting and thermal-electric plants, (2) the enactment of those provisions of pending legislation which would declare that discharge of the Mexican Water Treaty obligation is a national responsibility, and (3) the establishment of a Lower Colorado River Basin Development Fund to provide financial assistance in repaying the reimbursable costs of augmentation works.

As pointed out throughout this report, a number of conservative assumptions and choices of alternatives have been incorporated in the analysis of the basic plan. This approach has been taken with the objective of minimizing, to the extent possible, the potentially adverse impact which indeterminate future conditions could have upon the validity of study. The accomplishments of the base plan, as presented in the analysis, therefore, are reasonably capable of being achieved.

Furthermore, a number of opportunities exist to improve upon the base plan and achieve major financial advantages if detailed studies and future conditions prove favorable. Examples of the most significant of these potential improvements are siting of the desalting plant on the Gulf of California along with delivery of augmentation water downstream of Boulder Dam, postponement of the construction of facilities through weather modification or advantageous natural runoff in the Colorado River Basin, and coordination of the augmentation plan with pumped storage hydroelectric installations.

Augmentation of the natural runoff of the Colorado River in the amounts projected herein would, among other things, achieve the following:

1. Guarantee the Lower Basin States a minimum annual water supply from the Colorado River of 7.5 million acre-feet for beneficial consumptive use.
2. Resolve the question of responsibility for delivery of water to Mexico and thereby assure the right of the Upper Basin to deplete the flow of the river for beneficial consumptive use unhampered by any controversy over obligations for delivery of Mexican Treaty water.
3. Eliminate, or make completely academic, the question of a 4.4 million acre-foot priority for California.
4. Enhance, significantly, the quality of Lower Colorado River water.

Mr. ASPINALL. Mr. Secretary, do you not think it a little foolish to propose the conveyance of Pacific Ocean water into Lake Mead, lifting it more than 4,000 feet in the process?

Mr. DOMINY. I felt that way about it when we first started these studies, Mr. Chairman. But as we developed the facts of life and if we are going to fully use augmentation of the lower river to take care of the problems of the lower river which include water quality, I became convinced that we had to introduce the desalted water into the river at a point where it would do some good. It has to come in as far upstream as Lake Mojave in order to get the mixing that would be required.

Mr. ASPINALL. Why wasn't your report prepared on the basis of the closest and most economical source of water?

Mr. DOMINY. As you well recognize, this is merely a reconnaissance report. There is a joint study being made with the Republic of Mexico as to the possibility of locating a plant on the Gulf of California. We decided to fashion this study as to what the costs would be involved for a development entirely within the continental United States and not complicate it with international considerations, knowing that these other aspects would be fully considered if we go into a feasibility grade study.

Mr. ASPINALL. Assuming the water has to be obtained from the Pacific Ocean, surely it is not necessary to bring the water all the way to Lake Mead, is it?

Mr. DOMINY. As I have said, you have to bring it as far as Lake Mojave in order to get the essential mixing. If it is to be brought that far north, there is reason to pump it into Lake Mead and use it for peaking power purposes.

Mr. ASPINALL. Mr. Secretary, the report concludes that detailed studies will establish the feasibility of augmenting the river by desalting. Don't you believe that before we conduct feasibility studies of augmentation by desalting, we must at least have reconnaissance studies of all other possible means for augmentation?

Secretary UDALL. I would agree with that. I think the proper thing to do, Mr. Chairman, is to look at the economics of various alternatives. After all, this is a projection, it is an extrapolation. Let's see how the big Bolsa Island-southern California plant works. Let's see what the next generation of desalting plant looks like. We will know more 10 years from now than we do today.

Mr. ASPINALL. In this connection, I am bothered by the language in the reconnaissance report leaving the impression that we must await some word from a National Water Commission before there can be a study of the possibility of importing water from outside of the basin.

There is no National Water Commission and no assurance that there will be at this time, is there, Mr. Secretary?

Secretary UDALL. There is no assurance. I am optimistic that I can get the two bodies of Congress together sometime during this session on this issue.

Mr. ASPINALL. The chairman of the full committee was criticized because around the first of last June, we had not proceeded. Now we have passed the bill and they have had it over in the other body ever since last August. It seems there is no intent over there to pass it.

As you know, I have never been enthusiastic about the National Water Commission or the values that might accrue from its establishment, but I didn't oppose it. I have gone along with the legislation in hope that it might be useful in solving this Nation's water problems. But I tell you that it is not a National Water Commission that is going to make the policy decisions as to whether importations from other basins are appropriate augmentation sources for study purposes. This is the implication left by the language in the report. The Congress of the United States is going to make this determination and we are not going to take water from other basins simply because the National Water Commission says we should and we are not going to keep from taking water from other basins simply because the Water Commission, the proposed National Water Commission, says that we shouldn't. This is a question that will be worked out by agreement among the States as to what the studies will show will be feasible.

Would you agree with that statement?

Secretary UDALL. Mr. Chairman, I have no quarrel with your basic point, which is that the Congress is going to make the final decisions. I must say I think the improvements that the House committee put in the bill to establish a National Water Commission are very important improvements. I think the House bill is the better vehicle. I believe a National Water Commission could give guidance to the Nation for the kind of national action that may be needed in the future and could help make the case for the right kind of programs, whatever they are. That has been my real hope for a National Water Commission.

But the Congress and the Executive, in their usual way, are going to make the decisions; yes.

Mr. ASPINALL. I am surprised you defend the executive department.

I am interested in your discussion of weather modification as the means of increasing the water supplies of the river. I am in full agreement with the research that the department is conducting in this field, but, at the present time, you and I both know that this is not a dependable source of new water.

Do you agree with me on that at the present time?

Secretary UDALL. We have the scientists of the Bureau of Reclamation in Denver working on this. I have the highest regard for their scientific competence, their scientific approach. I know they want to move slowly and be sure of what they are doing. We are about 10 years off, in their judgment, if we give them the right kind of research support, from knowing what we really can do and how and what results are possible.

Mr. ASPINALL. At some time in the future, if the water supply from the Colorado River can be increased by this means, the additional supplies surely will be welcomed by all the States in the basin and quickly put to beneficial use. But this is surely not a source on which to base the planning and justification of the central Arizona project, or any other project in the basin, at least at the present time.

Secretary UDALL. I have to answer in two parts:

The central Arizona project, as the Bureau has planned it, does not rely on this kind of augmentation. It stands on its own merits.

On the other hand, however, when I look at the long-term future of the basin, I am rather optimistic about weather modification. But for the shorter term, I don't think we should base the plans for the central Arizona project on weather modification.

Mr. ASPINALL. One last question:

Under your present investigation and in accordance with your present thinking, when would you propose that the construction of the projects authorized in the legislation now before this committee be commenced?

Secretary UDALL. Fiscal year 1970 is the date we have in mind, Mr. Chairman.

Mr. ASPINALL. You say this when you know full well that the administration, the Bureau of the Budget, has looked at our $2.5 billion-plus backlog of authorizations and they are only giving us this coming year new construction money of approximately $203 million.

Mr. Chairman, I reserve the balance of my time with the understanding that the other members will have their time and if there are any other matters that come up during our proceedings, that I be allowed to come back again.

May I say to our committee members that we will adjourn but we will come back this afternoon. The Secretary will be with us. The Secretary will not be with us tomorrow, but he has said he will be with us Thursday if it is necessary for him to be here.

Mr. JOHNSON. We are in recess until 2 p.m.

(Whereupon, at 12 o'clock noon, the subcommittee was recessed, to reconvene at 2 p.m., this same day.)

AFTERNOON SESSION

Mr. JOHNSON. The Subcommittee on Irrigation and Reclamation will resume its hearing.

I now recognize the gentleman from Pennsylvania, Mr. Saylor.

Mr. SAYLOR. Thank you, Mr. Chairman.

As I left the committee room this morning, people in the audience said that they had observed that there was a smile on my face when the chairman of the full committee was interrogating the Secretary and the Commissioner of Reclamation, and they wondered why. I would just like to tell the chairman that I was torn, as it were, between two songs, as to whether to open my statement this morning with "Oh, what a beautiful morning, Oh, what a beautiful day, I've got a beautiful feeling, Everything's going my way" or "All the world is waiting for the sunrise, Every rose is heavy with dew."

You might wonder why two songs that are as opposite to one another have me torn. I want to say publicly that there is no Member of this Congress now or in the 20 years it has been my privilege to serve, who has been a greater advocate of reclamation than the Honorable Wayne A. Aspinall, the chairman of the full committee. And when he asked the question that he did this morning, he was following the same pattern of questions that a man from Pennsylvania named Saylor has been asking of the Bureau of Reclamation since 1949. And when I asked those questions—trying to get truthful answers—I was accused of being an enemy of reclamation. If the Bureau of Reclamation had given to me the same kind of forthright answers that the Secretary of the Interior has given to the chairman this morning, we might have had an entirely different picture in a great deal of the so-called semiarid West over the past number of years.

First, Mr. Secretary, let me say to you that I want to commend you for the answers you gave in response to the letter which the chairman forwarded to you. I think that you have conscientiously tried within the limits of the Bureau of Reclamation's ability to come as close as any Secretary has ever done in giving some of the best testimony that has been presented before this committee.

Now, I have a few questions to ask. Back when the Upper Colorado River project was authorized, in the hearings before this committee during the 84th and 85th Congress, the Bureau of Reclamation testified as to the flow of the river and when I at that time questioned the reliability of the Bureau's figures, I was told that there was absolutely no doubt about it. That the figures of the Bureau were correct and that there were not only 15 million acre-feet of water in the river, but that there was also enough water to do what people who met in Santa Fe in 1922 anticipated, that there would be water to divide over and above that figure between both the upper and lower basins.

Now, Mr. Secretary, I gather from the figures given us today that the only really dependable figures on which you have any absolute guarantee as to their reliability on the flow of the Colorado River are from 1929 until 1968. Is this correct?

STATEMENT OF HON. STEWART L. UDALL, SECRETARY OF THE INTERIOR—Resumed

Secretary UDALL. Mr. Congressman, I want to be understood on this. The words I used this morning with regard to the 1906–1922 or 1906–1929 period were that in the view of our experts these data are sufficiently accurate to be highly reliable. I do not want to confuse the record here on that point. It is our view that although the flows were not measured at Lee Ferry, as they were later, the data are accurate and reliable.

Mr. SAYLOR. In other words, you have evaded the question, sir, whether intentionally or otherwise? You have exact figures from 1929 until today?

Secretary UDALL. Yes; that is correct.

Mr. SAYLOR. These measurements that you are taking out there now, which the Bureau is collecting, are——

Secretary UDALL. No guesswork at all.

Mr. SAYLOR. It is exact. There is absolutely no guesswork on any of those figures? The figures from 1922 to 1929, in that 7-year period are more reliable because they were taken with a great deal more accuracy than the measurements before that time; is that not correct?

Mr. DOMINY. Well, Mr. Saylor, it is not that the figures available were not taken with accuracy. We had more gaging stations. We did not have some of them in the prior years. We did not establish the one at Lee Ferry, for example, until 1922. But we did have accurate figures of the flow at Yuma from 1903 and we did have other stations above Lee Ferry prior to 1922 with accuracy of measurement.

Mr. SAYLOR. Yes; but you will notice that the Secretary limited his figures to 1906. Now, there have been gaging stations on that river since the 1800's.

Mr. DOMINY. That is correct.

Mr. SAYLOR. 1886, I think, is the first time a gaging station was placed on the Colorado. So that the figures on the Colorado fall into three classifications—four classifications. Those before 1906, from 1906 until 1922, from 1922 to 1929, and from 1929 to 1968. Is that a fair statement?

Mr. DOMINY. I think that is a fair statement.

Mr. SAYLOR. And that the Secretary's testimony here has been based upon the figures from 1906 until 1968, which he says, from the experts in your Department, are reliable.

Now, if they are reliable, what has happened to the studies that were made when we had the Colorado River Storage project and indicated that we would have a full Lake Mead and a full Glen Canyon, and the date that they said they would be filled?

Mr. DOMINY. Let the record show that we had a full Lake Mead not long ago.

Mr. SAYLOR. When did you have a full Lake Mead?

Mr. DOMINY. In 1962 we had a full Lake Mead.

Mr. SAYLOR. When did you close the gates at Glen Canyon?

Mr. DOMINY. In 1963. Unfortunately, since that time, we have had only one above-average year and the rest have been below average.

Mr. SAYLOR. So that in order to take care of the requirements of the Hoover Dam and the payouts by the contract which the Department has entered into with the power users, you have had to release quantities of water out of Glen Canyon?

Mr. DOMINY. No, sir, we have never released one drop of water out of Glen Canyon just to make power. We have released it to meet the lower basin use requirements. Obviously, we have made power with it both at Glen Canyon and at Hoover in so doing. But we have never reduced the level at Lake Powell by 1 inch just to make power.

Mr. SAYLOR. Well, for whatever reason you may want to justify your releases——

Mr. DOMINY. The law is what I rely upon, Mr. Saylor.

Mr. SAYLOR. It is true that you did release the water out of Lake Powell?

Mr. DOMINY. That is right, to take care of the downstream uses—depletions.

Mr. SAYLOR. Now, what downstream depletions?

Mr. DOMINY. We have all of the California contracts, the Arizona contracts and the Indian uses downstream, as well as the Mexican Treaty obligation.

Now, it is true that we did not want Lake Mead to drop below minimum head, but we did not release any water out of Lake Mead just to make power. We did adjust the levels of the two reservoirs so that we did not build a higher head at Lake Powell at the expense of dropping below a minimum head at Lake Mead, for example. This would not have made sense. And we do try to make sense with our operation.

Mr. SAYLOR. Confidentially, many of the things you have done in that Bureau over the years have not made sense to some of us. So this one more would not be exception.

Mr. ASPINALL. Would the gentleman yield?

Mr. SAYLOR. Yes.

Mr. ASPINALL. Following up what you have said, Mr. Dominy, in order to take care of 75 million acre-feet of water for the consecutive 10-year period, counting the period which you are in now, we are going to have to release greater amounts than we have the last 3 or 4 years.

Mr. DOMINY. That is correct.

We were well ahead of the 75 million acre-feet 10-year moving average until we closed Glen Canyon Dam. Now, we have dropped consistently below that. So to meet the 10-year average release requirement, there will have to be some additional releases.

Mr. SAYLOR. Mr. Secretary, am I correct in understanding that the basic law of the Colorado River is contained within the so-called Colorado River Compact entered into in 1922 among the seven basin States?

Secretary UDALL. Well, this is one of the basic documents, probably the most basic, but there are others, such as the Upper Colorado Compact and so on.

Mr. SAYLOR. Just a minute. They do not affect—I asked for the Colorado River. Now, there are some agreements in the upper basin and in the lower basin. But outside of the Colorado River Compact and the Supreme Court decision, which only affects the lower basin, is not the Colorado River Compact and the Mexican Water Treaty the supreme law of the land?

Secretary UDALL. There are three basic documents, my lawyer tells me—the Mexican Treaty, the Compact between the States, and the Boulder Canyon Project Act of 1929.

Mr. SAYLOR. This was the one which authorized the construction of the Hoover Dam?

Secretary UDALL. The Hoover Dam; that is right.

Mr. SAYLOR. Now, under the terms of the Colorado River Compact, the Upper Basin States are obliged to deliver to the lower basin 75 million acre-feet every 10 years at Lee Ferry.

Mr. WEINBERG. The upper basin is obligated not to deplete the flow of the river at Lee Ferry below 75 million feet every 10 years.

Mr. SAYLOR. Now, will you explain the difference between the question as I put it and the answer you have given?

Mr. WEINBERG. Yes. An obligation to deliver would connote an obligation to take an affirmative action. An obligation not to deplete the river is an obligation only to hold up diversions so that there will be sufficient natural flow in the river to make up the 75 million acre-feet. The upper basin has no hard-and-fast obligation to make a delivery of water that Nature does not put in the river.

Mr. SAYLOR. Well, let us assume that there is only 7.5 million acre-feet of water in any year or 10 consecutive years in the Colorado. Where must it go?

Mr. WEINBERG. On that asumption, it must be released at Lee Ferry. It can't be withheld upstream.

Mr. ASPINALL. He is only partly right.

Your answer is keeping in mind the decreed rights that were in existence in the upper basin as of 1922.

Mr. WEINBERG. Yes.

Mr. ASPINALL. All right.

Mr. SAYLOR. Now, since the Colorado River Compact was entered into, the Federal Government has entered into a Mexican Treaty with the Republic of Mexico. Is that correct?

Secretary UDALL. That is correct.

Mr. SAYLOR. And this calls upon the delivery of a million and a half acre-feet to the Republic of Mexico at the border. Is this correct?

Secretary UDALL. That is correct.

Mr. SAYLOR. This over and above the 7.5 million acre-feet delivered at Lee Ferry?

Mr. WEINBERG. The compact provides that the Mexican treaty burden shall be made up first out of water that is surplus over and above the III(a) and III(b) quantities, and then if there still remains a deficiency, each basin is required to meet one-half of the deficiency.

Mr. SAYLOR. Well, if the Secretary's story is correct as verified by the Commissioner of Reclamation, the past number of years, there has not been any surplus and the average flow, according to the figures which have just been submitted, indicate that the total flow is only—is less than 15 million acre-feet. Is that not correct?

Mr. DOMINY. That is the projection for the future based on the longest period of record, that is correct.

Mr. SAYLOR. Now, Mr. Secretary, in your statement, you state that the lower basin has an obligation to deliver half of the Mexican treaty water, but you state that there is no such obligation—or that is the impression which I get from your statement—there is no such obligation on the upper basin. Now, is this correct?

Secretary UDALL. Well, your implication is not correct.

Mr. ASPINALL. If my colleague will yield, neither is the answer of Mr. Weinberg correct, because this is an unresolved situation as of the present time.

Mr. WEINBERG. That is a point, Mr. Chairman, that I was about to make. This issue is an unresolved issue and the Secretary's statement points out that it is an unresolved issue.

Mr. SAYLOR. Well, if your statement, then, Mr. Weinberg, is that each basin is required to make up half of the shortage, what is unresolved?

Mr. WEINBERG. I didn't quite say that, Mr. Saylor. I said the compact provides that the Mexican treaty burden shall first be made up out of water that is surplus in each basin. Now, the unresolved issue is whether or not there is surplus in the lower basin that would be available before the upper basin is called upon to meet a deficiency in the Mexican water treaty deliveries.

Mr. SAYLOR. All right.

Now, I would like to turn, Mr. Secretary, to your proposition with regard to the power which you intend to use. I would like to say for the record, Mr. Secretary, you must be contemplating leaving your office, because never before has a Secretary of the Interior been so open and frank and forthrightly honest as you have been in the second paragraph of your statement on page 7 with regard to power. If this does not cause the REA to tear their hair out and wonder what has happened to their great friends in the Department of the Interior, I do not know what it will take. Because for the first time, we have a Secretary of the Interior who admits that the yardstick method has two measurements, that they are not the same. And you have come forward and stated the reasons for the higher cost for utilities to furnish power in the commercial market.

This, Mr. Secretary, if you will be remembered for nothing else, will be a landmark day in American history. And I will quote it for the next thousand years.

Now, Mr. Secretary, you state that you estimate that it will be necessary to have power costing 6.5 mills at the Page site. Is this correct?

Secretary UDALL. If we had to buy it commercially, it would be 6½ mills.

Mr. SAYLOR. If you had to buy it commercially, it would be 6½ mills?

Secretary UDALL. That is right.

Mr. SAYLOR. Now, Mr. Secretary, when you came before this committee, or when your predecessors came before this committee and suggested that we authorize the Upper Colorado River storage project, they said that they were going to produce power at Glen Canyon and they were going to sell power up there and it was going to be available at 6 mills? Now, why do you not use some of this power up there? You have enough powerlines up there to run it down. Why should you get in the business of underwriting a steam generating plant?

Mr. DOMINY. The Upper Basin States, for which the Upper Basin Colorado River storage project is being built, want that power to be marketed in their area and the project criteria so provides. It is to be marketed in the lower basin until the upper basin has the need for it. We could not rely on upper basin power for the central Arizona project because it would soon be withdrawn for upper basin uses.

Mr. SAYLOR. Well, how soon? You have been producing power up there and it is cheaper than you say you can buy it from other companies on a commercial basis.

Mr. DOMINY. The uncertainty of its availability in the lower basin would preclude relying on it for the central Arizona pumping power needs. Furthermore, the upper basin power is being produced at a much lower load factor than is the requirement for energy to pump the central Arizona water supply. The power needs of the central Arizona project do not fit the generation pattern, Mr. Saylor. It could not be done economically.

Mr. SAYLOR. Now, Mr. Secretary, in this WEST group you mention, the planning group, you have mentioned several groups in the State of Arizona. There is the Salt River group and the Arizona public power group. Why could not they, being semipublic agencies, build this plant and you buy the power from them?

The reason I ask this, they have all the advantages—at least Salt River has the advantage of not being required to make a profit and they have the advantage of a pretty good interest rate—two of the three factors that you say cause this high cost of commercial power are already available to one of the partners in WEST. Why can't you go to that group and ask them to build this plant and you take the power from them?

Secretary UDALL. Congressman, you are very close to precisely what we are proposing here. The reason the WEST organization works is that the modern way to produce electric power is to go to very large units. We get the largest units we can in order to get the economies of scale and to get cheap power for everyone. And any participant, public or private, that wants a piece of the action can own a piece of the plant—12 percent, 15, 27, or whatever it happens to be. In this instance, we will not own part of the plant, we will simply be entitled to the product of the plant in a certain quotient, depending upon what we have contributed.

The plant will be financed in part by public agencies and in part by private agencies. We will contribute our part.

This is the way it works. One of the things that permits the Arizona project to stand on its own feet without subsidy and pay its way under the traditional approach is the fact that it will have 3.5-mill power instead of 6.5-mill power. This will help a great deal in the economics.

Mr. SAYLOR. Mr. Secretary, if my information is correct WEST proposes to build its plant somewhere in the area of Page, Ariz. Is this correct?

Secretary UDALL. This is a general vicinity description.

Mr. SAYLOR. I mean within miles?

Secretary UDALL. Yes, that is right.

Mr. SAYLOR. This is the so-called area for which it would be built. Does not the Federal Government own practically all the land in that area?

Secretary UDALL. No, the Navajo Indians do.

Mr. SAYLOR. Well, it belongs to the Navajo Indian Reservation. Who is the trustee for the Navajo Indians?

Secretary UDALL. I wear that little mantle, I am afraid.

Mr. SAYLOR. Now, you have that hat on, you have the hat of the Secretary of the Interior, and the hat for the Indians.

Now, in order to build a thermal generating plant, you have to have water, is that not correct?

Secretary UDALL. That is correct.

Mr. SAYLOR. You have to build cooling towers. And the only water in that area is in the Colorado River?

Secretary UDALL. In Lake Powell at the place where we will be operating.

Mr. SAYLOR. And who has charge of granting permits for the taking of water out of the lake?

Secretary UDALL. The Secretary of the Interior. We sign a contract the way we do in other parts of the river.

Mr. SAYLOR. That is the third hat you have on now.

Now, the minerals that we are going to use to produce steam from the water. We have to have some minerals. I understand that you are going to use coal?

Secretary UDALL. We felt this would be a point in our favor with the Congressman.

Mr. SAYLOR. Mr. Secretary, that is not wax in my ear, that is coal dirt.

Now, is the mineral deposit, coal, also on the Indian reservation?

Secretary UDALL. Yes.

Mr. SAYLOR. So that WEST will have to come with hat in hand to ask the Secretary of the Interior whether or not they can enter into a contract with the Navajo Indians to buy the coal? Is that not correct?

Secretary UDALL. Well, I want to make this plain, as I think the Committee knows. The Navajos have very tough, able executives that they hire. They have tough, mean lawyers. I do not tell them what to do these days. And if this project were not in their interest, it would never get to my desk.

We have a very happy situation here, because we might have an argument otherwise between the Indians and some of the Arizona people over this Arizona water that is in Lake Powell, this 50,000 acre-feet which is Arizona's entitlement. But here we would use it very happily to develop Indian coal to provide water for an Arizona water project. It is really a very excellent solution to the problem.

Mr. SAYLOR. Well, Mr. Secretary, as long as you are there, I think you will deal fairly. But I just want to point out for the record that whomsoever is involved in the WEST planning group is actually operating under a tremendous handicap, because even though they enter into a fine arrangement with the Indians, the power of veto or approval still rests with the Secretary of the Interior. Is that not correct?

Now, this is true whether or not you put any money in it or whether you buy power from just a block of power.

Secretary UDALL. We have considerable control, it is true. But I think you should understand that the WEST organization has been highly successful at this point. We put other plants together. We are planning for the whole region. This includes southern California with the fastest growing electric power load in the country. Although the Department of the Interior is not part of the WEST organization officially, we are keenly interested in its success and we are, therefore, helping all that we can to put these various projects together.

Mr. SAYLOR. Mr. Secretary, you may talk about the mean and competent lawyers that the Navajo Indians have. The Bureau of Reclamation and the Department of the Interior lawyers have never been known for their mealy-mouthed attitude in any manner. And when they get mean, they can be meaner than anybody else I know and they can have more standards to justify more things than any other group of lawyers I have ever known in my life, including the seven that sit on the Supreme Court.

Mr. BURTON of Utah. Will the gentleman yield?

Mr. SAYLOR. I yield to my colleague.

Mr. BURTON of Utah. I would like to say, Mr. Secretary, that your own lawyers are not surpassed by anyone I know in terms of being men, rough, and tough, vis-a-vis Great Salt Lake.

Mr. SAYLOR. Somebody up here asked did I not know that there are nine members on the Supreme Court, and I said sure I do, but there are only seven on it that I know are lawyers.

Mr. HOSMER. Will the gentleman yield?

Mr. SAYLOR. The chairman of the subcommittee has asked me to yield to him.

Mr. ASPINALL. Thank you.

I just wanted to ask one question at this point in regard to the coal. I presume that the large coal companies are dealing with the Indians on the coal matter and they in turn will offer the coal to the group that would build and construct the powerplant?

Secretary UDALL. Precisely. We have already put one WEST plant together using the same coal by the Peabody Coal Co. They will have a coal slurry pipeline 300 miles to Nevada. The coal companies must get together with the WEST power group. We are sort of looking over their shoulder, but there is a lot of negotiating that goes on to which we are not direct parties.

Mr. JOHNSON. That is the way I understand it. The coal companies have moved in there and have now under lease working arrangements for the coal that will fire this plant. Am I right?

Secretary UDALL. That is correct.

Mr. STEIGER. Will the gentleman yield at that point?

Mr. JOHNSON. Wait just a minute.

They have already secured their leases from the Navajo Indians, so the coal matter has been settled as far as this plant is concerned and can move forward.

Secretary UDALL. That is correct, as far as the coal leasing arrangement is concerned, this has already been consummated.

Mr. SAYLOR. Now, second to that, have they been given, the group that is going to build, the insurance that they will have the water that is supposedly Arizona water?

Secretary UDALL. We have openly indicated that if the Page plant goes forward, we see no obstacle to granting a water contract.

This has several advantages.

Mr. SAYLOR. I realize that.

Secretary UDALL. You should realize, too, that they have to pay a price for the water. The revenues go into the Upper Basin fund in this instance and it helps all the way along the line.

Mr. HOSMER. I would like to pay tribute to the Interior Department's lawyers, too, and give credit where credit is due. If it had not

been for them coming into the breach and standing up like Horatio at the bridge, we would have been invaded by a tax-paying, royalty-paying geothermal steam industry today and these lawyers saved us from being plagued with those extra revenues in the U.S. Treasury.

Mr. SAYLOR. Let us get this back on the hearing for which the Secretary came up here.

Secretary UDALL. I am overwhelmed with bouquets.

Mr. SAYLOR. Mr. Secretary, you would deal with the Lower Colorado River Basin development fund. Why do you not look to the revenues from Hoover and Parker-Davis for first payment into this fund. And, second, why do you not use the power from these sources for the development of pumping water for the project?

Secretary UDALL. In relation to the use of this power for Central Arizona pumping, there are several reasons why it can't be used. The power at Hoover Dam is under contract for the entire payout period and in effect has been sold at least for the first 50 years. These contractors have rights to renewal of contracts. So this is part of the answer.

Another reason is that the load factor is not suitable for meeting pumping requirements.

As far as the lower basin development fund is concerned, as I have indicated today, we have no objection to this. I simply make the point that the Arizona project does not need this help. It stands on its own feet the way we have the plan laid out now.

Mr. BURTON of Utah. Mr. Chairman, will the gentleman yield to me?

Mr. SAYLOR. I would like to go ahead here.

Mr. BURTON of Utah. Go ahead, then.

Mr. SAYLOR. Next I am coming to water supply, which is the next item which the Secretary has covered.

Mr. BURTON of Utah. I will renew my request that the gentleman yield, because I have a point on that particular issue.

Mr. SAYLOR. All right.

Mr. BURTON of Utah. Mr. Secretary, is it not true that if the revenues from Parker, Hoover and Davis are not applied in the Basin account, when the payoff period is complete, these revenues can be used to give, in effect, southern California a power windfall that is not available to any of the sister States, and these revenues will not be used to create any participating projects other than in that area?

This is one of the reasons why some of us wonder if your proposal to exempt those revenues from participation in central Arizona and other projects in the basin, including the Dixie, is not an unfair advantage to some interests in California.

Secretary UDALL. I am not proposing that they be exempted at all. All I am saying is that as far as this present legislation is concerned, it is not absolutely necessary. The Congress has the option to consider the policy question of what should be done when Hoover payout occurs. For the project, unlike most of the later power projects, there is no subsidy out of Hoover for irrigation at the present time. If the Congress wishes to create a development fund after payout, this is certainly a subject in which we can take a very keen interest. We are raising no objections to that.

Mr. BURTON of Utah. On that point, Mr. Secretary, previously when you testified before the committee—and I say this with all re-

spect—you have recommended the creation of a lower basin account which would include Arizona, which would include the Dixie project in Utah, and which would include the projects in California. I think that you have not directly answered the question, Is it not possible that these revenues, after the payout period, can be used to produce a power windfall for the people in southern California that the people—that the other States in the basin contributing their water and contributing their interest would not benefit by?

Secretary UDALL. One can give it that interpretation. I know the problem with the Dixie project, which is a project that needs an irrigation subsidy. This is an argument for some kind of lower basin development fund. But I have tried to layout the question for the committee as I see it. If it is the committee's desire to create a fund both for Dixie and for augmentation purposes in the future to help with the Mexican treaty, or for whatever purposes, the entire subject is before the committee.

Mr. BURTON of Utah. I realize this is a matter of conjecture, but it is something that I think legitimately ought to be raised on the record.

I thank the gentleman for his indulgence.

Mr. SAYLOR. Now, Mr. Secretary, on page 10 of your statement you have the figures for the virgin runoff at Lee Ferry. The first set of figures you have which you call the critical period from 1931 to 1967. That is 12,990,000 acre-feet average annual flow. If this figure is correct, that is 1,970,000 acre-feet below the figure which you state is the longest reliable period of record on the Colorado River. Is that correct?

Secretary UDALL. That is correct.

Mr. SAYLOR. And if we take the figures from 1922 to 1967, which you say are the actual records at Lee Ferry, of 13,750,000 acre-feet, you are still 1,210,000 acre-feet below the average of 14,960,000. Is that correct?

Secretary UDALL. That is correct.

Mr. SAYLOR. Now, Mr. Secretary, when this project was before the other body, those Congressmen who serve on the north side of the Capitol, your organization, the Bureau of Reclamation, gave to them certain figures which appear on page 35 of the Senate report to accompany S. 1004, first session of the 90th Congress.

I find on that page that you have the following: Net gain Lee Ferry to Hoover, you estimate in the year 1975, 772,000 acre-feet; in the year 1990, 753,000 acre-feet; in the year 2000, 732,000 acre-feet; and in the year 2030, 704,000 acre-feet; is that correct?

Secretary UDALL. As I read the figures on that line, yes.

Mr. SAYLOR. I have not had a chance, Mr. Secretary, to look at a map of that area, but relying upon my memory and the visits I have made to that area, I believe that at least the main streams which make that contribution are Kanab Creek, the Virgin River, the Little Colorado, Havasu Creek, and Johnson Creek. Is that correct? Are there any others that——

Secretary UDALL. That sounds like the main ones from my knowledge of it.

Mr. DOMINY. Paria comes in right at Lee Ferry, and the gauging measurement is taken above Lee Ferry.

Mr. SAYLOR. My recollection is that it would be taken below——

Mr. DOMINY. Paria River flows are included in those at Lee Ferry.

Mr. SAYLOR. Now, this committee some years ago authorized the Dixie project; is that not correct? They have had a little difficulty with those lawyers you have downtown.

Secretary UDALL. Yes.

Mr. SAYLOR. If the Dixie project is authorized, it will use about one-third of the total of that Virgin River; is that not correct?

Mr. BURTON of Utah. Mr. Chairman, if the gentleman will yield——

Mr. SAYLOR. No. The reason I am asking this is that some of us are questioning the reliability of your figures; that is all.

Mr. DOMINY. The present depletion is 35,500 acre-feet. We would increase the depletion if the Dixie project is built. Some of that area is already being irrigated. We would increase the depletion by 48,200 acre-feet.

Mr. SAYLOR. Now, one of these streams that runs in here is the Little Colorado. Now, I have walked up that Little Colorado when it has been bone dry, maybe a little pool somewhere up the line that the heat had not gotten down and dried up yet, but basically it was dry. Now, if you have to rely on these unusual washes and these strange rains, are you going to count on the Bureau seeding clouds somewhere along the line and putting a little water in the Little Colorado?

Mr. DOMINY. The Little Colorado was not dry after that 7-foot snow hit the area down around Flagstaff. It is a river that runs feast or famine, to be sure, but we have measurements on it.

Mr. SAYLOR. Now, in checking a little bit, Mr. Secretary or Mr. Commissioner, do not go overboard on that 7-foot snow. You had drifts of 7 feet, but you did not have 7 feet of snow.

Mr. DOMINY. There were areas around Flagstaff that measured 7 feet on the level, Mr. Saylor.

Mr. SAYLOR. Some of the people who came through there said they had a lot of snow, but they did not have that much.

Now, you anticipate, Mr. Secretary, that even if you take your figures of 1922 to 1967 wherein you indicate that there is only 13,750,000 acre-feet in the Colorado River, there will be sufficient water in the river to build the central Arizona project.

Mr. DOMINY. Mr. Saylor, as we have made abundantly clear, we do not accept projections that rely on the more critical years of record. We do not think that is realistic, to throw out the years of higher flow and limit analysis of projects in the future to conditions of the bad years. If that chart that has four of the major rivers of the West could be put up again I think this is something that is worthy of the committee's attention.

This chart starts in 1906 for four rivers of the West. The 100-percent line, is the average yield line derived from actual records on these four principal rivers. The flowing line is the 10-year moving average. So the first point on each of the rivers is the 1916 point, the 10-year moving average starting with 1906.

You will note that each of these rivers started out back in the period 1906 to 1930 above average. Then all of them dipped during that 1930 drought period. We could plot all the other rivers in America, including the Potomac, the Rappahannock, and the Susquehanna, and they would all do the same thing.

The only difference between the Colorado River and the Columbia and the Missouri and the Sacramento is that the Colorado has not yet recovered. Certainly that does not give me any reason to think that the climate of the United States has changed. Three of major drainage areas of the West—two of them drain more country than the Colorado River above Lee Ferry—have all had recurrences of wet cycles similar to the earlier records on those rivers. I think that the hydrology of the Colorado River, as was testified by the gentleman who went clear back to 1250 and took tree rings into account illustrates that this is a river that has longer periods of ups and downs than the average. It is kind of like the differences between the hog market and the cattle market. The hog market varies a lot faster than the cattle market. It takes the cattle market a lot longer to recover a longer cycle from one high point to the next.

The Colorado River has long periods of drought, then it has long periods of wet spells. I certainly think we would be doing an injustice to everybody who relies on the Colorado River for its future water supply to decide that it is only the years since 1922 that we ought to take into account in projecting water supply.

Mr. SAYLOR. Mr. Secretary and Mr. Commissioner, what you are trying to tell us is you have shown us some nice charts. The chart shows that for three of the four river basins which you chose—not me, nor members of his committee——

Mr. DOMINY. Do you know of any other four principal rivers in the West?

Mr. SAYLOR. Just a minute. You picked them out. We did not pick them out.

It shows that they have had their ups and downs. The Colorado River is the only one that you have shown that has gone down and down and down, and the indications are that it is still going down. You would ask us to come along here and authorize a billion dollar project or more on the basis of the fact that, well, somebody cut down a tree that went back to 1200 and counted tree rings and you are going to tell us we should rely on the tree rings rather than the statistics that you have. This is just what you suggested to us.

If you are going to talk about the hog market and the difference between the hog market and the cattle market, at least you can get a hamburger or pork chops out of those whether the market is up or down. You cannot get much out of a dry stream for irrigating crops as your own figures indicate. I want a project, but I do not want to ask the people of this country to buy a project where there is not going to be enough water to take care of it.

Now then, Mr. Secretary, let us move on a little bit to some of the next things that you have talked about in your upper basin depletion.

On page 15 you stated,

> It seems more likely that some reserves will be held for future municipal and industrial growth. Also influencing our judgment is the uncertainty as to whether the Upper Basin is obligated to meet part of any Mexican Water Treaty deficiencies. Until that issue is resolved, we doubt that projects dependent on the contested water supply, as a practical matter, would be authorized or undertaken.

My question to you, Mr. Secretary, is in view of that statement, is that the reason that I find absolutely no reference whatsoever to the five projects in Colorado in the upper basin. And is the im-

plication that we are not to authorize any projects in the upper basin until that matter is settled?

Secretary UDALL. Congressman Aspinall's letter did not request information on the five projects. Therefore, that is covered in the beginning of my statement, that our position on these projects is unchanged from our position of a year ago. We only responded in this statement to Chairman Aspinall's letter.

Mr. SAYLOR. Well, what other projects or what projects are in the upper basin which are dependent on a contested water supply which have been or would be authorized or undertaken?

Mr. DOMINY. All of those five projects, all of the others that were authorized as part of the Colorado River storage project, and those that were listed for advanced attention for continued planning have been taken into account, Congressman Saylor, in our own projections of upper basin depletions. The difference is that we project those depletions and full use of the upper basin water over a longer period of time than Mr. Tipton and others have suggested might be realized.

Mr. SAYLOR. The next item that you come to is the water losses along the Lower Colorado River. The last sentence of your statement, Mr. Secretary, states that we know that we can salvage water through ground water recovery. Now, ground water recovery in Arizona near the Wellton-Mohawk project was the cause of a tremendous international incident between the United States and the Republic of Mexico regarding the quality of water. If we are going to recover—salvage water through ground water recovery, what is its quality?

Secretary UDALL. Congressman, the Wellton-Mohawk project did provoke this serious problem. The ground water we are talking about here is in the Yuma area. In several of these projects—the Yuma Mesa area is a good example—we built up, by applying water on desert land, tremendous underground water reserves that had not existed. They call them underwater domes. We would pump out of those domes and salvage water in that fashion.

But the quality of water, in answer to your question, in this instance is very good as compared with that underlying Wellton-Mohawk.

I am not saying there is not a diminution in quality, but the quality is generally good.

Mr. SAYLOR. That is just it, the water is bound, Mr. Secretary, to have picked up certain minerals as it was leeched through the ground and leeched out certain minerals. There is no water purification plan that exists is there, that you know of?

Secretary UDALL. One thing you have to bear in mind is that as a project gets older, the solids are leached out and the quality of water gets better. This will happen with Wellton-Mohawk, we think.

Mr. SAYLOR. On page 17 you list the waters in the central Arizona project. You leave this committee in a position where they are going to have to act like Solomon because, assuming that this is the best possible presentation that the Bureau of Reclamation can make, you state that only time will tell which assumptions are more nearly correct. I notice you do not say which facts are more nearly correct. And you further state there is no way of guaranteeing or proving with certainty any given assumptions today.

Now, despite that fact, despite the fact that you have indicated that there is not going to be sufficient water to take care of a 2,500-second-

foot aqueduct or a 3,000-second-foot aqueduct, you still want us to authorize the building of the central Arizona project based on these assumptions and to guess that the assumptions, some of which have been made, as referred to by the chairman of the full committee, by men eminently as qualified as people in the Bureau, indicate that you just do not begin to have enough water to build this first phase of this project.

Secretary UDALL. I would rather the Commissioner answer the question, although I want to say one thing as a preface to his answer because essentially, when you authorize a long term water project, it seems to me you must make certain assumptions, make certain predictions, as it were, with regard to the future.

There is a question of whether one wants to be optimistic or pessimistic. There is certain elbow room of that kind. But I think the main point, as I understand it, that the Bureau makes—and I have let them make all the calculations and the figures are theirs—is that they feel the soundest and most scientific way to approach this is in terms of the known data. I do not regard their figures as being necessarily on the liberal side. I think they sort of cut down the middle. They do not say, "Well, we are going to be conservative this time," or "We are going to be liberal in our estimate." They have to hue to the best scientific data they have available.

Mr. DOMINY. This problem is no different for the central Arizona project than on any major project the Bureau has built in the last 60 years, Congressman Saylor. We have to operate on assumptions made at the time of planning and construction.

Mr. SAYLOR. If you will, permit me to give the chairman and myself at least one little pat on the back. Until we got on this committee, you and your predecessors had never built a project within its estimated cost. So your past record until this committee began to take a real good look at you was not good. Now you have improved. I want to commend you for the improvement you have made.

Mr. DOMINY. Thank you, sir. I only want to take credit for the last 9 years. That is as long as I have been Commissioner.

But let us go back to Hoover. There were people who thought this never should be built. They said it would silt up in 15 or 20 years. Well, it did not silt up in 15 or 20 years. Even before Glen Canyon was built, it took all the silt of the Colorado River for 25 years and was completely unimpaired.

They said Grand Coulee should not be built, that you could not possibly market the power up there. During the war that is the place we really used it to good advantage. They said after the war you will not need that power at all. We could not even stop the turbines and generators long enough to rewind them. That is how much the demand for power was.

So I am not impressed with negative assumptions that these projects will not work and they will not pay out and they are a boondoggle and that sort of thing. That has not been the case in reclamation history. Nor will it be in this project.

We have made valid assumptions based on known facts, and we are prepared to defend them before any tribunal. We have admitted that without augmentation there will be a gradual diminution of the amount of water available to the central Arizona project, and, as a

result of it, there will be a gradual declining of the agricultural lands because the domestic and municipal uses are going to be moving in the other direction.

We have testified repeatedly and we testify now that all of our judgment and experience in evaluating projects is that this project will pay out on the basis that we have presented.

Mr. SAYLOR. All right. Now you have brought up the proposition of augmentation. I did not expect to get into that until a little later on, but I think we ought to get into it now since you have brought it up, because one of your experts back there testified about all the spill that is taking place.

I have asked our staff to furnish me with a computation of a simulated year-by-year operation of this whole business of the Colorado River from 1906 until 1967. These are basically the same figures which the chairman asked that you furnish us, with the assumptions which you in your Department have based your records on or your recommendations. And assuming that each one of the reservoirs—namely, at Glen Canyon and at Hoover Dam—had been built in 1906, the best figures that our staff has—and they get those figures from you—tell me that there would have been a spill at Lake Powell anywhere from three-tenths of a million acre-feet in 1908 to $10\frac{3}{10}$ million acre-feet in 1909, a total of 88 million acre-feet spilled at Lake Powell, and a considerably less spill than that at Lake Mead.

Mr. McFarland's study indicates there would not have been a spill at Lake Powell from 1930 to 1967 or at Lake Mead from 1928 until the present time.

Now, where are we going to get all of these spills that were referred to at page 35 of the Senate report which was testified to this morning? Where are we going to get those spills?

Mr. DOMINY. We have a reservoir operations plan for the river repeating the hydrology from 1906 to 1967. We would be interested in seeing the staff study. To answer you, we would have to see what assumptions the staff made.

For example, you said assuming Hoover and Glen Canyon were built in 1906. But were they empty in 1906 or were they already filled?

Mr. SAYLOR. We assume we started right off with them full. We took those real lush periods that you referred to, and you did not have very good measurements, and the river ran full. We had all the trouble down below in California and the Salton Sea was developed. We assumed that Congress in its wisdom had been smart enough that we built those dams and got the runoff and we had them full.

We do not have any spills until any time after 1930.

Mr. DOMINY. I would be very interested in having a look at the study and having Mr. Riter and our hydrologic experts examine it.

Mr. SAYLOR. I would say, Mr. Chairman, that I would hope that after the Department has a chance to look at the figures of our committee staff, and they have submitted their figures, that at least the members of the committee be permitted to either have the Commissioner or the Secretary back to answer questions with regard to this item, because I think it is very important to know the amount of water that is anticipated below the Hoover Dam.

Mr. JOHNSON. You have heard the request of the gentleman from Pennsylvania. Is there objection?

(No response.)

Mr. JOHNSON. If not, I wonder, Mr. Secretary, if you would have your people bring in your figures and studies and, at the same time, the staff's figures and study will be made available to you so that you can have a double study made and your figures go into the record?

Secretary UDALL. I think the committee is certainly entitled to have the clearest picture it can get. I want to say we have, all of us, the very highest regard for Mr. McFarland and his own competence and integrity. I think this is the way to get at the differences, whether they are differences of assumptions or differences of fact.

Mr. JOHNSON. It is understood that yours will be prepared and brought up to the committee so the committee can make a study of yours and at the same time you take his and make a study of the staff's study?

Secretary UDALL. Yes.

Mr. ASPINALL. As I understand it, the Department cannot have this staff study until they bring their studies up to us. Then we will compare the studies.

Mr. DOMINY. I might say, Mr. Chairman, between the years 1930 and 1967, using the flows that we are recommending be used for future projections, I do not think there is any disagreement. I am sure our studies also will show very little opportunity for spill during that particular period of years.

The important thing is the basis used to project the future—what period of time and what average flow should be used, and should we project a succession of wet years such as we had in the early part of the 1906–67 period.

Mr. HOSMER. The difficulty seems to be that you are on the wet cycle and Mr. Saylor is on a Honda.

Mr. JOHNSON. I want to clear this up just a little bit in my own mind. I understood this morning when the figures were given to us by Mr. Riter that it was in this period of time these spills would have occurred or have occurred.

Mr. DOMINY. We were talking about what would have happened during the payout period if the 1906–67 cycle of the Colorado River repeats itself.

Mr. JOHNSON. We will exchange the studies, then. Your studies will be made available to the staff, the staff will make their studies available to you, and we will get together and see if we can resolve any differences.

Mr. DOMINY. All right, sir.

Mr. JOHNSON. If that is agreeable to the committee that is the way this matter will stand.

Proceed, Mr. Saylor.

Mr. SAYLOR. Mr. Secretary, do you know Frank C. Di Luzio?

Secretary UDALL. Yes; I know him well.

Mr. SAYLOR. For the record, will you tell us who he is?

Secretary UDALL. Until January 1 or thereabouts he was my Assistant Secretary supervising water pollution control and the saline water program. Prior to that he was Director of the Office of Saline Water.

Mr. SAYLOR. Mr. Di Luzio appeared before this committee on January 27, 1967, with regard to the Metropolitan Water District desalting plant. At that time he stated that the estimated cost of desalted water at plant site, when all units are onstream, would be approximately 21.9 cents per thousand gallons, $71 an acre-foot.

Mr. Secretary, at the same time we are conducting these hearings, word has come to me that there are certain people over in the Joint Committee on Atomic Energy conducting some hearings and making some public statements over there. Basically these are the figures that were given to me over the noon hour: The Atomic Energy Commission has said that between 1967 and 1968 there has been approximately a 40-percent rise in the cost of atomic energy and that the break-even point on a power plant, atomic powerplant in 1967, when Mr. Di Luzio gave us these figures, was 500,000 kilowatts, and, at the present time, it is 800,000 kilowatts. The cost has risen from 4 mills to 5 mills plus for a kilowatt of power.

Now, in view of that, Mr. Secretary, I was astounded and doubly so when I read last night the summary of the "Reconnaissance Report for the Augmentation of the Colorado River" by desalting seawater. I saw where your people were using costs which were below what Mr. Di Luzio gave this committee less than a year ago, and you indicated you might anticipate 9-cent water.

I am wondering how these two can be tied together or whether the information which the Atomic Energy Commission is now releasing to the public was never released to the people making your reconnaissance report.

Mr. DOMINY. First of all, Mr. Saylor, Secretary Di Luzio was talking about a plant that was going into construction on the basis of today's technology. The estimates which you read in our summary are based on the technology expected to be realized by the period 1990 to 1995. These were provided to us by the Atomic Energy Commission for the atomic reactors and by the Office of Saline Water for the desalting works. Now, these data reflect, as I said, the technology projected for a long time in the future. They depend upon a fast breeder nuclear reactor being available. They assumed improvements in the water plant, including a combination of vertical tube and multistage flash evaporators. And they assumed better heat transfer surfaces.

The results reflect an estimated production cost of 9.8 cents a thousand gallons at plant, provided there was combined a large atomic powerplant and a large desalting plant, to take full use of the advantages of size.

Mr. SAYLOR. Of course, I am sure that you assumed that there was no cost escalation between this and 1990, because I assume that you disregarded completely the admonition of Admiral Rickover when he, who was the one who saw the great potential in the fast breeder reactors, asked that it be withdrawn and all the other miracles that you have anticipated between this date and 1990. Because nothing less than a miracle is ever going to produce 9-cent water pumped 4,000 feet to run through the turbines at Lake Mead.

Mr. DOMINY. The 9.8-cent cost is at plant site on the seacoast. That is not the cost of delivered water. The larger portion of total cost is in the conveyance of the water to the Colorado River. This is what runs the costs up. The final costs are over $80 an acre-foot.

Mr. SAYLOR. Well, that is only a small step up from the $71 we were told we were going to have a year ago. That is only a $9 increase. This indicates there is not going to be much increase in costs.

Mr. Secretary, as the chairman pointed out this morning, the other body apparently had very, very little interest in establishing a National Water Commission. It is my understanding that this was a recommendation of the administration. I am not privy to most of the things in the administration because I sit on the outside and only get the crumbs that fall from the table when people walk out and shake their napkins on the outside. I am never asked to feast, or come to the festive board and to know all of the plans of the Great Society.

But if my information is correct that the President is in favor of this National Water Commission, and since the chairman has even stated that he did not believe it was going to accomplish very much, those of us who said that even though it might not accomplish much, we were willing to give it a chance, were able to get it out of this committee, predominated by the members of your party, and I was able to convince most of the people on my right, in my party, to go along with it and spoke for it on the floor of the House and got the bill passed.

It seems to me with the 2-to-1 majority over the Congressmen who serve on the north side of the Capitol, if the President was interested in that National Water Commission to help solve the problems of the West, he would have had that bill out and signed. Although if the people he appoints on it do not have any more expertise than the ones he appointed to take vacancies that were created in the Indian Claims Commission, I will have to agree with the chairman, I might not expect very much from the National Water Commission.

Now, if you care to comment.

Secretary UDALL. First, on the festive board, Congressman, it is not as sumptuous as it sometimes appears from the outside.

I think the House did a very good day's work when it passed this committee's bill on the National Water Commission. I sincerely hope we can get a bill. I am going to do what I can to that end. I want to assure you of that. I think this could serve a very useful function, to help lay the groundwork for the long-term future of this country in terms of its water supply.

Mr. SAYLOR. Now, Mr. Secretary, the last questions I have concern the decision of the Supreme Court in the case of *Arizona* v. *California*, in which they perfected the rights for Indian reservations. In March of last year the Solicitor General filed with the Court a list of present perfected rights. You have included those in your statement, but they do not correlate with the figures which you indicated you were supposed to get of 4 acre-feet of water on every acre of land in Arizona. Is this still contemplated?

Secretary UDALL. Yes, we base our estimate of consumptive use on the 4 acre-foot figure.

Mr. ASPINALL. If the gentleman will yield.

Mr. SAYLOR. Yes.

Mr. ASPINALL. That is on diversions.

Secretary UDALL. Our figures are referenced to a consumptive use of 4 acre-feet per acre.

Mr. SAYLOR. Now, Mr. Secretary, are the rights in California which you have listed the only Indian rights of which either the Bureau of Indian Affairs or the Solicitor General has any knowledge?

Mr. WEINBERG. Under the decree in *Arizona* v. *California;* yes.

Mr. SAYLOR. If these are perfected rights, are they inferior to the rights of the All-American Canal, the Imperial Valley Irrigation District, the Cochella Valley Irrigation District, the Metropolitan Water District of San Diego, and the Metropolitan Water District of Los Angeles?

Mr. WEINBERG. Congressman Saylor, the Indian rights in California are present perfected rights. There are other present perfected rights in California also. The Imperial Irrigation District has, to a considerable degree, present perfected rights. The Metropolitan Water District does not.

Mr. SAYLOR. If the committee decides that the 4.4 allocation to California is the total allocation to which that State is entitled, will the rights of the Indians be required to come out of California's 4.4?

Mr. WEINBERG. Yes, Congressman Saylor, with one exception: In the event of an extremely severe shortage so that there is only water for present perfected rights, present perfected rights are then met in the order of their priority without regard to State allocations. But with this exception, yes, they will be charged to the California allocation.

Mr. SAYLOR. In view of the fact that you have stated that there is only one or two irrigation districts in California which have present perfected rights on the river, does anybody in the Bureau of Reclamation believe the flow of the river will ever be at such a stage that there will not be sufficient waters to take care of all of the present perfected rights, be they Indian or irrigation district?

Mr. DOMINY. No, sir.

Mr. SAYLOR. Does the same conclusion hold for the present perfected rights of the Indians in Arizona and the present perfected irrigation rights in Arizona?

Mr. DOMINY. Yes, sir.

Mr. SAYLOR. In view of the fact that there is an Indian tribe in Nevada with a present perfected right, what would its effect be on the project which this committee authorized last year authorizing the diversion of water from Lake Mead for the benefit of metropolitan Las Vegas?

Mr. DOMINY. The estimated consumptive use for that Indian reservation is only 7,756 acre-feet and would be insignificant in terms of overall water supply.

Mr. SAYLOR. In view of the surveys that are being made for pumped storage, is it your conclusion, Mr. Secretary, that there is only one site which you are still seriously considering for pumped storage?

Secretary UDALL. No, Congressman, the engineers tell me there are several promising sites. Naturally an ideal pump storage site is where there already exists a reservoir because you need a body of water to pump from. The other requirement is a nearby high bluff that has a natural cachement basin on it or one can be built there. These are the two essential ingredients for a pump storage project, so that you can lift the water and drop it great distances. There are several promising sites.

Commissioner Dominy singled out the one at Mohave, right near Lake Mohave, because from a quick survey, it appeared to be the best one.

Mr. SAYLOR. If pumped storage is installed at one or more places in the lower basin, to whom will the evaporation losses be charged?

Mr. DOMINY. There would be little evaporation loss as there would be but a small holding reservoir. There would be a net loss of a few additional acre-feet.

I am sure it would be very small in terms of the total flow of the river, Congressman Saylor.

Mr. SAYLOR. Mr. Dominy, maybe you and I have been in the wrong places, because I am sure that some of those high mesas where you might find an indentation where you might store water for any period of time, the temperature growing, peak or offpeak hours, gets above 100 and those sandstone—chinle rock is it, Mr. Secretary?

Secretary UDALL. Chinle shale.

Mr. SAYLOR. Chinle shale, for instance, they drink that water up quite a bit and they put it out both day and night.

Mr. Dominy, you made a little mistake in bank storing up there in Lake Mead. I am just trying to make sure we do not have any more mistakes on evaporation above Mohave.

Mr. DOMINY. Of course, we do evaporate a lot of water at Lake Mead and Lake Powell with upwards of 30 million feet of capacity in each reservoir. But the little holding reservoir for a pumped storage project would involve only a few thousand acre-feet with consequently little additional evaporation losses.

Mr. SAYLOR. Mr. Chairman, I want to reserve the balance of my time, and I want to thank you and the members of the committee for having been so patient.

There is just one problem, I might add.

Mr. Secretary, the last time you appeared before this committee, one of the projects which you said would be included in the lower basin—in the Arizona project—would be a dam called Hooker Dam. At that time I asked the people in the department whether or not they had any idea about the size of this dam and was told then that nobody had any idea how much water was there, how much water would be put in or how much water could be put in. Has the Bureau, in the year's time, been able to come up with any definite figures on the size of the Hooker Dam if it might be included in this central Arizona project?

Mr. DOMINY. I will start by saying no, sir. The size of Hooker Dam, if we are to conform with the requirements of the Senate bill, must be such as to make available 18,000 acre-feet a year of additional water for use in New Mexico without prejudice to the rights of downstream water users under the Gila River decree and of the U.S. Supreme Court decree.

To size the reservoir to comply with those provisions involves very complex water supply and reservoir operation studies which we have not yet had the time nor the funds to make. We cannot tell you at this time how large that reservoir would need to be in order to comply with these requirements.

Reconnaissance studies indicate that a reservoir capacity of something like 265,000 acre-feet might be required as compared to the

98,000 that was originally contemplated. That is estimated on a reconnaissance basis. We have not had the time nor the funds to make the full study that would be necessary before we can say how large a storage cachement would have to be in order to comply with the requirements.

Mr. SAYLOR. In other words, Mr. Secretary, you are telling me that you have to have a reservoir large enough to have 15 years' storage? That is basically what you said. Even if that is true, then your own figures on what you anticipate this river will do are completely invalid, because you say you expect a return to a wet cycle and there will not be a reservoir big enough to take care of 18 years' supply.

Mr. DOMINY. We cannot overlook the fact that Hooker Dam is to supply flood control, and we cannot supply the 18,000 acre-feet of water to New Mexico to the disadvantage of the downstream users. This is why we cannot give you the figure until we have analyzed the complete effect of supplying 18,000 acre-feet upstream.

Mr. SAYLOR. Since you cannot give us that kind of a figure, do you think it should be authorized? This is a situation where you are just asking this committee to have blind faith in the Bureau of Reclamation.

I might say to you, Mr. Commissioner, in view of some of the changes you have made in the Frying Pan-Arkansas project without coming up and asking this committee, I for one am not going to give you the authorization to go ahead and build anything you want without coming before this committee. Especially when you come out now and say you have to change the plans for the Frying Pan-Arkansas project to make it feasible. That is what our releases from your Department downtown said. I assume your public relations man must have put those out with your blessing. The Secretary must have approved it.

The only conclusion is that the project as originally authorized was not feasible.

Mr. DOMINY. There has been a considerable change in the way power is produced and marketed between the time the original studies on the Frying Pan-Arkansas project were made and now. We found that a number of small powerplants did not fit the current needs and we combined them into two larger ones. This is the major change on the Frying Pan-Arkansas project.

Mr. SAYLOR. Of course you never came up to this committee and asked to do this and that is one of the reasons this committee has questioned the Bureau. Maybe the conclusions you have come to now are not correct. But if they were good, you should have come up and asked this committee. Heaven knows, as loaded as it is in your favor, if the project was any good, you should not have had any trouble getting it out of here.

Mr. Secretary, I thank you for coming forward with the answers that you have. As I say, I think this is, if for nothing else—your statement on the differences in the yardstick make this a day long to be remembered. I will be reminding you and your successors of this statement because of your wisdom in at least recognizing why your predecessors have refused.

Secretary UDALL. Congressman, just be sure to spell my name right.

Mr. UDALL. Would the gentleman yield?

Mr. SAYLOR. Yes.

Mr. UDALL. Would the gentleman be willing to paraphrase Churchill and say that should the Interior Department endure for yet a thousand years, surely it will be said this was its finest hour?

Mr. SAYLOR. Oh, no, I would not go that far.

Mr. Chairman, I have one further request. I ask unanimous consent that at this place in the record a speech made by the Honorable Morris K. Udall before the Town Hall of California, Biltmore Hotel, Los Angeles, on Tuesday, December 19, 1967, be placed in the record.

Mr. UDALL. Reserving the right to object, Mr. Chairman, would the gentleman not agree and so state for the record that this is undoubtedly one of the great orations of our time?

Mr. SAYLOR. Well, all I can say to my colleague is that he probably did not get paid even his expenses for going over, if I know most of the people in that group.

The only real reason I am doing it is because I want to have on record the violation of the law which the gentleman from Arizona blatantly admits he started out with in his opening statement.

Mr. UDALL. I admit my guilt, concede I was paid nothing even for expenses, and withdraw my reservation.

Mr. ASPINALL. Mr. Chairman, I reserve the right to object. I wish to know if the gentleman from Arizona still stands 100 percent on everything he said in Los Angeles, adamant and cannot be moved.

Mr. UDALL. If the chairman would yield, I have adopted a position of flexible rigidity and am prepared to negotiate at any time. Arizona never negotiates out of fear, but we never fear to negotiate.

Mr. BURTON of Utah. Reserving the right to object, Mr. Chairman, I would like to suggest to the gentleman from Arizona that a better Churchillian phrase which might characterize this project would be "we will fight them on the beaches, we will fight them in the fields, we will fight them in the ditches, we will fight them in the streets," and you are doing all of that.

Mr. UDALL. Perhaps we could go even further and state in Churchillian terms never have so many labored so hard and so long to produce so little water for so many?

Mr. JOHNSON. You have heard the requests.

Is there any further objection?

Hearing nothing, it will be so ordered.

(The speech referred to follows:)

COUNTDOWN ON THE COLORADO

Remarks of Hon. Morris K. Udall, U.S. Representative, District 2 of Arizona, Before the Town Hall of California in the Biltmore Hotel, Los Angeles, Tuesday, December 19, 1967

Gentlemen, I'm very happy to be here today, waving the white flag of truce which brought me safely through the outer defenses of the Colorado River Board. I hope I will be as fortunate on my return to the Arizona lines.

I brought with me today a little sample of what it is that's been causing all this fighting between our two states. Here it is. Don't get me wrong; this isn't whiskey. It says on the bottle you're not supposed to refill it. I suppose I violated the law. But if all this contained was whiskey, I don't think we would have much of a problem. We'd just break it open, everyone would have a "snort", and we'd all be friends.

No, this bottle doesn't contain whiskey. It contains much stronger stuff. It's been known to addle men's brains. It arouses uncontrollable passions. It divides father from son and brother from brother and—what's even worse—Demo-

crat from Democrat! This is the stuff that has had Arizonans and Californians shooting at each other, man and boy, for half a century. Along with a lot of salt and silt and maybe a few spent bullets this bottle, gentlemen, contains genuine, rare Colorado River water!

Take a good look at it because this is what I'm going to be talking about for the next half hour. But don't get any ideas about this possibly being a peace offering. It isn't. I intend to take this bottle with me when I leave. Judging by the way things have been going up until now this may be the last pint of Colorado River water I'll ever get my hands on!

As I began to draft this speech I thought of the old story about the fundamentalist minister who was delivering his Judgment Day fire-and-brimstone speech, and he was going on very heatedly some like this: "Ladies and gentlemen, on that great Judgment Day, there will be lightning and fire. On that Judgment Day, there will be earthquakes and storms, and the earth will shake. Brothers and sisters, on that great Judgment Day, there will be weeping and wailing, and you will all gnash your teeth." At this point, a lady in the front row said, "But Reverend, I ain't got no teeth." The minister pointed a stern finger at her and replied, "Madam, on that great Judgment Day, teeth will be provided."

I have entitled my address "Countdown on the Colorado" because a Judgment Day of sorts, a day of reckoning, is fast approaching not only for our two states, but for all the reclamation states of the West. When I say that this Day of Judgment will be "sooner than you think," I mean in just a few short weeks. And once that Judgment Day has come, nothing in the West will ever be the same again. Between now and then I believe it is vital that your state and my state and all the reclamation states consider most carefully the decisions they must make. The wrong decisions can have lasting and devastating consequences on the entire West.

I hope it will be said of me and my state that we acted with vision and reason and fair play, and without rancor or prejudice or parochialism. And I hope the same will be said of your participants in these decisions.

I have lived in the area of the Colorado River Basin all of my life. One of Arizona's original senators in 1912, the late Henry Fountain Ashurst, was accustomed to tell on himself the story of his maiden speech. After arriving in Washington, with some local reputation as an orator, he began his maiden speech saying something like this: "Oh, Mr. President, this great new baby state that I represent has every potential. Oh, Mr. President, this great baby state could become a veritable paradise. To become a paradise we need only two things, Mr. President. We need water, and we need lots of good people." At this point, according to Ashurst, a gruff old senator from New England interrupted to say, "If the distinguished gentleman will pardon me for saying so, that's all they need in hell."

Well, we've had the good people come into this great Pacific Southwest region by the millions—into your state and mine—but we in Arizona still have the same basic source of water we had when Senator Ashurst spoke in 1912—but in lesser and diminishing amounts each year.

My very earliest political recollections are of living in this little town in northern Arizona and as a boy of 9 or 10 observing, in the fall of an even-numbered year, various politicians coming through and telling the townspeople how they proposed to save the Colorado River from the greedy citizens of California. Well, Arizona followed that course of blind opposition for nearly two decades, and ended with nothing. I have seen my state pay a heavy price for its inflexibility, its rigidity and its unwillingness in those early years to cooperate with our neighboring states.

But, I must tell you in all frankness that I have seen something of the same sort in California—and I must remind you that your leaders, in those days, were not noted for *their* cooperation on Colorado River matters. And I believe the consequences of non-cooperation can be just as serious for California and the entire reclamation West as they were in that earlier era for Arizona.

I have come here today to speak with candor and to say the same things to you that I would say to audiences in Phoenix and Tucson. I want to give you my honest assessment of where our two states stand in relation to that coming Day of Judgment. There is no question that there are hard feelings between our states. Many of our people see each other as Machiavellian schemers and plotters. Some Arizonans view your water leaders as occidental Ho Chi Minhs: If we will but abandon our plans to take water from the Colorado River, they will agree to meet us at the conference table.

Shortly I'm going to review some of the things that have brought about these hard feelings—but let me say first that I sense a possible easing of tensions between us withn the last few weeks. I have begun to hope that we may yet find the way to a new period of cooperation. And surely this is the only course that holds any promise for any of us.

I am speaking to you today as an Arizonan who feels his state has been misunderstood, and I would like you to hear the history of some of these events as we view them in Arizona. I'd like you to play a mental game with me. Pretend that you were born in Arizona, that you had lived there all your life and, perhaps, even that you are a farmer in one of our central valleys, and that some of your land has gone out of production for lack of water—as thousands of acres already have. As you sit in Arizona and look out across your state and over the river into California, you think back on some of the things that have happened.

You recall the compact of 1922, when the flow of the Colorado River was divided roughly on a 50–50 basis between the three Lower Basin states and the four Upper Basin states. You recall the short-sightedness of your own Arizona leaders in refusing to sign that compact until 1944.

You recall that during those years other Colorado River Basin states moved ahead with their water projects and their development. But, going its own way, Arizona could do nothing about its greatest need—finding a way to channel water from the Colorado to the places where it was needed most. And then, in the 1940s your state came to life, ratified the Santa Fe Compact and entered into a contract with the United States for its 2.8 million acre feet of Colorado River water. In 1947 it introduced into the Congress a bill to authorize the Central Arizona Project.

You recall the great efforts of your Arizona senators which led to passage of that project in the Senate in 1950 and again in 1951. You recall the tense fight in the House when by a narrow margin the Interior Committee deferred action on the bill, and Arizona was told to settle its legal right to Colorado River water by a suit in the United States Supreme Court.

You remember the words of a great California governor, Earl Warren, who said:

"Whenever it is finally determined what waters belong to Arizona, it should be permitted to use that water in any manner or by any method considered best by Arizona."

And then you think about the 12 long years of litigation, the millions of dollars spent on it, the trial itself lasting from June 14, 1956, to August 28, 1958, the parade of 340 witnesses and 25,000 pages of testimony.

And you think of that great moment in 1963 when the Court handed down its decision, substantially upholding Arizona's claim to 2.8 million acre feet of river water, agreeing in the main that Arizona had just as much right to that share of the river as California had to its 4.4 million acre feet—and vice versa.

And you remember the elation and excitement of that moment as the people of Arizona looked to Congress to complete action on the water bill set aside in 1951.

You recall the words of another great California governor, Pat Brown, who said as the Court handed down its decision that California, having lost the Supreme Court case, "would not try to accomplish by obstruction what she had failed to accomplish by litigation."

And you recall with some bitterness your first realization that some of the same people who opposed you in 1951—and especially the people of Governor Warren's and Governor Brown's California—still opposed you and still insisted that their water rights and their needs were superior to yours, notwithstanding the decision of the Court.

You then recall the great efforts of Arizona's leaders to bring about regional cooperation, to put an end to this old feud, by drafting legislation that would not only build the Central Arizona Project but would solve most of the other problems of the region as well, legislation that provided for two dams in the vicinity of the Grand Canyon, for studies to implement water imports from the Northwest, and for a guarantee to California of priority for its 4.4 million acre feet over Arizona's 2.8 million—thus giving away much of Arizona's hard-fought legal victory in the Supreme Court.

You think about the enormous sums spent by Arizona interests to pass that legislation and about the big push of 1965–66 culminating in a favorable vote in the House Interior Committee.

And with real bitterness you reflect on the secret decision of California's water leaders who helped block that bill in the House Rules Committee, thus preventing it from ever coming to the House floor for a vote. In retrospect, you realize Arizona probably had insufficient time and momentum to get past the Senate in 1966 even if the House had acted, but the memory of California's role still rankles.

And as you think about that turn of events, much as you try to understand California's actions, you find a certain phrase going through your mind—the words of President Roosevelt in 1940: "The hand that held the dagger has struck it into the back of its neighbor."

You think about the shock wave that went through Arizona at that moment and about your state's efforts to scale down its legislation, to strip from it the controversial features that couldn't pass. And you recall its passage in the Senate this year over the heated opposition—you guessed it—from California.

And finally, you think about all the intemperate words thrown at your state in the past year, continuing almost to the present moment, accusing—not California—but Arizona of abandoning the cause of cooperation and breaking up the team effort toward a regional bill.

If you have followed me in this little recital, perhaps you can appreciate a little better why it is that you have on the east bank of the Colorado River some neighbors whose mood is one of anger and doubt and concern—and why it is that they tend to view with suspicion any suggestion, no matter how meritorious, coming from California.

And you may understand why it is that Arizona's leaders have told our congressional delegation: "Boys, this is it. Either you pass the bill in this Congress or Arizona builds its own project, whatever the cost."

As I look back at that great legislative effort of the last Congress—the one that California helped block in the home stretch—I recall the old fairly tales of my youth in which the brave but humble young man would seek to marry the king's daughter. The king would tell him. "Oh yes, you may have her hand in marriage if you will but slay the seven-headed dragon in yonder dark cave." The young man would go forth and slay the dragon, something the king thought impossible, and would return expectantly only to be told that he must then slay a three-eyed Cyclops across the water on a dangerous island. And when this was done, there would be still another obstacle. And so on.

Our legislative effort of 1965–66 was not unlike one of those fairly tales. First, we were told that a condition for passing the Central Arizona Project was an agreement, written in blood, that in times of shortage in river flow California's uses would have priority over Arizona's uses. It was hard to do, those of us in the congressional delegation were criticized at home for doing it, but we agreed.

Then we were told, "All right, now you must add to your bill provisions for trans-basin imports to augment the Colorado River. This will be very expensive, and it will lose you the support of powerful Northwest Congressmen who have other plans for that water, but you must do it." So we did.

Originally, we had planned to finance our project with power revenues from a dam 80 miles downstream from Grand Canyon. We expected some opposition from conservationists, who oppose such dams, but we were told this isn't enough. "You must put another dam in your bill," they said, "—this one 12½ miles upstream of the Grand Canyon and battle the conservationists all the more." And we did that.

About this time our friends in Colorado and the Upper Basin states said, "Now wait just a minute. Before you divert any water downstream from us you must guarantee that our future water needs are not endangered in any way." So we added protective language which they wanted, and we threw in five new reclamation projects in Colorado costing over $350 million. Could we then have the daughter's hand? We could not. We next had to do something for New Mexico. So we added Hooker Dam and a reservoir to our bill.

Then Utah said, "We don't have enough money to build our Dixie Project. It won't pay out without a subsidy. How about letting us participate in your basin development fund?" So we did.

Was this enough dragon slaying? It was not. About this time Texas and Kansas heard what was going on, and they said, "Hey, how about letting us get some of that Columbia River water?" So we said. "Well, OK, maybe."

And then what do you suppose happened? Why the good king—in this case, California—said, "Sure, you've done all these things I demanded and a few

more besides. But I'm still not going to let you marry my daughter because I don't think you've got the strength left to take her to the altar."

If you view things in this light it is little wonder that many Arizonans question the good faith of Californians who tell us, "We want you to get your share of Colorado River water, but first there are these few little old conditions."

Now I know, and most Arizonans know, that compromise is the essence of the legislative process. And we can't expect to pass any legislation as big as this without some give and take. But we'd certainly like to see a little more take with the give, or less give with the take.

What we are really complaining about in Arizona is a curious double standard for water development projects—one standard for the west bank of the river and quite another for the east. In my nearly seven years in Congress I've seen the enactment of at least ten projects in the states that make up the Colorado River Basin—projects like the $425 million Auburn-Folsom Project, which I voted for, and the $100 million San Felipe Project, both here in California. When projects like these come up—and I certainly want to mention the $72 million federal participation in your Bolsa Island desalting plant—the only questions raised are: Is it sound? Is it feasible? Will it repay its costs? If the answers are affirmative, the bill passes, and that's that. When Auburn-Folsom came up, no one suggested that hearings had to be postponed until your state had guaranteed Arizona's water requirements for the next fifty years; no one demanded that controversial dams be built, that the Mississippi River be diverted, or that Arizona's 2.8 million acre feet take precedence over your state's share of the Colorado River. When the $81 million Southern Nevada Project came up, no one suggested that the vote had to be delayed until all problems in the Colorado River Basin had been solved. No one demanded these things when the $43 million Dixie Project in Utah and the $170 million Fryingpan-Arkansas Project in Colorado came along, even though the waters were to come from the same river we are now told is too short.

Authorizations for your Central Valley Project here in California now exceed over one-and-three-quarter billion dollars, and on no occasion have you people in California had to stand on your little fingers, perform backward cartwheels, or demonstrate unusual heroics or feats of legerdemain in order to enact this legislation.

But on the east bank of the Colorado, once it passes Lee Ferry, it is quite another story. In the state which has the most serious shortages of all, which has the second most rapid population growth in the country and the most rapidly falling water tables, which has been stymied for 40 years while the other states of the basin have raced ahead—almost always with Arizona's support—in this one state only a different standard applies. It isn't enough that we show feasibility, need, cost-repayment criteria, and all the rest. According to California, we can't even bring our bill to a vote in the House of Representatives until we have given guarantees, single-handedly run over the Northwest, built the most controversial dams in the nation's history, and with our three-man delegation foreclosed any possibility that our 432 colleagues might change a single word, or even a comma, before final passage.

So much for dwelling upon the past, which, after all, is only prologue for what happens in the future. As we approach 1968 I think it's vital for your state and mine to assess where we are, what is possible and what is not, what is fair and what is right.

Where are we? Well, from the standpoint of reclamation, we're at essentially the same point we were at when the 89th Congress began. Nothing of consequence has moved forward. This big issue is holding up a backlog of reclamation issues—a lot of them in California—waiting to be considered. As long as this issue remains unresolved, the whole reclamation cause is hung up on a reef, going nowhere.

What is possible and what is not? Let me begin with a couple of major "impossibles" and get them out on the table for all to see.

For one thing, it is no longer possible to pass the big package of proposals we were all united on in 1966. Your leaders made the decision to help block final action in the 89th Congress, and the critical moment passed. In spite of all the charges of the Sierra Club and other organizations that we were going to flood the Grand Canyon—which wasn't true—and in spite of opposition from the Northwest that we were going to rob them of their water—a really absurd idea—we had succeeded in convincing a majority of the members of that Congress that our cause was just and that this bill should be passed. After 18 months of hard work, meetings, speeches, mailing campaigns and lapel tugging we were at the psycho-

logical moment for a floor vote. But it never came. The moment passed, and it will never return.

I must tell you bluntly that no bill providing for a so-called "Grand Canyon dam" can pass the Congress today. I fought them—we fought them together—but the protectionists have won—at least for now.

I must also tell you that no bill providing for augmentation of the Colorado River by importing water from the Columbia River system—or even feasibility studies directed at the Columbia—can pass the Congress today Senator Jackson, chairman of the Senate Interior Committee, will see to that.

There isn't a California water leader or Member of Congress with any knowledge of the situation who can say with a straight face that either of those two things can happen today any more than he can say that the sun can be made to rise in the west. Yet the official position of the California water agencies as I stand here at this moment is that the Central Arizona Project must be opposed vigorously unless these two impossible conditions are included.

Let's start with a good, strong dose of candor right here. If this is California's position, you are simply out to obstruct any Arizona bill from ever passing. You don't fool us, and you shouldn't try to fool yourselves.

All right, these things are impossible. What is possible? Obviously, this is where we ought to concentrate our efforts if we sincerely want to see reclamation move ahead, if we want to enable Arizona to utilize its share of the Colorado River, if we truly want to end this feuding that has gone on so long. And I will tell you that I see many avenues that are open to us, many ways in which our two states can proceed side by side to solve our common problems.

One of the greatest satisfactions for me in public life is reaching that point where divisions are bridged, feuds settled, where people who have been fighting can lay down their guns and begin to build instead of fight. Lyndon Johnson often quotes his father as saying that any jackass can kick a barn down, but it takes a pretty skilled carpenter to build one. I look back with real satisfaction on several such occasions in my congressional career.

Last year I thought we had reached such a meeting of minds in the Colorado River Basin states. I am hopeful that we may yet, in the six weeks remaining in our countdown, recapture the essence of that 1966 agreement, for it contains a whole bundle of things that *are* possible and can be enacted. Stripped of a lot of detail and many items of considerable but secondary importance you could write the essentials of that agreement on the back of an envelope. There were four main points:

1—California and Arizona's other neighbors would, at long last, support Arizona in building its aqueduct from the river to Phoenix and beyond.

2—Recognizing that this new drain on the river would bring shortages for all of us in 25 to 30 years, we agreed to start right now on a big, solid, meaningful program of studies and actions to augment that river so that, when the pinch of the 1990s comes, we would have enough water to meet all our needs.

3—We knew that augmentation would require big, bold steps and that they would cost money—hundreds of millions of dollars. This was where the dams came in. With their revenues we hoped to open a "savings account" to pay for the things our studies and investigations indicated were necessary and feasible.

4—Finally, to relieve California's great fears, we came to an understanding about what would happen in the 1990s and thereafter if, in spite of the augmentation program, there were shortages. We agreed that the Arizona aqueduct would beat those shortages to the extent required to get you your 4.4 million acre feet until this river was augmented or until the Resurrection, whichever came first. In effect, we gave away much of our "paper" victory in the Court to get our aqueduct built.

We have been promised that early in 1968 there will be a vote in the House Interior Committee on this legislation. We intend to try to win it—either with your help or over your dead bodies. But before that vote occurs there is time to get back on that four-point program—not in its precise form of 1966 as your leaders demand—but in its essence.

I suspect I'm going overboard on metaphors today, to make a metaphor. But another one comes to mind. I see that 1966 bill as a kind of jerry-built airplane designed to get a lot of people off a desert island. Because there were so many people to accommodate and so much excess baggage we put on about seven engines and five wings and three-and-a-half fuselages and six-and-a-half landing gears. It was a real dandy; it just had one defect: it wouldn't fly. In fact, California's designers and test pilots even refused to get on board. Out of that

experience I hope we've learned a lesson. This time let's build a smaller, sounder and less complicated airplane—but one that will fly. And if it won't accommodate all of our would-be passengers on one single glorious flight, we'll just take those with the most urgent business the first time and make several other trips for those who have no need to go right now.

In the context of our four-point agreement of last year I see the possibility for a new meeting of minds and a new joint effort of our two states and the other basin states. This is clearly evident when you realize how little change is necessary to bring that agreement into line with the realities of 1968.

I

On the building of the Arizona aqueduct there obviously can be no compromise, and no one has suggested one. This is the center of the controversy.

On the need for immediate, meaningful steps toward augmentation there certainly can be and ought to be complete agreement. Augmentation is more important than ever, for all of the basin states, and already we have lost over a year of irreplaceable time. It is not in the need for augmentation, but in the method of achieving it, that we have encountered difficulties. And I see no reason for these differences to continue.

When the Santa Fe Compact was signed in 1922, everyone assumed that the river would continue to flow at the same rate as it had in former years. But it hasn't, and we now know that there will be years when the river provides less water than the total of all our legally-constituted shares. This is the reason that your state has attemped to use its 38 votes in the House to exact from Arizona with its three votes the guarantee that I have discussed. Well, I happen to think it's a lot more important to augment the water supply than argue about dividing up shortages. And while the exact form of augmentation contained in our 1966 bill is no longer possible—at least not in the foreseeable future—there are three other methods of augmentation that are available to us. In other words, of the four, three are available to us. Let me list them.

First, there is desalting.

Second, there is weather modification. This is really exciting and may answer our problems all by itself.

And finally, there is salvage and conservation of existing water in the Lower Basin.

This leaves only so-called trans-basin transfers—in other words, importing water from the Columbia Basin—as unavailable to us at this time.

Let me tell you a little bit about this one method we're having to abandon for now. It would involve constructing a large, long, costly aqueduct, pumping system and other works—and doing it now in dimensions capable of meeting our needs 30, 40 and 50 years from now. To build a little aqueduct to meet our present demands would be an awful mistake, as it would simply have to be enlarged later. But to build a huge aqueduct now, many years in advance of actual need, would mean carrying an enormous investment that was yielding no return for up to half a century. At this moment no one, including those Californians most sanguine about this proposal, has any real idea what it would cost. However, the best engineering estimates based on today's technology price the water from that system at anywhere from $80 to $200 an acre foot.

Just to put that in perspective, we have a couple of friendly economists in Arizona who say that our farmers can't afford to pay $10 an acre foot. Domestic users, of course, can pay much more, even $200 an acre foot, but they certainly don't want to pay such prices if water is available more cheaply some other way.

Which brings me to the first of the *possible* means of augmentation available to us. This is desalting.

There are two very favorable factors working for us in this regard. The first is that today's technology will produce desalted water for us more cheaply than imported Columbia River water. The second is that desalting units can be built in stages as they are needed, rather than all at once, saving the "idle plant" cost inherent in importation.

I have said we must assume there will be shortages in the Colorado River. But they don't exist today because the four Upper Basin and three Lower Basin states aren't yet at that level of population and development to utilize all their allocations. Let's see what this means in relation to the construction of desalting plants to make up for these deficiencies.

I am told that the first of these staged desalting plants would not have to be put into service until the year 1992, the second in 2001, a third in the year 2013

and a fourth in 2025. And you can be sure that advancing technology will reduce the unit cost of water produced by each successive plant in the series.

Thus, instead of carrying idle plants for decades, adding immeasurably to the cost of our water, we will invest money only when it is needed and on a descending scale of unit cost. I happen to think that is more than an adequate substitute for the abandoned alternative of importation.

Incidentally, I understand that your big new desalting plant off the coast will produce fresh water for about $70 per acre foot. That's considerably less than the $80 to $200 price for Columbia River water.

The second method of augmentation I mentioned was weather modification. I find this so exciting that I think a few years from now we will wonder why we spent so much time arguing about whose share of the river had priority over other shares; there will be enough to meet all uses, including what we call the Mexican Treaty Burden. I won't weight you down with that matter except to say that we have to guarantee 1.5 million acre feet to Mexico, and in a water-short year we worry about which states are going to have to relinquish the most water. Well, weather modification—not here in Southern California or in Arizona either, for that matter, but rather in the headwaters of river basins such as the upper slopes of the Rocky Mountains in Colorado—may end those arguments. Through cloud seeding additional snowfall can be produced in these watersheds, increasing the spring thaw and ultimate river flow. This technology is progressing so rapidly that the Department of Interior suggests full-scale programs will be in operation in the next decade.

While any cost figure on such a program must be pretty rough right now, it has been estimated that additional streamflow can be generated at a cost of around $1 to $4 an acre foot. Compare that with the $80 to $200 for Columbia River water and the $70 for desalted water.

You can see from these figures that it would be a mistake to tie ourselves here and now either to a vast system of import works or to a precise schedule of construction on desalting plants when a much cheaper option may become available in 10 years or less.

This brings me to the third alternative available to us, and that is the salvage and conservation of existing water in the Lower Basin. If someone said he knew of a secret underground river which would add, right now, 1.5 million acre feet of water annually to the Colorado River—enough, for example, to satisfy that Mexican Treaty burden—I'm sure you would say, "Let's go after it." Well, there is no underground river, but there is something almost as good. Every year the irrigation districts of the Imperial and Coachella valleys run off as drainage and waste, some of it never having touched an irrigable acre, over a million acre feet of usable water. While I realize this is a subject concerning my friends in the Imperial Valley are understandably sensitive, I think this waste needs to be looked at. It includes drainage water, tail water and so-called "regulatory waste."

There are other ways in which we could get more use out of the water already existing in the Lower Basin. Every year more than three-quarters of a million acre feet of reclaimable sewage effluent is wasted in Arizona and Southern California—water which could be reused for agriculture with the resulting savings of an equal amount of potable water for domestic and municipal use.

Then there are still large amounts of mainstream water lost each year between Hoover Dam and Mexico through its absorption by salt cedars and other water-loving plants which are still permitted to grow along and in the river bed.

These are some of the avenues that are available to us and which ought to be getting our attention. They offer us more than adequate means to "make whole", as they say, the Colorado River Basin, to augment its water supply to the point that all shares can be utilized and new increments added with the passing of years.

III

Now to review briefly. I have already covered the first two of those four essentials I said could be written on the back of an envelope. They were the Arizona aqueduct and augmentation. Now we come to the third, which was how we raise the money. Last year our plan was to build two big power dams to provide a basin fund. Since these dams are now out of the question, where can we get the money to do these things we have to do? Well, let's see.

The Central Arizona Project bill, as it passed the Senate, takes a big step in this direction. It sets up the same basin fund we proposed last year, but without the revenues from the Grand Canyon dams. Going into that fund will be all

surplus revenues from the Hoover and Parker-Davis projects when they are paid out, and from the Pacific Northwest-Pacific Southwest power intertie located in the state of Arizona and Nevada. The basin fund in last year's bill would have built up to around $3 billion by the year 2050. This fund, without those two controversial dams, will still generate about $1.3 billion. And I think we're going to develop other revenue-producing projects in the next few years to add to that.

There is something else we can do, I believe, that will more than make up for the loss of those dams. In our bill last year we had a little feature that went almost completely unnoticed, and there was little controversy about it. That feature provided that the federal government would assume the Mexican Treaty burden, picking up the tab for the first 2.5 million acre feet of augmentation of the river. That little item, all by itself, could mean perhaps about $2.5 billion to the states of the Colorado River Basin, the equivalent of about two Hualapai Dams. I think such a transfer of that burden is still possible and ought to be getting our maximum attention and effort. I think what we can do for ourselves in this area is a lot more important than grousing about the loss of those two dams.

IV

Finally, we come to item four on the back of that envelope—what happens if the river is still short in the 1990s and thereafter—the 4.4 guarantee issue. Let's all stop a moment and take a good, hard, cold unemotional look at this. Of the four essential parts of the 1966 agreement this was really the least important. The other three dealt with water, with progress, with people's needs. But this one dealt only with words on a piece of paper—with emotions, with face, pride, fear and all the rest. On both sides of the river we found ourselves mesmerized with a paper controversy that actually didn't involve the life or death stakes Arizonans and Californians attributed to it. It had a lot of importance psychologically, or as a test of good faith, but in terms of bedrock problems it just didn't mean much.

The fundamental fact for all of us is that the Colorado River will be short in the 1990s—not now, but 25 years from now. If you manage to defeat and obstruct the Central Arizona Project, the river will still be short, and your long-term needs won't be met by the 4.4 you are entitled to—or even the 5.1 million acre feet you are using temporarily now.

If we beat you and pass the project without a guarantee, the river will still be short in the 1990s—short for you and for us as well. And if Arizona "goes it alone," the river will be short also.

Indeed, even if we capitulate and give you last year's guarantee, the river will still be short in the 1990s—in that case, short for you and even shorter for us.

The fact is, my friends, we will all be in trouble—guarantee or no guarantee—win, lose or draw—unless and until we take steps to make augmentation a reality. When that is done, there will be enough water in the river and the question of paper guarantees will be entirely academic—which, in the final analysis, is about what it now is.

For thirty long years now you have had your aqueducts. You've used your share of water and some of ours too. In the Senate bill passed this year Arizona consents to your continued priority over our uses for *another* 27 years. But your state says there can be no compromise; the guarantee must run until the river is fully augmented or Gabriel blows his horn. I see two things wrong with this California position:

1—The first of these is your leaders' insistence that, even if given a guarantee of 4.4, there can be no credit for water added to the basin through such programs as I have outlined unless that water is dumped physically into the Colorado River itself. Let me illustrate why this position makes no sense.

I have indicated that four large desalting plants, built in stages, could give our water-short region enough new water to make up for anticipated deficiencies in the basin. Suppose now that we give you a guarantee lasting until new water is found to relieve the basin of the Mexican Treaty burden of 1.5 million acre feet. And suppose that our engineers tell us the best place to build the first of these plants is the Los Angeles area along the seacoast.

All right. Now let's assume that Congress authorizes the project, and we pay for it with federal funds, perhaps out of the basin account. The plant is built and begins to pump brand new $70 water into the basin, cutting down the regional shortage for all of us. A reasonable person might expect that this new water would

apply as a credit on Arizona's guarantee. However, that's not the way your water leaders see it. Unless the water is dumped physically into the mainstream of the river, they say, it just doesn't count.

But, they say, if we build the same plant under the same arrangements with the same federal financing, *and* if we build a tremendous new aqueduct to Las Vegas and pump this new water to Lake Mead and dump it there, it *does* count on the guarantee. By the time we pump it to Lake Mead and then pump it back to Los Angeles, to meet this ridiculous requirement, that $70 water will cost perhaps $200—but it will count on the guarantee.

Similarly, they say Arizona can get no credit for the kind of "new water" made available by expensive basin fund expenditures for salvage, canal lining, phreatophyte control and the like.

This logic is a little hard for us to follow and impossible to accept. When you propose this kind of guarantee, you are really saying that Columbia River water counts, and nothing else does. I believe I have shown that this road, justly or not, is not now open to us.

2—The second thing wrong with your state's position on the guarantee is that it saddles Arizona, and Arizona alone, with the main burden of augmenting the river. It gives us every incentive to augment and you every incentive to block augmentation. I think this is unrealistic and unfair. It's unrealistic because your state is going to need much more water than this, and it's unfair because the burden is just as much yours as ours.

After all, by the time that 27-year guarantee runs out, California will have had preferential use of the Colorado River for a total of 60 years. I think we'll all be better off if the incentive to augment it after that date falls equally on both our states.

Thus, of the four items on that envelope, we have three on which I think we could reach agreement without too much difficulty, and one which remains a subject of controversy. I don't think my state will go beyond the 27-year guarantee of the Senate bill, but theoretically we could give a perpetual guarantee. While I don't think this whole argument makes much sense or makes much real difference, I suppose we can continue to haggle about it. If we do, I hope our haggling doesn't divert too much of our attention away from the far more important things we have to discuss.

I entitled this speech "Countdown on the Colorado." That countdown, which began some time ago, will end in late January or early February when we've been promised a committee vote on our Central Arizona Project-Colorado River Basin bill. As that day approaches it seems to me all of us—but espeically California—have two basic philosophies to choose from:

The first is a philosophy of pessimism, localism and defeatism—the philosophy Arizona observed in the 1920s and 1930s and which is now urged on you by some of your people. This philosophy says that not one single step can be made toward meeting Arizona's needs of the 1970s and 1980s until we know precisely—in the minutest detail—what will be done about California's needs in the 1990s. If your state follows this philosophy then whatever happens in Congress you will lose and we will probably lose with you—the river will remain short and no one will have enough. This is a fact that everyone has to face. If Arizona should go it alone and take its water out of the river under some kind of state plan, we will have to face the shortage of the 1900s, just as you will. This is the ultimate hard rock that everyone has to face. Furthermore, if Arizona is forced to build its own project, you can bet that we're going to oppose any and all federal projects sought by your state, perhaps your lawyers or ours will dream up some more lawsuits, and conceivably we'll even raise some questions about all that good water going to non-reclamation, non-municipal, non-economic use in the Salton Sea. I think your decision to follow this philosophy can be disastrous for our states and for the cause of reclamation.

The other choice is to continue the proven path of progress and cooperation, to adopt a philosophy of optimism and faith and hard work and a willingness to join together in solving—one step at a time—the problems as they arise. Except in water matters this has been the history or our two states. This philosophy acknowledges that we can't do everything we'd like to do right now. We can't fully and finally, in one bill, augment the river to meet the needs of all time. But we can make a substantial start on an augmentation program and we can create a basin fund to help pay for it. We can and we will meet Arizona's needs for an aqueduct now. And while it is being built we will spend money on investigations, feasibility studies, long-range plans. We will begin the great and im-

portant program to make sure that long before the 1990s we have the additional water our states need for their growing populations.

I'm sure you know which of these philosophies I believe is in the best interests of your state as well as mine.

Your state's position today seems to be based on the notion that, unless iron-clad arrangements are made now, the United States is going to let California and Arizona dry up and blow away. I have too much faith in the country, in the Congress, and in Arizona's and California's leaders to take this defeatist view.

The world was not built in a day; your Central Valley Project and your magnificent Imperial and Coachella Valley projects didn't spring full blown from the drawing boards to be rushed through in one gigantic omnibus bill. The fantastic Columbia River system wasn't authorized in one bill. All these successful efforts were authorized and built one sound step at a time.

This is the proven, progressive path by which all the Western states have been built. Today, Arizona is asking you to get back on that path with us. For your sake and for ours there is no time to lose.

Mr. JOHNSON. In response to the quorum call on the floor, the committee will adjourn for the day. Since the Secretary cannot be here tomorrow, we will resume with him on Thursday for questions by the members. The gentleman from Arizona will be recognized at that time.

(Whereupon, at 3:40 p.m., the committee recessed, to reconvene at 10 a.m., Thursday, February 1, 1968.)

COLORADO RIVER BASIN PROJECT

Part II

THURSDAY, FEBRUARY 1, 1968

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON IRRIGATION AND RECLAMATION
OF THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:55 a.m., in room 1324, Longworth House Office Building, the Honorable Harold T. Johnson (chairman of the subcommittee), presiding.

Mr. ASPINALL. The Subcommittee on Irrigation and Reclamation will now be in order for the consideration of such business as is regularly scheduled to come before it, which is the continuation of the hearing on H.R. 3300 and S. 1004.

It is nice to see you back, Mr. Secretary. I hope that you had a pleasant birthday.

STATEMENT OF HON. STEWART L. UDALL, SECRETARY, DEPARTMENT OF THE INTERIOR; ACCOMPANIED BY KENNETH HOLUM, ASSISTANT SECRETARY FOR WATER AND POWER; FLOYD E. DOMINY, COMMISSIONER, BUREAU OF RECLAMATION; AND EDWARD WEINBERG, DEPUTY SOLICITOR

Secretary UDALL. Thank you, Mr. Chairman.

Mr. ASPINALL. Now, I am going to throw you to the mercy of that very talented, young, and dedicated brother of yours. When he gets through, I want to know what your reaction is to his operations.

Mr. UDALL. Mr. Chairman, through a series of brilliant questions, I intend to rend these witnesses from limb to limb as the morning goes on.

Mr. SAYLOR. Will the gentleman yield to me for a unanimous request before proceeding with that task?

Mr. UDALL. The gentleman said the other day this was their finest hour. I hope this will still be the situation when we are finished today.

Mr. SAYLOR. Mr. Chairman, I ask unanimous consent that we be allowed to place in the record at this point a letter I addressed to Mr. Floyd E. Dominy, Commissioner of Reclamation, on October 18, 1967, together with the answers to that letter which I received from Mr. Dominy under date of October 24, 1967, and November 24, 1967.

Mr. HOSMER. Reserving the right to object, what does this blank check for the gentleman concern?

Mr. SAYLOR. This concerns only the Hooker Dam which, believe it or not, does not affect any water in California.

Mr. HOSMER. Does it have a Sierra Club twist to it?

Mr. SAYLOR. No, but I am going to ask that the report of the Sierra Club be placed in the file.

Mr. HOSMER. Does it discuss the water supply situation?

Mr. SAYLOR. It discusses only a proposed dam site.

Mr. HOSMER. No fallout that will move westward?

Mr. SAYLOR. There might be some if it finally got to the Gulf of Mexico, somewhere around where the Gila River runs into the mainstream of Colorado.

Mr. HOSMER. I withdraw my reservation.

Mr. ASPINALL. Is there any objection?

There being no objection, it is so ordered.

You have heard the request of the gentleman from Pennsylvania: that the correspondence on the Hooker Dam be made a part of the record and that the report of the Sierra Club be made a part of the file. Is there any objection?

(No response.)

Mr. ASPINALL. Hearing none, it is so ordered.

(The material deferred to follows:)

(The report referred to will be found in the committee files.)

CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
Washington, D.C., October 18, 1967.

Mr. FLOYD E. DOMINY,
Commissioner, Bureau of Reclamation,
Department of the Interior,
Washington, D.C.

DEAR MR. DOMINY: As you know, the House Interior and Insular Affairs Committee intends to take up in Executive Session early next year the Central Arizona Project. So that I may be properly informed before the bill is acted upon in Committee, I will from time to time submit questions concerning this project as it is considered.

I am listing below a series of questions in regard to the Hooker Dam and Reservoir, and wish you would provide answers at your earliest convenience. This project is one in which I have not arrived at any definite conclusion, therefore, my questions are quite detailed, and I sincerely hope that your answers are equally informative.

1. Present legislation expresses the size of the proposed Hooker Dam and Reservoir in indefinite terms. HR 3300 does prescribe an initial capacity for the Reservoir of 98,000 acre feet, but then, like S 1004 just passed by the Senate, sets the final size only in terms of the additional consumptive use to be provided for New Mexico, this being 18,000 acre feet per annum under both bills. What are the plans for the specifications of this project in the following terms:

(a) The height of the dam? The maximum water surface elevation?

(b) The capacity of the reservoir?

(c) The area of the water surface of the reservoir at full capacity?

(d) The length in river mileage of the reservoir at full capacity, together with the length of the encroachment on the Gila Wilderness and Primitive Areas?

(e) The water for additional consumptive use to be provided New Mexico, excluding evaporative losses; and

(f) The yearly evaporative losses?

Each of these characteristics of the project should receive multiple answers if the dam is to be built in stages.

2. (a) How extensive a study has been made of the project in order to establish its characteristics?

(b) Assuming that only a reconnaissance study has been made, as I understand to be the case, what degree of change can be expected in the characteristics as plans are made definitive upon authorization of the project?

3. Based on its reconnaissance studies, it is said that the Bureau of Reclamation has settled on the Hooker site as the best site for the project as conceived. What is the extent of these site studies?

4. What alternate sites along the Gila River were considered and studied by the Bureau? If any submit the studies.

5. (a) What is the benefit-cost ratio for Hooker Dam?

(b) What are the results of the studies by the Bureau with respect to each alternate site considered in comparison with the Hooker site, in terms of details, figures, prospective benefits, and benefit-cost ratio?

6. (a) How does the benefit-cost ratio of Hooker Dam compare with a potential project to supply New Mexico's water entitlement utilizing ground water storage and pumping? The ground water used in this manner would appear to be adequately recharged by periods of high flow in the Gila River. In view of its effect on surface flows in the Gila River above Coolidge Dam, such a project should include most presently irrigated land which might benefit from Hooker Dam. Potential benefits for such a project might include no evaporation losses from surface water storage and possible reduction in evapotranspiration by phreatophytes to lowering of the water table.

(b) Has there been consideration of any other alternate plans to the Hooker Project (n.b., project, not just dam)?

7. The primary objective of the Hooker project is to provide additional water for consumptive uses in New Mexico amounting to 18,000 acre feet per annum. How was this amount of water established. Is it?

8. What is the planned breakdown of this 18,000 acre feet to the various consumptive uses?

9. How was this breakdown arrived at?

10. Assuming that there was some delay in completing the Hooker project to its full capacity and that at a lesser capacity, presumably 98,000 acre feet, the project could provide some lesser amount of water for additional consumptive use, how much water would be provided and how would this quantity be broken down to consumptive uses?

11. (a) Is Hooker actually part of the Central Arizona Project in an engineering or an operating sense?

(b) If Hooker is actually essential to the Central Arizona Project, in what respect is this true?

12. What would be the type of construction of the Hooker Dam?

13. What would be the cost of the project as of October 1, 1967?

14. What would be the effect on type of construction and cost if the dam were constructed in stages?

15. Benefits to be derived from Hooker have been claimed for flood control, outdoor recreation, fish and wildlife, and for municipal, industrial, and agricultural uses through the provision of a firm water supply resulting from river regulation. Is this the extent of the claimed benefits?

16. These claimed benefits pertain only to New Mexico, do they not?

17. What are the full details in facts and figures which are the basis for the claimed benefits to agriculture, in terms of flood control, firm water supply, or additional consumptive use?

18. Does S. 1004 permit the irrigation of new lands in New Mexico with Gila River water? If so, how will the water be supplied to these lands?

19. How much land with appurtenant water rights was brought up in the Gila Valley on behalf of the Phelps-Dodge Corporation for use of the water rights in support of their Tyrone operation?

20. What will be the effect of the diversion of these water rights on the potential of the Gila Valley as an area for irrigated farming?

21. Would the Hooker project serve in any way to salvage the agricultural potential of the Valley in the foreseeable future?

22. What is the basis in detail for the benefits claimed for outdoor recreation?

23. Are the benefits claimed for outdoor recreation adequately discounted for the negative effect on outdoor recreation which would be caused by the intrusion of the reservoir on the Gila Wilderness and Primitive Areas?

24. How would a site for the project, downstream of the Hooker site, compare with Hooker site for conventional outdoor recreation?

25. What is the basis in detail for the benefits claimed for fish and wildlife?

26. Have the claims for benefits to fish and wildlife been checked by a qualified ecologist?

27. As planned, the Hooker Reservoir would encroach on the Gila Wilderness and Primitive Areas, and in doing so would be destructive of habitat for the native flora and fauna, thus altering the native ecology which it is the function of those Areas to preserve. Are the benefits claimed for "fish and wildlife" adequately discounted for this negative effect?

28. What is the meaning of "wildlife" as used in the claims for benefits from the Hooker project?

29. How could Hooker provide benefits for wildlife under any definition of the term?

30. What is the meaning of "fish" as used in the claims for benefits from the Hooker project?

31. Is the claim for benefits to "fish" based on prospective improvement of habitat for native water animals, or does it refer to improved facilities for stocking sport fish for "put and take" recreational fishing?

32. Would the New Mexico Game and Fish Department be allowed to contract for municipal and industrial water from the Hooker Reservoir to be used to compensate for evaporation at certain state-owned lakes?

33. What would be the effect of the Hooker project on the native flora?

34. How would a site for the project downstream of the Hooker site compare in terms of conventional fishing for recreation?

35. Has the prospective value of the Hooker Reservoir for conventional outdoor recreation and sport fishing been assessed by a qualified expert or experts on those subjects?

36. Has the Forest Service been consulted with respect to the problems of administering wilderness regulations on the Hooker Reservoir and in the vicinity, considering that it would lie astride the wilderness boundary?

37. Has the opinion of the Forest Service been sought concerning the Hooker project in general? What is its position? If in writing furnish copy of same.

38. What areas would be protected from floods that are not now protected or would be protected by authorized or pending projects?

39. How much water is allocated for use by Silver City? How would Silver City's share of the water be made available for use, what would be the cost of delivery, and at whose expense would this be?

40. It is understood that water allotments were established by interviews with appropriate industrial officials incident to the Bureau of Reclamation reconnaissance studies, thus allotments must be earmarked to specific users. Who are the prospective users for the 10,000 acre feet of water apportioned to mining and milling? How much would they be charged for this water?

41. (a) Is there any intention to transport mining and milling water east across the Continental Divide, or that is be so transported to users so located?

(b) If water is to be transported across the Continental Divide, for whom might it be destined and at whose expense would it be moved?

42. Will the income derived from water and power sales from Hooker Dam be sufficient to cover reimbursable project costs? If not, how much financial assistance is necessary from a basin fund?

In view of the fact that there is an unusual method of financing provided in the proposed legislation and which has already been approved by the Bureau, I also request an up-to-date breakdown of the amount of monies which will be advanced by the Federal Government for construction of a Thermal Electric Plant, which the Government will contract for, the length of time such power is available, your estimated cost to the taxpayers, and the cost per kilowatt under the most advantageous and adverse conditions.

The information that I am seeking is for my own personal edification and benefit. I would appreciate your forwarding these answers to *me personally* at your earliest convenience and without circulating them to any other Member of Congress as in the past.

With every good wish,

Sincerely,

JOHN P. SAYLOR,
Member of Congress.

DEPARTMENT OF THE INTERIOR,
BUREAU OF RECLAMATION,
Washington, D.C., October 24, 1967.

Hon. JOHN P. SAYLOR,
House of Representatives,
Washington, D.C.

DEAR MR. SAYLOR: This is in further reply to your letters of September 14 and October 18, 1967, enclosing a list of questions concerning the Central Arizona Project and proposed Hooker Dam in New Mexico. The following replies are numbered to correspond with your questions:

Answer No. 1.—The provisions in H.R. 3300 and S. 1004, 90th Congress, with regard to additional New Mexico consumptive use in the amount of 18,000 acre-feet per year are based upon negotiations between the States of Arizona and New Mexico. As we understand these provisions, if either bill is passed by the Congress, our Bureau would be authorized to proceed with definite plan studies to determine the reservoir capacity required to allow 18,000 additional acre-feet of consumptive use from the Gila River, its tributaries, and underground water sources in New Mexico without prejudicing the rights of downstream interests under the Colorado River and Gila Decrees. Our testimony to date before congressional committees has related to a reservoir with a capacity of 98,000 acre-feet, but we have not established the capacity which will be required to meet the provision of 18,000 acre-feet of additional consumptive use. The following data submitted in answer to subparagraphs (1) through (6) of Question No. 1 are, therefore, for a reservoir of that capacity.

(1) Height of dam	227 feet.
Maximum water surface elevation	4,880 feet.
(2) Capacity of reservoir (including surcharge storage)	117,000 acre-feet.
(3) Surface area, maximum water surface	1,250 acres.
(4) Reservoir length, full capacity	9.2 miles.
Length of encroachment:	
Gila wilderness	3.5 miles.
Primitive area	0.7 miles.
(5) Consumptive use additional to New Mexico—less evaporation	[1].
(6) Average annual evaporation loss over 100 years	3,700 acre-feet.

[1] Unknown; would vary with reservation for flood control and resolution of legal problems.

Detailed operation studies will be required to determine the reservoir capacity necessary to accomplish the exchange contemplated in the bills.

Answer No. 2.—(a) The design characteristics of Hooker Dam as presented in our 1947 report were adopted from studies made by the Corps of Engineers and presented in its December 1, 1945, "Interim Report on Survey, Flood Control, Gila River and Tributaries Above Salt River, Arizona and New Mexico." Cost estimates were updated to October 1963 price levels in our recent testimony before the committees. In total, these studies could be considered to be a little better than reconnaissance level.

(b) Our experience in the past is that feasibility-grade studies result in changes in cost and minor modifications in structure arising from additional foundation and hydrologic data which are not available from reconnaissance studies. In the case of Hooker Dam, if the requirement to provide 18,000 acre-feet of water for consumptive use is included in the authorizing legislation, we will need to perform detailed operation studies to size the reservoir. The resulting reservoir may be considerably in excess of the 98,000 acre-foot capacity used in the report.

Answer No. 3.—Various sites have been studied at a reconnaissance level by our Bureau and the Corps of Engineers over the past 35 years or so. Information on these studies is contained in our original Central Arizona Project report of 1947 and in the Corps of Engineers' 1945 interim report on the Gila River and tributaries above Salt River.

Answer No. 4.—Our reconnaissance investigations since about 1930 include the following:

(a) The Alum Dam site located upstream from the Hooker site.
(b) Hooker Dam and Reservoir.
(c) The Upper and Lower Cliff Dam sites located below the Cliff-Gila Valley.
(d) The Conner Dam site located below the Cliff-Gila Valley.

(e) The Fuller Ranch Dam site located downstream from the Red Rock Valley.

Answer No. 5.—(a) It is a feature of the Central Arizona Project dependent upon that project; hence, no determination of a separate benefit-cost ratio for Hooker Dam and Reservoir has been made.

(b) We have made reconnaissance investigations of numerous damsites on the Gila River in New Mexico since about 1930. These include the following, which are listed in downstream order:

The Alum Dam Site, being located upstream from the Hooker Dam site, could serve the same geographic areas and could provide similar benefits. The cost per acre-foot of net water yield at this site was shown by reconnaissance studies to be only slightly higher than at the Hooker site. The Alum Dam and Reservoir site, therefore, was considered to be a truly comparable alternative to the Hooker site but was dropped from further consideration because the site is located entirely within or surrounded by the Gila Wilderness Area at considerable distance from paved highways or habitations, making it less desirable than sites outside or on the edge of the wilderness area. Because the Alum site is located higher on the watershed, the quantity of water that could be developed and the degree of flood protection that could be provided to downstream areas also would be less than at the Hooker site.

Hooker Dam and Reservoir were proposed as features of the Central Arizona Project because of the strategic location and superior physical potentialities of the Hooker site relative to benefits within the State of New Mexico. Although the cost per acre-foot of net yield at the Hooker site was shown by reconnaissance studies to be less than at any other site studied, this finding was not the sole basis for selecting the Hooker site for more detailed investigation.

Hooker Dam site is located at the point where the Gila River emerges from the mountains and flows through the irrigated valleys of western New Mexico into eastern Arizona. A dam and reservoir at this strategic location would serve the three principal irrigated areas along the Gila River in New Mexico, the Cliff-Gila, Duck Creek, Red Rock, and Virden Valleys and also would provide the most practicable source of additional municipal and industrial water supply for the Silver City and Tyrone areas. It also would provide aquatic recreation and fishing and hunting opportunities readily accessible by paved highways to Silver City and other urban areas. The dam would be located outside the Gila Wilderness and Primitive Areas, and the reservoir would back water only a few miles inside these areas which, at this point, are comprised of typical, undistinguished, sparsely vegetated, desert hills located in close proximity to State highways, towns, and farmsteads.

The Cliff Dam Sites (upper and lower) were dropped from consideration because early reconnaissance investigations indicated that the physical potentialities of these sites were inferior to either the upstram Hooker site or the downstream Conner site. A dam at this site would inundate about 2,000 acres of presently irrigated farmland.

The Conner Dam Site, being located downstream from the Cliff-Gila Valley, would neither serve nor protect that valley, which contains nearly 50 percent of all farmlands irrigated from the Gila River in the State of New Mexico. This site, therefore, is not a comparable alternative to the Hooker Dam site insofar as it relates to benefits within the State and, for that reason, was not considered in the original Central Arizona Project report. New developments that have occurred during the 20 years since the original Central Arizona Project report was issued provide no basis for reconstruction of this site.

As previously noted, the 18,000-acre-foot increase in New Mexico's annual water use from the Gila River as provided for in the Arizona-New Mexico agreement includes the evaporation losses that would occur on any reservoir constructed to develop this water. Such losses would be far greater at the Conner site because of its lower location on the watershed and the resulting requirement for increased reservoir capacity due to its greater sediment inflow. It is estimated that the annual evaporation from the Hooker site will be about one-third that of the Conner site. Evaporation from a reservoir at the Conner site constructed with active storage capacity needed for water conservation purposes might easily consume most of the additional 18,000 acre-feet per year permitted by the interstate agreement. The Conner site is also less desirable from a recreation and fish and wildlife standpoint because

of its isolation and lack of access facilities. It also would require about 500 feet of additional pump lift to transport municipal and industrial water to the areas of potential use. A dam at this site would also inundate about 900 acres of presently irrigated farmland.

The Fuller Ranch Dam Site, being located downstream from both the Cliff-Gila and Red Rock Valleys and at great distance from potential municipal and industrial water users, was eliminated from consideration on the basis of its geographic disadvantages with respect to increased water use and other benefits in the State of New Mexico. A dam at this site would inundate about 1,400 acres of irrigated lands.

In general, the rate of evaporation would be greater in the locations of the downstream sites. Flood protection to the important developed lands of the Cliff-Gila can not be provided by reservoirs at the Cliff, Conner, or Fuller Ranch sites. Our studies of the alternative sites also are not to sufficient grade to ascertain that the foundations for the dams and reservoir areas are adequate.

We have not carried the studies of the alternative sites to the degree of refinement which would provide quantiative statements of current costs, benefits, and other factors.

Answer No. 6.—(a) No feasibility-grade hydrogeologic and ground-water studies of the Upper Gila River Basin have been made. It is our judgment, however, that, on the basis of reconnaissance studies, it would not be possible to sustain pumping an additional 18,000 acre-feet per year from the area. The two proposals, therefore, are not comparable.

It is doubtful that adequate well yields and adequate recharge in periods of high flow could be obtained in reasonable proximity to the potential water requirements. Also, operation of the suggested well fields in a manner that would not affect downstream rights would be extremely complex. For example, at low flow, it would be necessary to pump from the well systems into the river an amount equal to the computed effects of earlier pumping from the wells on river flows. Reliable computations of such effects, acceptable to downstream interests, might pose a difficult problem.

(b) We are now engaged in authorized feasibility investigations of the potential Upper Gila River Project, which embraces that part of the Gila River Basin in Arizona and New Mexico above Coolidge Dam. Consideration is being given in these studies to many alternative plans for increaisng water use in both the Arizona and New Mexico portions of the Upper Gila River Basin involving additional storage works, phreatophyte eradication, canal and lateral lining, and exchange arrangements with downstream water users to be supplied directly from the Central Arizona Project aqueduct system. Reconnaissance plan formulation studies evaluating alternatives which have so far been completed have included storage combinations without the proposed Hooker Dam and Reservoir, but all have demonstrated less favorable results than alternatives which include Hooker Dam and Reservoir.

Answer No. 7.—This amount was established by mutual agreement between the States of Arizona and New Mexico after a long period of negotiations. Our Bureau was not a part of these negotiations but, upon request, furnished both States such data as were available.

Answers Nos. 8 and 9.—Our reconnaissance studies indicate a potential demand for about 10,800 acre-feet of additional municipal and industrial water, leaving a balance of 7,200 acre-feet for reservoir evaporation, irrigation, fish and wildlife, recreation, or other uses. The amount of reservoir evaporation would depend upon the reservoir capacity and operating criteria. These figures were made available to both Arizona and New Mexico during the aforementioned negotiations. The figures or breakdown result from a determination of the potential need for M&I supplies.

Answer No. 10.—It would be our intention to give the first consideration to M&I uses in providing a water supply of any quantity. To the extent that water is available in excess of current M&I needs, it would be used in an interim irrigation supply.

Answer No. 11.—(a and b) Hooker Dam would not be a viable development insofar as its contemplated accomplishments are concerned without the Central Arizona Project. Hooker Dam, on the contrary, is not necessary to the engineering and operating viability of the other portions of the Central Arizona Project. Hooker Dam, as embodied in H.R. 3300 and S. 1004, however, is necessary to accommodate an exchange of water for the benefit of New Mexico. The physical

accomplishment of that exchange would require storage facilities in New Mexico.

Answer No. 12.—Hooker was originally planned as a concrete structure but, due to technological advancement since that time, we believe that definite plan studies may indicate that an earthfill structure would be more economical.

Answer No. 13.—The cost of constructing a 98,000-acre-foot reservoir with a concrete Hooker Dam is estimated at $28,797,000.

Answer No. 14.—If stage construction should be adopted, an earthfill design would probably be adopted. Costs for the first stage would be increased somewhat by the inclusion of structural features required for enlargement. Such costs might or might not be offset by savings in deferment of a portion of the total cost for a number of years.

Answer No. 15.—Benefits were claimed for flood control, outdoor recreation, and fish and wildlife. The benefits for municipal and industrial and irrigation water supply for the Central Arizona Project are associated with the quantities of water delivered by the main aqueduct (and also those developed at Buttes and Charleston Dams) without regard to the specific area of use. This amount of water, and hence these benefits, would be the same whether or not an exchange of water to New Mexico is accomplished. We do not, therefore, claim any additional irrigation or M&I water supply benefits for the Hooker Dam.

However, the benefits of the Central Arizona Project must be redistributed by means of the Hooker Unit to give New Mexico its equitable share in Lower Basin development as determined by the May 1966 agreement between the States.

Answer No. 16.—In addition to the benefits in New Mexico, there would be flood control benefits in the Duncan Valley in Arizona; and the project recreation and fish and wildlife benefits would accrue particularly to citizens of Texas, New Mexico, and Arizona, and to some extent to all of the citizens of the United States.

Answer No. 17.—As indicated above, no benefits to agriculture were claimed in terms of additional consumptive use. Flood control benefits of $70,000 annually were evaluated by the Corps of Engineers on a reconnaissance basis using average future conditions and 1961 price levels. This reflects the value of damage prevented as is usual in Federal water resource projects, and is predicated upon the operation of the reservoir basically for flood control and would be reduced if the operation were varied to meet other considerations.

Answer No. 18.—Section 2(c) of S. 1004 as passed by the Senate provides: "Unless and until otherwise provided by Congress, water from the Central Arizona Project shall not be made available directly or indirectly for the irrigation of lands not having a recent irrigation history as determined by the Secretary, except in the case of Indian lands, national wildlife refuges, and, with the approval of the Secretary, State-administered wildlife management areas."

Answer No. 19.—Our land status studies have not been recently updated, but we have been advised informally that the Pacific Western Land Company is reported to have acquired approximately 3,500 acres of land in the Gila Valley having surface and ground-water rights. We are not informed whether or not this company is affiliated with mining interests.

Answer No. 20.—If water rights appurtenant to farmlands are transferred to other uses, the lands would have to be retired from production until such time as an additional water supply is available.

Answer No. 21.—Yes. Under the Arizona-New Mexico agreement, water from Hooker Reservoir could be used to prevent the retirement of agricultural lands.

Answer No. 22.—Information on outdoor recreation is presented in summary in the report prepared by the Bureau of Outdoor Recreation, which is included in the appendix of the Secretary's report of January 1964 on the Pacific Southwest Water Plan. We are requesting the Bureau of Outdoor Recreation to reply further to you concerning Questions No. 22, 23, 24, and 35.

Answer No. 23.—See Answer No. 22.

Answer No. 24.—See Answer No. 22.

Answer No. 25.—The fish and wildlife benefits are reported in summary in the substantiating report of the Fish and Wildlife Service included in the appendix to the Secretary's January 1964 report on the Pacific Southwest Water Plan. We are requesting the Bureau of Sport Fisheries and Wildlife to reply further to you concerning Questions No. 26, 27, 28, 29, 30, 31, and 35.

Answer No. 26.—See Answer No. 25.

Answer No. 27.—See Answer No. 25.

Answer No. 28.—See Answer No. 25.

Answer No. 29.—See Answer No. 25.

Answer No. 30.—See Answer No. 25.

Answer No. 31.—See Answer No. 25.

Answer No. 32.—No provision of law would prevent such an allocation. This would be a matter for later determination in consultation with the State of New Mexico.

Answer No. 33.—We do not have available an analysis of the impact of Hooker Dam upon the native flora. We have made data available to the Forest Service for further evaluations of the impact of Hooker Dam on Forest lands, which are under way.

Answer No. 34.—No evaluation of fish and wildlife benefits has been made of the downstream sites.

Answer No. 35.—See Answers No. 22 and 25.

Answer No. 36.—Yes.

Answer No. 37.—Yes. The Department of Agriculture comments on the Pacific Southwest Water Plan are included in the Secretary's report dated January 1964. In summary, that Department recommended that close collaboration between it and the Department of the Interior be maintained to minimize any adverse impact which the developments included in the plan may have on programs associated with the National Forest System. We are providing data to the Forest Service for further impact studies.

Answer No. 38.—The areas protected would include Gila Valley lands in New Mexico below the Hooker site and Duncan Valley lands in Arizona.

Answer No. 39.—We have made no specific water allocations subsequent to the Arizona-New Mexico agreement as proposed in H.R. 3300 and S. 1004. Water could be made available at the reservoir site at the appropriate allocated cost, which has yet to be determined.

Answer No. 40.—The Arizona-New Mexico agreement provides for increased consumptive use in New Mexico in the amount of 18,000 acre-feet per year, but no specific allotments have been made. Ultimate users would be determined by the Secretary of the Interior in consultation with the State of New Mexico, and water would be marketed through contracts negotiated with the Secretary of the Interior, in accordance with the terms of the proposed authorizing legislation.

Answer No. 41.—(a and b) Our plans do not include provisions for transportation of water across the Continental Divide. We contemplate that water sales would be at the reservoir. (Water contractors would be determined by the Secretary of the Interior in consultation with the State of New Mexico.)

Answer No. 42.—The development of hydroelectric power is not contemplated at Hooker Dam. The repayment of the costs of this facility would be integrated into the overall repayment plan for the Central Arizona Project just as any other reservoir or major feature of the project plan. Under the Administration's proposal, the entire Central Arizona Project would repay its reimbursable costs without development fund assistance. The amount of assistance for the Central Arizona Project required under any other plan would be determined by the provisions of the legislation.

You also inquired concerning the prepayment power arrangements which have been recommended in the Administration's proposed plan for the Central Arizona Project.

The Administration's proposal included a main aqueduct with a capacity of 2,500 c.f.s. for the Central Arizona Project. This size aqueduct would require 400 megawatts of pumping capacity. S. 1004 as passed by the Senate includes a 3,000-c.f.s. aqueduct, which would require 470 megawatts of capacity.

In each case, the project cost would include the capital cost for prepayment for the required generation facilities and costs of prepayment for a part of the transmission facilities and of Government construction of part of the transmission facilities. These costs are as follows:

	Administration proposal	S. 1004
Prepayment for thermal electric generating capacity	$42,000,000	$49,000,000
Transmission facilities	49,950,000	54,000,000

The prepayment would be reimbursed from project revenues and is expected to provide for power from a thermal-electric powerplant which, with normal maintenance and minor replacement, would have a useful life of 35 years. The repayment analysis for the project further provides for payments into a reserve for replacement which would accumulate sufficient capital to provide for a new prepayment arrangement when major plant replacement becomes necessary.

Thus the repayment analysis provides for power throughout the life of the project.

The project would be charged 3 mills per kilowatt-hour for irrigation pumping and 5 mills per kilowatt-hour for M&I pumping. Power acquired under the prepayment plan but not needed for project pumping (because of fluctuations in water supply) would be sold commercially at 5 mills. The total of these revenues would repay the capital costs and operation and maintenance costs of the generation and transmission facilities and would provide the reserve for replacement.

Sincerely yours,

FLOYD E. DOMINY, *Commissioner.*

DEPARTMENT OF THE INTERIOR,
BUREAU OF RECLAMATION,
Washington, D.C., November 24, 1967.

HON. JOHN P. SAYLOR,
House of Representatives, Washington, D.C.

DEAR MR. SAYLOR: Please refer to our letter of October 24, 1967, in response to your inquiries concerning the proposed Hooker Dam in New Mexico.

As we explained, we requested the Bureau of Sport Fisheries and Wildlife and the Bureau of Outdoor Recreation to respond further to certain of your questions. We now have their comments. Your questions are repeated for convenient reference along with the replies of each of the agencies.

BUREAU OF SPORT FISHERIES AND WILDLIFE

25. What is the basis in detail for the benefits claimed for fish and wildlife?

Various plans for the Hooker Reservoir site have been studied intermittently since 1947, including preliminary studies conducted in 1962 for the Pacific Southwest Water Plan. The Bureau of Sport Fisheries and Wildlife participated in a reconnaissance study begun in 1963 and terminated upon completion of a report entitled, "Upper Gila River Project, Arizona and New Mexico—Bureau of Sport Fisheries and Wildlife Report," dated February 19, 1964. The Upper Gila River Project report presents a refinement of fish and wildlife data presented in the Pacific Southwest Water Plan. Enclosed is a copy of the Upper Gila River report.

Specifically, the February 1964 report provides two plans of development for Hooker Reservoir: Plan 1 with an active pool with a capacity of 150,000 acre-feet and a surface area of 1,780 acres, and Plan 2 with an active pool of 200,000 acre-feet and a surface area of 1,850 acres. In both plans, the sediment pool would be 65,000 acre-feet, with a surface area of 845 acres. Hooker Reservoir's value to fish and wildlife would be essentially the same under both plans.

The reservoir site is located in a narrow canyon in desert grassland-pinyon-juniper transition zone. About 13 miles of the Gila River would be in the Hooker Reservoir site and 13 miles below the dam would be affected. Channel catfish, smallmouth bass, and trout fishing projected over the life of the project would amount to about 9,400 man-days annually without the project. None of the sport fishes in the project area are indigenous.

With-the-project analysis is based upon the 845-acre minimum pool which would extend about 3 miles within the Gila Wilderness Area of the Gila National Forest. Preliminary studies by the New Mexico Department of Game and Fish indicate that the reservoir would be suitable for trout and would be stocked and managed as a trout fishery by the State. There would be an estimated 79,500 man-days of fishing annually distributed as follows: reservoir, 46,500 man-days; tailwater, 20,000 man-days; and the 13-mile-downstream reach, 13,000 man-days. Fishery benefits would total $222,000 annually. The above estimates are for fishing without specific facilities.

Fishing could be improved by the addition of the following specific facilities: construction of two launching ramps would increase fishing by 20,000 man-days with benefits of $60,000; access for 1,000 feet below the dam, including a berm or other platform, would provide 5,000 man-days with benefits of $15,000; and reservoir zoning would permit an additional 25,000 man-days with benefits of $75,000. The three additional measures to the project would increase fishing by 50,000 man-days with annual benefits of $150,000.

Upland-game species on the 8,000 acres of habitat under Plan I and 10,000 acres under Plan II include Gambel's quail, scaled quail, mourning dove, cottontail, and jackrabbit. A few Mearn's quail, wild turkeys, band-tailed pigeons, and chukars are on the site. The mule deer is the principal big-game animal at the

reservoir site. The rather sparse population of fur animals include raccoons, foxes, badgers, muskrats, and beavers. A few rails and waterfowl are found in the river bottoms during fall and spring migrations. Low densities of game species and lack of access limit hunting, and losses therefore would be low.

The above analysis is based upon the investigations and experience of Bureau of Sport Fisheries and Wildlife biologists who have been active in project planning for more than 20 years. It also is supported by the experience of New Mexico Department of Game and Fish biologists who are intimately familiar with the project area.

If this project enters detailed studies, the Bureau of Sport Fisheries and Wildlife, in cooperation with the New Mexico Department of Game and Fish, will intensively investigate the project and will make more detailed recommendations on means of preventing losses and enhancing benefits to fish and wildlife.

26. Have the claims for benefits to fish and wildlife been checked by a qualified ecologist?

The people who prepared the fish and wildlife analysis for Hooker Reservoir are qualified fish and wildlife biologists. One of them is a Ph. D. in wildlife management. Others who contributed to the study at both State and Federal levels have graduate training in fish and wildlife ecology.

27. As planned, the Hooker Reservoir would encroach on the Gila Wilderness and Primitive Areas, and in doing so would be destructive of habitat for the native flora and fauna, thus altering the native ecology which it is the function of these areas to preserve. Are the benefits claimed for "fish and wildlife" adequately discounted for this negative effect?

As indicated in the answer to question No. 25, there were no benefits to wildlife. Benefits to fishing were derived after consideration of losses. None of the sport fishes in the project area are native species. In addition, the aquatic habitat appears to have changed over the years as a result of changes in precipitation and the impact of past land use. There also have been changes in wildlife species and their abundance which cannot be specifically identified. It generally appears that the project site does not maintain an undisturbed native flora and fauna.

28. What is the meaning of "wildlife" as used in the claims for benefits from the Hooker project?

"Wildlife" as used in the Bureau of Sport Fisheries and Wildlife's report referred to the big game, upland game, fur animals, and wildlife referred to in question No. 25. Wildlife includes all vertebrate animal life other than fishes, but the wildlife other than those listed above usually are not susceptible to economic evaluation; however, it recognizes them and their importance in its investigations.

29. How could Hooker provide benefits for wildlife under any definition of the term?

Other than for waterfowl, Hooker Reservoir does not provide benefits to wildlife; rather there are minor losses as stated in the answer to question No. 25.

30. What is the meaning of "fish" as used in the claims for benefits from the Hooker Project?

Fish include all finned vertebrates. Although only those brought to creel are mentioned, the non-game species were considered in the analysis. There was no important loss anticipated for non-game species.

31. Is the claim for benefits to "fish" based on prospective improvement of a habitat for native water animals, or does it refer to improve facilities for stocking sport fish for "put and take" recreational fishing?

Benefits for fishing are based upon both improvement of habitat and stocking of fish. Incidentally, there have been so many introductions of fishes in this area that it would be difficult to define native water animals. There would be an initial stocking of warmwater species in the reservoir. These fishes would be expected to be self-perpetuating. The New Mexico Department of Game and Fish also has calculated annual fish requirements of 46,555 pounds of trout comprising 512,000 6-inch fish in the reservoir, stilling basin, and downstream; 900,000 3-inch fish in the reservoir and downstream; and 1,800,000 1-inch fish in the reservoir.

35. Has the prospective value of the Hooker Reservoir for conventional outdoor recreation and sport fishing been assessed by a qualified expert or experts on these subjects?

Qualified fish and wildlife biologists of the New Mexico Department of Game and Fish and the Bureau of Sport Fisheries and Wildlife participated in the field studies, and their work in turn was reviewed and found adequate by other highly trained biologists. Some of the biologists have had as much as 20 years experience in fish and wildlife management problems on water development projects.

BUREAU OF OUTDOOR RECREATION

22. What is the basis in detail for the benefits claimed for outdoor recreation?

Benefits in the February 1967 report on the Central Arizona Project for outdoor recreation at Hooker Reservoir are those reported in the Pacific Southwest Water Plan of 1964, as follows:

Activities	Visitor-days	Value (per day)	Total
General use	30,000	$0.52	$15,600
Boating and skiing	10,000	.55	5,500
Camping	15,000	.50	7,500
Total			28,600

The Bureau of Outdoor Recreation is currently making a detailed study of use, costs, and benefits for the Hooker Project. New benefit figures are being developed. Indications are that they will be higher than the above.

23. Are the benefits claimed for outdoor recreation adequately discounted for the negative effect on outdoor recreation which would be caused by the intrusion of the reservoir on the Gila Wilderness and Primitive Areas?

The outdoor recreation benefits displayed above have not been discounted for negative effect. Possible negative effects of Hooker Reservoir resulting from minor intrusion on the existing wilderness are being evaluated by the Bureau of Outdoor Recreation.

24. How would a site for the project, downstream of the Hooker site, compare with Hooker site for conventional outdoor recreation?

Storage downstream from the Hooker site has been considered by the Bureau of Reclamation to be undesirable for other purposes, and no recreation study has been made.

35. Has the prospective value of the Hooker Reservoir for conventional outdoor recreation and sport fishing been assessed by a qualified expert or experts on those subjects?

Recreation resources specialists of the Bureau of Outdoor Recreation are currently making a detailed recreation study of the Hooker Project. This study is being coordinated with the Bureau of Sport Fisheries and Wildlife.

If we can be of further service in this matter, please call on us.

Sincerely yours,

FLOYD E. DOMINY, *Commissioner.*

Mr. ASPINALL. I thank the gentleman from Arizona for yielding. He is now recognized.

Mr. SAYLOR. I ask that he yield.

Mr. UDALL. I yield for one further reasonable request.

Mr. SAYLOR. I ask unanimous consent that the Secretary of the Interior be directed to furnish to the committee a copy of a report which was made in 1967 from the chief design engineer, Ralph Charles, with regard to the Conner damsite.

[NOTE.—The Bureau of Reclamation is not aware of any such report as requested. Mr. Ralph Charles also stated that he had not prepared any such report.]

Mr. HOSMER. Reserving the right to object, is that one that——

Mr. SAYLOR. This is again the same river, has nothing to do with the Colorado. It is simply a proposed damsite in the State of New Mexico.

Mr. UDALL. It is a proposed alternate for Hooker Dam, as I understand it.

Mr. SAYLOR. That is correct.

Mr. HOSMER. I withdraw my reservation.

Mr. ASPINALL. Is there objection?

(No response.)

Mr. ASPINALL. Hearing none, it is so ordered.

The gentleman from Arizona.

Mr. UDALL. Mr. Chairman, I do not have too many questions this morning.

I want to say, after consultation with my Arizona colleagues in the House, that we generally approve what you are trying to do in connection with the Fort McDowell Indian Reservation. I hope that you can work this out and submit some language to us which will take care of the rights and needs of that Indian tribe in connection with the construction of Orme Dam. I assume since you were talking the other day in terms of taking 15,000 acres of their territory for this damsite, that the Department is presently contemplating some flood-control component in the Orme Dam which would help to protect the metropolitan area of Phoenix from the kind of disastrous floods they have had in the past.

Secretary UDALL. If we can work out the type of amendment that I am thinking about, the flood control component does not present a serious problem. If we are going to wipe out an Indian reservation without doing what this committee has done so generously with Indian tribes previously, I think you present me then with some very serious choices. We all ought to work on this.

I will be frank to say I am having some difficulty with the Forest Service. I hope that Secretary Freeman will cooperate with me, and I think he will, and that we can work something out. To me, there is a rather simple solution and we have some people spending full time on it. I hope that by the time the subcommittee gets to the conclusion of its markup, we can have an amendment and come and tell you that everyone has agreed upon it. But I may need some help from the Arizona delegation on this.

Mr. UDALL. You will get it. If we can't do it, we will enlist the aid of the gentleman from Florida.

Mr. HALEY. Will the gentleman yield at that point?

Mr. UDALL. I will yield.

Mr. HALEY. Mr. Secretary, you say that is not a wipeout of an Indian reservation in this project?

Secretary UDALL. It is not as bad as the Seneca Indian problem, where the reservation was eliminated entirely. If we use the idea of an easement taking, taking an easement rather than taking the land in fee for the flood-control aspect, and if we can give these Indians a little of the river bottom and upstream, I think we can preserve basically the integrity of the reservation and come in with a solution that would be better in a sense, Congressman, much better than we had with the Seneca Indians.

Mr. HALEY. Well, the Secretary does not propose to allow the Bureau of Reclamation to take the devious methods that were being taken by the Corps of Army Engineers in the Seneca situation, do you?

Secretary UDALL. Congressman, I do not propose that by any means. We can use a newer method and new approach.

The other thing that I propose to do, and I do not think there is any disagreement with the Arizona people on this, is to make the small but fine little reservoir we are creating here into an Indian recreational development. Let us give them the control of the development and make this a benefit to them rather than just taking it away from them, as we did in some of these other instances, by turning the recrea-

tion development over to some other agency. I think this could be of tremendous economic benefit to the Indians and I propose we do it this way.

Mr. UDALL. It would be within 30 miles of a million people where water recreation is in great demand and short supply. I think we could work out something that would really do justice to them and give them tremendous benefits.

Mr. HALEY. I just hope the Secretary will present the program to the Indian Affairs Subcommittee of the House and not let the Bureau go over to this fine hall of justice we have, who, knowing they can't take Indian land, will let them take a flowage easement over the Indian land. Of course, they said that was not taking land, but of course, the land is under 100 feet of water and I do not know how you are going to do much farming and that sort of thing. I hope the Secretary will come to the Indian Affairs Subcommittee and let us take a look at the project before it is started.

Secretary UDALL. It is because the chairman of the Indian Affairs Subcommittee has been such a stanch champion of Indian rights and of justice for them that I want him to be particularly satisfied. I have had him in mind in working out this amendment. I want him to know that.

Mr. UDALL. He comes out like a mother bear when one of her cubs is threatened and we can count on him for that.

Mr. HALEY. I thank the apostle from Arizona.

Mr. UDALL. Mr. Dominy, I know you and the Secretary had considered various alternatives suggested for the Page plant, including buying the power commercially from public or private utilities. The Secretary said the costs would be 30 percent higher if purchased from a public utility and about 60 percent higher if purchased from a private utility. I think you contemplated getting power from the Page plant at about 3.5 mills?

Mr. DOMINY. That is about right on the average. It would be about 3 mills for irrigation and 5 mills for municipal and industrial water. It would average out to about 3.5 mills per kilowatt-hour.

Mr. UDALL. For the record, I would like to have you translate this into dollars if you have a figure. I was given a rule-of-thumb figure that, for every increase of one mill you had to pay for that power, you would deprive the development fund or the repayment revenues of about $2.5 million a year.

Mr. DOMINY. We can do that for the record, Congressman. I don't have it in mind.

Mr. UDALL. I ask unanimous consent that that figure be placed in the record at this point.

Mr. JOHNSON (presiding). You have heard the request of the gentleman from Arizona.

Are there objections?

(No response.)

Mr. JOHNSON. If not, it is so ordered.

(The material referred to is as follows:)

With the average cost of energy of 3.5 mills per kwhr, as now contemplated for the Federal share of Page powerplant under the prepayment scheme, an added cost of 1 mill per kwhr. would increase the cost of project power by $2.6 million per year. Over a 50-year period this amounts to $130 million.

Mr. UDALL. On the hydrology question, both you, Mr. Secretary, and Mr. Dominy indicated that the hydrology figures you are using in planning and evaluating the central Arizona project see reasonably accurate and highly reliable even back to 1906.

Is this correct, Mr. Dominy?

Mr. DOMINY. Yes.

Mr. UDALL. To put it in focus, I should say that we are really talking in terms of degrees of reliability here in considering these different periods and the different factors that we have to estimate the water supply. I suppose there has been some refinement in hydrology techniques in the last 50 years; but, has there been any basic change in the method of determining the flow of the river?

Mr. DOMINY. No, sir; the refinement basically is just more years of record and more gaging stations at more different places on the system.

Mr. UDALL. To use a homely analogy: if I wanted to measure speed, I could, (*a*) use my old Ford speedometer, which is accurate to within 5 or 6 percent, I suppose, or, (*b*) get a brand new speedometer carefully calibrated, or, (*c*) get Massachusetts Institute of Technology, with laser beams and what not within a thousandth of 1 percent, perhaps. But, as I understand it, you are saying that, while the 1906–1922 figures are less reliable, perhaps, than the very latest ones because of these factors you mentioned, they are nevertheless as reliable as my old speedometer.

Mr. DOMINY. I think you have a very good analogy. I think this is right.

Mr. UDALL. If those 1906 to 1922 figures are off, isn't it just as likely that they are off on the low side as the high side?

Mr. DOMINY. This is correct.

Mr. UDALL. There may have been even more water during those years?

Mr. DOMINY. A marginal error, plus or minus.

Mr. UDALL. Once in a while, I see the implication that you are somehow using a brandnew kind of hydrology to justify the central Arizona project. I want to ask you this question: Have you used the same technique and the same figures, as they were available for the central Arizona project, as you used for the Colorado River storage project for San Juan-Chama, for all of the Upper Basin projects, all of the Utah projects, Dixie and the other reclamation projects in the Colorado River Basin?

Mr. DOMINY. That is absolutely correct, and we are plowing in the longest period of record, which includes a long period of dry years.

Mr. UDALL. Is it not true that any engineer in a water project does exactly what you did, that is, use the longest period formula?

Mr. ASPINALL. I think, if my colleague will yield, that is a misleading question, because two or perhaps three other prominent engineering firms have used some other formula. I think you should confine that question to the Bureau of Reclamation.

Mr. UDALL. I am trying to get, Mr. Chairman, at a very narrow point. I remember a rainfall in my area of 5 inches in 24 hours. This was 30 or 40 years ago. It has never happened since.

But would not any engineer, if he had an accurate record of such an event that took place, assume that it is going to happen again sometime?

Mr. DOMINY. He would have to plow it into his projections for future protection against floods.

Mr. UDALL. This is why we use flood flow frequency analyses whereby we extend the records to encompass the 50-year flood, the 100-year flood, and so forth, in all standard enginering projections?

Mr. DOMINY. This is right.

Mr. UDALL. Now, we have had a lot of talk here in these hearings about spills from Lake Mead and spills from Lake Powell. There is no suggestion that all of the Arizona water is going to come from spills, is there?

Mr. DOMINY. No; indeed not.

Mr. UDALL. The primary factor in regulating Mead is to meet your contract commitments for irrigation down below?

For example, am I correct in assuming that you do not hold water back to provide power needs?

Mr. DOMINY. No, sir. Since Glen Canyon has been completed we have adequate storage capacity to control the river. We release no water at either Glen Canyon or Hoover Dams strictly for power purposes. It is all released on the basis of requirements for diversion.

Mr. UDALL. We will just talk about spill.

I think I made the point when you testified previously on this legislation that the talk about spills emphasizes the importance of adequate sizing of the Arizona aqueduct. The bigger aqueduct Arizona has, within reasonable limits, the better able we would be to take more water and to utilize these spills and to prevent waste?

Mr. DOMINY. That is correct.

Mr. UDALL. And the bigger aqueduct we get, within reasonable limits, the more feasible and more beneficial the project is?

Mr. DOMINY. Yes. The big advantage of the central Arizona project over the average project is that it has a ground water reservoir which will continue in use. You can take water whenever it is available and put it on the surface and thus preserve the underground water for use in the years when there is not much surface water available.

Mr. UDALL. Has it ever been contemplated, in your planning, that the central Arizona aqueduct would have a full supply at all times and that it would always be running full?

Mr. DOMINY. No, sir. All of our projections have indicated that there would be an overall diminution of water supply with time. However, there would be years when water is adequate and there would be years when water is scarce.

Mr. UDALL. Taking all this into account, is it your professional judgment and the judgment of the Bureau that the central Arizona project is an engineeringly feasible project, a financially feasible project and a project that has a very favorable cost-benefit ratio?

Mr. DOMINY. Yes, sir; without qualification.

Mr. UDALL. None of the things that have been brought up in these hearings have shaken your faith in these conclusions?

Mr. DOMINY. No, sir.

Mr. UDALL. I will leave this water supply issue if I may cover one more point.

A person can actually make somewhat less favorable water supply assumptions than you have made and still come out with a feasible central Arizona project, can he not?

Mr. DOMINY. That is correct. We would still have a favorable benefit-cost ratio and a project that would pay out if we took more adverse conditions that have been mentioned.

We might have to make the municipal and industrial water rate somewhat higher under more unfavorable circumstances.

Mr. UDALL. Just to clarify this, let us assume, for a moment, a 4.4 guarantee—and it pains my soul to even assume this for purposes of arguments—but let's assume that California gets this pristine pure, total perpetuity guarantee that has been talked about.

Let's assume that we fully respect the Upper Basin's compact rights as the Upper Basin States develop and agree to give back whatever water we, in the Lower Basin, have been temporarily using. Let's assume there is no augmentation in the river—not a drop. I think this is a very violent assumption, because I am as sure as anything in this life that there will be augmentation.

Let's assume the Upper Basin depletion figures that you have used in your calculations are correct and assume a repetition of the 1922–1967 water cycle. Surely, we would have something less than a full aqueduct in those circumstances. We would have a lot less water than we would like to have in those circumstances. But let me ask whether that project would be financially feasible and have favorable benefit-cost ratio in those circumstances?

Mr. DOMINY. With one other assumption, assuming that the Upper Basin met half of the Mexican obligation, yes. This would be a key. Under those adverse assumptions, if they didn't deliver half of the Mexican Treaty, then you would be in trouble. Otherwise, you could have a viable project.

Mr. ASPINALL. Will my colleague yield?

Mr. UDALL. Yes.

Mr. ASPINALL. Will my colleague put into the record at this time the other assumption—the assumption that the Upper Basin will use its water in accordance with its understanding of what its availabilities may be?

Then what would you say, Mr. Dominy?

Mr. DOMINY. I would say you would still have a viable project providing the Upper Basin delivers one-half of the Mexican Treaty obligations.

Mr. ASPINALL. This, I think, is most important because this is the only way, as I see it, that the Upper Basin can support this project. Because the Upper Basin takes umbrage, as I suggested the other day, to the difference between its understanding of its water availability and the Bureau's understanding this last assumption is very important. With this last assumption, I think that we have the complete picture. Unless the Upper Basin has water, we just do not have the whole picture.

I yield back.

Mr. UDALL. I yield to Mr. Saylor.

Mr. SAYLOR. Will you ask the Commissioner whether or not he will also include what the President said in his budget message, that hereafter, all agencies of Government will be required to figure the interest rate not on the 15-year average, but on the interest rate which the Government is required to pay for money at the time of authorization?

Mr. DOMINY. That, Mr. Saylor, is directed not toward the repayment provisions of reclamation law, but to benefit-cost ratio calculations. I am sure that it would reduce the project benefit-cost ratio significantly, but I am confident it would still remain better than 1 to 1, because this project has a high benefit-cost ratio now.

Mr. UDALL. It is 2.6, now, isn't it?

Mr. DOMINY. 2.5 to 1 and I am certain it would still remain well above unity, but it would decrease substantially.

Mr. SAYLOR. The reason I ask that, it will work in this project, but there are many that you have down there that it is going to put at less than 1 to 1.

Mr. DOMINY. I agree with you.

Mr. HOSMER. Will the gentleman yield?

Mr. UDALL. Mr. Tunney had asked me to yield previously.

Mr. TUNNEY. Thank you, Mr. Udall.

I would like also to ask you how much more would California be getting, assuming that the central Arizona project goes through?

Mr. DOMINY. He assumed a 4.4 million acre-feet priority for California.

Mr. TUNNEY. And you assumed that California would get——

Mr. DOMINY. Yes; in my answer I was assuming 4.4.

Mr. HOSMER. Will the gentleman yield?

Mr. UDALL. I yield to the gentleman from California.

Mr. HOSMER. I was assuming that in the 4.4 there would be certain Lower Basin projects that would have inadequate water to supply their capacity in later years.

Mr. DOMINY. In the low water years, certainly. In high water years, California has been using more than 4.4.

Mr. HOSMER. I understand that. But what I am trying to get at is it seems to me there is a cost detriment back there when you consider forgoing use of existing installations that cost many millions of dollars. I wonder if this cost detriment factor has been put into your answer that the cost-benefit ratio would be still above unity?

Mr. DOMINY. Well, no, because under the Supreme Court decision, there are certain entitlements to the water on the river.

Mr. HOSMER. But this is in fact a loss, but it is a loss that is not factored into the answer that you have given relative to the cost-benefit ratio?

Mr. DOMINY. It has not been considered, that is right, sir.

Mr. HOSMER. The point, Mr. Dominy, that I am making is you can make any assumptions you want to, but you do not have to take the best assumptions of all to make the CAP feasible? You can take some assumptions that are less favorable and still have a highly feasible project?

Mr. DOMINY. That is right.

Mr. HOSMER. If you do not assume a 4.4 formula or something less than the actual pristine perpetuity guarantee, CAP is even more favorable.

Mr. DOMINY. That is correct, you would have a considerably better water supply over the life of the project if there were a sharing of shortages, for example, under the Rifkind formula or some such pattern.

Mr. HOSMER. I yield back to the gentleman.

Mr. UDALL. Let me ask the Secretary, the Department's testimony and Department's calculations have all been made on the assumption that California will have a 4.4 guarantee. I assume that this does not mean to imply that the Department advocates that or takes the position that California is entitled to it or anything like it?

Secreary UDALL. Our position on that is the same as it was a year ago when we presented our testimony. We assumed this because at one point, at least, there was the appearance that Arizona and California, or at least some of the States, were operating on this as an assumption. We regarded this as something that was primarily a matter, an argument between the two States, to be adjusted and determined by the committee. If it is the view of the Congress that the 4.4 is the right thing to do, we have no objection. If there is some modified position determined upon, we have no objection to that.

Mr. UDALL. Obviously, if the river is augmented, all this argument about the guarantee or about the water supply for the central Arizona project goes out the window; these things become academic, as you say in your statement.

Secretary UDALL. It disappears; that is right.

Mr. UDALL. Mr. Chairman, I have a unanimous consent request.

I have finished with my questions, except to yield to Mr. Haley.

Let me make my request, first.

We are making a record here for the future and some of my Arizona hydrologists and experts are concerned about the modest differences we have in hydrology or in conclusions from hydrology with the Department, or with statements of members here. They fear that my silence here might be mistaken by historians as acquiescence. I would like to ask unanimous consent to file a brief memorandum setting forth some further comments on hydrology and other matters concerning water supply and related matters, particularly dealing with Indian water rights on their lands.

Mr. HOSMER. Reserving my right to object.

Mr. JOHNSON. The gentleman from California.

Mr. HOSMER. Would the gentleman include permission for me to do the same?

Mr. UDALL. Of course, and Mr. Hosmer should have the same right.

Mr. SAYLOR. Reserving the right to object, I oppose the request.

Are these to be statements by the respective members or are these to be statements from other hydrologists and engineers?

Mr. UDALL. I had not reached that point. I was assuming that I would file a memorandum on behalf of Arizona setting forth any modest differences we have in conclusions to be drawn from various water studies, and the figures which our experts tell us are slightly different from those of the Department and those submitted by other members of the committee.

Mr. SAYLOR. Does the gentleman from California have the same thought in mind?

Mr. HOSMER. My thought in mind would be to produce such a statement with or without accompanying authoritative materials as the situation demanded.

Mr. SAYLOR. I withdraw my reservation. I just wanted to know the ground rules on which we might expect these two statements.

Mr. ASPINALL. Mr. Chairman.

Mr. JOHNSON. The gentleman from Colorado.

Mr. ASPINALL. As I understand it, all the gentlemen are asking for is that these be made a part of their own statements.

Mr. UDALL. That is right.

Mr. ASPINALL. I withdraw my reservation.

Mr. JOHNSON. Any further objection?

(No response.)

Mr. JOHNSON. Hearing none, the statements will be allowed to be placed in the record.

(The letter containing the information from Mr. Udall and dated February 7, 1968, follows:)

CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
Washington, D.C., February 7, 1968.

Hon. WAYNE N. ASPINALL,
Chairman, Committee on Interior and Insular Affairs, House of Representatives, Washington, D.C.

MY DEAR MR. CHAIRMAN: On Thursday, February 1, 1968, I requested and received permission to submit for the record comments as to certain matters which I felt were not fully explained in the record. The following comments deal primarily with the suggestion of hydrology and the availability of water for a Central Arizona Project.

Arizona does not subscribe to California's claims of highly efficient utilization of Colorado River Water in the area tributary to the Salton Sea.

In general, Arizona subscribes to the hydrologic analysis presented by the Bureau of Reclamation. However, we believe they tend to be conservative in that the amounts of water hereafter available for use by the Central Arizona Project will be more rather than less than that forecasted by the Bureau of Reclamation.

My only additional comment is to present the latest position of the American Public Power Association with respect to the thermal plant. The following resolution was adopted by the "Legislative and Resolutions Committee" of the APPA at its meeting on January 30, 1968:

"Whereas this Association, at its 24th Annual Conference in Denver, Colorado, adopted Resolution No. 21 endorsing, among other things, the maximum development of hydroelectric facilities at Hualapai damsite on the Colorado River and opposing the substitution of steam generating stations for such hydroelectric generating facilities; and,

"Whereas on August 7, 1967, the Senate of the United States passed and sent to the House of Representatives for its consideration S. 1004, (1) reserving Hualapai damsite for further and future consideration by the Congress; (2) authorizing construction of the Central Arizona Project and various other reclamation projects in Colorado, Utah and New Mexico; and (3) authorizing the Secretary of the Interior to participate in a larger thermal generating unit to provide electric power for pumping water for the Central Arizona Project; and

"Whereas the Committee on Interior and Insular Affairs currently has under consideration various proposals, including S. 1004, H.R. 14834, introduced January 25, 1968, by Congressman Johnson of California for himself and a majority of the California delegation, and various amendments to H.R. 3300, introduced by Chairman Aspinall in the 1st session of the 90th Congress, all of which legislation would defer authorization and construction of Hualapai Dam and would further authorize the Secretary of the Interior to participate in a large thermal generating plant in order to acquire electric power and energy to pump water in connection with the Central Arizona Project; and

"Whereas such legislation, in all probability, will be promptly considered by the House Committee on Interior and Insular Affairs and acted on by the Congress prior to the next annual conference of this Association—necessitating current advice and instruction to the staff and management of this Association as to the Association's present policy in connection with S. 1004, H.R. 14834, other similar legislation and amendments to H.R. 3300 now being considered by the Committee and the Congress: Now, therefore, be it

"*Resolved*, That the present policy of the Association be and is as follows:

"1. The Association continues to approve and endorse the maximum development of the nation's hydroelectric sites as sources for electric power—including sites on the Colorado River—to satisfy the needs of public agencies.

"2. Recognizing that under existing circumstances the authorization and construction of Hualapai Dam as a part of the pending Colorado River legislation is improbable and unlikely in this 2nd session of the 90th Congress, this Association endorses and approves the removal of Hualapai damsite from the jurisdiction of the Federal Power Commission as provided in S. 1004 and other similar current proposed legislation, and approves deferral of authorization of Hualapai Dam and related hydroelectric generating facilities for future consideration by the Congress.

"3. Recognizing the need for large amounts of electric power for pumping in connection with the Central Arizona Project, this Association endorses and approves the participation of the United States in a large thermal generating station pursuant to the general concept and plan provided in S. 1004, H.R. 14834 and other similar proposals now under consideration by the Congress.

Sincerely,

MORRIS K. UDALL.

Mr. UDALL. I yield to the Great White Father of all the Indians, the gentleman from Florida.

Mr. HALEY. That is just what the Great White Father wants to do, protect the Indian people up there. You people in the upper and lower basin are well able to take care of yourselves. As long as we have the assistance of the Secretary, and as I suggest, the junior Senator from New York, I think we may get help for the Indians.

Mr. Secretary, on page 10 of your statement, something disturbs me a little bit. As I understand the history of this compact, what you propose actually in order to take care of all the entitlement of the upper and the lower basin and the Mexican treaty will require approximately 16.5 million acre-feet of water. Is that correct?

Secretary UDALL. Over the long haul, that is roughly correct.

Mr. HALEY. Mr. Secretary, none of your figures, and you go back to 1906—and frankly, I think the only reliable figures that you have here are the figures from 1931 to 1967—but in no place do you or anybody claim that there is even 15 million acre-feet in this river. Is not that what your figures say?

Mr. DOMINY. Yes; we are willing to take that as a factual situation based on the hydrology as we know the river today. We think that the reasonable assumpton is 14,960,000 acre-feet average over the next 62-year period. That is why we recognize that unless nature changes and we get better than that on an average in the future, we do need an augmentation program to keep the States that use the Colorado from losing their economic base.

Mr. UDALL. The difference, Mr. Dominy, between the 14.9, which is almost 15, and the 16.5 figure that my friend used, is almost precisely the amount of water that the 48 States gave to Mexico during World War II as part of the Mexican treaty, is it not?

Mr. DOMINY. This is correct. It actually takes about 1,890,000 acre-feet a year to supply the million and a half to Mexico, considering the losses associated with delivering it.

Mr. HALEY. I understand all of that. However, we do have a treaty with Mexico that guarantees the delivery of a certain amount of water. Isn't that the law of the river, that you have priorities in it?

Mr. DOMINY. Yes, sir; this is perfectly normal to have compacts and international agreements.

Mr. HALEY. Wouldn't the treaty between the U.S. Government and the Government of Mexico override any State laws?

Mr. DOMINY. Yes, sir; it has the first right.

Mr. HALEY. Well, that is fine. So actually, what you are going to have to do, and you might as well face up to it, you have to go somewhere else to steal enough water to meet the commitments down there. There is only one place you can get it, as I see it. And that is the Columbia River. Let's not kid ourselves that when you start this project you are going to have to eventually go over someplace and steal the water from someplace esle—maybe not at the moment.

Mr. Secretary, I just want to ask one more question, and I realize this is probably a little frivolous. But on the Indian reservations, the various Indian reservations, they have a right for diversion of 905,496 acre-feet of water. That is spread over California, Arizona, Nevada—those are the only States affected.

Mr. Secretary, do you consider these rights superior to any other rights, with the exception possibly of the rights of the Government of Mexico.

Secretary UDALL. They are superior to every right that is dated after their right. They are among the oldest, of course, on the river. I am not so sure that the Indian rights as such—that is a legal question—would not take precedence over the Mexican treaty commitment, unless the Congress itself may have directed otherwise.

Let me nail this down. I will ask Mr. Weinberg: did not the Supreme Court say, as the basis of its decision on this point, that there was a presumption when Congress created each one of these Indian reservations that the Congress then and there gave them the right to enough water as of that date, to cover every irrigable acre on the reservation?

Mr. WEINBERG. Yes; that is the basis of the right. That is why their priority dates back to the establishment of the reservation and that priority exists even though they are not using the water at the present time.

Mr. HALEY. There would be no obligation on the part of these Indian tribes entitled to these rights, there would be no obligation on their part to return anything to the river, is that right? I mean if they want to use the water. In here somewhere—I don't see it right now—it is stated that so many acre-feet presumably would be returned to the river. But they don't have to do that.

Secretary UDALL. I want to assure the Congressmen that these Indian tribes that have this water right—the Colorado River Indians near Parker are a good example—have some of the most valuable farming land in the United States. We have had a very aggressive program over the last 3 years in putting thousands and thousands of new acres into production. We are moving right ahead on this. But any wisely managed irrigation practice means that there are return flows. You have to drain water off or your land gets waterlogged. Therefore, I think that in any formal assumptions concerning agricultural operations there has to be a return flow.

Mr. HALEY. I am well aware of the fact, Mr. Secretary, that water rights in the Western States, in my knowledge of that, water rights are more valuable, sometimes, than land, because if you happened to have some land and did not have water rights, you probably could not do anything with it. So it is the view of the Department, Mr. Secretary, and if you want to have your legal counsel submit a brief or statement for the record so there will be no doubt that these rights of the Indians on that river are superior to any rights or if they are not, say who has the prior right.

Secretary UDALL. I cannot think of any parties having a prior right because most of these Indian reservations date back to the 1860's or 1870's. The earliest non-Indian irrigation, the Palo Verdo project, in my recollection was in the 1890's. There may be a few exceptions, but most of the Indian rights are prior water rights in terms of the river.

Mr. HALEY. They go back to 1856 and then move up to 1873, 1874, 1890, 1894, 1907, 1917.

Secretary UDALL. I think we ought to be precise on this. I know the Congressman wants to make a clear record. I would like to submit something on this myself so that it will be in the record at this point that would answer the question precisely.

Mr. HALEY. Mr. Chairman, I ask that that be made a part of the record at this point when received.

Mr. JOHNSON. You have heard the request of the gentleman from Florida, Mr. Haley; is there objection?

Mr. SAYLOR. Reserving the right to object, Mr. Chairman. I will not object.

Mr. Secretary, could you enlarge that information to include not just the Indian reservations in the Lower Basin, but also the Indian reservations and their rights in the Upper Basin?

Secretary UDALL. Yes.

Mr. SAYLOR. Because while they were not affected in the case between Arizona and California, I think your lawyer would tell you the same law would apply if the case got back to the Supreme Court again.

Secretary UDALL. I think that is true.

Mr. JOHNSON. Is there any other objection?

Mr. SAYLOR. I withdraw my reservation.

Mr. JOHNSON. It is so ordered.

(The material referred to follows:)

As presented in our prepared statement, in March of 1967 the Solicitor General of the United States filed the following list of claimed Indian "present perfected rights" for the Lower Basin pursuant to Article VI of the Supreme Court Decree in *Arizona* v. *California*:

PRESENT PERFECTED RIGHTS FOR INDIAN RESERVATIONS IN WATERS OF THE MAIN STREAM OF THE COLORADO RIVER[1]

Indian reservation	State	Diversion acre-feet	Net acres	Priority date
Yuma	California	51,616	7,743	Jan. 9, 1884
Fort Mojave	Arizona	27,969	4,327	Sept. 18, 1890
	do	68,447	10,589	Feb. 2, 1911
	California	13,698	2,119	Sept. 18, 1890
	Nevada	12,534	1,939	Do.
Chemehuevi	California	11,340	1,900	Feb. 2, 1907
Cocopah	Arizona	2,744	431	Sept. 27, 1917
Colorado River	do	358,400	53,768	Mar. 3, 1865
	do	252,016	37,808	Nov. 22, 1873
	do	51,986	7,799	Nov. 16, 1874
	California	10,745	1,612	Nov. 22, 1873
	do	40,241	6,037	Nov. 16, 1874
	do	3,760	564	May 15, 1876
Total		905,496	136,636	

[1] According to the terms of the decree, the quantity of water in each instance is measured by (i) diversions or (ii) consumptive use required for irrigation of the respective acreage, and for satisfaction of related uses, whichever of (i) or (ii) is less.

There are no comparable judicial determinations of quantitative water rights or irrigable lands for Indian Reservations in the Upper Basin. Article XIX of the Upper Colorado River Basin Compart of 1948 states "Nothing in this Compact shall be construed as: (a) Affecting the obligations of the United States of America to Indian tribes; * * *" The Indian Reservations in the Upper Basin are as follows:

Indian reservation:	*State*	Indian reservation:	*State*
Navajo	Arizona.	Southern Ute	Colorado.
Do	New Mexico.	Ute Mountain	Do.
Jicarilla	Do.	Uintah	Utah.
		Uncompahgre	Do.

Mr. HALEY. I yield back to my colleague.

I think if he has any further questions, he had better go ahead and take his time.

Mr. UDALL. Mr. Chairman, in the words of my great Indian colleague from Florida, I have spoken.

Mr. JOHNSON. Mr. Secretary, I want to say I did take in the Prayer Breakfast this morning. The Prayer Breakfast and all its activities were over in time, but there was a slight traffic congestion and I thought we would never get out of there once we got started. I do thank the chairman for taking over and utilizing the time of all you people here. They prayed and I prayed, too. I had in mind the meeting that was taking place in this room when I prayed.

Mr. HALEY. I hope the chairman prayed for the water users in Arizona, too.

Mr. JOHNSON. I wanted to hear what the gentleman from Arizona would say. I did get here in time to hear him say that even with California getting their 4.4, he thought there was only one thing standing in the way of that and that was augmentation. I think we might put this in the bill that while we are waiting for augmentation in California, we will be taken care of.

Mr. UDALL. My silence should not be deemed as acquiescence.

Mr. JOHNSON. The gentleman from California, Mr. Hosmer.

Mr. HOSMER. Mr. Secretary, the State of Arizona went out and got itself a study on the feasibility of going it alone, a do-it-yourself State project for the central Arizona project. That report indicated that such a project was financially feasible. The State as a matter of fact, proceeding upon it, has made application for certain power dam sites along some of the rivers, has held discussions with financial people in Wall Street relative to getting the money; the State legislature has in fact acted, authorized certain of the agencies within the State to go ahead with the project.

Do you have any objection to Arizona going ahead with a do-it-yourself project on a State basis?

Secretary UDALL. There has been a lot of discussion in the State in the last 2 years on this. The legislature has taken action. It is very obvious to me, as I said yesterday, that there is a determination, a rather fierce determination in Arizona, that one way or the other, they are going to have a water project. I am convinced if the State is willing to pay the price, that it could achieve that if the Congress finally and conclusively indicated that there was no possibility of Arizona having what all the other States on the river have, a Federal project to put its water to use.

I would quickly add there are many obstacles. Some of them that they have to jump over are higher than I think the Arizona people realize.

I think their assumption, for instance, that they could key such a project to Marble Canyon Dam or Hualapai Dam has some quicksand in it. And I think because of the added costs——

Mr. HOSMER. They are going to find out if, under the circumstances you have mentioned, whether or not you would be one of those roadblocks to such a project.

Secretary UDALL. I would think, Congressman, we are getting into a very "iffy" situation. I think this Congress is going to act.

Mr. HOSMER. I think so, too, but I am trying to get an evaluation of the proposal from your standpoint whether you would stand in its way or not.

Secretary UDALL. For me to say what I would do or for me to even assume that I would be Secretary at that time that came up gets into an "iffy" situation. Generally speaking, I think if the Congress in its wisdom said no project and Arizona was determined to go, in order for the Federal Government to be fair and to do justice, it ought not to unnecessarily obstruct such a project if the State were willing to pay the price and do the things that were necessary.

Mr. SAYLOR. Mr. Chairman, point of order.

Mr. JOHNSON. The gentleman from Pennsylvania.

Mr. SAYLOR. Mr. Chairman, on behalf of the committee, I would hope my colleague from California would remove from the record the implication that the present Secretary of the Interior is a roadblock. He and I have had our differences, violent differences. But I have never considered him a roadblock.

Mr. HOSMER. Well, I have not considered him a roadblock in all senses myself. I was asking him specifically about a hypothetical situation, as to whether he would under those certain assumptions constitute himself a roadblock to what appears to be somewhat of a fervent desire in Arizona for a do-it-yourself project.

Mr. SAYLOR. I would hope, Mr. Chairman, that the gentleman from California would use a more descriptive adjective for the Secretary than a roadblock.

Mr. HOSMER. I think I also used the term "barrier."

Mr. BURTON of Utah. Would the gentleman yield?

Mr. HOSMER. I yield.

Mr. BURTON of Utah. Wouldn't you think a more appropriate term would be "detour?" After having gone through Marble Canyon and Hualapai and now to steam generators.

Mr. HOSMER. After the rough going of the past 2 days, I don't know whether "detour" would be better than "barrier" or not.

Mr. JOHNSON. I am wondering if the gentleman from California would use the wording there, would you be in opposition to Arizona?

Mr. HOSMER. Cumulatively, I would be delighted to.

Mr. JOHNSON. Would you have any objection, Mr. Secretary, to that?

I do think you are on record as opposed to the dams in the river.

Secretary UDALL. I would think, myself, if Arizona were forced to another alternative, it would have to key to a steamplant solution something like the Page plant. This is very clear to me as a practical matter if it wants action, rather than have a 10-year argument before the Federal Power Commission, for example, and lose it.

But on the other hand, I think that there are ways that this could be accomplished. I think the State would probably have to have, realizing that the whole State and its economic system would benefit from water, a statewide ad valorem tax or a tax of some kind imposed on at least the counties that would benefit from a water district. They could accomplish this and they could have a project. The water would be much more costly. It would put Arizona in the position of having to go to a much more costly solution than any other State on the river. I don't think that is right, I don't think it is fair.

But if they were put to it, I think Arizona would do this. That is what I would advocate if I were an Arizonan that had a vote on it.

Mr. HOSMER. As long as we are quibbling about semantics, I would like to direct your attention to page 10 of your statement in connection with the 4.4. You use the term "California priority." The gentleman from Arizona, Mr. Udall, has spoken in terms of a guarantee.

Isn't this rather a shortage formula? Does it not put the burden first of any shortages because of CAP diversions on California and then at a point shift a share of the shortages to Arizona?

Secretary UDALL. Well, Congressman, there are two strong arguments. California has one, Arizona has the other. The committee is simply going to have to evaluate them. I am glad we can sort of toss it back to you and step aside on this one, because California on the one hand can say that it has put works in place and that it is entitled to have its uses that are keyed to these works protected.

On the other hand, Arizona very strongly feels in terms of equity and justice that for the Congress at California's behest to take away water that was given to Arizona by the U.S. Supreme Court is not right and fair. There you have the argument and I do not propose to get in the middle of it.

Mr. HOSMER. Could it not be, and is it not truly, a shortage formula?

Mr. UDALL. Would the gentleman yield?

Mr. HOSMER. I ask Mr. Dominy.

Secretary UDALL. My people say yes. I suppose it is in a sense a way of dealing with a shortage.

Mr. DOMINY. Certainly, if there is enough water for everybody, there is no objection to their taking it.

Mr. UDALL. Will the gentleman yield?

Mr. HOSMER. Yes.

Mr. UDALL. I also believe the term "priority" is more accurate than "guarantee." We have lapsed into using that term. It is a shortage-sharing formula, if you want to call it that.

Mr. HOSMER. Carrying forward this question about the Indians and recalling that you, I think, initiated withdrawal of the Hualapai Dam, how is the morale of the Hualapai Indians these days?

Secretary UDALL. Well, quite naturally they are not happy. They would like to see their resources developed. But we just have to find some other ways of helping this tribe at the present time.

Mr. ASPINALL. Will my colleague yield?

Mr. HOSMER. Yes.

Mr. ASPINALL. My colleague is not suggesting that there is any question about Federal relations with the Indians, is that right?

Mr. HOSMER. That is the way it appeared to me. The Indians came out second.

There are certain provisions in this bill with respect to transmission lines, power. It occurred to me that almost every time we have had one of these bills, there has been some hassling about transmission line problems and I suppose in this case, the same bears true, does it not?

Secretary UDALL. I do not see any serious transmission line problems. Our only problem presented by this bill is that we are going to have to get a substantial quantity of power from the Page plant to the place where we have to use it for pumping.

Now, we already have a transmission net. It is beginning to be merged together more and more, which it should be. I think we will just let the engineers decide this. This is the way we are making the decisions on powerlines, what the best way to do this is.

Mr. HOSMER. And I suppose that the Secretary would have no objection if approximately the same principle and procedures that were included in other priority authorizations of this type with respect to transmission lines would be included——

Secretary UDALL. With regard to the Upper Colorado project as an example, I would not think so. We work so well together now that we have the WEST organization, I think I can say to you I do not see any problems. If you want to put the Upper Colorado formula in, I think that is fine.

Mr. HOSMER. Back to the Indians, you submitted a figure of 905,496 acre-feet of present perfected rights of the Indians in the lower basin. Mr. Aspinall subsequently obtained unanimous consent to put in an estimation that had it only about half as big—546,544 acre-feet.

I wonder if your figure includes the diversion——

Mr. DOMINY. I think so. The first figure is the diversion and the later is the consumptive use.

Mr. HOSMER. Thank you.

Now, those diversions were calculated in your formula using the Blaney-Criddle method of converting those, were they not?

Mr. DOMINY. That is correct.

Mr. HOSMER. I wonder if it would be possible for the Bureau to furnish their tabulations for diversion and return flow, measured and unmeasured, and consumptive use for each of the projects in the Lower Colorado River Basin for the past 10 years?

Mr. DOMINY. Yes, if the committee wishes that information, I am sure we can work it up.

Mr. HOSMER. Mr. Chairman, I ask unanimous consent that the Bureau be permitted to furnish that.

Mr. JOHNSON. You have heard the request of the gentleman from California.

Is there objection?

Hearing none, it is so ordered.

(The material referred to follows:)

The information requested is available in full only for the Colorado Indian Reservation in Arizona. Information on measured diversions only is available for the Cocopah and Yuma Indian Reservations. As no lands are irrigated on the Ft. Mohave or Chemehuevi Indian Reservation nor on the Colorado River Indian Reservation in California, the requested information is not pertinent.

For the Colorado River Indian Reservation in Arizona, the following are records of diversion, measured return flows, irrigated area, estimated consumptive use and estimated unmeasured return flows. It will be observed that in this 10 year period the average annual diversion per acre is nearly twice that granted by the Supreme Court in *Arizona* v. *California*. This over diversion of water results in a very large measured return flow.

COLORADO RIVER INDIAN RESERVATION, ARIZ.

Year	Acreage irrigated	Measured diversions	1,000 acre-feet		
			Measured return flows	Estimated consumptive use[1]	Water unaccounted for[2]
1957	31,041	320.9	159.1	124.2	37.6
1958	31,381	367.5	208.8	125.5	33.2
1959	30,471	378.0	212.5	121.9	43.6
1960	30,616	412.8	227.4	122.5	62.9
1961	30,755	438.6	267.7	123.0	47.9
1962	31,710	466.8	288.6	126.8	51.4
1963	31,008	484.5	298.5	124.0	62.0
1964	31,998	455.7	275.7	128.0	52.0
1965	31,940	414.6	253.1	127.8	33.7
966	36,919	461.7	259.8	147.7	54.2

[1] Using value of 4 acre-feet for acre irrigated.
[2] Unmeasured return flow plus phreatophyte losses.

For the Cocopah Indian Reservation in Arizona and the Yuma Indian Reservation in California the diversions and return flows are encompassed in the records for the Yuma Project which include both Indian and non-Indian lands. For the past three years the diversions by these reservations have been determined to be as follows:

[In thousands of acre-feet]

Year	Diversions	
	Cocopah, Ariz.	Yuma, Calif.
1964	2.9	43.5
1965	2.7	39.9
1966	3.7	47.3

Mr. HOSMER. Mr. Secretary, late in your statement, around page 24, you alleged that with the existing system of large storage reservoirs, there is no utilizable water from the Colorado River escaping to the sea. Early in the paper, around page 5, you said even during the earlier years, there will be dry periods when low river flow will decrease pumping requirements with the CAP.

I am wondering in the context of all the storage you have on the river, why the variation in the water supply could not be handled on the basis of storage regulations so you pump the same amount of water in CAP each year?

Mr. DOMINY. May we have that chart that shows the annual fluctuations of the Colorado River? If we could operate in terms of averages over a 62-year period of hydrology and assume we would have that average at any given time, then we could assume a constant even flow in the aqueduct. Unfortunately, you can see the wide disparity on an annual basis of the flows of this river. We talk about the droughts since the thirties on the Colorado River, but, as you can see, even there we have years that are well above the median.

The high years are not grouped in consecutive periods. That is what is needed to fill the big reservoirs to provide carryover storage.

Mr. HOSMER. In short, the annual variations may be so great as to——

Mr. DOMINY. That is right, the reservoirs have to be designed for long cyclical periods of drought.

Mr. HOSMER. I understand in connection with the sizing of the CAP at 2,500 cubic feet per second, there was a considered need in some

years to pump more water than in others to average out at 1.2 million acre-feet per year.

Mr. DOMINY. That is correct. You have a project with ground water capable of variable use. When you get good years, you would curtail pumping. In dry years, you would increase pumping.

Mr. HOSMER. If you did not have that problem, you could size it at 1,800 cubic feet per second with a steady flow every year?

Mr. DOMINY. Yes; if we had certain water assured at all times we could design a smaller canal and still get the same amount of water.

Mr. HOSMER. But you size it at 2,500 so it takes into account fully all annual variations in your chart and projections.

Mr. DOMINY. I cannot say fully, because we could even justify an aqueduct larger than 2,500 cubic feet per second under certain assumptions. But 2,500 cubic feet per second does a lot better in capturing water for the project than would an 1,800-cubic feet per second aqueduct.

Mr. HOSMER. That size is calculated to provide an average of 1.2 million acre-feet——

Mr. DOMINY. This is essentially so.

Mr. HOSMER. To the CAP project, which is the CAP's project requirement.

Mr. DOMINY. This is correct.

Mr. HOSMER. So that is a correct figure for the CAP?

Mr. DOMINY. I think it is an adequate figure; yes, sir.

Mr. HOSMER. Now, on the matter that you mentioned 2 days ago, Mr. Secretary, relative to the basin fund on page 10 again of your testimony—pages 8 and 9—there is a figure of a total of $38 million annual contribution. Would you explain just what that figure is?

Mr. DOMINY. Yes, that is the Hoover-Parker-Davis power revenues after payout, $14.5 million, and revenues from the Arizona-Nevada portion of the Pacific Northwest-Southwest intertie after payout, which would be $5,200,000. The central Arizona project revenues after payout, assuming a municipal-industrial water rate of $56 an acre-foot would put $18,300,000 into the account, for a total of $38 million.

Mr. HOSMER. That is the amount that you calculate as sufficient to insure the financial stability of the project?

Mr. DOMINY. Well, as the Secretary testified——

Mr. HOSMER. I mean—not to Arizona, the $18.3 million.

Mr. DOMINY. As the Secretary testified, the central Arizona project with a $56 municipal-industrial rate does not need assistance from the basin account in and of itself.

Mr. HOSMER. And that would leave the basin account revenues then applicable to augmentation if this or subsequent legislation so provides?

Mr. DOMINY. Yes, it could be so.

Mr. HOSMER. These revenues without these special provisions in these laws, they would just go straight to the U.S. Treasury without earmarking?

Mr. DOMINY. Except for the Hoover revenues. We would have to have legislation to handle those after payout.

Mr. HOSMER. By legislation now, where do the Hoover revenues go?

Mr. WEINBERG. They go into a special fund to be available for water development throughout the Colorado River Basin. They do not go into the general fund, though.

Mr. HOSMER. Except for the provision of law they would go into the Federal Treasury?

Mr. WEINBERG. Yes.

Mr. DOMINY. It would also be true that there could be reduced rates for the central Arizona project after project payout. If you had no provision in law for a basin account for revenue purposes for additional projects, then there would be no justification for continuing the municipal-industrial rate at $56 after payout. The users certainly would want to reduce it down to their operation and maintenance requirements.

Mr. ASPINALL. Will the gentleman yield?

Mr. HOSMER. Yes.

Mr. ASPINALL. As I understand it, this figure of $500 million came from the annual Hoover-Parker-Davis report which is based upon an increase in the cost of power from the present rate of 2.46 to approximately 4. Is that not correct?

Mr. DOMINY. This is based on raising Hoover production to a 4 mill rate and continuing Parker-Davis at the present level of about 4.7 mills.

Mr. HOSMER. Now, the pumped storage projects and the other science fiction features of your testimony, were they dangled before us as just possible things that we might look at, kind of a shopping list of cash registers for river augmentation?

Secretary UDALL. Well, I would put them in two categories, Congressman. I personally am willing to be a little bit of a prophet and predict that we might very well find that the Mexican treaty obligation ultimately will be fulfilled by a combination of weather modification and desalting. I do not think that is too much in the fictional category.

As far as pumped storage projects of the kind I am talking about, these are very vital and necessary features of highly integrated modern electric power systems. I would think they would serve two purposes: one, they would be peaking facilities for the entire electric power grid, and number two, they might very well be an attractive source of funds for an augmentation project.

Mr. HOSMER. But they are not a part of the legislation before us?

Secretary UDALL. No, sir. We simply discussed them in our testimony because the chairman in his letter, very wisely I think, asked us to. I think that the pumped storage technology is not something that engineers are dreaming about. It is in existence. It is proven.

Mr. HOSMER. But insofar as augmentation is concerned, they would be a cash register feature rather than a——

Secretary UDALL. That could be considered, yes, sir.

Mr. SAYLOR. Will the gentleman yield?

Mr. HOSMER. Yes.

Mr. SAYLOR. It seems to me when you refer to some of his science fiction features, it comes with rather poor grace from the ranking Republican member of the Joint Committee on Atomic Energy, which has developed more science fiction than any other Government agency in all history.

Mr. HOSMER. And also more science fact.

Mr. SAYLOR. That is a matter of opinion, only of the Joint Committee on Atomic Energy.

Mr. HOSMER. Let's develop this theme.

Mr. Secretary, in your statement 2 days ago, as I understand it, you stated that the desalting features that you describe were based on 1995 desalting technology and on 1995 atomic electricity technology. Would you explain what desalting technology you are contemplating in this period?

Secretary UDALL. Congressman, this does involve a great deal of guesswork. I am sure the idea was to put this in as a basis for assumption. There is much more speculation with regard to that than there is as to the feasibility of a pumped storage project of the kind we describe. I know there is some skepticism on this committee, which may be well founded—

Mr. HOSMER. I am not exactly skeptical. I am just wondering what you are doing. So far, we have been brute forcing and in order to get an additional amount of desalted water, you have to put in an additional unit. I was wondering if you had some breakthrough in mind that would overcome that?

Secretary UDALL. Quite frankly, the big breakthrough in desalting is going to be your Bolsa Island project. When we get that completed and in operation, I think we are going to be fairly well grounded in projecting whether we can then move to larger sizes of nuclear reactors in desalting and get further reductions in cost.

All the engineers think this will be the case. But let's get Bolsa Island in operation and then we will know. That is the reason I may be a little more conservative than the Bureau of Reclamation engineers who prepared this reconnaisance study, because I feel I would be a little more sure about projections, and I am sure they would, if we had a large plant in operation. There is no such plant in the world. This is going to be the first one. Let's get it in operation and then we will know.

Mr. HOSMER. Leaving the desalting technology for a moment, insofar as the nuclear technology is concerned, did you say you were assuming that it would be such in 1995 that you would be getting two mill power?

Secretary UDALL. Well, the Congressman is a member of the Joint Committee on Atomic Energy. I would really defer to your judgment on this as to what kind of reactors we are going to have in 1990 and whether the fast-breeder technology will be perfected. I do not want to pretend to be an authority on this.

Mr. HOSMER. No, but you have made this nice feasibility study or reconnaisance study based upon some assumptions and I am trying to find out if there is a two mill power assumption. I may think you can go down to a half mill, maybe.

Mr. DOMINY. This is based on the atomic energy people's assumptions that we would have fast breed nuclear reactors in the period 1990–95. It was also based on the salt water research people's judgment that we would have improved in the water plant, including the multistage flash evaporators and converters and we would have better heat transmission facilities in the next 25 years.

Mr. HOSMER. Of course, there is an alternative, as you understand. What you do is instead of desalting sea water, is to break it down into its components of hydrogen and oxygen at the sea. Then you, through a pipe, send the hydrogen to Arizona, say, and make sale of the oxygen. Then in Arizona, you burn the hydrogen and the smoke is water and use the heat for Arizona's factories and the water for its farms. Dis-

cussing that with the Atomic Energy Commission, I understand it would require about one mill power.

Secretary UDALL. Congressman, I have the feeling the oxygen might be needed for breathing in southern California.

Mr. HOSMER. I think you just got yourself a triple purpose project which also solves the smog problem.

At any rate, I understand that one mill power will do this and that the saving on pumping costs between liquid and gas over these long distances might make the idea economically feasible.

Another thing along this line, at the present time, at the University of Arizona at Tucson, Dr. Norman Hillberry and some of his associates are speaking seriously of the application of underground engineering to the Arizona water problem. By underground engineering, we mean the use of nuclear explosives beneath the ground for a number of purposes. In Arizona, the first purpose would be to create large underground catch basins, where a more efficient recovery of rainfall could be obtained. The second purpose would be for fracturing conduits so that the collected underground water could get into the aquifers. The third purpose would be, like up where you have that secret water bank in the Chino Valley or wherever it is, to fracture that underground volcano cavity so that the millions of acre-feet of water could get out into your aquifers and the underground reservoir level would be reduced at the same time and thereby provide capacity to receive fresh rain waters.

You did not discuss those in your submission, but would they be possibilities?

Secretary UDALL. Congressman, this is very advanced thinking. I have asked my scientific people, within the last 2 or 3 weeks, in relation to the water pollution control program, if it would be feasible to use the plowshare program. For example, where very saline water gets into water systems, would it be possible to force it underground or desalt it.

Well, the geologists are giving a lot of thought to what you might do with the plowshare program.

None of us really know. I have not talked to any geologists in my Department that really know. I think the most interesting thing is that with the peaceful uses of atomic energy, maybe we can come up with some solutions. We are just beginning to consider them. Project Gas Buggy is the first one.

We hope to put together an oil shale project, Project Bronco, to see what the application may be made there.

I would not venture to say where plowshare will lead us, what we will be doing 30 years from now. It may be a very exciting future. It may be that there are problems that make it not as promising. But I would not want to discuss it in any other than that context here.

Mr. HOSMER. I understand that, Mr. Secretary. But I am optimistic that these techniques will, in fact, make a substantial increase in available water supply.

Secretary UDALL. They might; I hope they do.

Mr. HOSMER. I am wondering whether or not we should anticipate it in this legislation, at least by deciding what happens.

Suppose Arizona picks up 3 to 5 million acre-feet of water in this manner. Should that be credited to all the Colorado River or shouldn't it?

Secretary UDALL. This is a broad problem. This committee may be discussing it 25 years from now. I would rather not be drawn into it at this time, because it presents policy questions that none of us has had a chance to seriously analyze. I do not think I could be helpful.

Mr. HOSMER. Well, I was thinking of the possibility that we could see Arizona with a tremendous supply of water within her boundaries, yet the possibility of her six sisters on the river still suffering from a lack of augmentation and so forth I am wondering if this should really be a basin asset.

Secretary UDALL. Congressman, it seems to me that if the plowshare program involving peaceful uses of nuclear energy proves able to augment the underground sources, improve the acquifers, this would probably be true in all States or most States. It would depend on geological conditions. Another problem in the Colorado River Basin would involve use of a development fund to support various projects Also involved would be the manner of crediting the augmented supply. This is a very broad subject and it will be discussed in the future if the system works.

Mr. HOSMER. Very well. One final question.

On this M & I water, about the biggest customer there would be is Phoenix. Is there any problem about Phoenix actually buying it?

Secretary UDALL. Phoenix and Tucson would purchase M & I water. Tucson has a far more crucial problem than Phoenix. Both, of course, are very much interested in having this augmentation supply for future growth.

Mr. HOSMER. Tucson is?

Secretary UDALL. Tucson has a much more critical problem. Phoenix is in the Salt River watershed.

Mr. HOSMER. But Phoenix uses much more water and if we are going to sell a lot of this at M & I prices, we must at least be questioning whether Phoenix is going to want to pay that.

Secretary UDALL. The Commissioner tells me we already have applications for the supplies that we will be able to provide.

Mr. HOSMER. For whom?

Mr. DOMINY. Phoenix and Tucson both have indicated firm applications for even more water than we think we will be able to supply.

Mr. HOSMER. Would these be under long-term contracts?

And what prices are we talking about?

Mr. DOMINY. We have not, of course, finalized any contractors. This depends on the kind of legislation finally enacted. We have been talking of a $50 plus per acre foot rate for M & I water.

Mr. HOSMER. I reserve the balance of my time.

Mr. JOHNSON. The gentleman from California, Mr. Tunney.

Mr. TUNNEY. Thank you, Mr. Chairman.

Mr. Secretary, assuming that there is no augmentation water on the Colorado River, and assuming also that the central Arizona project is constructed with 2,500-cubic-feet-per-second capacity, at what year would California go below the 5.2 million acre-feet she is now using?

Mr. DOMINY. We estimate, Congressman Tunney, that as soon as CAP was actually functioning, it would probably get to that point very quickly.

Mr. TUNNEY. It would go below 5 million two?

Mr. DOMINY. Yes, very quickly.

Mr. TUNNEY. I notice somewhere in the record of last year—it disappeared and I have not been able to dig it out—assuming that there is no 4.4 protection to California, when would you anticipate that California would have to share shortages in the lower basin below 4.4?

Mr. DOMINY. Below 4.4, we do not anticipate——

Mr. TUNNEY. Even if the upper basin completes its project?

Mr. DOMINY. You could run into deficiency on the 4.4 along about 1990, or possibly a little earlier.

Mr. TUNNEY. Assuming that you were going to have extensive works construction to, say, import water from some other source, or assuming that you were going to have to build a huge desalinization plant that could make up the Mexican Treaty obligation, how long a leadtime do you think would be needed to either construct the canals or build the desalinization plant?

Mr. DOMINY. From 5 to 10 years leadtime, depending on how far you went to the augmenting source.

Mr. TUNNEY. Five or 10 years?

Mr. DOMINY. Yes.

Mr. TUNNEY. So then if the Congress approved, we will say, the program by 1980, we could then have those works in operation that would supply the additional water by 1990?

Mr. DOMINY. I think this is a reasonable assumption.

Mr. TUNNEY. One of the great problems for water users in the Southwest, especially in Coachella and Imperial Valley is the fact that the salinity of the water is getting worse and worse. Has the Department gone into a study of what the salinity factor will be, assuming that you have development of the upper basin projects and runoff back into the Colorado River?

Mr. DOMINY. Yes, the Geological Survey and Bureau of Reclamation have been monitoring the Colorado River for water quality purposes for a long while. We have made periodic reports as requested by the Congress on this subject. Our judgment at the moment, collective judgment of the Geological Survey and the water pollution people and the Bureau of Reclamation in the Department, would be that with full Upper Basin development the water quality at Imperial Dam would gradually worsen to probably something like 1,400 parts per million of dissolved minerals.

Mr. TUNNEY. Has there been any discussion with the Department of Agriculture or with water users in the area to determine what effect or impact this would have upon crops?

Mr. DOMINY. Yes, indeed. We are considering this all the time and there is research underway on how to prevent adverse effects from happening, and what measures can be taken to prevent the quality from worsening. And, of course, augmentation would have tremendous influence on this, too, if that were to occur.

Secretary UDALL. Congressman, I want to add here just so the record shows this, I know your interest in your problem, because some of your people are, like the Mexicans, the last man on the ditch, so to speak. In our statement 2 days ago, we in effect officially announced that we have decided to set aside and hold in abeyance the determination under the Water Pollution Control Act of salinity standards for the river. The reason we did this is that we do not know all the an-

swers yet. The States, I think quite rightly, raised this as a basic question. I think the whole region has to be much more conscious of the needs for a regimen of water quality management from now on. We have to find ways, if we can through scientific research, of minimizing the deterioration of quality and of maintaining the river.

This is another reason why we feel strongly that ultimately, a desalination project in the estuary of the Colorado River, with the introduction of pure water for blending purposes, may very well be a must and may very well be a fine solution to the problem.

Mr. TUNNEY. Located above what point?

Secretary UDALL. Well, it would be located in Mexico. This is the one we have been studying for a year and a half with the Mexican Government.

Mr. TUNNEY. Where would the water be put into the Colorado River?

Secretary UDALL. Probably above the border with some perhaps blended in at the border.

Mr. TUNNEY. What about the people who are farming just above the border?

Secretary UDALL. Well, it might be put in at a point to benefit them. I am not prejudging that.

Mr. TUNNEY. I don't want to be excessively chauvinistic but I personally am more concerned about American farmers than I am about Mexican farmers.

Secretary UDALL. I would expect you to be.

Mr. TUNNEY. I would anticipate that if there were such a blending, it would take place at a point where it could help American farmers rather than Mexican farmers.

Secretary UDALL. It is not such a problem to begin, for example, at Imperial Valley rather than at the border. What I am saying is if the quality deteriorates to a certain point, it may very well be that the Imperial irrigation district has a problem that is just as severe as the problem that the Yuma farmers and the Mexicali Valley farmers in Mexico have, and that we have to have a solution for all of them.

Mr. DOMINY. As a matter of fact, Congressman Tunney, our reconnaissance study indicates that we probably would have to put that desalted water, whether we got in the Gulf of California or the coast of California in the United States, as far north as Mojave in order to get the kind of mixing that would prevent users from getting desalted water one day and a thousand parts per million the next. This you could not live with under any circumstances.

Mr. TUNNEY. I should ask the Secretary this question:

To your knowledge, Mr. Secretary, are there any serious negotiations, hard negotiations, going on now with the Mexican Government regarding a desalination plant in southern California?

Secretary UDALL. We actually set up the desalination conference in 1966 in Washington. We announced at that time the signing of an agreement with Mexico on that study. The study has been going on since then. We have made some headway on it. It is a big project. We will also have the international atomic energy agency in the picture. So we are working on this. This is not something that is abstract. We are trying to lay out the parameters now and we are very active in this.

Mr. JOHNSON. Would the gentleman yield to the gentleman from Pennsylvania?

Mr. TUNNEY. Yes.

Mr. SAYLOR. Thank you for yielding.

I did not want the Secretary to leave this point of water quality in the river with the implication that the Department has done nothing about it.

Mr. Secretary, you have been complying with the provisions of the Boulder Canyon Project Act all these years, requiring the Bureau of Reclamation to study constantly the water quality of the Colorado River.

Is this not true?

Secretary UDALL. This is correct. I think the water quality of this river has probably been monitored and studied more than any other river in the country. It has had to be.

Mr. SAYLOR. I did not want anybody to get the impression from questions of my colleague from California that the Secretary of Interior was not complying with the Boulder Canyon Project Act which requires him to make these studies every year, constantly.

Mr. TUNNEY. I am glad you cleared the record. It certainly was not my intention to leave that implication.

Mr. SAYLOR. Thank you.

Mr. TUNNEY. What is the target date, Mr. Secretary, for completion of that study you just referred to?

Secretary UDALL. We don't have a target date as such. I just expressed my own hope that we could have a pretty good idea of what kind of project might be possible in a first stage within the next year or so.

Mr. TUNNEY. Is the Government of Mexico cooperating?

Secretary UDALL. It has been cooperative. We have had some delays, but I would say the study has moved along about as you would expect, with a major project of this kind. We have a lot of problems—how you would finance it, how the benefits would be shared. It would be built in Mexico and so on. There will be a lot of very serious problems that have to be worked out.

Mr. TUNNEY. Mr. Secretary, from the point of view of the Department, do you think that right now you favor augmentation in the form of desalinization and weather modification or the importation of water from some other source, wherever that might be?

Secretary UDALL. My answer would be I think we have to be very open minded on this subject now. These are different methods. Two involve new scientific techniques. Another involves massive engineering works which involve not only engineering problems, but also political problems. I think people who are concerned about the long term welfare of the country ought to be open minded at this point, look at alternatives and see what the economics are, what the problems are, and then make judgments at some subsequent time.

Mr. TUNNEY. Well, what date do you think the Department would be ready to make a decision on alternatives? Because this is extremely important to those of us who realize that we are dividing up shortages. I certainly appreciate the philosophy that you have to weigh alternatives. But people have been weighing all alternatives for many years. I would like to know when you feel the Department would be willing to make a solid recommendation.

Now, last year, you had a solid recommendation, or the year before last. Now, there has been a change of philosophy for various political reasons. I am just wondering if you can make any statement today when you think the Department will be prepared to make a solid decision on alternatives?

Secretary UDALL. Congressman, I want to be as candid as I can on this. You have asked a pertinent question.

Here is the way I see it and I am just giving you the personal impression of somebody who sits where many related problems are being studied.

It is going to take us about another 8 to 10 years to perfect weather modification if Congress gives the appropriations we need. It is going to take until 1976, let's say, or 1977, if we move on target to get the Bolsa Island project built and in operation for a year or two. If we have a National Water Commission—and both Houses are committed to that if we can work out the differences—its study is going to take 5 years.

All in all, I think that within 8 to 12 years, in that range, the country and the Congress ought to be in a position where they can begin to make some judgments on these alternatives.

Mr. TUNNEY. I would like to turn to page 15 of your statement. You indicate that—

> Our proposals for the Colorado River Basin Project include works to salvage some 680,000 acre-feet of Colorado River water that have constituted river losses in the past.

Now, I know this is a question of hydrology and the studies you have done to determine what the losses are. But one of the things that I would like to ask you is has this hydrology taken into consideration that such places as Imperial Valley and the Coachella Valley, you have to have extensive leaching of the soil and in a sense, it is wasting water if you are going to talk in terms of irrigation in the Midwest, but wasting water to get the salts out of the soil to make it productive.

Now, does this figure constitute a recognition of the leaching that must go on?

Secretary UDALL. Congressman, let me say two things in regard to that:

I would say it does contemplate that. This is a sound irrigation practice. You have to leach out your soils. Hopefully, at least in some areas, as the leaching continues to take place, there will be less dissolved solids that will be picked up and the return flows will improve.

The only other thing that we have omitted here, and I have not had time to ask my people why, is that, in the long run, it may very well be that the biggest saving in water conservation might be lining of the All American Canal. Again, you would have to decide how you did it, what the economics of it were. I think I can say very straightforwardly that the normal leaching associated with sound agricultural practices will have to continue.

Mr. TUNNEY. Does it also contemplate that the water is going to get more saline as the upper basin begins to put in more projects and return flow to the river? This is one of the problems that we face down in that area. As the water gets more saline, you have to use more water to leach the soil.

Secretary UDALL. This is the problem the Commissioner has already mentioned, that the likelihood is that we will have more of a salinity problem. We will have to decide how serious a problem this will be, and that is the reason I deliberately set aside the question of the establishment of water standards. I don't think we know enough in the Department yet so we can sit down and lay this thing out cold, say here is what we face now, here is what we are going to have to face, here is what we are going to have to do, so that everybody understands the consequences of water salinity standards.

Mr. TUNNEY. Can I go to my area, to my district, and say this 680,000 figure was arrived at considering that water was going to get more saline in the river and that there is probably going to have to be an additional use of water for leaching purposes as a result of the increased salinity and that the 685,000 feet contemplated all these factors I have just mentioned?

Can I go down to my area and tell them this is a possible fact, that you said that today?

Mr. DOMINY. The salvage that we are referring to in that figure is actually comprised of phreatophyte control, ground water recovery, channelization, and includes the 170,000 acre-feet that we are saving at Senator Wash which is already being accomplished. None of those actually affect the quality of water for use in your district, Congressman Tunney.

Mr. TUNNEY. Does it assume a reduction in the use of water by irrigators?

Mr. DOMINY. No; as a matter of fact, there have been some rather emotional statements made about the wasting of water. I think the Imperial Irrigation District, for example, has a very commendable record, because all of the research work at Riverside and other irrigation and agricultural experimental stations indicate that on soils of the type that you have in Imperial Valley and the ground water conditions that prevail there, you need an override in your irrigation delivery to the farm of something in the order of 23 to 25 percent in order to take care of the leaching requirements and keep the land in cultivation. And this is about what you are doing.

This last year, the Imperial Irrigation District figures it used about 48,000 acre-feet in total above the 23-percent factor. Our measurements would put it at about 100,000, but that is within the plus or minus margin of error of calculations.

So I think they are doing a very commendable job, actually, in irrigating soils of the character involved.

Mr. TUNNEY. Mr. Dominy, then I can assume that even if we have this saving of 680,000 acre-feet, we would not see Salton Sea dry up.

Mr. DOMINY. No, sir; I think you are going to be putting return flows, from the Coachella and Imperial Valley, into the Salton Sea because of the nature and character of the soils you are irrigating.

Mr. HOSMER. Will the gentleman yield?

Mr. TUNNEY. Yes.

Mr. HOSMER. I understand the Imperial Valley Irrigation District has gone into the Salton Sea problem in considerable detail. We do have a paper before the members of the committee.

Mr. TUNNEY. They have a statement which I am going to have introduced; yes, when I have completed my questioning.

Secretary UDALL. Congressman, let's make the other side of that clear, though, because now having the water pollution control responsibility in my Department, I am much more aware of water quality problems. I would think that your people ought to anticipate that the amount of water that will be going into the Salton Sea from the irrigation district is that amount of water that sound agricultural husbandry in that region requires in terms of leaching and return flows, and that there will not be water that is not needed for agriculture put into the Salton Sea.

Now, I mean we ought to be honest with each other because we are entering into a water shortage era. We are entering into an era where we have to watch water quality and I think everybody ought to know we have these problems.

Mr. TUNNEY. But as I understand the statement of the Commissioner that there is also going to be a flow of water from the farm to the Salton Sea, even if you have a reduction of 680,000 acre-feet in the use of water——

Mr. DOMINY. This is true.

In the last year, for example, 881,000 acre-feet entered Salton Sea from the Imperial Irrigation District. Even if you took the minimum standard of leaching requirements, you would have an excess of 544,000 acre-feet.

Now, we are also getting water from Mexico that flows into the Salton Sea that comes out of the New and Alamo Rivers. There are about 104,000 acre-feet, a little better than that, on an average that comes out of Mexico and drains down across the Imperial Valley and into the Salton Sea.

So what I said a moment ago is that there is only about 100,000 acre-feet more that went into the Salton Sea than would have been under a perfect job of irrigation in the Imperial Valley.

Mr. TUNNEY. Who is going to make the final decisions as to whether or not the irrigation districts in southern California are making proper use of their water or whether they are wasting their water? Is that going to be the Secretary?

Secretary UDALL. Congressman, we have had one experience in 1964 when we had a low water year. This will have to be a joint decision that will be made by the irrigation districts and the Department. What we did that year when we were so short and we had to put overselves on a very strict regimen was to tighten down as much as we could. The Imperial District took what reduction?

Mr. DOMINY. 10 percent.

Secretary UDALL. They took a 10-percent reduction and they felt that by better management of the water they could get by with that. So we are going to have to be working together closely on what the requirements are. I say it will be a joint decision.

Mr. TUNNEY. I have a few more questions, but Mr. Reinecke, of California, has asked me to yield to him.

Mr. JOHNSON. You are yielding to Mr. Reinecke?

Mr. TUNNEY. Yes.

Mr. JOHNSON. I was going to recognize Mr. Burton before that.

Mr. BURTON of Utah. Mr. Chairman——

Mr. TUNNEY. I would like to reserve the balance of my time, then. Could I just ask a question off the record?

Mr. JOHNSON. We will accomplish the same thing, but I just want to keep this in the proper order. You have reserved the balance of your time. Now I will recognize Congressman Burton, from Utah, and I am sure he will yield to Congressman Reinecke.

Mr. ASPINALL. Mr. Chairman, I want this understood by everyone. I think this is all right if it is all right with Congressman Tunney. Congressman Tunney will be recognized first in the morning.

Mr. TUNNEY. Yes. I yield my time back to the chairman.

Mr. BURTON of Utah. Thank you, Mr. Chairman. I will be able to be here tomorow morning. I would like to yield to my colleague, Mr. Reinecke.

Mr. REINECKE. I thank all the gentlemen.

Mr. Secretary, three questions:

Will the Bureau of Reclamation have anything to do with management of the proposed powerplant, steamplant, as far as the management is concerned?

Secretary UDALL. The answer to that is, "No."

Mr. REINECKE. How will the customers for the surplus power be determined?

Secretary UDALL. The way we presently contemplate disposal of this very small amount of surplus that would exist is that the plant manager and operator, which would be the Salt River project, will probably have a contract whereby it would, in effect, be responsible for taking care of the surplus to the extent that we didn't use it in banking, didn't use it to help support the Colorado River storage project. It would be up to Salt River, then, to work out the arrangements for disposal.

Mr. REINECKE. I don't think the arrangement calls for Salt River, specifically, does it?

Secretary UDALL. No, but I am simply saying this could be done by contract.

Mr. REINECKE. I see.

But basically, the Bureau or the Department will not have the power to say who the power will be sold to or under what circumstances?

Secretary UDALL. We would have a very considerable say. As I indicated yesterday, we might want to use it to integrate it with the Glen Canyon. We might want to use banking arrangements on some of it. To the extent that there might be a surplus—no one knows what the extent of surplus would be under these circumstances—we would feel the most logical way to handle it would be to let the Salt River project be the purchaser.

Mr. REINECKE. Then the Department will, in one way or another, have a great deal to say about the sale and distribution of this power?

Secretary UDALL. We are purchasing it and we are going to have to, if we do our job. We are going to have to have the full say with regard to how it is used; yes.

Mr. REINECKE. In the statement regarding augmentation or other resources, was there any reason why not a word was said regarding evaporation control?

Secretary UDALL. I had better let the Commissioner answer that.

Of course, the problem on evaporation control is a very tough problem. The two areas where you have large surfaces of water, where you get the most evaporation, are Lake Mead and Lake Powell. We are dedicated to making these recreational areas.

Mr. REINECKE. I guess I could rephrase the question.

Have we given up on evaporation control?

Mr. DOMINY. We have not given up on it but the problems of finding a material that does not pollute the water and make it nonusable for all purposes, including fish and wildlife and doesn't increase temperature unduly, and which stays in place when high winds come is almost insurmountable. We are still seeking that material.

Mr. REINECKE. Weather modification, you estimated an increase of a $1 or $1.50 a foot. Where would this come from?

Secretary UDALL. This could come from a number of sources. It could be appropriated directly, or could be repaid from a basin fund.

Mr. REINECKE. That is what I want to get at.

In your opinion, is the operational aspect of the basin fund such that you as Secretary will be able to use that without prior appropriation from Congress?

Secretary UDALL. Undoubtedly, Congress would want to control the appropriation of it. But I would think this would be an ideal situation of how a basin fund could and should be used.

Mr. REINECKE. Well, yes, but when you are talking about a very scarce fund being used at $1 and $1.50 an acre-foot, we could perhaps find other sources at that same price that would hopefully yield——

Secretary UDALL. If we could get weather modification water at $1 or $1.50 an acre-foot, this could be 50 times as cheap as bringing it in from long distances, from northern California or from any other place.

Mr. REINECKE. On that subject, this report is not to be considered as part of the legislation, is that correct?

Secretary UDALL. No, sir. This is merely a report that was prepared to see what the picture might be if we projected future technology.

Mr. REINECKE. One other question regarding the cost of power.

You indicated, I believe, in the report that the steam plant as proposed would provide power at a rate something like 60 percent less costly than if a private utility did it and 30 percent than if a municipal utility did it?

You are not stating here or trying to impress upon the committee that the Federal Government has the Indian sign on power generation, that you can manufacture power cheaper than a private utility?

Secretary UDALL. No, it just happens that under these particular circumstances, this plant, if we did it the way we propose, is very economical.

Mr. REINECKE. The truth really is then that we are subsidizing Federal power. The point is what we think is the cost is not true cost. If it were all stacked up together, since one of the functionaries of WEST is going to operate this as they might operate any other plant, the power is no cheaper to produce, it is just whether we are willing to admit the full cost of Federal power. Is that right?

Secretary UDALL. One can argue it that way. For example, one of the big reductions we get is from the interest-free aspect of repayment of irrigation costs. This helps a great deal. So there are some distortions in there.

Mr. REINECKE. How will the distribution of the central Arizona project water be handled? By the Bureau?

Secretary UDALL. It will be handled by contracts with the various Arizona entities.

Mr. REINECKE. Is there any plan at the present time to use any spreading in Arizona of existing water from CAP?

Secretary UDALL. No.

Mr. REINECKE. In S. 1004, I believe, it indicates on page 26 a cost of CAP of $768 million. Is this a figure on which your cost and analysis was based to provide that the project would pay out even without a basin fund at present?

Mr. DOMINY. That is correct.

Mr. REINECKE. My recollection is that the prices we were dealing with earlier were somewhat smaller than this.

On the same page, it is indicated that the prices will be not to exceed $100 million in drainage distribution and facilities. Is this included in the payout from the basin fund?

Mr. DOMINY. That would be repaid by the water users through separate loans. They would be small project-type loans.

The costs are not part of the estimate cost of CAP. They would be additional obligations picked up on separate contract.

Mr. REINECKE. The Senate bill calls for it in the CAP legislation.

Mr. DOMINY. But it would be separate contracts.

Mr. REINECKE. It is in addition to the $786 million. I do understand that.

Mr. DOMINY. Yes.

Mr. REINECKE. But I am wondering where the revenue for that would come from?

Mr. DOMINY. It would come under separate contracts for the distribution systems.

Mr. REINECKE. Then the cost analysis which led you to think the project was feasible would be a total cost of $878 million or the $787 million figure?

Mr. DOMINY. It would wash out because it would be under separate contract with the full cost being paid by the water district.

Mr. REINECKE. Is this considered subsequent money at interest rate?

Mr. DOMINY. It would be repaid without interest.

Mr. REINECKE. You mentioned earlier something about you may have to line some canals over the California side, I believe. This was 2 days ago. I am interested in knowing what specific areas you are referring to where you feel this might be necessary.

Secretary UDALL. I was referring primarily to the All-American Canal.

Mr. REINECKE. I was under the impression that there was some substantial amount of lining done there and a lot of tests indicate that that might not be necessary.

Mr. DOMINY. There has been some substantial lining and, of course, the Coachella distribution system is a closed pipe system. The difficulty in lining the All-American Canal is the fact that you cannot take it out of use. We are still trying to find a material that can be put in the water to seal the canal.

Mr. REINECKE. Would the funding for this lining also come out of the development fund without prior appropriation?

Secretary UDALL. This is something we would have to determine. We are not proposing it and we have not analyzed it in any fashion to have the answer to that.

Mr. REINECKE. I thank you, Mr. Chairman.

Mr. JOHNSON. We want to thank you, Mr. Secretary, for being here. We understand that you will be with us tomorrow at 9:45. We will start off with Congressman Tunney, when he will be given the balance of his time. Then we will go on and hope to complete the hearings sometime around noontime.

Mr. ASPINALL. Congressman Burton has not yielded his time as the record now stands.

Mr. BURTON of Utah. I yield back the balance of my time to the Chairman, with the understanding that I will be recognized tomorrow.

Mr. JOHNSON. The committee stands adjourned until tomorrow morning.

(Whereupon, at 11:50 a.m., the subcommittee was adjourned, to reconvene tomorrow, Friday, February 2, 1968, at 9:45 a.m.)

89-657—68—pt. 2——12

COLORADO RIVER BASIN PROJECT

Part II

FRIDAY, FEBRUARY 2, 1968

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON IRRIGATION AND RECLAMATION
OF THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:50 a.m., in room 1324, Longworth House Office Building, the Honorable Harold T. Johnson (chairman of the subcommittee) presiding.

Mr. JOHNSON. The subcommittee will come to order.

We will start off this morning with further questioning by Congressman Tunney of California.

Mr. TUNNEY. Thank you very much, Mr. Chairman.

Mr. Secretary, statements have been made in the past by some of my more able colleagues, as well as certain so-called experts in the Southwest, that the Imperial Irrigation District and the Coachella Irrigation District are pouring 1,320,000 acre-feet of usable water into the Salton Sea. Now, if this is true, and inasmuch as there is only a pump lift of about 240 feet from the Salton Sea to the Colorado River, why is it that the Department of the Interior has not suggested a plan to take this water, this used irrigation water, from the New River as it flows into the Salton Sea, and put it back into the Colorado River?

Now, it is my understanding that inasmuch as we are entitled, California is entitled to 4.4 million acre-feet and we also have diversions less returns, if we could only divert 4.4 million acre-feet now, but if we returned the 1,320,000 acre-feet, we would be entitled to a total allotment of 5,720,000 acre-feet from the river. This would satisfy all water needs in southern California.

The whole thrust of the question goes to the statement that has been made that this 1,320,000 acre-feet is usable water and is just flowing into the Salton Sea. Why, if this is true, has not the Department come up with a plan to return this water to the Colorado River today?

STATEMENT OF STEWART L. UDALL, SECRETARY, DEPARTMENT OF THE INTERIOR, ACCOMPANIED BY FLOYD E. DOMINY, COMMISSIONER, BUREAU OF RECLAMATION; EDWARD WEINBERG, DEPUTY SOLICITOR; AND ARLEIGH B. WEST, DIRECTOR, REGION 3, BUREAU OF RECLAMATION

Secretary UDALL. Congressman, that is a question I never had put to me before. It is a very interesting question. Of course, some of the large California irrigation districts, such as Palo Verde, take out a large amount of water, but return a substantial portion to the river for reuse. The consumptive use is what is actually consumed. The natural drainage basin for the irrigation district is not to the river but to the Salton Sea. Those persons who have made developments and investments on the Salton Sea expect to have the drainage water go into the Salton Sea to maintain it.

On the other hand, I think this is a problem, primarily for California, rather than a problem for us, because California has a certain overall entitlement to water and it has, through the seven party agreement which was adopted by the Secretary of the Interior as a part of the Colorado River water contracts with California users, made the order of intrastate priorities.

If the State were to propose a project to accomplish what you suggest, thereby augmenting the supply, say, for the metropolitan area, I would assume that could be considered. I have never heard this proposed before, though.

Mr. TUNNEY. Well, I do not mean to be in any way tricky. But the point is that a statement was made recently by Mr. Les Alexander, who is the associate general manager of the Salt River project in Phoenix, Ariz., and I quote:

> Perhaps the outstanding example of usable water being wasted in the lower basin is the 1⅓ million acre-feet which annually flows into the Salton Sea.

The point is if this is a true statement, why has not the Department come forward with a plan to get this water from the Salton Sea, or from the New River where it flows into the Salton Sea, up the 240 feet into the Colorado River?

I think the answer is quite clearly why you have not, because it has 3,000 parts per million of salt and it is not usable. Mexico rejects water which has a content of 1,500 parts per million. What I am simply trying to say is that some of the statements that have been made regarding the way we in southern California have wasted water by pouring it into the Salton Sea have no justification in fact.

Secretary UDALL. I would like the Commissioner to comment on this. I do know that particularly with the newer lands that do have a lot of dissolved solids, the leaching process does seriously deteriorate the quality of the water. There is no question that we have a real water quality problem concerning the water that moves across the border. The Commissioner would like to comment.

Mr. DOMINY. You are quite correct, Congressman Tunney, that this drainage water from the Imperial Irrigation District is not considered usable. It has a minimum of 3,000 parts per million of dissolved solids as it flows out of these salty lands of Coachella and Imperial. Many days, it runs about 4,000 parts per million. But as I explained

the other day, I do not think anyone familiar with the type of soils to be irrigated would consider this wasted water. A great deal of research has been done on lands of this type—and incidentally, the Imperial and Coachella Valleys are laboratories for proper use of salted lands for the whole world. People are coming there in ever-increasing numbers to study the manner in which successful irrigation has developed on lands of this character.

I can understand why people from the Salt River Valley in Arizona would not recognize this, because they do not have a similar problem. They have a falling water table, their salts go down naturally, and they have not had serious problems of this nature in the Salt River Valley. But in Imperial and Coachella, you have an entirely different situation. The high water table creates difficult problems of proper irrigation and keeping the salt moving out. This does take from 23 to 25 percent more water than would otherwise be necessary. It is not wasted because of the facts of the case.

Mr. ASPINALL. Would my colleague yield?

Mr. TUNNEY. Yes.

Mr. ASPINALL. This proves that grass is always greener in the other fellow's pasture. Water is always purer in the other fellow's basin, as far as that is concerned.

What interests me is that we have before us the water desalination proposal for ocean water. Nothing has been said about desalting this brackfish water here and getting it closer to use than what has been proposed. This could undoubtedly be made part of the conduit system and would be much less expensive than what was proposed in this rather questionable report.

Is it possible, Mr. Secretary or Mr. Dominy, to use any of this water or is there something sacred about keeping the water of the Salton Sea at a certain level?

Mr. DOMINY. Certainly, you have a major problem with regard to the level of Salton Sea.

Mr. ASPINALL. Why is it important to keep a certain level of the Salton Sea? Is it to take care of the birds or the beautiful shores or what?

Mr. DOMINY. There has been extensive development on the shores of the Salton Sea. It has developed into one of the finest recreational areas in the Southwest. I assure you, before a final decision is made as to the best and most economical way of augmenting the Colorado River by desalting, the Salton Sea should be studied much more thoroughly than it ever has been.

However, it is below sea level and it is pretty far south and west. The conveyance would not be appreciably cheaper, in my judgment.

Mr. ASPINALL. After all, if this water is to be used by exchange in the Imperial Valley, you must raise it 300 or 400 feet to put it back upstream again. Certainly, that is a most expensive proposition.

I do not want to argue that. I just wanted to ask the question.

Secretary UDALL. I would like to comment on this, because I think we are really making a record for the long term here. I think the Chairman has raised a very interesting point.

We sometimes lose sight of the fact that the desalting technology is not merely to desalt sea water but also to desalt brackish water. Considering the economic consequences, I think when we start talking

about alternatives, we want to look at all of them. It may very well be that desalting this brackish water might be much more attractive than other alternatives, whether it were for reuse in Imperial or for blending or for other purposes.

An interesting comparison to me is the Great Salt Lake, which has been receding constantly, as Congressman Burton well knows, largely because of use of water for irrigation and industrial and municipal purposes that would otherwise go into the basin, plus, I suppose, the long term drought which has had an effect on it, too.

But there has been a constant shrinking. This is part of the overall process of the region.

Mr. TUNNEY. Thank you.

Speaking as a supplicant, Mr. Chairman, please do not take away our Salton Sea. That was not the point of my line of questioning.

Mr. ASPINALL. This goes to prove how important this is. All that I suggest is that you please do not take away our fresh water when there is an alternative. This is a give-and-take effort and we have to face it in that respect—and each one of us gives.

Mr. TUNNEY. I think California is probably in the process of giving right now on this central Arizona project on many points that before we thought were terribly important to our survival.

I would like to just add as a footnote that the U.S. Public Health Service has established as drinking water standards for consumptive use a 500 parts per million standard of salt and the Imperial Valley now is receiving water that has 945 parts per million. So it is almost twice the amount of salt that the Public Health Service establishes as a standard for desirability in consumptive use.

Mr. Secretary, one point that I would just like to clear up. I questioned you on it yesterday with regard to moving water from a desalting plant in the Gulf of California north to some point where it could sweeten up the water that comes down into the southwestern part of the United States.

In our dialog, we talked about putting the water in, perhaps, at Imperial Dam or putting it in at the Mexican border and then finally Mr. Dominy said that probably the most likely place would be at Mojave.

I would just like to ask Mr. Dominy, is it not true that there is no storage facility available at Ventura? The only storage facility that would be available would be either at Mojave or Lake Mead?

Mr. DOMINY. Yes, that is what we confirmed in this reconnaissance study. In order to have economy of production, the desalting plant must operate around the clock, 24 hours a day on a steady basis. During many days the desalted water would be sufficient to meet all demands and there would be no blending. Without blending, water users would have serious problems operating with desalted water for a few days and then with water of a thousand or so parts per million for the next few days.

In order to make operations feasible, the desalted water should be delivered to the river as far up as Lake Havasu.

Mr. ASPINALL. Have you gone so far on the desalting plant as to determine whether or not there would be a need for the power in the South-

west and Mexico—to determine whether this power would be purchased in the future?

Mr. DOMINY. The projections of the power needs of the Southwest indicate that if the desalting plants were phased over a period as we proposed, the first one in 1990, the second in 2000 and the third one about the year 2010, this schedule would fit in very well with the growing power needs of the Southwest. The power producers that serve the market of the Southwest could very well be interested in installing these power features of the dual purpose plant.

Mr. TUNNEY. One last point I would like to make. This is that yesterday in the discussion, there were figures given that perhaps 640,000 acre-feet of water could be salvaged in the Lower Basin. One of the items that was mentioned as a possibility for salvaging water was the lining of the All-American Canal. To make the record clear on this point, I would like to refer to page 243 of the House Interior Committee hearings of March 13 through 17, 1967, a statement by Robert Carter who is the general manager of the Imperial Irrigation District, which indicates that losses along the main branch of the All-American Canal are within allowable tolerances for a lined canal. The point simply is that if we are thinking in terms of lining a canal that does not lose sufficient water to make this desirable or make it compulsory, then we are talking about just throwing away $80 million, which is what the cost would be to line this main branch.

Would you not agree, Mr. Commissioner, that your studies indicate that along that main branch, there is not that loss of water?

Mr. DOMINY. I would like Regional Director West to comment on that.

Mr. JOHNSON. Will you come forward and identify yourself, please?

Mr. WEST. I am Arleigh B. West, Director of Region 3, Bureau of Reclamation.

As Congressman Tunney has said, there has been over the last several years a lessening in the losses from the All-American Canal. We undertook some comprehensive studies in cooperation with the district and the USGS which corroborated the figures that were introduced into the record by Mr. Carter last year. We think that perhaps the reason for this is that during the several decades that the All-American Canal has been in service, it has, of course, lost a great volume of water. This is undoubtedly now asserting itself in the form of a hydrostatic head which, in effect, makes it very difficult for water to seep out of the All-American Canal, for the reason that there is underground hydrostatic pressure preventing it.

Mr. TUNNEY. Thank you.

The CHAIRMAN. Thank you.

Mr. Chairman at this point, I would like to ask unanimous consent to introduce into the record a statement by Mr. Bob Carter, general manager of the Imperial Irrigation District, plus some attachments thereto.

Mr. JOHNSON. You have heard the request of the gentleman from California, Mr. Tunney. Is there objection?

(No response.)

Mr. JOHNSON. Hearing none, it is so ordered.

(The material referred to follows:)

IMPERIAL IRRIGATION DISTRICT,
Imperial, Calif., January 26, 1968.

THE HONORABLE COMMITTEE MEMBERS OF THE HOUSE OF REPRESENTATIVES
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D.C.

GENTLEMEN: A number of public statements have been made concerning the alleged waste of usable water into Salton Sea, California, by Imperial Irrigation District and Coachella Valley County Water District. Examples are:

"*Conservation and Improved Uses of Existing Usable Water in the Lower Basin.*—Perhaps the outstanding example of usable water being wasted in the Lower Basin is the one and one-third million acre feet which annually flows into the Salton Sea. This water is unused Colorado River water which is diverted for irrigation use in Imperial and Coachella Valleys—but is permitted to flow unused into the Salton Sea through New River and the Alamo River as 'regulatory waste.' "[1]

"*Water Salvage.*—If someone said he knew a secret underground river which would add right now 1.5 million acre-feet of water annually to the Colorado River—enough to satisfy the Mexican Treaty burden—you would agree to go after it. Such an underground river does not exist, but something about as good does. An annual average of 1,320,000 acre-feet of usable water pours into the Salton Sea in Imperial Valley as waste from the Imperial Valley and Coachella Valley irrigation districts."[2][3]

These statements are simply not true. Imperial Irrigation District does, as a matter of fact, divert between 2.9 and 3 million acre-feet of water annually, most of which is a present perfected right, and is not used indiscriminately, but beneficially. The accompanying reports have been prepared to set the record straight and are submitted for that purpose:

"Imperial Irrigation District, Diversion Required at Pilot Knob for Imperial Unit Based on Blaney-Criddle Formula and 1959–1966 Crop Pattern for Historic PPM Salinity Concentration of Irrigation Water."

"Imperial Irrigation District, Diversion Required at Pilot Knob for Imperial Unit Based on Blaney-Criddle Formula and 1964–1966 Crop Pattern for Historic PPM Salinity Concentration of Irrigation Water."

I believe that the most significant information to be derived from the two reports is developed on the final page of each captioned, respectively:

"Imperial Irrigation District, Theoretical Distribution, 'IID Contribution to Salton Sea' 1959–1966."

"Imperial Irrigation District, Theoretical Distribution, 'IID Contribution to Salton Sea' 1964–1966."

I call your attention to the fact that the difference between "Total Theoretical" and "Observed to the Sea" (measured), aggregates on the annual average for the 3-year period, 46,000 acre-feet and on the 1959–1966 report the annual average is 52,000 acre-feet. Since the "Theoretical" does not take rainfall into consideration and the "Observed to the Sea" does include rainfall (for any runoff from rainfall would of necessity have to pass through the measuring instruments logging the quantity of water flowing to the Sea from all measurable sources) and, as the reports indicate, the area irrigated for crops averages 434,000 acres and, assuming that at least two inches of the historic 3-inch average rainfall over the District's system finds its way to the Sea, this would develop approximately 72,500 acre-feet of water per annum. I wish to point out that 72,500 acre-feet is almost one-half again as much as the quantity diverted annually to the Sea which could be classified as that quantity over and above the amount required for beneficial consumptive use based on the consumptive-use formula used in the Arizona vs. California lawsuit, as tabulated.

Imperial Irrigation District feels very keenly about the charges of wasting water to the Salton Sea and it has taken the opportunity of having these two re-

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[1] "Central Arizona Project Report" delivered to Mountain States Association, Salt Lake City, by Les H. Alexander, Associate General Manager, Salt River Project, Phoenix, Arizona, September 11, 1967.

[2] Letter dated October 2, 1967, to Mr. William H. Nelson, Associate Editor, The Daily Sentinel, Grand Junction, Colorado, from Congressman Morris K. Udall of Arizona.

[3] "Countdown on the Colorado," a speech by Congressman Morris K. Udall of Arizona, before the Town Hall of California, Biltmore Hotel, Los Angeles, December 19, 1967.

ports checked by the Bureau of Reclamation with the thought in mind of determining differences with respect to the application of the Blaney-Criddle Formula in arriving at consumptive use, leaching requirements, irrigation efficiency, etc. We have been advised by officials of the Bureau of Reclamation that, though we differ in the application of the formula in some respects which has a minor effect on the end result, the total over-all contribution differential to the Sea between Imperial Irrigation District and the Bureau of Reclamation studies is less than 60,000 acre-feet per annum.

It should be noted that this small variation is less than the aggregate difference between the observable and theoretical flow to the Sea of 72,500 acre-feet contributable to rainfall. We do not know whether the Bureau took rainfall into consideration; if not, the 60,000 acre-feet difference would be offset by rainfall with the effect of reducing the difference to zero. But, even if they did take rainfall into account, there would only be an annual difference of 60,000 acre-feet. Compared to our average Pilot Knob diversion of 2,930,000 acre-feet per year, this amounts to only 2.5 per cent, a very low figure for a District which operates from a diversion point 60 miles away on an order placed eleven days in advance at a point 150 miles up the River at Parker Dam. I believe that it is difficult enough to anticipate what we are going to do today, without trying to anticipate what we are going to do ten days hence.

I appreciate the opportunity afforded to me in these few minutes to spread the facts upon the record for one and all to examine at will. Careless and unthinking charges have been made regarding the use Imperial Irrigation District makes of its share and right to Colorado River water. Let there be no doubt that the record of this District is clear, is based on fact and speaks for itself.

Sincerely yours,

R. F. CARTER, *General Manager.*

[Enclosures]

IMPERIAL IRRIGATION DISTRICT

DIVERSION REQUIRED AT PILOT KNOB FOR IMPERIAL UNIT BASED ON BLANEY-CRIDDLE FORMULA AND 1959–1966 CROP PATTERN FOR HISTORIC PPM SALINITY CONCENTRATION OF IRRIGATION WATER

Double cropping, average 8 years—1959–66 (acres)

Acres in crops: 548,000.
Area irrigated for crops: 434,000.
Double cropped: 114,000 or 20.8% of 548,000 acres—Say 21%.

T–1018.—REQUIRED FOR DELIVERY TO FARMS

Input irrigation water at—	845 p.p.m.[1] (percent)	Acre-feet per irrigated acre
Average consumptive use per irrigated acre, 1959–66 [2]		4.26
Leaching requirement [3]	20	5.33
Farm efficiency (leaching requirement)	95	5.61
System regulation and system loss (historic 8-year average) [4]	18	[5] 6.84
Required for delivery at Pilot Knob per acre irrigated		6.8

[1] Average measured salinity, 1959–66.
[2] Refer T–1030.
[3] Based on leaching requirement for historic 8-year average salinity of irrigation water, refer T–1031.
[4] System loss includes seepage, transpiration, and evaporation losses, unmeasured deliveries to some 1,500 or more service pipes, deliveries to farm homes, and farms less than 2 acres.
[5] Round to 6.8 acre-feet.

Quantity required at Pilot Knob [1]

		Acre-feet
Consumptive use by crops	4.26×434,000=	1,849,000
Leaching requirement and/or irrigation efficiency	(5.61–4.26)×434,000=	586,000
System regulation and system loss	(6.8–5.61)×434,000=	516,000
Total required to IID at Pilot Knob [1]		2,951,000

[1] Based on Blaney-Criddle formula.

IMPERIAL IRRIGATION DISTRICT

T–1019.—DISTRIBUTION OF PRESENT USES, IMPERIAL UNIT, 1959–66

	1959	1960	1961	1962	1963	1964	1965	1966	Average, 8 yr.
To Imperial Irrigation District at Pilot Knob_____thousand acre-feet__	2,898	3,060	3,036	3,006	3,062	2,808	2,688	2,886	2,930
Loss, Pilot Knob to drop 1 (Imperial Irrigation District)_____do____	58	76	79	55	71	37	64	69	64
Loss, drop 1 to EHL_____do____	36	51	46	41	44	35	43	49	43
Loss, EHL to WSM_____do____	13	23	24	28	35	18	19	21	23
Gross AA canal loss_____do____	107	150	149	124	150	90	126	139	129
Canal loss and regulation [1]_____do____	453	528	394	366	332	283	223	249	341
Total, all Imperial Irrigation District Losses_____do____	560	478	543	490	482	373	349	388	470
Spill for system regulation_____do____	88	86	78	70	67	36	27	28	60
Total for system regulation and canal loss_____do____	648	664	621	560	549	409	376	416	530
Total deliveries to users [2]_do____	2,250	2,396	2,415	2,446	2,513	2,399	2,312	2,470	2,400
System efficiency_____percent__	77.7	78.3	79.5	81.4	82.1	85.4	86.0	85.6	82
Gross area of crops___thousand acres__	564	540	526	525	547	548	554	581	548
Net acreage irrigated_____do____	440	434	436	430	430	432	432	437	434
Delivered to users:									
Acre-feet per acre of crop_____	3.99	4.44	4.59	4.66	4.59	4.38	4.17	4.25	4.38
Acre-feet per acre irrigated_____	5.11	5.52	5.54	5.69	5.84	5.55	5.35	5.65	5.53
At Pilot Knob: Acre-feet per acre irrigated_____	6.59	7.05	6.96	6.99	7.12	6.50	6.22	6.60	6.75

[1] Canal loss and regulation includes seepage, transpiration, and evaporation losses, unmeasured deliveries to some 1,500 or more service pipes, deliveries to farm homes, and farms less than 2 acres.
[2] Deliveries to users and canal loss and regulation have been corrected to allow for estimated 10 percent undermeasurement of deliveries for years 1959 through 1963.

T–1020.—WATER DISTRIBUTION, 1959–66

[In thousands of acre-feet]

Year	Received at Pilot Knob	Operational loss			Canal loss and regulation [1]				Delivered to users [1]
		Main canals	Lateral canals	Total	A.A.C.	Main canals	Lateral canals [1]	Total	
1959_____	2,898	30	58	88	107	245	208	560	2,250
1960_____	3,060	28	58	86	150	232	196	578	2,396
1961_____	3,036	24	54	78	149	206	188	543	2,415
1962_____	3,006	20	50	70	124	190	176	490	2,446
1963_____	3,062	19	48	67	150	186	146	482	2,513
1964_____	2,808	12	24	36	90	81	202	373	2,399
1965_____	2,688	11	16	27	126	67	156	349	2,312
1966_____	2,886	12	16	28	139	76	173	388	2,470
8-year average__	2,930	20	40	60	129	160	181	470	2,400

[1] Canal loss and regulation and deliveries to users have been corrected to allow for estimated 10-percent undermeasurement of deliveries for years 1959 through 1963.

T-1021.—CONSUMPTIVE USE OF AREAS CROPPED, 1959

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	204,500	5.3	1,083,850
Alfalfa seed	2,500	4.7	11,750
Barley	101,000	1.8	181,800
Cotton	57,000	3.2	184,000
Corn	20,500	2.4	49,200
Flax	33,000	2.5	82,500
Sesbania	4,000	2.3	9,200
Sudan	5,000	2.3	11,500
Sugarbeets	48,000	2.4	115,200
Miscellaneous field crops	8,500	2.5	21,250
Melons	12,500	2.3	28,750
Lettuce	41,000	1.4	57,400
Carrots	6,000	2.2	13,200
Tomatoes	4,500	2.1	9,450
Miscellaneous garden crops	10,500	2.2	23,100
Citrus	2,000	4.0	8,000
Dates [2]			
Grapes [2]			
Miscellaneous permanent crops	2,500	3.7	9,250
Total	563,500	3.37	1,899,400

[1] Based on Blaney-Criddle formula.
[2] Included in miscellaneous permanent crops.

Note: Net acres irrigated, 440,000; consumptive use per acre irrigated, 4.32

T-1022.—CONSUMPTIVE USE OF AREAS CROPPED, 1960

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	214,500	5.3	1,136,850
Alfalfa seed	6,000	4.7	28,200
Barley	82,000	1.8	147,600
Cotton	58,000	3.2	185,600
Corn	26,000	2.4	62,400
Flax	16,500	2.5	41,250
Sesbania	4,500	2.3	10,350
Sudan	5,500	2.3	12,650
Sugarbeets	48,500	2.4	116,400
Miscellaneous field crops	9,000	2.5	22,500
Melons	11,500	2.3	26,450
Lettuce	40,500	1.4	56,700
Carrots	3,500	2.2	7,700
Tomatoes	2,000	2.1	4,200
Miscellaneous garden crops	7,500	2.2	16,500
Citrus	2,000	4.0	8,000
Dates [2]			
Grapes [2]			
Miscellaneous permanent crops	3,000	3.7	11,100
Total	540,500	3.50	1,894,450

[1] Based on Blaney-Criddle formula.
[2] Included in miscellaneous permanent crops.

Note: Net acres irrigated, 434,500; consumptive use per acre irrigated, 4.36.

T-1023.—CONSUMPTIVE USE OF AREAS CROPPED, 1961

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	205,000	5.3	1,086,500
Alfalfa seed	8,500	4.7	39,950
Barley	86,500	1.8	155,700
Cotton	53,500	3.2	171,200
Corn	37,500	2.4	90,000
Flax	10,500	2.5	26,250
Sesbania	1,500	2.3	3,450
Sudan	6,500	2.3	14,950
Sugarbeets	49,500	2.4	118,800
Miscellaneous field crops	10,500	2.5	26,250
Melons	8,000	2.3	18,400
Lettuce	31,000	1.4	43,400
Carrots	3,500	2.2	7,700
Tomatoes	1,500	2.1	3,150
Miscellaneous garden crops	7,000	2.2	15,400
Citrus	2,000	4.0	8,000
Dates [2]			
Grapes [2]			
Miscellaneous permanent crops	3,000	3.7	11,100
Total	525,500	3.50	1,840,200

[1] Based on Blaney-Criddle formula.
[2] Included in miscellaneous permanent crops.

Note: Net acres irrigated, 435,500; consumptive use per acre irrigated, 4.23.

T-1024.—CONSUMPTIVE USE OF AREAS CROPPED, 1962

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	176,500	5.3	935,450
Alfalfa seed	8,000	4.7	37,600
Barley	70,500	1.8	126,900
Cotton	69,500	3.2	222,400
Corn	36,000	2.4	86,400
Flax	26,500	2.5	66,250
Sesbania	1,500	2.3	3,450
Sudan	6,500	2.3	14,950
Sugar beets	55,500	2.4	133,200
Miscellaneous field crops	10,000	2.5	25,000
Melons	9,500	2.3	21,850
Lettuce	35,500	1.4	49,700
Carrots	5,500	2.2	12,100
Tomatoes	1,500	2.1	3,150
Miscellaneous garden crops	7,500	2.2	16,500
Citrus	2,500	4.0	10,000
Dates [2]			
Grapes [2]			
Miscellaneous permanent crops	2,500	3.7	9,250
Total	525,000	3.38	1,774,150

[1] Based on Blaney-Criddle formula.
[2] Included in "Miscellaneous permanent crops."

Note: Net acres irrigated, 429,500; consumptive use per acre irrigated, 4.13.

T-1025—CONSUMPTIVE USE OF AREAS CROPPED, 1963

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	189,000	5.3	1,001,700
Alfalfa seed	6,500	4.7	30,550
Barley	75,000	1.8	135,000
Cotton	63,000	3.2	201,600
Corn	54,500	2.4	130,800
Flax	8,500	2.5	21,250
Sesbania	1,500	2.3	3,450
Sudan	10,500	2.3	24,150
Sugar beets	60,000	2.4	144,000
Miscellaneous field crops	19,500	2.5	48,750
Melons	18,500	2.3	19,550
Lettuce	34,500	1.4	48,300
Carrots	3,500	2.2	7,700
Tomatoes	1,000	2.1	2,100
Miscellaneous garden crops	6,500	2.2	14,300
Citrus	2,500	4.0	10,000
Dates [2]			
Grapes [2]			
Miscellaneous permanent crops	2,500	3.7	9,250
Total	547,000	3.39	1,852,450

[1] Based on Blaney-Criddle formula.
[2] Included in "Miscellaneous permanent crops."

Note: Net acres irrigated, 430,500: consumptive use per acre irrigated, 4.30.

T-1026.—CONSUMPTIVE USE OF AREAS CROPPED, 1964

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	200,500	5.3	1,062,650
Alfalfa seed	8,500	4.7	39,950
Barley	74,000	1.8	133,200
Cotton	68,000	3.2	217,600
Corn	44,000	2.4	105,600
Flax	4,500	2.5	11,250
Sesbania	500	2.3	1,150
Sudan	7,000	2.3	16,100
Sugar beets	66,000	2.4	158,400
Miscellenous field crops	14,000	2.5	35,000
Melons	5,500	2.3	12,650
Lettuce	40,000	1.4	56,000
Carrots	3,000	2.2	6,600
Tomatoes	1,000	2.1	2,100
Miscellaneous garden crops	7,000	2.2	15,400
Citrus	2,000	4.0	8,000
Dates [2]			
Grapes [2]			
Miscellaneous permanent crops	3,000	3.7	11,100
Total	548,500	3.45	1,892,750

[1] Based on Blaney-Criddle formula.
[2] Included in "Miscellaneous permanent crops".

Note: Net acres irrigated, 431,500; consumptive use per acre rrigated, 4.39.

T-1027.—CONSUMPTIVE USE OF AREAS CROPPED, 1965

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	187,000	5.3	991,100
Alfalfa (seed)[2]			
Barley	99,000	1.8	178,200
Cotton	69,500	3.2	222,400
Corn	57,500	2.4	138,000
Flax	4,500	2.5	11,250
Sesbania	1,000	2.3	2,300
Sudan	4,000	2.3	9,200
Sugarbeets	64,000	2.4	153,600
Miscellaneous field crops	11,000	2.5	27,500
Melons	6,000	2.3	13,800
Lettuce	35,500	1.4	49,700
Carrots	2,500	2.2	5,500
Tomatoes	500	2.1	1,050
Miscellaneous garden crops	6,500	2.2	14,300
Citrus	2,500	4.0	10,000
Dates [3]			
Grapes [3]			
Miscellaneous permanent crops	3,000	3.7	11,100
Total	554,000	3.32	1,839,000

[1] Based on Blaney-Criddle formula.
[2] Included in alfalfa.
[3] Included in miscellaneous permanent crops.

Note: Net acres irrigated, 432,500; consumptive use per acre irrigated, 4.25.

T-1028.—CONSUMPTIVE USE OF AREAS CROPPED, 1966

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	168,500	5.3	893,050
Barley	101,500	1.8	182,700
Cotton	39,000	3.2	124,800
Corn	116,000	2.4	278,400
Flax	2,500	2.5	6,250
Sesbania	1,500	2.3	3,450
Sudan	4,500	2.3	10,350
Sugar beets	62,000	2.4	148,800
Miscellaneous field crops	18,000	2.5	45,000
Melons	8,500	2.3	19,550
Lettuce	45,500	1.4	63,700
Carrots	2,000	2.2	4,400
Tomatoes	500	2.1	1,050
Miscellaneous garden crops	6,500	2.2	14,300
Citrus	2,000	4.0	8,000
Miscellaneous permanent crops	3,000	3.7	11,100
Total	581,500	3.12	1,814,900

[1] Based on Blaney-Criddle formula.

Note: Net acres irrigated, 437,500; consumptive use per acre irrigated, 4.15.

T–1029.—CONSUMPTIVE USE, IMPERIAL UNIT, 1959–1966 AVERAGE

[Use rates, Imperial unit]

Year	Acre-feet per acre			
	Consumptive use per acre of crop [1]	Delivered per acre of crop	Consumptive use per acre irrigated	Delivered per acre irrigated
	(1)	(2)	(3)	(4)
1959	3.37	3.99	4.32	5.11
1960	3.50	4.44	4.36	5.52
1961	3.50	4.59	4.23	5.54
1962	3.38	4.66	4.13	5.69
1963	3.39	4.59	4.30	5.84
1964	3.45	4.38	4.39	5.55
1965	3.32	4.17	4.25	5.35
1966	3.12	4.25	4.15	5.65
8-year average	3.38	4.38	[2] 4.26	5.53

[1] Based on Blaney-Criddle formula.
[2] Refer T–1030.

Note: Refer T–1021 through T–1028.

T–1030.—CONSUMPTIVE USE, 1959–66

[Acres in crop to nearest 500 acres]

Year	Acres of crop	Comsumptive Use [1]		Acres irrigated	Consumptive use per acre irrigated
		Acre-feet per acre	Total acre-feet		
1959	563,500	3.37	1,899,400	440,000	4.32
1960	540,500	3.50	1,894,450	434,500	4.36
1961	525,500	3.50	1,840,200	435,500	4.23
1962	525,000	3.38	1,774,150	429,500	4.13
1963	547,000	3.39	1,852,450	430,500	4.30
1964	548,500	3.45	1,892,750	431,500	4.39
1965	554,000	3.32	1,839,000	432,500	4.25
1966	581,500	3.12	1,814,900	437,500	4.15
8-year average	548,000	3.38	1,851,000	434,000	[2] 4.26

[1] Consumptive use based on Blaney-Criddle formula.
[2] Weighted average.

Note: Refer T–1029.

T–1031.—SALINITY OF IRRIGATION WATER RECEIVED BY DISTRICT AND LEACHING REQUIREMENT, 1959–66

Year	Annual discharge acre-feet [a]	Total salt (tons) [b]	Historic weighted average salinity			Leaching requirement (percent)
			TAF	Parts per million	K×10 [c]	
	(1)	(2)	(3)	(4)	(5)	(6) [d]
1959	2,840,173	2,852,019	1.00	735	1,050	17
1960	2,983,860	3,162,485	1.06	779	1,110	19
1961	2,957,200	3,330,087	1.13	831	1,190	20
1962	2,951,266	3,399,464	1.15	845	1,210	20
1963	2,991,429	3,378,583	1.13	831	1,190	20
1964	2,770,474	3,284,284	1.19	875	1,250	21
1965	2,624,363	3,406,457	1.30	956	1,370	23
1966	2,817,912	3,650,447	1.30	956	1,370	23
Average	2,867,035	3,307,978	[e] 1.15	[e] 845	1,210	20

[a] Total discharge, all-American Canal below drop 1.
[b] Based on weekly salinity samples.
[c] Based on conversion factor of 0.7 for parts per million to conductivity (micromhos/cm. to nearest 10).
[d] Based on average salt tolerance for 50 percent yield reduction and historic conductance of water delivered to district. Refer USDA Handbook No. 60 and Bulletin 283. Includes allowance for minimum nonuniformity of application.
[e] Weighted average.

T–1032.—THEORETICAL DISTRIBUTION "DELIVERED TO USERS," 1959–66

Year	Consumptive use (thousand acre-feet) [1]	Delivered to users [2]	Total leaching required [3]	Water available for farm efficiency-leaching requirement [4]	
				Thousand acre-feet	Percent
1959	1,899	2,250	(5.20—4.32)×440.0=387	(—36)	(101.6)
1960	1,894	2,396	(5.38—4.36)×434.5=443	59	97.5
1961	1,840	2,415	(5.29—4.23)×435.5=462	113	95.3
1962	1,774	2,446	(5.16—4.13)×429.5=442	230	90.6
1963	1,852	2,513	(5.37—4.30)×430.5=461	200	92.0
1964	1,893	2,399	(5.56—4.39)×431.5=505	(1)	(100.0)
1965	1,839	2,312	(5.52—4.25)×432.5=549	(—76)	(103.3)
1966	1,815	2,470	(5.39—4.15)×437.5=543	112	95.5
Average	1,851	2,400	(5.33—4.26)×433.9=464 [5]		

[1] Based on Blaney-Criddle formula.
[2] Refer T–1019.
[3] (Total in 1,000 acre-feet) refer T–1033 for acre-feet per irrigated acre.
[4] Represents water that was available for farm loss after leaching requirement and consumptive use had been satisfied.
[5] Weighted average.

T-1033.—WATER FOR CONSUMPTIVE USE AND LEACHING REQUIREMENT AND THEORETICAL FARM EFFICIENCY, 1959–66

Year	Total irrigated acres (thousands)	Per irrigated acre				Total delivered to users	Total consumptive use [1] (col. 1 times col. 2)	Total leaching requirement (col. 1 times col. 2)	Available for farm efficiency [2] (col. 6 minus col. 7 plus col. 8)	Farm efficiency percent (col. 6 minus col. 9 divided by col. 6 times 100) [2]
		Consumptive use	Leaching requirement (percent)	Consumptive use plus leaching requirement (col. 2 times 100 divided by 100 minus col. 3)	Leaching requirement only (col. 4 minus col. 2)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1959	440.0	4.32	17	5.20	0.88	2,250	1,899	387	(−36)	(101.6)
1960	434.5	4.36	19	5.38	1.02	2,396	1,894	443	59	97.5
1961	435.5	4.23	20	5.29	1.06	2,415	1,840	462	113	95.3
1962	429.5	4.13	20	5.16	1.03	2,446	1,774	442	230	90.6
1963	430.5	4.30	20	5.37	1.07	2,513	1,852	461	200	92.0
1964	431.5	4.39	21	5.56	1.17	2,399	1,893	505	(1)	(100.0)
1965	432.5	4.25	23	5.52	1.27	2,312	1,839	549	(−76)	(103.3)
1966	437.5	4.15	23	5.39	1.24	2,470	1,815	543	112	95.5
8-year average	433.9	[3] 4.26	20	[3] 5.33	[3] 1.07	2,400	1,851	[3] 464	----------	----------

Note: Cols. 1, 6, 7, 8, and 9 are in 1,000 acre-feet. Col. 2 refer T–1029; col. 3 refer T–1031; col. 6 refer T–1019.

[1] Based on Blaney-Criddle formula.

[2] Represents water that was available for farm losses after leaching requirements and consumptive use had been satisfied.

[3] Weighted average.

T–1034.—INFLOW TO SALTON SEA, IMPERIAL IRRIGATION DISTRICT AND MEXICO, 1959–66

[In thousands of acre-feet]

Year	From Mexico at international boundary	From Imperial Irrigation District			Total, Imperial Irrigation District and Mexico
		Operational loss	Farm drainage	Total, Imperial Irrigation District	
1959	124	88	933	1,021	1,145
1960	123	86	973	1,060	1,183
1961	117	78	973	1,051	1,168
1962	134	70	1,019	1,089	1,223
1963	141	67	1,087	1,154	1,295
1964	107	36	869	905	1,012
1965	113	27	856	883	996
1966	104	28	977	1,005	1,109
8-year average	120	60	961	1,021	1,141

T–1035.—THEORETICAL DISTRIBUTION "IMPERIAL IRRIGATION DISTRICT CONTRIBUTION TO SALTON SEA," 1959–66

[In thousands of acre-feet]

	1959	1960	1961	1962	1963	1964	1965	1966	8-year average
Leaching requirement [1]	387	443	462	442	461	505	549	543	464
Operational loss	88	86	78	70	67	36	27	28	60
85-percent canal loss and regulation [2]	476	491	462	417	410	317	297	330	400
50-percent water available for farm efficiency [3]		30	57	115	100			56	45
Total theoretical [4]	951	1,050	1,059	1,044	1,038	858	873	957	969
Observed to sea [5]	1,021	1,060	1,051	1,089	1,154	905	883	1,005	1,021
Difference	−70	−10	+8	−45	−116	−47	−10	−48	−52

[1] Refer T–1033.
[2] Based on 15-percent allowance for surface evaporation and consumptive use of vegetation along and adjacent to canal section in Imperial unit, refer T–1020, "Total canal loss and regulation."
[3] Estimated 50 percent of water available for farm losses after leaching requirement and crop consumptive use had been satisfied from amount of "deliveries to users"; refer T–1033.
[4] Does not include contribution from rainfall.
[5] Includes contribution from rainfall.

DIVERSION REQUIRED AT PILOT KNOB FOR IMPERIAL UNIT BASED ON BLANEY-CRIDDLE FORMULA AND 1964–1966 CROP PATTERN FOR HISTORIC PPM SALINITY CONCENTRATION OF IRRIGATION WATER

Double cropping, average 3 years—1964–66 (acres)

Acres in crops: 561,000.
Area irrigated for crops: 434,000.
Double cropped: 127,000 or 22.6% of 561,000 acres—Say 23%.

T–1036.—REQUIRED FOR DELIVERY TO FARMS

Input irrigation water at—	926 p.p.m. [1] (percent)	Acre-feet per irrigated acre
Average consumptive use per irrigated acre, 1964–66 [2]		4.26
Leaching Requirement [3]	22	5.46
Farm Efficiency (leaching requirement)	95	5.75
System regulation and system loss (historic 3-year average) [4]	15	[5] 6.76
Required for delivery at Pilot Knob per acre irrigated		6.8

[1] Average measured salinity, 1964–66.
[2] Refer to T–1043.
[3] Based on leaching requirement for historic 3-year average salinity of irrigation water, refer T–1044.
[4] System loss includes seepage, transpiration, and evaporation losses, unmeasured deliveries to some 1,500 or more service pipes, deliveries to farm homes, and farms less than 2 acres.
[5] Round to 6.8 acre-feet.

Quantity Required at Pilot Knob [1]

	Acre-feet
Consumptive use by crops	4.26×434,000=1,849,000
Leaching requirement and/or irrigation efficiency	(5.75–4.26)×434,000= 647,000
System regulation and system loss	6.8–5.75×434,000= 456,000
Total required to IID at Pilot Knob [1]	2,952,000

[1] Based on use of Blaney-Criddle formula.

T–1037.—DISTRIBUTION PRESENT USES, IMPERIAL UNIT, 1964–66

[In thousands of acre-feet]

	1964	1965	1966	Average, 3 years
To Imperial Irrigation District at Pilot Knob	2,808	2,688	2,886	2,794
Loss, Pilot Knob to Drop 1 (Imperial Irrigation District)	37	64	69	57
Loss, Drop 1 to EHL	35	43	49	42
Loss, EHL to WSM	18	19	21	19
Gross AA canal loss	90	126	139	118
Canal loss and regulation [1]	283	223	249	252
Total all Imperial Irrigation District losses	373	349	388	370
Spill for system regulation	36	27	28	30
Total for system regulation and canal loss	409	376	416	400
Total deliveries to users	2,399	2,312	2,470	2,394
System efficiency, percent	85.4	86.0	85.6	[2] 85.7
Gross area of crops, acres [3]	548	554	581	561
Net acreage irrigated, acres [3]	432	432	437	434
Delivered to users, acre-feet per acre of crop	4.38	4.17	4.25	4.27
Delivered to users, acre-feet per acre irrigated	5.55	5.35	5.65	5.52
At Pilot Knob, acre-feet per acre irrigated	6.50	6.22	6.60	6.44

[1] Canal loss and regulation includes seepage, transpiration and evaporation losses, unmeasured deliveries to some 1,500 or more service pipes, deliveries to farm homes, and farms less than 2 acres.
[2] Round to 85 percent.
[3] In thousand acres.

T–1038.—WATER DISTRIBUTION, 1964–66

[In thousands of acre-feet]

Year	Received at Pilot Knob	Operational loss			Canal loss and regulation				Delivered to users
		Main canals	Lateral canals	Total	A.A.C.	Main canals	Lateral canals	Total	
1964	2,808	12	24	36	90	81	202	373	2,399
1965	2,688	11	16	27	126	67	156	349	2,312
1966	2,886	12	16	28	139	76	173	388	2,470
3-year average	2,794	12	18	30	118	75	177	370	2,394

T–1039.—CONSUMPTIVE USE OF AREAS CROPPED, 1964

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	200,500	5.3	1,062,650
Alfalfa seed	8,500	4.7	39,950
Barley	74,000	1.8	133,200
Cotton	68,000	3.2	217,600
Corn	44,000	2.4	105,600
Flax	4,500	2.5	11,250
Sesbania	500	2.3	1,150
Sudan	7,000	2.3	16,100
Sugar beets	66,000	2.4	158,400
Miscellenous field crops	14,000	2.5	35,000
Melons	5,500	2.3	12,650
Lettuce	40,000	1.4	56,000
Carrots	3,000	2.2	6,600
Tomatoes	1,000	2.1	2,100
Miscellaneous garden crops	7,000	2.2	15,400
Citrus	2,000	4.0	8,000
Dates [2]			
Grapes [2]			
Miscellaneous permanent crops	3,000	3.7	11,100
Total	548,500	3.45	1,892,750

[1] Based on Blaney-Criddle formula.
[2] Included in "Miscellaneous permanent crops."

Note: Net acres irrigated, 431,500; consumptive use per acre irrigated, 4.39.

T–1040.—CONSUMPTIVE USE OF AREAS CROPPED, 1965

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	187,000	5.3	991,100
Alfalfa (seed) [2]			
Barley	99,000	1.8	178,200
Cotton	69,500	3.2	222,400
Corn	57,500	2.4	138,000
Flax	4,500	2.5	11,250
Sesbania	1,000	2.3	2,300
Sudan	4,000	2.3	9,200
Sugar beets	64,000	2.4	153,600
Miscellaneous field crops	11,000	2.5	27,500
Melons	6,000	2.3	13,800
Lettuce	35,500	1.4	49,700
Carrots	2,500	2.2	5,500
Tomatoes	500	2.1	1,050
Miscellaneous garden crops	6,500	2.2	14,300
Citrus	2,500	4.0	10,000
Dates [3]			
Grapes [3]			
Miscellaneous permanent crops	3,000	3.7	11,100
Total	554,000	3.32	1,839,000

[1] Based on Blaney-Criddle formula.
[2] Included in alfalfa.
[3] Included in miscellaneous permanent crops.

Note: Net acres irrigated, 432,500; consumptive use per acre irrigated, 4.25.

T-1041.—CONSUMPTIVE USE OF AREAS CROPPED, 1966

[Acres in crop to nearest 500 acres]

	Acres	Consumptive use	
		Acre-feet per acre [1]	Acre-feet
Alfalfa	168,500	5.3	893,050
Barley	101,500	1.8	182,700
Cotton	39,000	3.2	124,800
Corn	116,000	2.4	278,400
Flax	2,500	2.5	6,250
Sesbania	1,500	2.3	3,450
Sudan	4,500	2.3	10,350
Sugar beets	62,000	2.4	148,800
Miscellaneous field crops	18,000	2.5	45,000
Melons	8,500	2.3	19,550
Lettuce	45,500	1.4	63,700
Carrots	2,000	2.2	4,400
Tomatoes	500	2.1	1,050
Miscellaneous garden crops	6,500	2.2	14,300
Citrus	2,000	4.0	8,000
Miscellaneous permanent crops	3,000	3.7	11,100
Total	581,500	3.12	1,814,900

[1] Based on Blaney-Criddle formula.

Note: Net acres irrigated, 437,500; consumptive use per acre irrigated, 4.15.

T-1042.—CONSUMPTIVE USE, IMPERIAL UNIT, 1964-66 AVERAGE

[Use rates, Imperial unit]

Year	Acre-feet per acre			
	Consumptive use per acre of crop [1]	Delivered per acre of crop	Consumptive use per acre irrigated	Delivered per acre irrigated
	(1)	(2)	(3)	(4)
1964	3.45	4.38	4.39	5.55
1965	3.32	4.17	4.25	5.35
1966	3.12	4.25	4.15	5.65
3-year average	3.29	4.27	4.26	5.52

[1] Based on Blaney-Criddle formula.

Note: Refer T-1039 through T-1041.

T-1043.—CONSUMPTIVE USE, 1964-66

[Acres in crop to nearest 500 acres]

Year	Acres of crop	Consumptive use [1]		Acres irrigated	Consumptive use per acre irrigated
		Acre-feet per acre	Total acre-feet		
1964	548,500	3.45	1,892,750	431,500	4.39
1965	554,000	3.32	1,839,000	432,500	4.25
1966	581,500	3.12	1,814,900	437,500	4.15
3-year average	561,500	3.29	1,848,900	434,000	4.26

[1] Consumptive use based on Blaney-Criddle formula.

Note: Refer T-1042.

T–1044.—SALINITY OF IRRIGATION WATER RECEIVED BY DISTRICT AND LEACHING REQUIREMENT, 1964–66

Year	Annual discharge (acre-feet) [a]	Total salt (tons) [b]	Historic weighted average salinity			Leaching requirement (percent) [d]
			TAF	Parts per million	K×10⁶ [c] million	
	(1)	(2)	(3)	(4)	(5)	(6)
1964	2,770,474	3,284,284	1.19	875	1,250	21
1965	2,624,363	3,406,457	1.30	956	1,370	23
1966	2,817,912	3,650,447	1.30	956	1,370	23
Average	2,737,583	3,447,063	1.26	[e] 926	1,320	22

[a] Total discharge All-American Canal below drop 1.
[b] Based on weekly salinity samples.
[c] Based on conversion factor of 0.7 for parts per million to conductivity (micromhos/cm. to nearest 10).
[d] Based on average salt tolerance for 50 percent yield reduction and historic conductance of water delivered to district. Refer USDA Handbook No. 60 and Bulletin 283. Includes allowance for minimum nonuniformity of application.
[e] Weighted average.

T–1045.—THEORETICAL DISTRIBUTION "DELIVERED TO USERS," 1964–66

Year	Consumptive use (thousand acre-feet) [1]	Delivered to users [2]	Total leaching required [3]	Water available for farm efficiency-leaching requirement	
				Thousand acre-feet	Percent
1964	1,893	2,399	(5.56—4.39)×431.5—505	(1)	(100.0)
1965	1,839	2,312	(5.52—4.25)×432.5=549	(—76)	(103.3)
1966	1,815	2,470	(5.39—4.15)×437.5=543	112	95.5
3-year average	1,849	2,394	(5.46—4.26)×433.8—521		

[1] Based on Blaney-Criddle formula.
[2] Refer T–1037.
[3] (Total in 1,000 acre-feet) refer T–1046 for acre-feet per irrigated acre.
[4] Represents water that was available for farm loss after leaching requirement and consumptive use had been satisfied

T-1046.—WATER FOR CONSUMPTIVE USE AND LEACHING REQUIREMENT AND THEORETICAL FARM EFFICIENCY, 1964–66

Year	Total irrigated acres (thousands)	Per irrigated acre				Total delivered to users	Total consumptive use [1] (col. 1 times col. 2)	Total leaching requirement (col. 1 times col. 5)	Available for farm efficiency [2] (col. 6 minus col. 7 plus col. 8)	Farm efficiency percent (col. 6 minus col. 9 divided by col. 6 [2] times 100)
		Consumptive use [1]	Leaching requirement (percent)	Consumptive use plus leaching requirement (col. 2 times 100 divided by 100 minus col. 3)	Leaching requirement only (col. 4 minus col. 2)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1964	431.5	4.39	21	5.56	1.17	2,399	1,893	505	(1)	(100.0)
1965	432.5	4.25	23	5.52	1.27	2,312	1,839	549	(−76)	(103.3)
1966	437.5	4.15	23	5.39	1.24	2,470	1,815	543	112	95.5
3-year average	433.8	4.26	22	5.46	1.20	2,394	1,849	[3] 521		

[1] Based on Blaney-Criddle formula.
[2] Represents water that was available for farm losses after leaching requirements and consumptive use had been satisfied.
[3] Weighted average.

Note: Cols. 6, 7, 8, and 9 are in 1,000 acre-feet. Col. 2 refer T–1042; col. 3 refer T–1044; col. 6 refer T–1037.

T-1047.—INFLOW TO SALTON SEA, IMPERIAL IRRIGATION DISTRICT AND MEXICO, 1964–66

[In thousands of acre-feet]

Year	From Mexico at international boundary	From Imperial Irrigation District			Total, Imperial Irrigation District and Mexico
		Operational loss	Farm drainage	Total, Imperial Irrigation District	
1964	107	36	869	905	1,012
1965	113	27	856	883	996
1966	104	28	977	1,005	1,109
3-year average	108	30	901	931	1,039

T-1048.—THEORETICAL DISTRIBUTION "IID CONTRIBUTION TO SALTON SEA," 1964–66

[In thousands of acre-feet]

	1964	1965	1966	3-year average
Leaching requirement [1]	505	549	543	521
Operational loss	36	27	28	30
85 percent canal loss and Regulation [2]	317	297	330	315
50 percent water available for farm efficiency [3]			56	19
Total, theoretical [4]	858	873	957	885
Observed to sea [5]	905	883	1,005	931
Difference	−47	−10	−48	−46

[1] Refer T-1046.
[2] Based on 15-percent allowance for surface evaporation and consumptive use of vegetation along and adjacent to canal section in Imperial unit; refer T-1038, "Total Canal Loss and Regulation."
[3] Estimated 50 percent of water available for farm losses after leaching requirement and crop consumptive use had been satisfied from amount of "deliveries to users"; refer T-1046.
[4] Does not include contribution from rainfall.
[5] Includes contribution from rainfall.

SALINITY OF OUTFLOW TO SALTON SEA, 1959–66

Year:	*Tons of salt per acre-foot* [1]
1959	3.33
1960	3.36
1961	3.40
1962	3.50
1963	3.51
1964	4.02
1965	4.33
1966	4.13

[1] Yearly weighted average of measured outflow including rainfall: 1959–66 8-year average tons per acre-foot, 3.68; 1964–66 3-year average tons per acre-foot, 4.16; 1959–66 8-year average PPM, 2,695; 1964–66 3-year average PPM, 3,057.

Mr. TUNNEY. Thank you, Mr. Chairman. I yield whatever time I have left to Mr. Hosmer.

Mr. JOHNSON. You cannot do that. He has reserved the balance of his time. You wish to reserve the balance of your time, I am sure.

Mr. TUNNEY. No, I do not. I yield back my time.

Mr. JOHNSON. The Chair now recognizes the gentleman from Utah, Mr. Burton.

Mr. BURTON of Utah. Thank you, Mr. Chairman.

Mr. Secretary, would you give us a description of what the feasibility of central Arizona would be if there were no development of the upper basin entitlement, including central Utah?

Secretary UDALL. On what time schedule?