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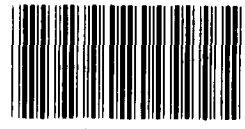
BY THE COMPTROLLER GENERAL 114588

Report To The Congress

OF THE UNITED STATES

Federal Charges For Irrigation Projects Reviewed Do Not Cover Costs



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GAO reviewed six Federal irrigation projects and found that the water produced will cost the Government between $54 and $130 an acre-foot each year, but the crops grown by the farmers will not yield enough revenue to cover this cost. The farmers will continue to buy the Federal water, however, because they are charged a price below Government cost.

Repayments for irrigation are presented to the Congress as full repayment. Since no interest is charged, however, these payments actually cover less than 10 percent of the Federal Government's actual cost.

This large subsidy arose because of the desire 80 years ago to settle the West and to promote regional economic development. This report suggests that the original rationale for the subsidy be measured against today's conditions.

GAO recommends that the Federal Government's cost of irrigation be recognized in the supporting analyses and that the size of the subsidy be clearly presented for each project before Federal funds are provided. Matters for consideration by the Congress are also presented.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-200981

To the President of the Senate and the
Speaker of the House of Representatives

In this report, we examined six Federal water projects to find out what the economic effect of higher irrigtion prices might be. The issue of Federal charges for irrigation arises often during congressional deliberations about water project funding. The information in this report should be useful to the Congress in future consideration of water charges and in authorization of water resource projects.

The Departments of the Interior and Agriculture did not provide official comments on the report within the 30-day limit as required by P.L. 96-266. They were eventually received and are included as an appendix to the report.

We are sending this report to the appropriate House and Senate Committees; to representatives and senators from States mentioned in the report; to the Director, Office of Management and Budget; and to the Secretaries of the Departments of Agriculture and the Interior.

Comptroller General
of the United States

called the interest-subsidy price. (See chap. 3.)

EVALUATING WPRS' IRRIGATION CHARGES

WPRS fixes a price for its irrigation water based, in part, on its interpretation of a 1939 act. The price is set according to the farmers' ability to pay for the water. In WPRS' practice, that price is the amount which is left over from an average farmer's gross income after deducting for all production costs (except Federal water) and for allowances which give a positive return to capital, management, and owner's labor. This left over amount, or residual value, is much less than the Federal Government's cost of producing the water. (See pp. 17-18.)

Because of the way WPRS makes its ability-to-pay analysis, GAO could not substitute a full-cost or interest-subsidy price into the existing project analyses. In addition, GAO found WPRS' analysis to be inaccurate at times and misleading because it does not concentrate on the acres which will actually be irrigated nor on the crops which will be irrigated. (See pp. 19.)

RESULTS OF GAO'S ANALYSIS

All six project areas reviewed by GAO are established farming areas, and irrigation is practiced in five of the six areas. While the supplemental water which will be provided by the WPRS projects will allow the farmers to increase yield, in conjunction with increased use of other farming inputs, the price at which the water will be offered is critical. If the project area farmers were to be faced with the GAO estimated prices instead of the WPRS ability-to-pay prices, the decisions about how much water to buy, if any, would be different.

Water is an input which will help increase yield. Its cost will determine whether the farmer will make the extra effort to increase yields. If the price of the water is greater than the potential increase in income, there would be no economic reason for the farmer to

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

FEDERAL CHARGES FOR IRRIGATION IN PROJECTS REVIEWED DO NOT COVER COSTS

D I G E S T

The Water and Power Resources Service (WPRS) in the Department of the Interior is responsible for most Federal irrigation projects and charges beneficiaries for the use of the water. The original 1902 legislation stipulated that the charges should return all the costs of building the projects. Subsequent laws have not required certain beneficiaries to repay their share in full.

Water is now recognized as a scarce natural resource because of increased competition for its use in many places, recent droughts, and the overdrafting of ground water, and this has caused more attention to be focused on water and the charges for its use. Therefore, GAO reviewed several WPRS projects under construction to determine what charges will be made for the water, to what extent the charges will cover the costs to the Federal Government for providing the water, and whether farmers could pay more for the water without impairing their operations or seriously damaging their profits.

SCOPE AND METHODOLOGY

The six projects GAO selected for the case study approach were under construction but not completed when the study began. The projects are geographically dispersed and include a project area which is now dryland farmed, four projects with multiple crops and some existing irrigation, and a project with a full water supply for its apple crop. (See chap. 4.) GAO reviewed WPRS project files, interviewed officials and farmers, and discussed the review with academic experts. Basic WPRS data were used with necessary adjustments in the GAO analysis of the six projects. GAO used two prices in its economic analysis--the full-cost price of water at a 7.5 percent interest charge, and the full-cost price without the interest charge, which is

This analysis would focus attention on the crops and land actually receiving the water. It would also show how much subsidy WPRS was allowing. (See pp. 41-42.)

GAO believes that the recommended analysis would improve the information provided the decisionmakers concerning water project funding. The actual costs to the Government, the effects on the farmers, and the farmers' likely responses would be clearly described.

MATTERS FOR CONSIDERATION BY THE CONGRESS

The process for funding water projects and repayment of costs has evolved over 75 years. While the Congress receives a lot of detailed information about projects as they are proposed, authorized, and funded, GAO believes that the Congress should also consider broader issues. During this review, GAO identified several points about water projects that the Congress might consider during future deliberations on water projects and repayment.

--The nature of subsidies.

GAO's analysis shows that even seemingly full repayment of Federal costs does contain a very large subsidy. The terms of repayment--lack of interest and length of time without repayment--combine to give a large subsidy to users of Federal irrigation. Accurately measuring and reporting subsidies would assist the Congress when it considers individual programs as well as when it compares various projects and programs.

--The origin of the large subsidy.

The original rationale for building the Federal projects and increasing the subsidy was based on early 20th century goals for the settlement of the West and for regional development. Those goals have been reached and the projects should now be reevaluated in the light of current economic and social conditions.

contract for the water. When GAO analyzed the increases in net income possible with full-cost water at the 7.5 percent interest, GAO found that the costs associated with increasing yield with irrigation were greater than the income produced. Federal water at full cost is simply too expensive.

When GAO inserted the interest-subsidy price into the analysis, GAO found that this lowered the costs of irrigated agriculture enough so that farmers in four of the six projects could probably increase net income by buying Federal water.

Given that the interest-subsidy price is between three and 50 times as high as the ability-to-pay price that the WPRS is planning to charge the farmers in these projects, it seems that more of the Federal investment could be recovered from the farmers and still allow them a positive net income from the Federal water. (See chap. 4 for summaries of the case studies and appendix I for the case studies.)

RECOMMENDATIONS TO THE SECRETARY OF THE INTERIOR

GAO recommends that the Secretary of the Interior direct the Commissioner of the WPRS to perform an economic analysis of water projects not yet under construction that includes estimates

--based on the full cost of water to the potential irrigators, including interest, of constructing the irrigation facilities at WPRS projects;

--of the increases in yields from only the acres that will actually receive project water; and

--of the potential change in the project farmers' net incomes if they use Federal water to increase production.

--WRPS evaluation of projects.

WPRS' analysis may over or understate the yield attributable to irrigation. Government decisionmaking will be improved by implementing the recommendation to the Secretary of the Interior (see pp. 41-42).

--Federal responses to irrigation farming problems.

Such responses need careful attention and should consider more solutions than they do now. One problem is that many of the earlier public and private irrigation projects are deteriorating and their maintenance costs are rising. (See pp. 34 and 44-45.) A second problem for the future is the possible depletion of underground aquifers used for irrigation. The emerging problems of irrigated agriculture are different from the problems at the time of settlement and westward expansion. Different solutions are required and need to be predicated on rigorous analysis of many alternatives.

AGENCY COMMENTS

The Departments of the Interior and Agriculture did not provide official comments on the report within the 30 day limit specified by legislation. Comments from both departments were eventually received, and these comments, along with GAO responses, are included as appendix II.

Interior maintained WPRS is doing what it is legally mandated to do. In this report GAO focused on the costs to the Government and what might happen if the irrigators were asked to pay more of the costs or the full cost of Federal water. GAO is currently looking into the legal issues.

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In 1975, the Water Resources Council, an independent Federal body, studied cost sharing and found the value of payments by non-Federal groups during 1974 to be as follows: 1/

Limited Reimbursement	Percentage	Full Reimbursement a/	Percentage
Flood Control	10	Irrigation	18
Fish and Wildlife	13	Hydroelectrical power	65
Recreation	18	M&I water	71

a/No full (100 percent) cost sharing is listed because the Council computed the shares according to the present value of the repayments. Hydroelectrical and M&I shares are as high as they are because their repayments usually include some interest charge. The percentage is not 100 because the discount rate used in the Task Force study is higher than the interest rate charged.

Source: Task Force Reports, Water Resource Policy Study, U.S. Government, December 6, 1977, "Cost Sharing Task Force Report," p. 9.

Notice that the cost-sharing percentage for irrigation, although it is considered fully reimbursable, is as low as the percentages for limited reimbursement because no interest is assessed on the costs allocated to irrigation. Most of the repayment is from other users of WPRS project outputs, usually after a long grace period.

The amount of subsidy to irrigators has raised, in recent years, questions and criticism about whether or not federally subsidized water projects "are effectively targeted toward the most pressing national water needs." 2/ In his 1977 environmental message, President Carter recommended that users of Federal water pay more of the costs. The debate about funding water projects centers on the relationship between beneficiaries and repayment, and often relies on

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1/This study was required by the Water Resources Development Act of March 7, 1974 (P.L. 93-251). It is commonly referred to as the Section 80 study because section 80(c) directed the President to analyze several points at issue.

2/Office of the White House Press Secretary, Water Policy Message, Detailed Background, June 6, 1978.

CHAPTER 1

INTRODUCTION

Since the beginning of the 20th century, the Federal Government has been constructing water projects in the western United States. The purpose of the earlier projects was almost solely irrigation, but today water projects also provide recreation, municipal and industrial (M&I) water, hydroelectrical power, flood control, and fish and wildlife enhancement. Most Federal irrigation projects today are the responsibility of the Water and Power Resources Services (WPRS, formerly the Bureau of Reclamation) in the Department of the Interior.

The Reclamation Act of 1902 stipulated that the costs of construction be repaid by the beneficiaries. Three of the main purposes of current water projects--irrigation, hydroelectrical power, and M&I water--are considered fully reimbursable. 1/ Each dollar allocated to these functions is eventually returned to the Federal Government by someone (often power or M&I water users on behalf of irrigators) at low or no interest rates. The other purposes of WPRS projects--recreation, fish and wildlife enhancement, and flood control--are largely nonreimbursable.

The value of the cash payments or the contributions in-kind 2/ by all non-Federal sources--direct beneficiaries, regional groups, or local/State governments--is much less than the cost of these water projects to the Federal Government, and ultimately to the Federal taxpayer. One of the costs which we considered in this study was the interest cost of the money expended by the Federal Government.

1/ According to the Department of the Interior, "it has long been the philosophy of the Nation that all Reclamation projects costs for the purpose of irrigation, power, and municipal and industrial water supply should be repaid in full." Repayment of Reclamation Projects, Department of the Interior, Washington, D.C., 1972, p. ix.

2/ Federal legislation requires local users of water resource projects to provide contributions in kind--needed land, easements, rights-of-way, and utility relocations. This is generally true for all water resource projects, except large flood control reservoirs.

used to grow those crops. The test of market value is not, of course, the only test of a project's worthiness.

We found that all of the six project areas are active farming areas, a condition that is vastly different from the conditions faced by the sponsors of the early legislation. Today the WPRS projects usually supply supplemental water to areas already irrigated or they irrigate areas that are now successfully dryfarmed. Early projects were to make the desert bloom.

During our study, we examined WPRS records in project offices and regional offices and interviewed Federal and local officials. Our initial findings were reviewed by several academic experts with water policy knowledge and experience with irrigation in the specific project areas. As part of our normal review process, the Departments of Interior and Agriculture were asked to comment on the draft report. Their comments were not received within the 30-day limit as required by P.L. 96-266. We continued final processing of the report and eventually received comments from both Departments. We have included their comments and GAO responses in appendix II.

Chapter 2 traces Federal water policy from the 1800s to now and chapter 4 summarizes our analyses of the six projects we chose for review. Chapters 5 and 6 contain our conclusions and recommendations and a discussion of broader issues. The six case studies are printed in appendix I of this report.

personal viewpoints about equity, legislative prerogative, and on historical practices.

OBJECTIVES, SCOPE, AND METHODOLOGY

To help the Congress make decisions about funding water projects, reimbursement of Federal funds for water project construction, and cost sharing for water projects, we isolated the most controversial issue in the cost sharing/repayment debate--irrigation--and estimated what might happen if the farmer had to pay back the full costs of the irrigation facilities. (See p. 20 for definitions.)

We selected six of the 32 irrigation projects WPRS currently has underway and analyzed them as if the price for irrigation water covers full project costs rather than the low price WPRS intends to charge users when the projects are completed. The six projects which were selected give geographical diversity, and differences in size and in crop patterns. The projects were selected randomly from the 32 which were categorized by size and major purpose. The sampling was not scientific, but the results of the draw did satisfy our desire for geographical diversity and differences in crops. We explain our analytical method in detail in chapter 3, but we summarize it here as the estimation of farmers' responses to the change in increased production (i.e., revenue) with irrigation when the full costs of all factors are taken into account. Estimations of this type, which assume rational decisions designed to maximize profits, are standard techniques of economic analysis and are especially useful when trying to predict decisions about increasing or decreasing an ongoing business activity. In analyzing the effect of water prices on the economic well-being of the project farmers, we gained insights about how WPRS sets the price for Federal water as well as what the WPRS water is worth to the irrigators.

We did not, however, set out to examine the six projects' economic justification, often represented as the benefit-cost ratio. But a careful look at the WPRS analysis reveals that the issues of pricing irrigation and economic justification are intertwined because the same tool of analysis--farm budgets--is used to support both issues. Therefore, much of what we say about pricing could be related to economic justification. For example, when we analyzed the six irrigation projects using a water price that returns all construction costs at a 7.5 percent interest rate, the result was that none of the farmers in the six project areas could afford to irrigate with Federal water. This means that the market value of the crops to be grown with Federal water is less than the cost of the water and the other farming supplies

and to clearing channels for navigation. The Congress and the executive branch understood that financing other purposes, such as flood control, would be unconstitutional. 1/

EASING INTO FINANCING IRRIGATION PROJECTS

The inland waterway navigation expenditures begun in 1824 were mostly for the eastern United States and were made to assist interstate commerce. Tracing the history of Federal involvement in another area of water policy moves one from navigation into agriculture and from interstate commerce into settlement and public lands policies.

Through purchase and war, the United States gained control of large areas of the continent during the first half of the 19th century. The Federal Government gave away or sold much of this land to private citizens or companies to encourage westward settlement.

Much of the western movement was by farmers. As long as they remained east of the 100th Meridian, rainfall was adequate for their traditional farming practices. West of that line, roughly from the middle of the Dakotas down through Texas, the climate is arid or semi-arid, and irrigation was often necessary for farmers to continue their traditional crop and farming patterns. The Mormons were the first pioneers to irrigate land successfully in the 19th century. By 1850 they had begun farming with water turned out from streams and were irrigating a few thousand acres. Other

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1/ Congress also found it politically expedient to exclude direct Federal funding of overflow control projects because the constitutionality of such activity seemed doubtful. A majority of Congressmen concluded that the major purpose of flood control was the reclamation of swamp and overflow lands for the benefit of private owners. They were willing to vote for improvements to the river to aid navigation because fostering and encouraging the commerce of the nation was accepted. Improvements to non-governmental lands, however, were considered to advance purely local interests.

From Single-to-Multi-Purpose Planning: op. cit., p. 15.

CHAPTER 2

THE EXISTING REPAYMENT SITUATION

AND HOW WE GOT THERE

EARLY DEVELOPMENTS

From our beginnings as a Nation, all levels of government have played an important role in developing water resources. In 1807 the Congress directed the Secretary of the Treasury to "prepare a plan for the application of such means as are within the power of Congress, to the purposes of opening roads and making canals." 1/ The subsequent plan for extensive canal development was justified by national goals of "speedy and easy communications" and uniting remote regions of the United States. Waterway development was assisted by a federally financed survey of inland rivers authorized in 1820.

Direct financial support for waterway development was withheld, however, because of the possibly unconstitutional nature of such expenditures. The issue was decided by the Supreme Court when it ruled on whether the State or the Federal Government had control of inland waterways. In a decision written by Chief Justice Marshall, the Court said that the Constitution required the Federal Government to maintain all forms of transportation among the States. 2/ The decision, based on the commerce clause, paved the way in 1824 for the first appropriation specifically for river improvements. 3/

The Federal Government also assisted the boom in waterway development between 1825 and 1840 with loans and public land grants to the States. During most of the 19th century these improvements were confined to moderate dredging efforts

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1/Federal Power Commission, Service Monograph of the United States Government, No. 17, p. 17, John Hopkins Press, Baltimore, 1923.

2/Gibbons v. Ogden 22 U.S. 1 (1824).

3/"An Act to Improve the Navigation of the Ohio and Mississippi Rivers" From Single-to-Multi-Purpose Planning: The Role of the Army Engineers in River Development Policy: 1824-1930, Department of the Army, Office of the Chief of Engineers, February 1976, Washington, D.C., p. 15.

Reclamation Act, introduced by Representative Newlands of Nevada in the 1900-1901 session.

THE 1902 RECLAMATION ACT

The 57th Congress enacted this legislation on June 17, 1902. A cogent rationale for the Act was presented in the U.S. Reclamation Service's first annual report:

> The question may be asked at this point, 'Why has it been found desirable for the Government to take up the work of reclamation if private enterprise has already done so much?' The answer lies in the fact that, while this is true, the results have not been wholly satisfactory, as far as the large interests of the country are concerned. While the development of the choice spots has been accomplished and the easily available waters have been utilized, the larger public interests have not been guarded, and the making of homes has not been carried on to the extent which the wisest statesmanship required. In smaller projects, especially those cooperative in nature, private enterprise has been successful, but in the larger and more difficult undertakings, it has not been financially successful, and the public lands have not been utilized to the highest good of the people. 1/

The funds for the irrigation works, to be located and constructed by the Secretary of the Interior, were to be obtained from the sale of public lands in 16 western States (Texas was added in 1905, but had no public lands). Six major projects were approved by the Secretary in 1903, and construction on the first--the Truckee-Carson in Nevada--began in that same year. Other projects were quickly approved, and by 1917, 25 were either completed or under construction. 2/ These original 25 projects were located in 17 States and were planned to fully irrigate about 1.8 million acres.

1/ First Report: Reclamation Service, June 17 to December, 1902, Washington Government Printing Office, 1903, pp. 31-32.

2/ Repayment of Reclamation Projects, Bureau of Reclamation, Department of the Interior, Washington, D.C., 1969; U.S. Reclamation Service, op. cit., p. 24-25.

efforts rapidly followed, and by 1880 about a million acres were being irrigated throughout the West. 1/

The Federal Government made two legislative attempts prior to 1900 to stimulate irrigated agriculture. Under the Desert Land Act of 1877 a lot of Federal land was transferred to private ownership; under the Carey Act of 1894 little was transferred. Implementation of both was beset with fraud and scandal, 2/ and little irrigated agriculture resulted.

Although these two acts failed to stimulate irrigation of public lands, irrigation of private lands had increased from 1 million acres in 1880 to 3.6 million in 1889, and further increased to 7.5 million acres in 1899. 3/ Advocates of direct Federal support for irrigation believed that private development could not grow after 1900 because the land that was inexpensive to develop would be exhausted by that time.

Direct Federal construction of major irrigation works was first supported by John W. Powell, an Army major, who suggested in 1878 that large engineering projects could solve the problem of reclaiming arid lands. In 1888 the Congress authorized investigation of the practicability of building irrigation reservoirs in the West. They held hearings in 1889, several private irrigation congresses were held in the 1890s, and several Federal documents were published. 4/ Because of these efforts, interest in federally supported irrigation of western lands increased. The 1900 presidential campaign was noteworthy in this regard as all three parties--Republican, Democrat, and Silver Republican--had platform planks favorable in various degrees to irrigating lands in the West. Congressional activity culminated with the 1902

1/The U.S. Reclamation Service, Service Monographs of the United States Government, No. 2, Institute for Government Research, D. Appleton and Co., New York, 1919, p. 3.

2/The U.S. Reclamation Service, op. cit., p. 6 for the Carey Act; A Study of Land Frauds on the Western Lands of the United States, 1875-1900, Masters Thesis by Virginia Carol La Manna, New York University, January 1934, p. 46 and Report of the Public Lands Commission, Senate Document 189, 58th Congress, 3rd Session, Washington, D.C. 1905, p. 93, for Desert Land Act.

3/The U.S. Reclamation Service, op. cit., p. 16

4/The U.S. Reclamation Service, op. cit., pp. 8-16.

had to pay 5 percent up front, but were allowed 5 years to pay the first of 15 annual installments.) 1/

The emerging subsidy

Extending the repayment from 10 years to 20 years also turned out to be inadequate. Many of the irrigators in the projects were in arrears at the end of the new repayment period. The Congress reacted by passing a major relief act in 1926. 2/ Twenty-one projects were affected and about 13 percent of all costs incurred up to that time--about $17.3 million--were written off. 3/ In addition, all the projects --about 26--had their repayment periods extended. As a result of the 1926 relief act repayment was to be made within 40 years.

Irrigators are charged according to their ability to pay

The final major shaping of the reclamation program as we know it today came with the Reclamation Project Act of 1939. 4/ This law was interpreted by the Bureau of Reclamation (now the WPRS) to limit the financial obligations of irrigation beneficiaries to their ability to pay for the water. The construction costs for irrigation not repaid by the farmers would come primarily from excess revenues earned from the sale of electrical power generated by WPRS facilities. The ability-to-pay concept rests on the idea that many reclamation benefits are national in character and should not be a burden on the direct users of irrigation water. Estimates of the ability-to-pay price are based on economic analyses of the proposed projects. The repayment period can be as long as 50 years, including a grace period of up to 10 years.

When the legislative developments sketched above are looked at in combination, the various elements of the

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1/(38 Stat. 686)
Another major aspect of the 1914 Act was the transfer of project approval to the Congress from the executive branch.

2/Omnibus Adjustment Act of May 25, 1926. (44 Stat. 636).

3/Repayment of Reclamation Projects, U.S. Department of the Interior 1972, p. xxxix.

4/(53 Stat. 1187)

The Reclamation Service found that many of these project areas encompassed considerable tracts of private land. Yet, despite the congressional intent that most of the lands so irrigated should be public lands, 1/ it decided to proceed with construction regardless of the ownership.

Repayment according to the 1902 Act

The 1902 Act contains language in Section 4 that indicates that the construction costs of the irrigation projects would be repaid by the beneficiaries:

> the Secretary (of Interior) . . . shall give public notice . . . of the charges which shall be made per acre . . ., the number of annual installments, not exceeding ten, . . . and the time when such payments shall commence. The said charges shall be determined with a view of returning to the reclamation fund the estimated cost of construction of the project 2/

Monies to construct the irrigation projects were to come from a reclamation fund administered by the Secretary of Interior. The fund was financed initially by sales of public lands, and thereafter replenished with repayments from farmers. By 1911 the fund was also receiving revenues from the sale of excess electrical power (34 stat. 116) and water (36 stat. 925). Power revenues were credited to the project that supplied the power, but not until the Fact Finder Act of 1924 (43 Stat. 703) was revenue from surplus water sales credited to the originating project.

The farmers in the early reclamation projects had a difficult time meeting the annual payment requirements of the 1902 law. The costs of establishing irrigated farming on previously unfarmed, arid land were much higher than expected, and the costs of building the projects were much higher than the original estimates. Reacting to these reasons, the Congress passed the Reclamation Extension Act in 1914, which extended the repayment period to 20 years. (New irrigators

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1/U.S. Reclamation Service, op. cit., p. 26-27.

2/(32 Stat. 389).

In 1950 the Cooke Commission said that "reimbursement procedure should aim, as far as possible, to recover a reasonable portion of the benefits accruing from public expenditures for water resource development." 1/ In its assessment of irrigation repayment, however, the Commission recommended that the existing practices should be continued. "The primary beneficiaries of reclamation activities should repay without interest an amount assessed according to their ability to pay . . . ." 2/

The Second Hoover Commission's task force on water resources issued a report in June 1955 which found that "the Federal Government has paid too much of the costs of water resource and power development and has required too little of the beneficiaries." 3/ This Commission recommended:

> That the Congress . . . establish cost distribution principles, which 'cohesive and clearly identifiable groups receiving substantial benefits will be required to observe . . . . That . . . agencies representing the groups of cohesive and clearly identifiable recipients be required . . . to bind themselves to pay at least 50 percent of the cost prorated to them . . . with interest." 4/

Thus, from the Cooke Commission in 1950 to the Second Hoover Commission in 1955, experts recommended water pricing policy ranging from the ability to pay with no interest to payment of half the allocated costs with interest.

1/A Water Policy for the American People: The Report of the President's Water Resources Policy Commission, U.S. Government Printing Office, Washington, D.C., December 1950, p. 12.

2/Ibid., p. 84.

3/Report on Water Resources and Power, Volume one, Task Force on Water Resources and Power for the Commission on Organization of the Executive Branch of the Government, U.S. Government Printing Office, June 1955, p. 14.

4/Ibid., p. 98.

irrigation repayment situation become evident. The 1902 Act was interpreted to mean that irrigators were obligated to repay just construction costs, not costs plus some interest charge. Various other relief acts forgave some of the debts and extended the repayment periods. The 1939 Act was used to reduce the repayment obligations of the irrigators to a fraction of the construction costs. For the projects reviewed in this report, the value of the repayments is less than 10 percent of the payment that would be required if full costs are to be recovered. 1/ Thus, irrigators are receiving a large subsidy because much of the money allocated for constructing the irrigation facilities is scheduled to be repaid by someone other than the beneficiaries.

CONTEMPORARY DEVELOPMENTS

Total irrigated land in the United States is 41 million acres, or about 4 percent of all farm land. The WPRS program has fully irrigated about 4.3 million acres and partly irrigated about 5.2 million acres, accomplished by 176 operating projects in 1977. Of the WPRS projects now under construction, about 32 include some irrigation facilities. If these projects are completed at current cost estimates, they would total over $14 billion.

The efforts to irrigate lands in the West and to provide water for other purposes have not been without critics. Several major studies commissioned by the Federal Government have recommended changes in the way the reclamation program is carried out. Below we have summarized several of the studies that addressed cost sharing and repayment of Federal expenditures for water projects.

1/ Water users in irrigation projects are required to pay back a portion of the irrigation capital, . . . but they pay no interest. The portion they are judged capable of repaying rarely is the full cost per acre of the project. Recently the general range has been between one-quarter and one-third of the capital costs, and a few are as low as 10 percent. . . . Over and above the portion of the construction costs that water users do not pay, the foregoing of interest alone usually provides an additional subsidy equal to the total costs of construction.

Source: Water Supply, Economics, Technology and Policy, Hirshleifer, DeHaven & Milliman, The University of Chicago Press, 1960, p. 227.

> All costs of new Federal irrigation facilities should be recovered from irrigators and other direct beneficiaries through contracting entities, with interest . . . ." 1/

The Executive Branch rejoined the debate in 1977 when President Carter directed the Secretary of the Interior to chair a review group to "conduct in consultation with the Congress and the public, a review of the present Federal water policy." 2/ So far the group has issued a series of interagency task force reports and suggested new regulations. In June 1980, the review group sent the President a report that discussed the repayment issue. 3/ For water conservation, the report said that the Executive Branch is "in the process of changing water contracting procedures to increase cost recovery."

The group is also reviewing the estimating procedures for water pricing to see if they can be strengthened or whether another price-setting device should be used. Legislation has been proposed to change the non-Federal role in cost sharing, but without success. 4/ The bills' main provisions are that the States would fund 5 to 10 percent of the estimated costs before a project is constructed. If a project produces revenues, the States would share these on a pro rata basis.

Federal efforts since World War II to change cost sharing and repayment criteria have not resulted in many changes for irrigation users. The Department of the Interior continues to administer the price charged to users, but the price covers only a small percentage of the costs to deliver water. Concern is still voiced that planning, evaluation, and cost-sharing arrangements result in inefficient projects and ineffective use of Federal monies.

1/ Ibid., p. 497.

2/ "Detailed Background on the Water Policy Message to Congress," Office of the White House Press Secretary, June 6, 1978.

3/ Final Report of Phase I of Water Policy Implementation, report submitted to the President by the Secretary of Interior, June 6, 1980.

4/ S. 1599 (Federal Water Projects Financing Act of 1979), HR 4127, HR 4135, all 96th Congress, 1st session.

In 1961 the Kerr Committee, which was much less interested in cost sharing than the previous two commissions, issued its recommendations for water resource policy. 1/

> Ideally, responsibility for bearing costs should be divided, between the Federal Government . . . and non-Federal interest . . . . But the division point is not easy to determine.
>
> The committee is not overly concerned with the cost sharing aspect . . . because it believes that the present policies tend to even out the sharing of costs over the long run, among all the people.

Over a decade passed before another commission tackled the issue of water policy. In 1973 the National Water Commission discussed payments for water projects, noting that:

> Policies for cost-sharing are separate from, although closely related to, policies of economic evaluation . . . . However, the question of who pays for a project will often determine the enthusiasm with which the project is supported. . . .
>
> The need for reform of cost-sharing policies has long been recognized, but numerous attempts . . . have met with little success. The supporters and beneficiaries of project construction . . . have resisted proposals for higher non-Federal shares as a threat to development programs and, in the case of beneficiaries, to their pocketbooks. 2/

The Commission found that "present cost-sharing policies are grossly inconsistent and lead to inefficiencies and inequities . . . ." It recommended a repayment principle for irrigation that basically called for full-cost water pricing.

1/Report of the Select Committee on National Water Resources, U.S. Senate, Senator Robert S. Kerr, Chairman, 87th Congress 1st Session, Report No. 29, Jan. 30, 1961, p. 23.

2/Water Policies for the Future, Final Report to the President and to the Congress of the United States, National Water Commission, U.S. Government Printing Office, June 1973, p. 485.

The first point can be made about all of WPRS' analyses because WPRS excludes the cost of project water as a matter of standard procedure. The second point, WPRS' inconsistent application of its own assumptions, typifies the problems with the estimates of income and costs that we found in every farm budget analysis.

Taking the WPRS analysis as given, we show in Table 2 how WPRS uses the net income estimate to arrive at an estimate of water price.

Table 1

WPRS' Farm Budgets for North Loup

Estimated income and costs	Without project water	With project water	Estimated changes attributable to project water
Gross Income	$51,868	$82,121	$30,253
Crops	21,344	39,025	
Livestock	28,244	40,816	
Other	2,280	2,280	
Costs	$43,899	$68,931	$25,032
Crops	2,571	12,307	
Livestock	24,374	37,254	
Interest	9,418	11,122	
Other	7,536	8,248	
Net Income	$ 7,969	$13,190	$ 5,221

Table 2

How WPRS Calculates
Its Water Price Estimates

From the net increase in farm income attributable to project water	$5,221
Subtract total allowances of	$2,582
--10% of net income*	522
--additional labor**	2,060
--return on investment***	0
The remaining net income is the payment capacity	$2,639
The price per acre for project water is	$19.40

* WPRS' compensation for management skills.

** Allowance to the farmers for the extra work caused by irrigation.

*** Most payment analyses include an estimate of return on investment. This WPRS analysis for North Loup does not.

CHAPTER 3

METHODOLOGY

WPRS ANALYSIS CANNOT ACCOMMODATE A CHANGE IN THE COST OF WATER

We needed an analytical framework on which to build our discussion of how water priced at its full cost would affect farmers in the proposed WPRS irrigation projects we selected for review. After careful study we found that WPRS' analysis, which it conducts to establish project economic viability and to determine the price farmers will pay for the water, was not useful for our purposes. WPRS bases its analysis on farm budgets, which are supposed to represent all the gross incomes and costs of typical farms in a proposed project area. WPRS makes one set of farm budgets that accounts for actual conditions without project water, and it makes another set for conditions expected as a result of project water. The net income (gross income minus costs) of both farm budgets is then compared, and the increase in net income that results from project water becomes the estimate of the project's economic value and the figure upon which WPRS bases its water price (payment capacity) analysis.

To help explain the WPRS analysis, we compiled figures from an actual farm budget developed by WPRS for the North Loup project in Nebraska, one of the six projects we studied. Table 1 shows the actual income and cost estimates for a 640-acre farm with 136 acres to be irrigated with project water. The base year is 1974 with yields projected to 1990.

When we looked at the North Loup farm budget in detail, we noticed that

1) the costs used to arrive at the estimate of net income attributable to project water did not include a cost for Federal irrigation water. Including such a cost would drastically reduce or eliminate the estimated increase in net income.

2) WPRS analysts made assumptions about ratios of purchases to levels of activities that they followed for some economic calculations, but did not follow for their payment capacity (water price) calculations. When we brought the water price analysis into line with the analysts' benefit assumptions, the net income attributable to the project water rose by $6,535.

this method is that WPRS' analysis cannot accommodate any change in the price of water without undermining its own estimates of income, costs, and allowances.

b) WPRS bases its estimates of increased net income on assumed increases in all farming activities as well as increases in yields from land irrigated by project water. In the North Loup project, the farmer without project water now raises corn, alfalfa, wheat, and cattle and hogs. With the addition of project water, WPRS analysts assumed that the corn yield would increase, thereby increasing the yield in cattle, while all other yields remained the same. We do not think an increase or decrease in the cattle herd depends on project water. A University of Nebraska professor says there is already more than enough corn grown in the North Loup area to feed the cattle herds, so if a farmer wanted to produce more cattle, his decision would probably not depend on producing more corn. The further the WPRS analysts go from the actual use of the water to enhance a farm's yield, the more precarious their assumptions become about how farmers will decide to conduct their other farming activities.

c) WPRS' analysis treats land to be irrigated as though crop yields from those acres would be equivalent to the yield of already irrigated acres. Thus, it overlooks the consideration that land yet-to-be irrigated by project water is often of lesser quality and that when such land is irrigated its yield will not be as great as the land currently irrigated. For the Auburn-Folsum project, one of our other case studies, WPRS analysis noted that about 75,000 acres would be irrigated in addition to the 250,000 already irrigated from other sources.

The water price analysis was calculated based on 162,000 acres of "new land equivalent," 1/ which will produce both high- and low-value crops. We think the high-value crops would be grown, up to market-imposed restraints, even if project water were not available,

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1/New land equivalent is where the WPRS analysis reflects the same value for water from project and nonproject sources. The without-project condition is assumed to be unirrigated and the water to be supplied by the project is applied analytically to as many acres as there is water.

For several reasons the WPRS analysis impelled us to look for another analytical framework.

a) WPRS prices water as a residual value. The analysts estimate the increase in gross income possible with the addition of irrigation water, calculate the increase in costs associated with the gain except the cost of Federal water, establish a level of profit they believe should be sufficient for the farmer to make the effort to increase farm yields and, after subtracting the profit from the increased yields, they assign a monetary value to the water that is equal to the remainder. This residual approach to water pricing is one of the reasons why WPRS' analysis is invalid for our purposes.

Think of the water price charged to the irrigator as an equation where X, the unknown element, is the ability-to-pay price. For the North Loup project, the equation would read:

income - costs - allowances = X

$30,253 - $25,032 - $2,582 = $2,639

To solve for X, one uses the income and cost figures derived from the estimates of actual conditions and the predetermined allowances that give the farmer a fair return for additional labor and management. Note, however, that any exogenous change in X that is not accompanied by a change in the other elements of the equation, such as costs, results in an inequality.

We wanted to change the price of water to a figure that reflects water's full cost, not merely an estimate of the farmers ability to pay for it. If we changed the water price per acre for North Loup from about $19 to $57 (our estimate of the water's full cost), the increased price would destroy all the carefully crafted assumptions, estimates, and judgments in the analysis. Tripling the water price raises the estimated payment capacity to $7,752. Since the net income attributable to the project is only $5,221, our hypothetical X change means that the farmer would lose $2,531 if project water priced at full cost were used.

In effect WPRS arrives at a price for water that is a residual price or value. The result of

How we determined the water prices used in this analysis

The proposed WPRS water prices would confer a considerable subsidy on the farmers in the irrigation districts. As shown in chapter 2, the subsidy consists of two elements. The first is the small, partial payment of the capital costs of construction; the second is the lack of interest on any of the repayments. So that we could analyze the effect of eliminating the total subsidy, we developed two prices, which represent both elements of the subsidy.

- Interest-subsidy price: The price for water that WPRS would have to charge farmers to recover all the costs of constructing the irrigation facilities, but with no interest charged. We kept the same liberal repayment period of 50 years.

- Full-cost price: The price calculated under the conditions above but including an interest rate. For this analysis, we selected a 7.5 percent interest rate. 1/

Effects to be measured

Our analysis is based on the anticipated reactions of farmers. We assume they will not invest in irrigation equipment or expend additional effort unless the anticipated differences between the expected increases in income and the expected increase in costs is high enough to make the investment worthwhile.

Farmers know that irrigated agriculture requires more production supplies, such as fertilizer and seeds, and more farming skills, such as knowledge of water schedules. They will decide to either increase irrigated acreage or begin irrigation of dry-farmed acreage only if the increased yields bring in enough revenue to cover the increased costs and the risk of increased entrepreneurship. Approached in this manner, irrigation water can be thought of as the scarce resource it is because additional water supplies can be acquired only with the expenditure of additional resources.

1/This was arbitrarily selected as we did not want to confuse the analysis with a range of numbers or to defend a rate based on objective criteria. As a practical matter, a lower rate would mean that the annual acre-foot full-cost price would be lower than our estimates; conversely, a higher rate would translate to relatively higher prices.

and that the crops grown on the remaining acres would yield less than the land now under irrigation.

OUR ANALYTICAL APPROACH

We uncritically used the WPRS cost of water and, after validation or correction, the WPRS production cost data. We were unable, however, to rely on much of the WPRS supporting analysis and were faced with the problem of analyzing the effect of increased water prices on farmers at Federal projects. After posing the problem we wished to solve--would the increases in gross income from increased production because of irrigation be greater than the increases in production costs if such costs included a price for water--we decided to use a measuring tool called marginal analysis.

Marginal analysis helps assess alternative courses of action open to individuals by measuring incremental (or marginal) changes in a well-established economic activity. The addition of WPRS irrigation water is a marginal change because only some part of the project lands will receive the water. For example, if 10,000 acres in a 40,000-acre project area are irrigated from other sources, any water added to that supply may be used to irrigate part of the unirrigated 30,000 acres. Our marginal analysis concentrated only on the acreage yet to be irrigated with Federal water. We were not interested in land irrigated before the project began delivering water, nor were we interested in land that would not be irrigated, even with Federal water. The net income of the increase in the newly irrigated acreage is compared only to the net income of the same acreage without irrigation.

All the proposed Federal irrigation projects are located in established farming areas. Some are partially irrigated, some are dryfarmed. None are arid, unfarmed lands.

We assume that the farmers will accept Federal water if the price charged for it would help generate enough revenue to cover all additional costs. If the price for water is so high that production costs would outweigh increases in income, we assume that the farmers would not choose to purchase the Federal water. Our conclusions about the possible economic effects of higher water prices are based on changes in a farmer's economic well being. For instance, if water from project "X" is offered at a price that covers all the allocated construction costs plus a moderate interest rate, the farmer's decision to buy that water will depend on whether irrigated agriculture adds some profit. If irrigation does not add a profit, the farmer is better off economically not to irrigate.

The ability-to-pay estimate becomes the basis for contracting with the farmers for the water.

When we included the price of water in the WPRS analysis as a direct cost of doing business, the difference between the income and the yield is profit or return to the owner. If the farmer does not consider the return great enough, or if the return is negative, the farmer will forego the activity.

Farmers will change their normal business patterns only after making a pragmatic analysis of the expected gains and the risks associated with change. A Kansas farmer, who has been growing corn without irrigation, would consider many factors before changing to irrigated corn. The farmer knows the water will cost a lot of money, the husbandry needed for irrigated corn will be more intense than with dry-farmed corn, and the harvesting costs will rise. The farmer will also consider the uncertainty associated with future corn prices.

COMPARISON OF OUR ANALYSIS TO WPRS' ANALYSIS

The WPRS and our analyses are similar in that costs and incomes are compared. As we noted earlier, our analysis is limited to the farm acreage that will receive WPRS water. The larger unit of analysis, which includes nonirrigated lands, used by WPRS is only appropriate, we believe, if the area is not being used for farming before the water is applied. This is not the situation in our six case studies, nor has it been true for any period except some of the early Reclamation Service projects.

When we compare the way costs and incomes are entered in the two analyses, we see that WPRS first calculates the gross income from all the farming activities for a representative farm in the project area, with and without project water. Costs of producing the income are then subtracted from this gross income, save for the cost of Federal water. The resultant net income is equated to the net national benefit from irrigation.

This approach seems reasonable, except for the problem of how much of the farm unit's increase in yield can be attributed to the water supplied by WPRS. However, the cost of supplying WPRS water to the farm unit is not included as a cost of producing the income. It is calculated separately when the net income from irrigation is compared to costs in the benefit-cost analysis.

The WPRS analysis then takes a turn which magnifies the differences in approach up to this point and highlights the philosophical underpinnings of the reclamation program. It takes the "net income" figure for the representative farm and subtracts from it several items normally called profit or return to the owner. These include a wage rate for the hours worked by the farmer and family, a fixed fee for management, and a return on capital.

Once these items are subtracted from the net income figure, the result is called the ability-to-pay for WPRS water.

acre-foot to almost $20 an acre-foot. Table 3 lists the projects and some of their relevant characteristics.

WPRS estimates of ability-to-pay for each project are shown in table 4. The operation and maintenance charges are to be paid as they are incurred each year. To arrive at the ability-to-pay price estimated by WPRS, add the operation and maintenance charge and the ability-to-pay price which goes toward the irrigators' repayment of the construction costs of the irrigation facilities. We contrast the ability-to-pay price to the prices that would have to be charged the irrigators, including the estimated operation and maintenance charge, (1) if the interest subsidy were the only subsidy, and (2) if the full costs of construction had to be repaid by the irrigators.

Our calculated cost to produce water at Federal irrigation projects is between $87 and $130 an acre-foot except for the Fryingpan-Arkansas project at $54, which distributes supplemental water through existing facilities, thus eliminating one of the major costs at the other projects. The payment the WPRS intends to charge to the irrigators to recover the construction costs is not nearly as even. It ranges from a low of 27 cents (or 7 cents according to our estimates) an acre-foot at the Fryingpan-Arkansas project to a high of $9.82 an acre-foot at the Oroville-Tonasket project. Some of the projects are subject to an ad valorem tax, to which the farmers contribute, but only at the Fryingpan-Arkansas is the irrigator's share of the tax very large.

Auburn-Folsom South Unit
Central Valley Project--California

The irrigation facilities at this large multipurpose project were estimated as of June 1978 to cost $724 million, or almost 60 percent of the total project costs. The project area covers over 500,000 acres on the east side of the Central Valley between Sacramento and Stockton. It is extensively farmed--about 60 percent of the arable land is already irrigated from ground water and local streams. The WPRS rationale for the project was that the additional water would help develop and stabilize the local agricultural economy.

The irrigators are scheduled to repay about 23 percent of the nominal construction costs of the irrigation facilities through the ability-to-pay price. The total of $170 million, which will be repaid without interest over 40 years, amounts to about $8 an acre-foot each year. The operation and maintenance charge of almost $12 an acre-foot raises the total to about $20 an acre-foot.

CHAPTER 4

HIGHER WATER PRICES AT SIX WPRS PROJECTS UNDER CONSTRUCTION

We analyzed specific irrigation projects to estimate the possible economic effects of higher prices to irrigators. These prices reflect the costs of providing the water rather than the ability-to-pay prices now used by the WPRS. Six projects in various stages of construction were selected for review.

From our review we conclude that none of the projects would have contained irrigation facilities if the potential beneficiaries had been offered the water at a price that would repay the construction costs plus a 7.5 interest charge. Additional irrigated crops in the proposed project areas simply would not generate enough additional income for the farmers to be able to pay for the production expenses associated with irrigated agriculture and repay the Federal Government for the costs to build the projects.

The situation would be different if the water from these six projects were offered at a price that covered construction costs at no interest. Such a price would confer an interest subsidy and would be substantially lower than the full-cost WPRS price. With irrigation, farmers in some of the project areas could produce enough additional crops at low enough cost to turn a profit.

The results of the case studies are briefly summarized in the rest of this chapter. The full case study analyses are contained in appendix I.

CASE STUDY RESULTS

We selected the six projects from about 30 major WPRS projects now under construction with irrigation as a major project function. They represent the varied geographic conditions and cropping patterns in the West, and they range in size from less than 10,000 acres to over 500,000. In 1978 the estimated overall project costs were between $35 million and $1.3 billion. One project area raises only one crop; another is in a fertile, multicrop agricultural center; and four of the areas are mainly forage and cattle.

The WPRS's estimates for the water prices according to its ability-to-pay calculations range from about $6 an

Table 4

Comparison of Prices per Acre-Foot

	WPRS-estimated ability-to-pay price, construction costs	O&M charge	GAO calculated prices: Interest subsidy	GAO calculated prices: Full cost
Auburn-Folsom	$ 7.79 a/	(11.79)	$25.13	$ 86.54
Dallas Creek	$ 3.62 a/	(0.62)	$25.18	$103.04
Fryingpan-Arkansas	$ 0.27/ $ 0.07 a/b/	(9.81/ (2.69)	$14.91	$ 54.24
Oroville-Tonasket	$ 9.82	(9.89)	$34.11	$129.11
North Loup	$ 6.67	(5.40)	$31.60	$117.93
Pollock-Herreid	$ 3.10	(8.51)	$35.34	$130.50

a/The acre-foot estimates for these three projects are not the same as those in the annual data presented to the Congress. The estimates in table 4 are GAO adjustments based on the detailed pay-out schedules available from the project documentation. For example, the WPRS makes no estimate of the acre-foot payment capacity of the Auburn-Folsom project as a separate part of the Central Valley Project. The Dallas Creek estimates by WPRS are $3.96 an acre-foot for construction costs and $0.34 an irrigated acre for O&M. WPRS claims they cannot express the acre-foot ability-to-pay estimates for the Fryingpan-Arkansas on that basis.

b/The second price under ability-to-pay is for comparison to the GAO-calculated prices. On the Fryingpan-Arkansas project, WPRS says there will be 32,300 acre-feet produced each year, but GAO believes that the irrigation district would charge the irrigators based on the delivered totals of 118,000 acre-feet each year.

Source: Respective project data sheets presented to the Congress in the annual budget hearings and the backup data, usually the definite plan reports.

Table 3

Case Study Characteristics

	Total cost (millions)	Irrigation as a percentage of total cost	Firm water yield (year) (acre-feet)	Project area (acres)	Type of agriculture
Auburn-Folsom, California	$1,267	57.2	545,000	500,000	Varied crops
Dallas Creek, Colorado	$ 62	26.2	11,200	63,700	Forage & cattle
Fryingpan-Arkansas, Colorado	$ 568	15.5	32,300	280,600	Forage & cattle
North Loup, Nebraska	$ 137	96.2	80,000	250,000 a/	Corn & cattle
Oroville-Tonasket, Washington	$ 42	92.8	22,800	9,500	Apples
Pollock-Herreid, North Dakota	$ 35	98.4	35,700	75,000 a/	Corn & cattle

a/Estimated by GAO from farm budget data. In all project areas except Oroville-Tonasket, the area which will actually receive some WPRS water is a small percentage of the project area.

SOURCE: Project Data Sheets, Fiscal Year 1979 Budget Hearings, Bureau of Reclamation presentation to the House Appropriation Subcommittee, February, 1978.

now privately irrigated. WPRS says the current water supply is about 10 percent less than ideally required. WPRS believes that inadequate water supplies will hinder the full agricultural potential of the area.

The project area is in a high mountain valley and most of the crops--alfalfa, hay, and pasture--are grown to feed cattle. WPRS estimates that about 18,000 acres in the existing Uncompaghre project area and 2,850 acres of private land will be irrigated by the Dallas Creek water.

WPRS' ability-to-pay analysis and our marginal analysis of this project reveal startling different results. We believe that the WPRS approach hides more than it discloses about the usefulness of the water produced by the Dallas Creek project. WPRS was not able to accurately measure how much the small amounts of extra irrigation water would increase production. Instead, it measured what the full (old project of 5.0 acre-feet per acre plus Dallas Creek project of 0.2 acre-feet per acre) application of irrigation water to dryland would produce. This estimation process revealed that the farmers could afford to pay between $17 and $22 an acre for irrigation water. The average presented to the Congress in 1979 for the annual budget hearings was $20.41 an acre. WPRS analysts then divided by 5.2 acre-feet and came up with an average ability-to-pay price of approximately $3.96 an acre-foot. This calculation was the basis for the water-use price which was contracted for between the irrigation district and WPRS. Therefore, the average productivity of all the water was used to determine the ability to pay.

The price for water from the existing WPRS project in the area is $8.63 for 5.0 acre-feet (a maximum price). We believe, using WPRS' approach to water pricing, that this other-project price should have been subtracted from the overall ability-to-pay price. The farmers could then be charged $58.90 an acre-foot for Dallas Creek project water ($20.41 - $8.63 = $11.78 for 0.2 acre-feet or $58.90 for 1 acre-foot). The interest-subsidy price for the Dallas Creek project water would be $29.64 an acre-foot--a price irrigators could easily pay, according to WPRS' analysis, but a price considerably less than the $107.63 an acre-foot needed to pay for the full cost.

WPRS officials did not agree that its analysis could be used in the way we have presented it here. We agree that our results using WPRS data do not compare with the reality of the situation of the relationship of the Dallas Creek water and the crops grown in the project area, but not because the methodology was misused.

Our analysis of this project was based on linear programming models of the area's farms. 1/ We varied the water costs, and the models produced estimates of what kind of crops would be planted and how much land would be irrigated from both public and private sources at each price level. The full-cost price for Auburn-Folsom water, based on 1978 estimates of construction costs and a 7.5 percent interest rate, would be almost $100 an acre-foot. The interest-subsidy price would be around $36 an acre-foot. Both prices include the $12 acre-foot charge for annual operation and maintenance.

When the models were run with the full-cost price of $100 an acre-foot, we found that Federal water would not be purchased by the irrigators. In short, the farmers would farm as they do now--without water from the WPRS project. Some land would be in unirrigated pasture or grains, some would be irrigated from wells, and some would be irrigated from local streams.

At the interest-subsidy price of $36 an acre-foot, the models indicated that the farmers would purchase the Federal water, but only 47 percent of it. Thus, some of the land now unirrigated could be irrigated and the net income of the farmer would increase, but not all the unirrigated land would be utilized.

These farmers, we found, would be sensitive to increases in water prices, and they would respond by changing their cropping patterns and irrigation techniques. In the specific case of the farmers in this project area, the models showed that the demand for WPRS water began to slacken between the proposed subsidized ability-to-pay price of $20 an acre-foot and the interest-subsidy price of $36 an acre-foot. Some water would be taken under 1978 conditions up to $76 an acre-foot. (See pp. 47-72 for case study.)

Dallas Creek Participating Project
Upper Colorado River Storage Project--Colorado

The irrigation facilities will cost about $16.2 million out of the total project costs of $62 million according to 1978 estimates. The irrigation water--11,200 acre-feet a year--will be added to an area already irrigated by one of WPRS' oldest projects. A small amount will go to an area

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1/For details about these models, see our case study of the Auburn-Folsom project, pp. 59-63, appendix I of this report.

Table 5

Various Estimates of Water Price for the Fryingpan-Arkansas Project

	Direct water charge	Indirect charge per acre (280,600 project acres)	Total 50 years
Project data sheet	$31.66 a/f		$
Payout sheet at 32,300 annual a/f	$ 0.27 a/f	$ 0.31	$
Payout sheet at 118,000 annual a/f*	$ 0.07 a/f	$ 0.31	$

* As explained in appendix I, we believe that the irrigators districts based on this 118,000 acre/feet estimate.

Source: Project Data Sheet contained in Congressional Budget Bureau of Reclamation, op. cit. Payout sheet obtain in Pueblo, Colorado.

When we asked how the Dallas Creek irrigation water would aid crop production, WPRS officials told us that the gains in crop production could not be measured accurately, but that the project would improve seed germination and crop finishing. Without any gains in crop production from the Dallas Creek project, the irrigators' gross income would not increase to offset the increased costs of water--instead net income would be reduced if the water was not free. We do not believe that the irrigators could pay even the interest-subsidy price of almost $30 an acre-foot. (See pp. 73-88.)

Fryingpan-Arkansas Project--Colorado

Water from several small rivers on the western slope of the Rockies is being diverted through the mountains near a tunnel to add to the water supplies and to generate electricity on the eastern slope. In 1978 the estimated costs of the irrigation facilities were $88 million, or about 15 percent of the total project costs. The project service area lies along the Arkansas River, up to the Kansas/Colorado border. This long-established agricultural area is now irrigated with water from the Arkansas River. WPRS recommended the project because the additional irrigation water would stabilize agricultural production.

The ability-to-pay on an acre-foot basis was difficult to estimate from WPRS analysis and presentations. We did find a payout schedule indicating that area farmers would pay $456,000 in direct water charges after paying for operation and maintenance. This total payment is spread over 50 years. If these figures are accurate, the annual acre-foot charge to repay construction costs would be $0.27, based on the releases of 32,325 acre-feet of stored water.

WPRS suggests in its annual budget that the irrigators in the project will repay $31.66 an acre-foot each year. A difference exists between WPRS' calculation and ours of $0.27 an acre-foot because WPRS figures include an ad valorem tax which totals $55 million from an area nine counties large. Only a small part of this amount will be paid by irrigators. We estimate their contribution to the total will be 8 percent, or $4.4 million. If we then assume that the ad valorem tax will be paid on an acreage basis and not on a water-use basis, we can present in table 5 the following estimates for the per acre-foot price for the Fryingpan-Arkansas project.

The full cost of the Fryingpan-Arkansas water is $57 an acre-foot when using an annual water supply of 118,000 acre-feet. The interest-subsidy price would be about $18 an acre-foot. Corn for grain is the only field crop grown in the area which could, if irrigated with the late season water

The price for the water was recently fixed by a contract between WPRS and the irrigation district. The ability-to-pay estimate was $18.10 an irrigated acre, or about $12.07 an acre-foot. Repayment for the construction costs is $9.90 an acre of the total price, leaving operation and maintenance at $8.10 an acre. This means that $27.3 million of the $131.6 million will eventually be returned to the U.S. Treasury by the farmers who directly benefit from the water.

Since about half the acreage scheduled for irrigation from the project is already irrigated from local streams or wells, the economic effect of fully or partially eliminating the subsidy depends on whether the land is now dryfarmed or irrigated. For both types of analysis, we used corn as the irrigated crop because it is almost 90 percent of the irrigated cropland in the area.

Dryland versus irrigated land

WPRS estimates that the irrigated land will produce 104 more bushels of corn per acre than dryland. At $2.20 a bushel, an acre converted from dryland to irrigated land would yield an increase in gross revenue of about $230. Production costs, not including water, range from $107 to $139 an acre. 1/

At the full-cost price, WPRS water would cost $185 an acre (about $123 an acre-foot). This price would increase production costs to $292 to $324 an acre for the extra 104 bushels of corn, which would exceed the increased revenue by $60 to $90 an acre. For the farmer to break even on corn irrigated with water priced at full cost, corn prices would have to rise by almost 40 percent. We do not believe that the dryland farmers would accept the WPRS project at the full-cost price.

At the interest-subsidy price, WPRS water would cost about $56 an acre ($37 an acre-foot). The increased production costs would be $163 to $195 an acre, including water expense. The increase in gross income would be about $230 an acre so the farmer could expect an increase of about $32 to $64 in net income per acre under these conditions. We believe this net increase would be high enough to induce the farmer who now dryfarms to buy WPRS water and grow irrigated corn.

1/The range in cost reflects two different irrigation technologies. Sprinkler irrigation (center pivot) is more expensive than flood irrigation.

produced by the Fryingpan-Arkansas project, generate enough increased revenue to cover all the costs for the increased irrigation. We doubt if the farmers would shift enough land into corn for grain to pay the full costs of the irrigation water.

For water priced at the interest-subsidy level of $16 an irrigated acre, the farmers could buy the water, and without changing their cropping patterns--corn for both grain and silage, sorghum, and alfalfa--put the water on crops that yield an increased net revenue of $3 to $16 an acre. We believe that this increase in income is large enough to induce the irrigators to purchase WPRS water at the $16 an irrigated acre price (including O&M).

The Fryingpan-Arkansas project is truly a supplemental irrigation effort in that the water produced by WPRS facilities will be stored to use late in the season when the flow of the Arkansas River is very low. Even with the water available so as to enable the irrigators to put a properly timed, late season watering on the crops, there would be no profit to the irrigators if the water had to be paid in full like other production supplies. If the water were available with the interest subsidy intact, the farmers could probably increase their profits with WPRS water.

As is the case with the other projects we studied, nothing in the WPRS analysis indicates that the area farmers would be economically disadvantaged without the project if the water were priced at full cost. Again this is not to say that any number of subsidies or grants from the Federal Government would not help increase a farmer's profit. They probably would. The question that needs to be asked is whether a selective subsidy, such as water, is the solution to insulating Arkansas River Valley agriculture from the long-term trends of increasing farm size and specialization. (See pp. 89-104.)

North Loup Division
Pick-Sloan Missouri Basin Program--Nebraska

This project, located in central Nebraska from Ord to Fullerton along the North Loup River, is planned to irrigate 53,000 acres on farms of about 250,000 acres. The irrigation facilities were estimated to cost $131.6 million in 1978, which is about 96 percent of the total costs. The farmers in the area produce corn and cattle. According to WPRS estimates, about 30,000 acres are now irrigated and the rationale for the project was to "stimulate and restore a viable local economy."

will pump water from local rivers and deliver it through pipes under pressure to be sprinkled onto the apple trees.

In 1978 the new irrigation facilities were estimated to cost $38.9 million, which is 94 percent of the total construction costs. WPRS proposed this project because the existing system badly needs replacing and presents the threat of a major failure that could leave mature apple orchards without water.

WPRS estimated that the growers' ability-to-pay is $47 an acre, or about $20 an acre-foot. The ability-to-pay estimate includes $23.50 an acre for operation and maintenance of the new system and $23.50 to repay the construction costs. The growers, therefore, will repay about 29 percent of the total costs, or $11.2 million, over 50 years.

Our analysis of replacement projects such as this one, and half of the North Loup project discussed earlier, is slightly different than the other case studies. In the other studies, we examined and compared changes in revenues and costs. In replacement projects, WPRS water substitutes for privately supplied water, so only costs need to be compared.

The apple growers in the Oroville-Tonasket area will choose the most cost effective way to water their trees. WPRS expects to charge $47 an acre each year for the project and for pressure as compared to the present payments to the private irrigation district of about $50 an acre. In the following sections we present how we expect the growers would react to the option of buying the water at either the interest-subsidy price of $106 an acre or at the full-cost price of $334 an acre.

Interest-subsidy price

At this price, the irrigators would pay more than twice what they now pay for water and pressure. The growers would choose the project water if the cost of repairing the existing system was more expensive than the interest-subsidy price.

Estimates supplied to us by the regional WPRS office indicate that the cost of repairs for merely a 17-mile-long flume would exceed the interest-subsidy price. From this, we conclude that the growers would choose the project at the interest-subsidy price over private repairs.

Full-cost price versus private alternatives

The full-cost price at 7.5 percent interest would be about $334 an acre each year. Such a seven-fold increase

Replacing private irrigation with WPRS water

We estimate that the farmers now irrigating in the North Loup area pay almost $47 an acre for their water. At first glance neither the interest-subsidy price of $56 an acre nor the full-cost price of $185 an acre appears to offer any advantage to these farmers.

The division of the costs between capital and operation and maintenance for the two contrasting systems, and the possibly different rates of cost increases, could cause them to accept WPRS water. If energy costs continue to escalate at current rates and if the wells have to pump water from greater and greater depths, private irrigation costs could well surpass WPRS water at the interest-subsidy price by 1987 when the project is scheduled for completion. We believe uncertainty about future private irrigation costs makes WPRS water a viable alternative at the interest-subsidy price of $56 an acre, but not at the full-cost price. But our opinion is very conjectural since it is based on estimates of growth rates of costs 8 to 10 years into the future.

Conclusion--North Loup

We believe that the economics of growing corn on irrigated acreage, which formerly had been either dryland or privately irrigated, would favor the WPRS project at the interest-subsidy price of $56 an acre. Our belief is based on a comparison of the area without WPRS water and with WPRS water at one certain price. It is not a comparison of the highly subsidized ability-to-pay price with either baseline conditions or with possible interest-subsidy price conditions.

On the other hand, WPRS water at the full-cost price of $185 an acre ($123 an acre-foot) is too expensive for the North Loup farmers. They would lose money whether they are now dryfarming or irrigating from wells. As with the other project areas we analyzed, the North Loup is an established farming area. We found nothing in the WPRS analysis indicating that the area suffers from any agricultural problems that could be solved only by adding water from a WPRS project. (See pp. 105-117.)

Oroville-Tonasket Unit Extension
Chief Joseph Dam Project--Washington

This project will replace an existing private irrigation system in north-central Washington. The project is in a long-established apple growing area and covers almost 10,000 acres. The water in the existing system is delivered to the orchards by gravity through flumes and canals. The proposed system

The ability-to-pay price was estimated by WPRS to be $15.10 an acre ($11.61 an acre-foot). Operation and maintenance charges were estimated to be $11.07 an acre ($8.51 an acre-foot), so $4.03 an acre ($3.10 an acre-foot) would go towards construction costs each year.

The full-cost price for the water produced by the project would be $181 an irrigated acre ($139.10 an acre-foot), while the interest-subsidy price would be $57 an acre ($43.85 an acre-foot). Analyzing the change from dryland corn to irrigated corn at $2.20 a bushel indicates that the farmers would be about $9 an acre better off economically at the interest-subsidy price. Irrigating corn with full-cost water would lower net income by $116 an acre from the dryland conditions. Corn prices would have to rise 42 percent over the current $2.20 a bushel (based on 1978 cost and price conditions for the irrigation of corn in Pollock-Herreid) to become a break-even situation if the farmers were charged the full-cost price.

We believe the project area farmers would be indifferent to the project if they were offered the water at $57 an acre, the interest-subsidy price. At the full-cost price of $181 an acre they would hardly be indifferent as the costs to irrigate corn would far exceed the increased revenue.

Without the project, traditional dryland farming would continue. The farmers would be subject to the vagaries of weather and crop prices, and would continue to react to national farming trends. (See pp. 132-143.)

SUBSIDIES

As discussed in chapter 1, irrigators are required to repay only the construction costs of the irrigation facilities, up to what WPRS estimates is their ability to pay for the water. Other sources of income associated with WPRS projects, usually a fee charged to users of hydroelectrical power, make up the difference between the amount the irrigators actually pay and the costs of construction.

Table 6 shows the subsidy figures we calculated for the case studies analyzed in this report. These subsidies are inordinately high for a program that supposedly recoups full repayment of cost. Two general conditions in the repayment of WPRS projects account for the high subsidies.

The first is length of the repayment period. Fifty years may elapse from the time the project is completed until the final payment is made. Coupled with this are grace periods in the repayment schedule that cluster around 10 years and

over existing water prices would seriously erode the net income of the growers, even though apples are a high-value crop. We did not find out how much a complete, privately financed rehabilitation would cost, but when it planned the project, the WPRS estimated that the price difference between new construction and a full set of repairs would be small.

We believe, however, that if WPRS did not finance the new project, the rehabilitation and repair of the existing system could be made at much less than full-cost price ($334 an acre) of WPRS' system. The WPRS baseline analysis of the project area was not realistic because it assumed that all the orchards would be ruined without the project. We believe that WPRS should have estimated how many of the orchards would have received water at various levels of repair and rehabilitation.

As postulated in this case study, the alternatives facing the apple growers are to purchase a new $39 million irrigation system at the interest-subsidy price of $106 an acre or at the full-cost price of $334 per acre, or to repair and rehabilitate the existing system. Although we are not sure what the minimum level of private financing would cost, we estimate very generally that it would be higher than the interest-subsidy price, but less than the full-cost price. However, without more precise knowledge of the private costs, which WPRS should have estimated, we cannot say whether the apple growers would suffer economically if the project were not constructed. (See pp. 118-131.)

Pollock-Herreid Unit
Pick-Sloan Missouri Basin Program--South Dakota

The 15,000 acres to be irrigated by this project are in north-central South Dakota. The system will pump water from Lake Oahe--an existing flood control reservoir--into a canal distribution system. The area is now dryland farmed and produces primarily cattle, with wheat and corn the primary field crops. Corn is expected to be the irrigated crop. WPRS recommended the project because it believes irrigation would stabilize agricultural enterprise and prevent the outflow of population.

The Pollock-Herreid project was expected to cost $35.2 million in 1978, with irrigation facilities costing $34.6 million. This total will be repaid by the irrigators, by residents of a 15-county area, and by regional power users. The irrigators return $3 million through direct charges over 50 years.

the Fryingpan-Arkansas project--is interpreted and reduced to payment streams for the present value calculations necessary for the subsidy estimates.

50 years. For example, the irrigators repay their ability-to-pay share in equal installments of 40 or 50 years but usually there is a grace period of 10 years. The power users repay their allocation after a grace priod of 40 to 60 years, and the payments are ballooned in a 1- to 3-year period.

Table 6

Subsidy in Six Irrigation Projects

Project area	Construction costs eventually repaid ($ millions)	Present value ($ millions) a/	Subsidy b/
Auburn-Folsom	$724.5	$39.8	94.5%
Dallas Creek	16.2	1.3	92.2
Fryingpan-Arkansas	88.0	4.4	95.0
North Loup	131.6	2.9	97.8
Oroville-Tonasket	38.9	3.0	92.3
Pollock-Herreid	34.6	1.3	96.4

a/The discount rate used was 7.5 percent.
b/Present value as a percentage of nominal construction costs.

The second condition is that no interest is charged on the repayments. A dollar repaid without interest after 40 years is worth very little when compared to the dollar expended today.

Two prices are postulated in this review for water produced by WPRS projects. The first is the interest-subsidy price, which simply moves all costs, except interest, to the direct user of the irrigation water. The interest costs are still borne by a larger group of Federal taxpayers. The subsidy to irrigators who repaid in equal annual installments over 50 years without interest is about 75 percent when calculated according to the method used for the results in table 6. The second price, which eliminates the subsidy, is the full cost at a moderate interest rate.

As a part of the work that went into this review, we prepared a technical paper 1/ that gives a detailed example of the way a complicated repayment structure--the actual one for

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1/Roberts, Paul E. and D. Lamar White, Subsidy Calculations at Bureau of Reclamation Projects, Technical Papers in Economics, Program Analysis Division, Morton A. Myers, Director Program Analysis Division 441 "G" Street, NW Washington, D.C. 20548

net income would be increased when compared to the without-project conditions.

We found that Federal water is so costly to produce under present conditions that at the full cost price, computed with a 7.5 percent interest, none of the areas we analyzed could produce crops that would yield an increase in net income. Some agricultural areas with WPRS projects under construction could increase crop production enough to cover all additional expenses if the water were priced at the interest-subsidy price.

No water sales if full costs to the Federal Government determine the water price

If WPRS water were priced high enough to recover the construction costs plus a 7.5 percent interest charge, the potential customers of irrigation water could not generate enough extra agricultural yield to pay for the additional expenses required by irrigated agriculture. The projects we studied fail the pragmatic test of economic viability for the irrigation facilities. Crop yields, under any of the varied conditions present in the six project areas, could not increase enough to cover increased production costs. Consequently, we can say that farmers would not accept full-cost WPRS water because their income would fall compared to what it could have been without the WPRS water.

Without the projects all the areas would continue to be farming areas. In five of the areas, some combination of dryland and irrigated farming would continue. In the sixth, financing would have to be found to repair the existing irrigation system.

Some areas could pay the interest-subsidy prices

Crop yields in the Fryingpan-Arkansas, North Loup, Auburn-Folsom, and Oroville-Tonasket projects could be increased enough to pay for all the production cost increases, pay for the water at the interest-subsidy price, and return an increase in net income over the baseline conditions. This is significant because the interest-subsidy price is much higher than the ability-to-pay price that the WPRS intends to charge the farmers for the water.

CONCLUSION

WPRS' economic studies are used to set a price for irrigation water within the estimated payment capacity of the farmers who receive the water. Based on WPRS data, the

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Most of WPRS' program was born three-quarters of a century ago from a desire on the part of the Federal Government to encourage westward expansion and develop regional agricultural. Irrigation projects continue to be built. Much of the support for continuing to spend money on these projects has come from the traditional authorizing and funding patterns that treat irrigation projects as public works even though they may no longer meet the settlement goals.

We wanted to determine if direct beneficiaries of Federal water supplies could pay more of the costs of constructing the projects. We estimated the potential economic effects to farmers of eliminating all or some of the subsidies given to irrigators at WPRS projects, but we did not try to determine what the price for the irrigation water should be.

RESULTS OF OUR CASE STUDY ANALYSES

The six projects selected for review came from 32 major WPRS projects presented in its fiscal year 1979 planning and construction budget. None of them has been completed, although contracts have been signed between several of the irrigation districts and the Federal Government for water delivery at a fixed price. The lands in all of the projects' proposed service areas are now farmed; none of the land is raw, arid land waiting to be placed under a family farmer's ownership and irrigated.

In our analysis, we compared the income from the increase in crop production possible with Federal irrigation to the increase in production costs required to irrigate the crops. The economic effect turns on whether the farmer's net income would go up or down after irrigating. If the income from those acres is expected to be greater than costs, the economic effect on the farmer would be positive. Conversely, an increase in costs greater than the expected increase in income would lower the farmer's economic well being. In the latter case, we expect that the farmer would not choose to irrigate those acres with Federal water.

An important point to remember is that we did not make any of our comparisons to the subisidized price established by the WPRS. This price for water is usually low enough that

by the Federal Government. To place this cost in perspective, it should be presented as an annual figure on an acre-foot and irrigated acre basis.

--Estimates of only the yield increases expected for the acres that will receive Federal water. This will allow the Congress and other decisionmakers to compare the gains in net income from WPRS' farm budget approach to the gains directly attributable to the application of more irrigation water.

--Estimates of the change in net income on the acres to receive Federal water at full cost. This comparison of costs and gross income changes because of irrigation will show policymakers the direct economic value of producing more irrigation water.

When this information is presented in the annual budget documents along with the existing project descriptions, decisionmakers will have a simple measure of the full costs of the water, of the expected increases in yield, and of the economic changes.

If this information shows a decrease in net income at full cost for water--as did our study of six projects--then the discussion of funding will have useful benchmarks against which to compare the amount of subsidy that the Federal Government is willing to pay to achieve the increase in agricultural production.

AGENCY COMMENTS

The comments from the Departments of the Interior and Agriculture were not received within the 30-day limit as required by P.L. 96-266. We continued final processing of of the report and eventually received comments from both Departments. We included their comments, along with our replies, in appendix II. In general, the Department of the Interior's comments maintained that the WPRS is doing what it is legally mandated to do regarding repayment. We did not address the legal issues in this review but rather focused on the costs to the Government and what might happen if the irrigators were asked to pay more of the costs or the full costs of providing water. We are currently looking into the legal issues. The Department of Agriculture's comments were generally supportive of the report's conclusions.

farmers can only pay less than 8 percent of the cost of the water, but they also estimate that the projects will be economically beneficial to the Nation.

WPRS ability-to-pay analysis produces results at odds with ours. We found that irrigators in some areas could increase their net income beyond baseline (i.e., without project irrigation) conditions even if they paid the interest-subsidy price--a price considerably higher than the WPRS plans to charge them. They could not, however, directly pay for the irrigation water and improve their economic well-being if the water price was based on full costs at an interest rate of 7.5 percent.

We do not believe that the differences between WPRS results and our analysis are merely definitional. We believe that our analysis, based on comparing just the increases in gross income and the increases in production costs for the areas to be irrigated, captures the factors farmers use to make their own decisions. WPRS analysis is often judgmental, is oriented toward guaranteeing all farms in an area a positive income and insuring positive returns for management risk, and has been shown to be inaccurate. We believe that WPRS attempts to do too much with their economic analysis and has not clearly identified the economic results of their programs.

We assume farmers will estimate the increase in income possible from irrigation and compare it to the increases in production costs associated with irrigated agriculture. Water is an integral part of the cost equation. If the costs for increasing crop production are expected to be higher than the increases in income, the farmers cannot be expected to put the effort and capital into irrigated agriculture.

RECOMMENDATIONS TO THE AGENCY

Irrigated farming is a commercial venture and the water produced by the Federal Government uses resources that could be used elsewhere. We believe that decisions made by the Federal Government on project funding would benefit from more analysis. We recommend that the Secretary of the Interior direct the Commissioner of the Water and Power Resources Service to develop the following economic analyses and include them in their documents prepared as support for the Congress during the authorization and appropriation process.

--Estimates of the Federal Government's full cost of producing irrigation water, including an interest rate that reflected the then-current cost of money borrowed

income attributable to project water from the gains assumed for other farm activities.

WPRS' regulation of water prices affects all three of these areas. The subsidy is as large as it is in spite of repayment of construction costs because the WPRS, through its economic analysis, estimates the ability-to-pay price to be very low. Low water prices contributed to settlement of the West. Changes in water prices for irrigation would probably affect the WPRS construction program. As we have shown in this report, a Federal requirement for full repayment of construction costs including interest by the irrigator would make water from projects under construction too expensive for the farmers' use. They would be economically better off continuing their existing farming practices--irrigating from existing sources or dryland farming.

THE FUTURE OF FEDERAL INVOLVEMENT IN IRRIGATION

In our review of six projects, we found that the WPRS had begun to grapple with two emerging irrigation problems. These problems--overdrafting underground stores of water and aging irrigation distribution systems--are becoming serious and Federal involvement may be called for. We are not sure, however, that the solutions that we saw from WPRS will be optimum. We would prefer to see other options analyzed before Federal funds are spent for water projects to solve these problems.

Declining ground water was cited as a problem in two of the case studies reviewed in this report--the Auburn-Folsom and the North Loup projects. The WPRS solution was to dam up local streams and use the impounded water to replace the overdraft. We do not believe that the solutions are as obvious as their actions indicate. A recent GAO report indicates that several avenues should be explored when dealing with declining ground water. 1/ These include licensing of wells, improved irrigation techniques, and a return to dry farming.

A deteriorating distribution system was the reason the WPRS stepped in at the Oroville-Tonasket irrigation district. This private system will be replaced by a federally funded project. WPRS did not consider higher water prices or improved irrigation practices as an alternative to a complete replacement of the existing system. When the choice to the

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1/"Ground Water Overdrafting Must Be Controlled," CED-80-96, September 12, 1980 and "Ground Water: An Overview," CED-77-69, June 21, 1977.

CHAPTER 6

BROADER ISSUES FOR CONGRESSIONAL CONSIDERATION

In a review such as this, the details of the subject matter assume a lot of importance and attention. Indeed, we feel that understanding the details of economic analysis and using such analysis realistically is important to better decisionmaking. Details, however, sometimes mask the overall issues that determine the direction of programs. In this chapter we make several general observations that we think are important in any discussion of WPRS and Federal water policy.

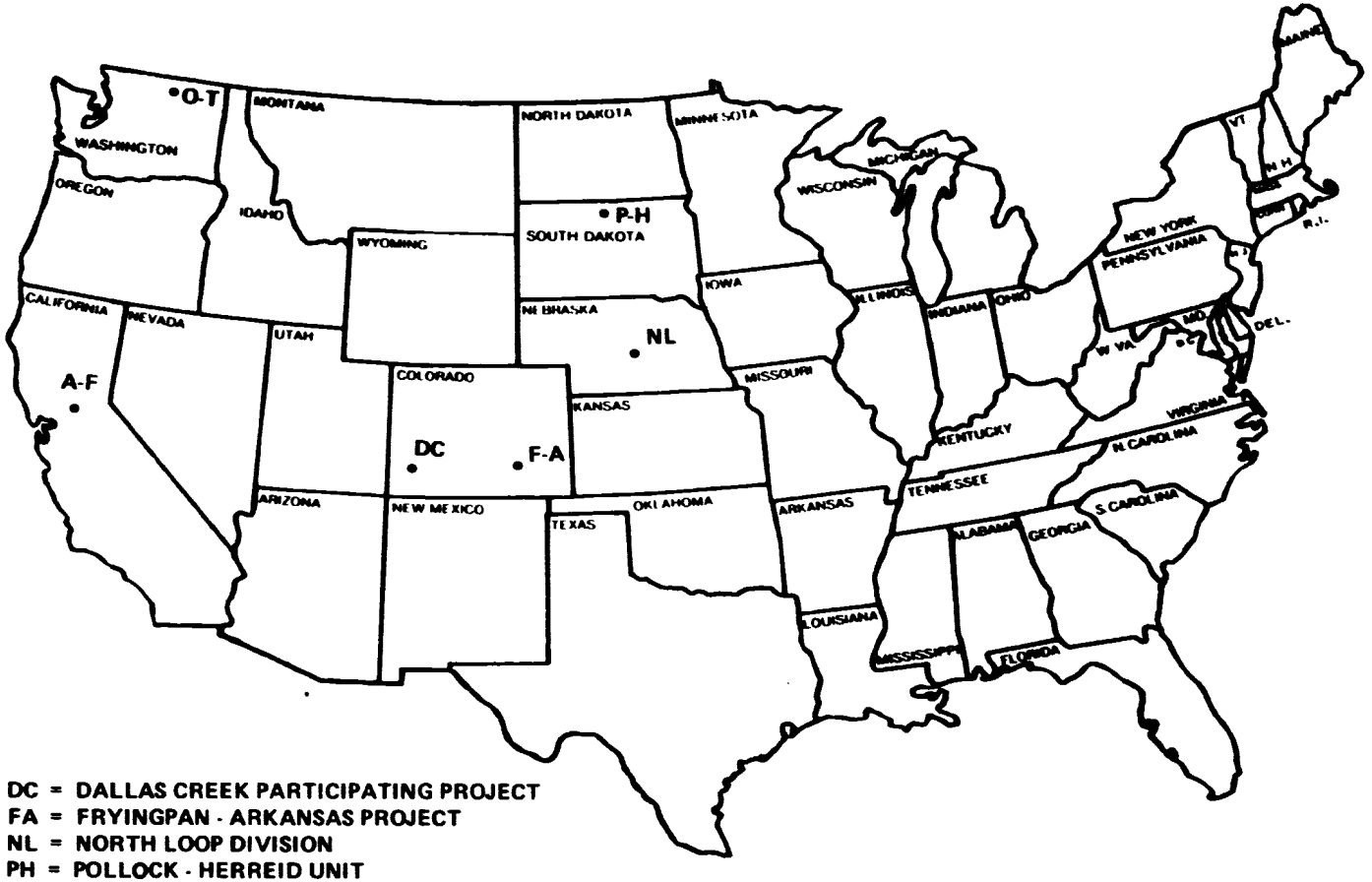
Our first observation is that even though reclamation law and WPRS regulations call for full repayment of irrigation construction costs, the real value of the repayments in the case studies we analyzed was less than 8 percent of the cost to the Federal Government. This subsidy is so large because the terms of repayment are so generous. For the irrigation repayments, no interest is charged and payments are delayed.

Subsidies can also take the form of reduced interest charges, loan guarantees, and outright grants. Of couse, many reasons exist to transfer income through subsidies from one group to another, but often the size and type of subsidy goes unrecognized. We believe that the size of subsidies should be calculated for programs such as the Federal water projects and presented to decisionmakers.

Our second observation is that the large subsidy given to irrigators is based on goals of homebuilding and settling the West. These goals were established at the beginning of the 20th century and were considered important enough for the Federal Government to step into what had been primarily private enterprise. The original rationale for subsidized irrigation projects is probably no longer applicable.

Our final observation is that analysis done by the WPRS to economically justify the projects may overstate or understate the yield attributable to the irrigation water. Two techniques are responsible: the use of average acres to measure the increases in yield between nonirrigated and irrigated lands and measuring both crop and livestock production on the average farms. We believe that implementing the recommendations made in chapter 5 to the Secretary of the Interior will improve this area of concern by isolating the gains in

FIGURE 1
LOCATIONS OF SELECTED WPRS IRRIGATION PROJECTS



DC = DALLAS CREEK PARTICIPATING PROJECT
FA = FRYINGPAN - ARKANSAS PROJECT
NL = NORTH LOOP DIVISION
PH = POLLOCK - HERREID UNIT
AF = AUBURN - FOLSOM SOUTH UNIT
OT = OROVILLE - TONASKET UNIT

farmers in areas with aging systems is between market-financed replacement systems or highly subsidized Federal water, there should be little surprise at the decision.

Contemporary Federal irrigation projects extend a substantial benefit--very cheap water--to a small group of farmers. Our analysis of the economic effects of higher water prices shows that prices could be higher, but that the subsidy could not be eliminated if the Government wanted to continue to sell irrigation. Issues in the existing program, such as the extent of the subsidy and the analysis performed by WPRS should be reexamined by decisionmakers. Also, upcoming problems with irrigated agriculture may require solutions which could involve the Federal Government. Such involvement needs comprehensive analysis of many options before settling on Federal water projects as the solution.

recommended seismic stress factors to be incorporated in the dam's design.

The information contained in the various studies, as well as WPRS recommendations, are currently being reviewed by officials in the California Department of Water Resources Division of Safety of Dams, and the State Seismic Safety Commission. The Secretary of the Interior has said that no dam will be built without State approval.

Folsom South Canal

The Folsom South Canal will supplement the water needs of agricultural and municipal and industrial users in the southern Sacramento and northern San Joaquin Counties. When completed the canal will consist of five segments and be approximately 68 miles long, originating near Sacramento at Nimbus Dam on the American River and extending southward, ending at Lone Tree Creek southeast of Stockton. When fully operational, the canal will supply about 850,000 acre-feet annual canalside deliveries to the Folsom South service area. 1/ Of this amount, approximately 545,000 acre-feet will be allocated to irrigators and 305,000 acre-feet to municipal and industrial users.

The first two segments of the canal, extending almost 27 miles southward from Nimbus Dam, were completed in 1973 and are in operation. WPRS currently supplies Sacramento County irrigators with up to 5,000 acre-feet of water annually from these segments. The water is contracted for under one-year interim contracts at a price of $6 per acre-foot. In addition, the Sacramento Municipal Utility District has received 11,000 to 17,000 acre-feet of water annually for use in its Rancho Seco nuclear power plant. The East Bay Municipal Utility District, which also has a contract with WPRS for water from the Folsom South Canal, has not received any water from the canal.

Work on the final three segments of the canal has been halted by legal proceedings. In December 1972, the Natural Resources Defense Council filed suit in the U.S. District Court, Eastern District of California, to halt construction of the Folsom South Canal, claiming that the Environmental Impact Statement on the canal was inadequate. The court prevented WPRS from proceeding with canal construction and conducting contract negotiations until all objections could be

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1/Canalside refers to the point where water is diverted from the main conveyance channel into the distribution system channels.

AUBURN-FOLSOM SOUTH UNIT

CENTRAL VALLEY PROJECT

PROJECT DESCRIPTION

The proposed Auburn-Folsom South unit, located in north-central California, is part of the larger Central Valley Project. The two biggest structures of the unit will be the Auburn Dam and the Folsom South Canal. The unit will also contain several smaller structures, including the Sugar Pine Dam and Reservoir with the associated Forest Hill conduit, and the County Line Dam and Reservoir with the associated Malby conduit. Virtually no construction work has been done on the smaller features.

Auburn Dam and Reservoir

Until recently the Auburn Dam was proposed as a double curved, thin arch type dam with a reservoir storage capacity of 2.3 million acre-feet of water. State concerns about the earthquake safety of such a dam, however, will likely change the design to either a rock filled or concrete gravity structure. The dam will be the most upstream of the three in-line dams on the American River--the other two are the Folsom Dam and reservoir with a capacity of about one million acre-feet and the holding facility at Nimbus Dam, both already constructed and in operation.

The Auburn Dam will initially house a hydroelectrical power plant consisting of two units with a total generating capacity of 300,000 kilowatts of electricity. A provision exists for the addition of three more units, each capable of generating 150,000 kilowatts of electrical power.

The area surrounding the Auburn Dam site has been cleared to permit construction activity. To date only the foundation of the dam has been completed. In addition, a small temporary dam and diversion tunnel have been built to divert flows of the American River around the Auburn dam during construction.

Construction work on the dam has been halted because of earthquake safety studies, conducted by a private consulting firm and five independent consultants retained by the Water Power and Resources Service (WPRS). The purpose of the studies was to determine the likelihood of an earthquake with a given magnitude occurring in the area. The studies have been completed and the results were reviewed by WPRS officials and engineers. Based on these studies, WPRS engineers have

In addition, stabilizing ground water levels could retard or prevent deterioration of water quality.

Power

Population growth, increased irrigation pumping, and industrial expansion have all contributed to an increasing demand for electrical power. If this growing demand continues, the hydroelectrical power generating capabilities of the Auburn Dam plants will help satisfy this need.

Fish and wildlife, recreation, and flood control

The Auburn Reservoir is planned to assist in controlling critical water temperature releases for downstream fish spawning and propogation. The reservoir will also increase the surface area available for water sports and should help reduce the number of recreationists at the Folsom Reservoir. In addition, the Auburn Reservoir will supplement Folsom in providing flood protection for the Sacramento area.

ALTERNATIVES CONSIDERED

As mentioned earlier, the Auburn-Folsom South Unit consists of two main features, the Auburn Dam and Reservoir (Auburn Unit) and the Folsom South Canal (Folsom South Unit). The former is a storage facility and the latter a conveyance facility for distributing water to satisfy agricultural and municipal and industrial requirements in the Folsom South service area. WPRS officials considered alternative dam sites, reservoir sizes, and conveyance facilities in preparing the feasibility report issued in January 1962.

Dam sites

Several sites along the north fork of the American River were considered as possible locations for construction of the dam. Selection of the site was governed by whether or not the (1) foundation conditions were suitable for a large dam, (2) spillway site was economical, and (3) earth construction materials were available in the event the dam was to be an earth fill. The most favorable combination of these factors led to selection of the chosen site.

Reservoir sizes

Reservoir size was selected by determining the last increment of capacity that would be economically justified. Four reservoir sizes were originally considered having gross capacities of 900,000 acre-feet, 1 million acre-feet, 1.2

resolved and a final Environmental Impact Statement was completed. The interested parties in the lawsuit are currently trying to reach a satisfactory agreement regarding water diversions and river flows.

Proposed completion date of the project

WPRS officials are presently estimating 1990 as the year for completing the Auburn-Folsom South Unit. However, they emphasized that this is not a firm estimate due to the seismic and environmental uncertainties surrounding construction of Auburn Dam and the Folsom South Canal.

WPRS RATIONALE FOR PROJECT DEVELOPMENT

Congress authorized the Auburn-Folsom South Unit in 1965 with agriculture as the primary function to be served. Other benefits provided by the project include municipal and industrial (M&I) water supplies, electrical power, fish and wildlife, recreation, and flood control.

Agriculture

Irrigation on WPRS projects will develop and stabilize the local agricultural economy. The availability of project water in the Folsom South service area will permit, WPRS estimates, the development and irrigation of approximately 75,000 additional acres of farm land thus enabling diversification of cropping patterns and stabilization of crop yields and income in the area. In addition, the availability of supplemental surface water could control, or eliminate, ground water over-drafting (pumping in excess of recharge) thereby stabilizing ground water levels.

Continued over-drafting of ground water has potentially several undesirable consequences. (1) As the ground water levels decline and pumping costs increase, lands currently irrigated with ground water may be forced out of production. (2) As the ground water levels decline, there may be salt-water intrusion which reduces water quality, making it unsuitable for agricultural purposes.

Municipal and industrial

The municipal and industrial sector would also benefit from the availability of supplemental surface water. The project will ensure that an adequate water supply exists for the anticipated increase in municipal and industrial growth.

were available. In this case, 555,000 acre-feet 1/ of project water will be placed on the equivalent of approximately 162,000 acres of new farm land. Since WPRS estimates only about 75,000 actual new acres remain for agricultural development, the remaining new land equivalent acreage will be needed to stabilize the declining ground water level and to replace natural surface water supplies not available in the future. We were unable to fully reconcile the difference between the new land equivalent acres and the actual number of projected new acres coming into the service area.

Large data variances exist regarding the potential new acres available for agricultural development in the Folsom South service area. The California Department of Water Resources has recently forecasted that approximately 27,000 acres of new agricultural land (20,000 acres in Sacramento County and 7,000 acres in San Joaquin County) will be developed by the year 2020. If these projections are accurate, then the agricultural benefits of the project would be considerably less than the WPRS estimates.

Allocation of costs

There are four components to the Auburn-Folsom South Unit which incur costs; storage, power, conveyance, and distribution facilities. The storage facilities refer to the dam and reservoir. The power facility refers to the powerplant housed within the dam. The conveyance facility refers to the main channel that carries water from the storage facility to the service area, and the distribution facility refers to the system of channels that carries water from the main conveyance channel to the individual users.

Two types of costs are incurred by each component, (1) construction or capital costs and (2) operation, maintenance, and replacement (OM&R) costs.

Project costs are allocated to the various functions of the Auburn-Folsom Unit, (agriculture, municipal and industrial, and hydroelectrical power) by the separable cost-remaining benefits method. Under this method a maximum and minimum allocation is determined for each function. The maximum allocation is the lesser of (1) the present worth of the benefit during the period of analysis or (2) the present worth of the

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1/Although the irrigation allocation was recently changed to 545,000 acre feet, WPRS still uses 555,000 acre-feet for benefit purposes.

million acre-feet, and 1.8 million acre-feet. Final results favored the one million acre-feet size. Due to a surge in population growth which increased demands for M&I water service, recreation and fishery facilities, and electrical power, however, the proposed size now stands at about 2.3 million acre-feet.

Conveyance facilities

Four possible alternatives for distributing supplemental water for the Folsom South Unit were considered. Criteria for selection included cost estimates and advantages related to development of the overall Central Valley Project. The adopted plan, a single canal receiving a full supply of water from the American River, best satisfied the criteria.

BENEFIT-COST RATIO AND ALLOCATION AND REPAYMENT OF COSTS

Benefit-cost ratio

The economic justification for a project is determined by comparing benefits with costs. Ordinarily, every WPRS project and each individual function served by a project must have a benefit-cost ratio greater than one prior to receiving congressional authorization. The ratio is a comparison between annual equivalent benefits attributable to the project and annual equivalent Federal costs incurred.

In computing the benefit-cost ratios, annual benefits and costs are discounted to a base year and amortized over a selected period of analysis. The periods of analysis used for the Auburn-Folsom South Unit are 50 and 100 years.

In the Auburn-Folsom South Unit, benefits accrue from and costs are allocated to several functions including irrigation, commercial power, M&I water service, flood control, fish and wildlife, and recreation. WPRS' 1978 estimate of total project costs is $1.27 billion. The project's direct benefit-cost ratio is 1.7 to 1. Further, WPRS has allocated $724.5 million in costs to irrigation, the function of primary concern in this report. The benefit-cost ratio for irrigation is 1.5 to 1 as calculated by WPRS.

WPRS used the "new land equivalent" methodology to derive the irrigation benefits of the Folsom South service area. The new land equivalent is the number of irrigated acres which project water would support if no other water supply

FOLSOM SOUTH SERVICE AREA

Existing environmental conditions

As indicated earlier, the Auburn and Folsom reservoirs are intended for use mainly in the Folsom South Canal service area. Containing about 553,000 acres in the southern part of Sacramento County and the northern part of San Joaquin County, the service area is approximately 15 miles wide and 55 miles long.

Topographically, most of the service area is relatively smooth with a gentle slope to the west, but the extreme eastern portion, comprised of the valley foothill transition zone of the Sierra Nevada, is rolling terrain. The main streams traversing the area generally flow westerly and southwesterly from the foothills and include the Mokelumne and Calaveras Rivers in San Joaquin County and the Consumnes River in Sacramento County. Many smaller streams also flow across the area.

Older terrace hardpan soils (classes 3 and 4) constitute over 60 percent of the area soils, and river flood plains and alluvial fans of recent soils (classes 1 and 2) constitute the remainder. Whereas class 1 lands are capable of producing high yields of nearly all climatically adapted crops at relatively low development and production costs, class 2 lands have some limitations, and class 3 and 4 lands are subject to major agricultural limitations. The proportion of class 1 lands to other land classes in San Joaquin County is much larger than in Sacramento County. Because about three-fourths of the Sacramento County service area consists of class 3 soils, this land is more limited to the types of crops which can be grown on it.

The Folsom South service area has a semi-arid, two-season climate typical of the Central Valley. It is characterized by a long, hot dry summer season and a cool, rainy winter season. The normal annual precipitation is 14 to 16 inches through the service area. Daytime summer temperatures occasionally exceed 100 F, while winter temperatures rarely drop below 20 F.

Land use

Right now, approximately 300,000 acres of irrigated crops are being grown in the service area, although a much higher percentage of San Joaquin County is irrigated than Sacramento County. Irrigated pasture, forage, and miscellaneous field crops account for about 94 percent of the irrigated land in Sacramento County and about 55 percent of the irrigated land in the San Joaquin County area. Vineyards, deciduous fruit,

cost of providing these benefits from the most likely alternative. The minimum allocation is the separable cost assigned to a given function. The separable cost is defined as the difference between the cost of the multifunction project with the given function and the cost of the project without the given function.

The difference between the maximum and minimum allocation provides the basis for the percentage needed to distribute project joint costs among the various functions. The cost allocation to each function is the sum of the separable costs and their allocated project joint costs.

Subsidy

A large difference exists between the planned long-term repayments, which would return $724.5 million to the U.S. Treasury, and the alternative repayment possibility of treating the construction costs as a 7.5 percent interest loan. One way to measure the difference is to calculate the present value of these two repayment streams and express the smaller amount as a percentage of the larger. The resulting figure for the planned repayments at Auburn-Folsom indicate that they are but one-eighteenth as large as the same repayments with a 7.5 percent interest. 1/

Another way to measure the size of the subsidy is to estimate how large a loan at 7.5 percent interest would have to be to return the same stream of income as the planned no-interest repayments. The Federal Government would receive equal value if they wrote off $684.7 million of the $724.5 million which will eventually be repaid on a dollar-for-dollar basis, and treated the remaining $39.8 million as an interest bearing loan.

The subsidy, similar to all projects of the Auburn-Folsom generation, is high because interest is not required on any of the $724 million; and the $555 million which is estimated to be above the irrigators' ability to pay is returned to the U.S. Treasury by power revenues after a 40-year period.

1/The use of 7.5 percent as the discount and interest rate is for illustration; subsidy calculations can be made with any appropriate rate.

Folsom South service area farmers are currently paying between $10 an acre-foot in Sacramento County and $20 1/ an acre-foot in San Joaquin County for pumping their underground water supplies. The costs vary because of considerably higher pumping power rates and smaller size farms in San Joaquin County.

Surface water supplies

Three rivers and many small local streams provide natural surface water to the Folsom South service area. These surface water supplies recharge the ground water through seepage losses and provide direct annual diversions of about 230,000 acre-feet. Only about 120,000 acre-feet of natural surface water annually will be available in the future, however, due to previous commitments outside the service area.

To protect their existing water supplies and to assist in obtaining water from the Folsom South Canal, agricultural users have established a number of water service organizations. The water irrigation districts which we contacted were charging farmers $4 to $6 an acre-foot for water diverted directly from natural surface supplies. The quality of surface water in the major streams is generally good, and saline water degradation is not a problem.

Irrigation technology

Crops grown in the Folsom South service area are irrigated using primarily furrow and border flood irrigation methods. A 1975 report to the California State Water Resources Control Board showed that approximately 92 percent of the general Folsom South region 2/ was irrigated using surface irrigation methods and 8 percent using sprinkler irrigation. Table 7 shows this in further detail.

Surface irrigation methods are used for most field, forage, and vegetable crops in the Folsom South service area. Sprinkler irrigation methods, on the other hand, are generally used for tree and vine crops.

1/These are 1979 costs that include about $7 annualized capital expenses for the well and pump investments.

2/Although the study region encompasses an area considerably larger than the Folsom South service area, this represents the most comprehensive data available.

and nut trees occupy about 38 percent of the irrigated land in the San Joaquin County but only minor acreages in Sacramento County. Tomatoes, melons, squash, peppers, and various other vegetable crops are grown on the remaining irrigated acreage, primarily in San Joaquin County. Grain, grain hay, and pasture are produced on non-irrigated land.

As indicated earlier, WPRS estimates that approximately 75,000 more acres of potentially productive land exists in the 553,000-acre Folsom South service area. The remaining 178,000 acres cannot be irrigated because of urban, suburban, military, and industrial developments. Expansions of the urban and suburban areas are projected to occur within the service area and will use some of the potentially irrigable land for agriculture. Particularly, this expansion is expected in the vicinity of Sacramento, Lodi, and Stockton. Although not included within the service area boundaries, the city of Sacramento is surrounded by a large metropolitan community that overlaps into the service area.

Ground water conditions

Most of the water supply now being used in the Folsom South service area is from ground water sources. Consequently, ground water levels in both counties have declined in nearly all parts of the service area, averaging 1.7 feet for a total decline of 55 feet from 1946 to 1978. In some severe locations near urban areas, the ground water levels have been declining 2 to 3 feet per year. The average annual overdraft is approximately 75,000 acre-feet, and the WPRS has estimated the safe ground water supply (pumpage) at about 600,000 acre-feet annually.

The declining water level has made it necessary to drill new wells or deepen existing wells and upgrade the pumps. The average depth to ground water has increased from about 30 feet in 1946 to more than 80 feet in 1978. Agricultural extension specialists and other field contacts indicated that many Folsom South service area farmers are pumping at about 100 to 150 feet below ground surface.

The continued lowering of ground water levels will also degrade the good quality water because of salinity intrusion from the nearby saltwater delta. (This has already occurred near the city of Stockton.) Also, land subsidence has occurred, particularly in the Stockton area, due to continuing ground water overdraft.

charging irrigators full cost for water. This discussion is contained in a later section of the appendix.

We calculated the 1974 full cost figures to compare them with the amount which WPRS computed that service area irrigators could pay for water during 1974. Our 1978 full-cost calculation reflects the most recent project cost data available. To find annual costs we made calculations using projected 50-year capital and OM&R costs. This information is summarized in table 8.

Table 8

GAO Computed Price of Project Water
(per acre-foot)

	1974		1978	
	Interest-subsidy	With interest (7-1/2%)	Interest-subsidy	With interest (7-1/2%)
Storage, power conveyance capital	$12.57	$37.73	$20.88	$71.89
OM&R	1.49	1.49	1.28	1.28
Total (at canalside)	14.06	39.22	22.16	73.17
Distribution capital	3.50	10.49	4.25	14.65
OM&R	7.30	7.30	10.51	10.51
Total	10.80	17.79	14.76	25.16
TOTAL (at farm headgate) a/	$24.86	$57.01	$36.92	$98.33

a/Farm headgate refers to the point where water is delivered to individual users.

Payment capacity analysis for the service area

WPRS' most recent determination of what Folsom South irrigators could pay for project water was made in 1976 using 1974 data. WPRS determined that Sacramento County irrigators could pay $8.13 per acre-foot for water at canalside and $14.71 at farm headgate and San Joaquin County irrigators

APPENDIX I APPENDIX I

Table 7

Irrigation Methods Used in Folsom South

Methods	Percent acreage served
Furrow	50
Border flood	38
Basin	4
Total surface irrigation	92
Hand moved	4
Solid set	3
Mechanically moved	1
Total sprinkler irrigation	8
TOTAL (surface and sprinkler irrigation)	100

Approximate farm sizes

University of California county farm advisors estimated in 1978 that about 90 percent of the irrigated farms in the Folsom South service area were less than 160 acres and 92 to 95 percent were less than 320 acres. According to WPRS, owner-operated farm enterprises constitute the backbone of the area's agricultural economy. A few corporate type farms accounted for a relatively small portion of the irrigable acreage.

The 1974 Census of Agriculture, however, showed some evidence of consolidation in the Sacramento and San Joaquin Counties over a 5-year period spanning from 1969 to 1974. At the end of this time period, there were 11 percent fewer farms under 1,000 acres and 22 percent additional farms with 1,000 or more acres.

FULL COST OF PROJECT WATER WITH AND WITHOUT INTEREST

We calculated the full project cost, with and without interest, of delivering WPRS water to irrigators in the Folsom South service area. This was done for 1974 and 1978 and will serve as the basis for discussing the effect of

without project water, and we subtracted the resources required by these crops from the service area. Thus, the development of additional acres will depend primarily on the profitability of lower value field crops. As indicated earlier, these crops currently represent 94 percent of the irrigated land in Sacramento County and 55 percent of the irrigated land in San Joaquin County.

The projected local, ground, and project water available to irrigators on field crop farms in the Folsom South service area is shown in table 9.

Table 9

Available Water
(acre-feet)

	Local surface	Ground water	Project
Gross amount of water available	120,000	600,000	850,000
Less municipal & industrial	40,000	75,000	305,000 a/
Water available to agriculture	80,000	525,000	545,000
Deduct for vegetables & perennials	38,108	234,092	- 0 -
Net amount water available for field crop farms	41,892	290,908	545,000

a/This amount includes approximately 75,000 acre-feet of water for the Sacramento Municipal Utility District and 150,000 acre-feet for the East Bay Municipal Utility District.

The linear programming model maximizes net return from the farm at various water price levels subject to environmental and economic constraints. This type of analysis simulates a farmer's decisionmaking by answering the following types of questions: (1) What is the optimum crop mix given the price of water? (2) How many new acres of land will be developed? (3) How much water will he buy at various prices? (4) What is the most profitable irrigation technology?

In contrast, WPRS' payment capacity analysis is performed without including the price of water. Its analysis assumes that a predetermined amount of project water will be delivered and accepted, a planned amount of new acreage will be developed, and a historical crop rotation produced. The residual net farm income less an estimated profit and living allowance becomes the farmers capacity to pay for project water.

Certain assumptions made by WPRS in the payment capacity (farm budget) analysis may tend to overstate the farmer's net income. Therefore, in applying the WPRS' data to the linear programming model, we have made several adjustments to better reflect the farmers' actual economic condition. These adjustments are discussed below.

Crop prices received and farm production costs

Crop prices were unusually high during 1974 when WPRS performed its payment capacity analysis. Therefore, linear programming models have been developed for both the 1974 and 1978 time periods. With the exception of high alfalfa prices resulting from the 2-year California drought, the 1978 crop prices are considered to be more representative of the long-run conditions. Crop prices for 1974 and 1978 were derived from the Water Resources Council normalized prices for California. For crops where this data was not available a 3-year average county price was used.

Farm production costs for the 1974 linear programming model were the same as those used in WPRS' 1974 payment capacity analysis. Input costs for 1978 were inflated 23 percent to reflect current cost levels. This increase was computed from the USDA Crop Reporting Board's index of farm production prices paid.

Soils and crop yields

Discussions with University of California county farm advisors disclosed that presently irrigated lands occupy most of the class 1, class 2, and better quality class 3 lands. Therefore, the remaining soils to be developed consist primarily of poorer class 3 and class 4 soils. For the most part the latter are tight, shallow soils on hilly terrain that is difficult to level and expensive to irrigate. Particularly suitable for raising shallow-rooted crops and livestock production, it is anticipated that most of this poorer class soil will be planted with irrigated pasture, forage, and miscellaneous field crops.

In the 1974 payment capacity analysis, WPRS reflected crop yields as weighted averages and made no distinction by soil class. Based on recommendations from University of California county farm advisors, crop yields were adjusted for each soil group.

Dairy farms

WPRS includes all the costs and high net returns attributed to dairy farms (milk production) in the payment capacity analysis. In this study, we assumed that only farm activities directly using irrigation water would contribute to project repayment. Therefore, all dairy-related crops were valued at their market value or opportunity cost.

Although the costs and returns from milk and beef-producing operations were not included in our model, the livestock enterprise was simulated by requiring the farm to provide sufficient digestable nutrients for 100 mature animals. The farmer had the option of producing the feed on the farm or purchasing it on the open market, whichever alternative was most economical. The representative field crop farms in Sacramento and San Joaquin Counties were analyzed with and without a livestock enterprise.

Crops considered and rotational constraints

The field and forage crops included in the linear programming model were the same as those contained in WRPS' payment capacity analysis (see table 10).

Table 10

Field Crops Considered In Linear Program

Sacramento County	San Joaquin County
Irrigated land	Irrigated land
Corn for grain	Corn for grain
Corn silage	Alfalfa hay
Barley	Barley
Grain sorghum	Grain sorghum
Alfalfa hay	Drybeans
Pasture	Corn silage
Oat and vetch hay	Pasture
	Oat and vetch hay
	Sugar beets
Dryland	Dryland
Barley	Barley
Range pasture	Range pasture

Unlike WPRS, however, our model includes the possibility of dryland crops as an alternative to irrigation farming operations. In addition, sugar beet acreage in San Joaquin County was constrained to 10 percent of the irrigated cropland due to pest problems and contractual limitations.

WPRS implicitly assumes that a portion of the irrigator's row crops (corn, beans, and sugar beets) would be rotated with irrigated barley to maintain soil quality. Our linear programming model specifically assumes that portion will be 30 percent.

Irrigation technologies on undeveloped land

WPRS assumes that its estimate of 75,000 acres 1/ of new agricultural land will be developed, regardless of the irrigation techniques employed. Based upon discussions with University of California farm advisors, our linear programming model assumes that 20,000 acres in Sacramento County and 5,000 acres in San Joaquin County could be leveled and developed using surface irrigation methods. The remaining 50,000 acres was assumed to be too rolling or the top soil too shallow for surface irrigation, and therefore must be irrigated by sprinklers at higher capital and operating costs.

Interest on debt recomputed

WPRS calculated interest on debt based upon the total farm investment. The 1974 Census of Agriculture revealed, however, that only about 25 percent of Sacramento County farms and 30 percent of San Joaquin County farms are actually financed by debt. Using a 6-1/2 percent interest rate in 1974 and a 9-1/4 percent interest rate in 1978, we recomputed the model farm interest on debt. This reduced the annual fixed cost and thus improved the model farm profitability by approximately $7,500 to $9,000.

LINEAR PROGRAMMING MODEL RESULTS

The linear programming models were programmed to predict farmer responses to changes in project water price at $5 intervals from $1 to $101. We were particularly interested to ascertain impact at our computed full cost price of project water at farm headgate and at the interest-subsidy price during both the 1974 and 1978 time periods, $24.86 and $36.92.

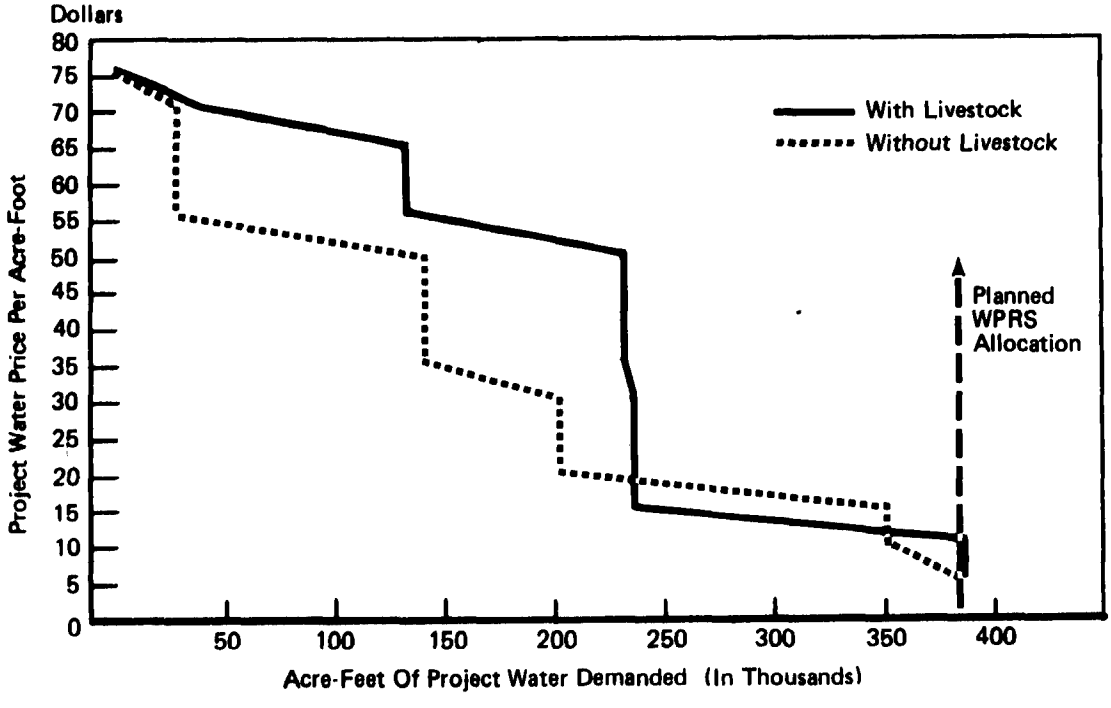
1/See pp. 49 and 51-52 for discussion of the estimate.

Demand for project water

The linear programming models revealed that farmers would continue to purchase decreasing amounts of project water up to $76 an acre-foot in San Joaquin County and $46 an acre-foot in Sacramento County under 1978 conditions. However, Folsom South farmers experienced net losses at these price levels as they did without WPRS water; and the demand for project water stopped completely at any higher prices. (See figures 2 and 3 for the 1978 Folsom South service area demand curves.)

Under 1974 conditions, the price sensitivity of Folsom South service area farmers was approximately $5 to $20 an acre-foot higher than the 1978 prices. Even at these higher price levels, farmers still experienced profits during 1974 due to high crop prices. With the exception of San Joaquin County farmers during 1974, all the linear programming models showed that Folsom South service area farmers would not purchase project water at a price which reflected full cost with interest. Area farmers would, however, purchase some project water at the interest-subsidy price, but this left a large unused water supply (see table 11.)

FIGURE 2
1978 SAN JOAQUIN COUNTY SERVICE AREA DEMAND CURVE FOR PROJECT WATER



APPENDIX I

FIGURE 3

1978 SACRAMENTO COUNTY SERVICE AREA DEMAND CURVE FOR PROJECT WATER

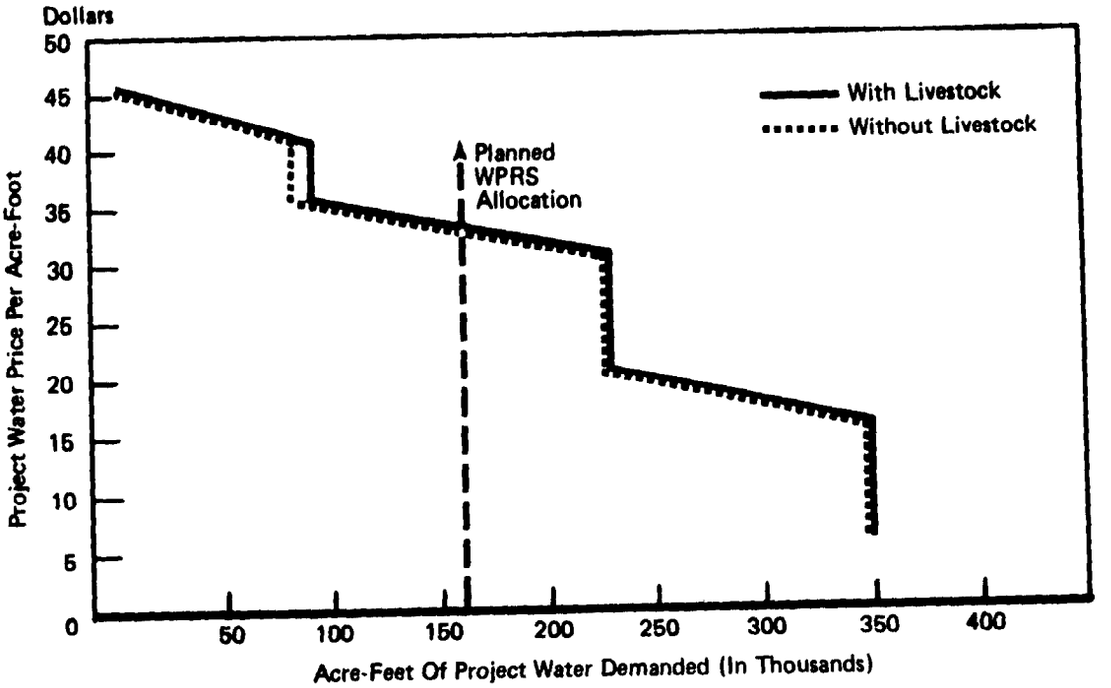


Table 11

Irrigation Water Demand

	Acre-feet of project water demanded at interest-subsidy price		WPRS allocation
	1974 ($26)	1978 ($36)	
San Joaquin County	143,767	166,729	384,100
Sacramento County	199,167	88,382	160,900
Folsom-South Service area demand	342,834	255,111	N/A
Planned WPRS allocation	545,000	545,000	545,000
Percent of WPRS allocation demanded	63	47	N/A

Due to different commodity prices, Sacramento County farmers would have demanded considerably more project water and developed new agricultural land under 1974 conditions but not under 1978 conditions. The results also imply that 47 to 63 percent of the Folsom-South service area will accept WPRS water, and the remainder will choose not to participate as a project water recipient. This remaining portion of the service area would continue with their existing farm operations and would probably not be affected by the lack of project water.

In addition, our linear programming models disclosed a serious WPRS misallocation of project water between Sacramento and San Joaquin Counties. Despite more undeveloped acreage in Sacramento County, WPRS is currently planning to allocate 385,000 acre-feet of project water to San Joaquin County and only 160,000 acre-feet of project water to Sacramento County. Our model showed that at project water prices, less than $36 an acre-foot under 1978 conditions, Sacramento County farmers would demand more project water than WPRS plans to provide them. At $11 to $16 an acre-foot project water under 1978 conditions (prices which approximate the expected WPRS price to the farmers) Sacramento County farmers would demand over twice the projected WPRS allocation. San Joaquin County farmers, on the other hand, would demand less than the projected maximum allocation even in the $11 to $16 price range. These results imply that WPRS should allocate a larger proportion of total project water to Sacramento County in order to maximize project water use.

WPRS officials responded that water was allocated to Sacramento County based upon a residual supply concept which is not related to the actual demand. In allocating project water to the service area, WPRS gives priority to San Joaquin County locations since it has higher payment capacities. WPRS estimates the actual water demand of Sacramento County agriculture at about 215,000 acre-feet annually.

Model farm profitability

The linear programming models disclosed that at the interest-subsidy price, Folsom South service area farmers who accept project water would lose money or almost break-even under 1978 conditions. However, these same farmers would have made profits under 1974 conditions. This is shown in table 12.

Table 12

Profit Results--Linear Program

	1978 model farm profits (or losses) at $36 per acre-foot project water	
	San Joaquin County	Sacramento County
With livestock	($10,833)	($ 941)
Without livestock	(8,555)	(937)
Without WPRS water, with livestock	(21,206)	(2,205)
	1974 model farm profits (or losses) at $24 per acre-foot project water	
With livestock	$13,588	$ 7,821
Without livestock	20,907	$12,046
Without WPRS water, with livestock	2,958	- 0 -

These farm profits (or losses) are based upon our adjusted fixed costs (see pp. 61-63), and the models already include a wage return to the farm operator for on-farm labor. The models have not made any deductions for management expertise or a return on the farm investment. Thus, zero net income represents the farmer's break-even point at which level he will be somewhat indifferent as to whether or not to purchase project water.

Whereas San Joaquin County farmers will start losing money above $11 an acre-foot project water under 1978 conditions, Sacramento County farmers do not start losing money until the water price reaches $36 an acre-foot. However, San Joaquin County demands considerably more project water than Sacramento County at these price levels. Under 1974 conditions, Folsom South service area farmers stop demanding high priced project water before farm losses are actually experienced.

As indicated earlier, with one exception, Folsom South service area farmers will not purchase any quantity of project water at full cost with interest. Under 1974 conditions, San Joaquin County farmers would have accepted $56 an acre-foot project water and still maintained farm profits of $7,059 with livestock and $14,337 without livestock. Since project water would not be purchased unless it added to net

income, all situations where some water was purchased were better than the situation without WPRS water.

Potential land development

The linear programming models showed the Folsom-South service area farmers will develop all 19,500 undeveloped acres in San Joaquin County for irrigation and 55,500 undeveloped acres in Sacramento County up to the maximum water prices shown on the following table.

Table 13

Maximum Water Price
(per acre-foot)

San Joaquin County		Sacramento County	
1974	1978	1974	1978
$51	$31 a/	$26	$16

a/ Forty-one dollars under the without livestock condition.

At water prices higher than those shown on table 13, the number of acres developed for irrigation starts decreasing. No new agricultural land is developed in San Joaquin County at $56 an acre-foot, and Sacramento County farms stop developing new farm land at $36 an acre-foot in 1978 and $46 and acre-foot in 1974.

At the interest-subsidy price for project water during 1974 ($26 an acre-foot), Folsom South service area farmers develop all the potentially irrigable acreage. But unless Sacramento County receives more project water than currently proposed, some of this potential new farm land would not come into production.

The linear programming results at the full cost price for project water without interest under 1978 conditions are somewhat more mixed. Whereas San Joaquin County farms will develop most new agricultural land at $36 an acre-foot project water, Sacramento County farmers would not develop any new farm land. However, at $31 an acre-foot, Sacramento County farmers would develop approximately 20,000 acres of new agricultural land which can be placed into surface irrigation methods.

As indicated earlier, Sacramento County farmers would demand considerably more project water at lower prices than WPRS is planning to allocate. As a result, virtually no new land development will occur in Sacramento County at lower water prices unless substantially more water is made available to that county. With no new agricultural development in Sacramento County, the actual benefits of the project would be significantly lessened.

Crop rotation changes

The linear programming models did not reveal any crop rotation changes until water prices rose above those shown on table 13. Therefore, Folsom South service area farmers would not have made any crop shifts under 1974 conditions as a result of paying the interest-subsidy price for project water ($26 per acre-foot). However, cropping pattern changes would occur under the 1978 price-cost conditions at $36 per acre-foot.

To reduce the complexity of discussing these changes, we have combined the with and without livestock crop rotations using WPRS' dairy/non-dairy field crop percentages from the payment capacity analysis. Also, our analysis of the 1978 ground water prices assumes that currently undeveloped land has already come into production and sufficient water supplies are available to meet the demand.

The following table illustrates the anticipated field crop rotation changes in San Joaquin County under 1978 conditions as a result of increasing the current water price to the interest-subsidy price. Except for shifting 22,520 acres from alfalfa to dry beans, the crop changes are not significant in San Joaquin County. Of about 7,200 acres of corn taken out of production, over 5,000 acres will be planted with irrigated barley and almost 2,200 will remain undeveloped at higher water prices. In the case of Sacramento County, approximately 45,000 acres will be taken out of alfalfa production and placed into corn and irrigated barley. Although no new agricultural land is developed in Sacramento County at $36 an acre-foot project water, approximately 20,000 previously unirrigated acres would be planted with alfalfa at $31 an acre-foot project water.

Irrigation technology changes

Despite a 10 percent water savings factor, the Folsum South Service area model farms did not shift from surface to sprinkler irrigation methods at higher project water prices. Although some shifts from flood to furrow irrigation occurred during 1978 due to crop rotation changes, there were no shifts

from surface to sprinkler irrigation methods on existing irrigated land. Apparently, the potential water savings of sprinkler irrigation did not outweigh the increased capital and pumping power costs. Furthermore, sprinkler systems were so costly that land developed with sprinkler irrigation was always cut out of production at lower water prices prior to furrow development.

Table 14

Field Crop Rotation
1978 Ground Water and Interest-subsidy Prices

	San Joaquin County	
	Ground water price ($21 an acre-foot) a/ (acres)	Interest-subsidy price ($36 an acre-foot) (acres)
Corn (grain)	63,087	55,893
Barley	24,906	29,971
Dry beans	- 0 -	22,520
Alfalfa	38,276	15,756
Sugar beets	12,362	12,362
Dryland b/	- 0 -	2,171
TOTAL (field crop acres)	138,631	138,673

	Sacramento County	
	Ground water price ($11 an acre-foot) (acres)	Interest-subsidy price ($36 an acre-foot) (acres)
Corn (grain)	- 0 -	34,103
Barley	- 0 -	11,254
Alfalfa	134,602	33,779
Dryland c/	- 0 -	55,500
TOTAL (field crop acres)	134,602	134,636

a/WPRS water is priced at this level also.

b/San Joaquin County farmers may develop up to 19,500 acres for irrigated crops.

c/Sacramento County farmers may develop up to 55,500 acres for irrigated crops.

CONCLUSIONS

Based upon the linear programming model results, we conclude that Folsom South service area farmers who accept project water could and would pay for WPRS water at the interest-subsidy price over the long run. The farmers could not, however, pay for Auburn-Folsom water at the full-cost price of $98.33 an acre-foot. Although San Joaquin County water recipients would lose money under 1978 price-cost conditions, this situation would not be detrimental to them unless sustained over a long period of time because they would lose more without the project water. To compensate for continued losses, San Joaquin County farmers may shift some existing developed land from low value field crops to higher value vegetable and perennial crops. San Joaquin County farm advisors indicated this is already occurring in some locations of the service area.

With the exception of Sacramento County during prolonged 1978 conditions, new agricultural land will continue to be developed for irrigation at the interest-subsidy price for project water. Although no new land was developed in Sacramento County during 1978 in the model, approximately 20,000 acres were developed at slightly lower water cost and all 55,500 acres were developed during 1974 price-cost conditions. Thus, over the long run, most potential new farmland should be developed at interest-subsidy water prices.

Although increased water prices would not have caused field crop rotation changes in the model under 1974 conditions, alfalfa acreages were reduced considerably under the 1978 price-cost conditions. However, the irrigation technology in the Folsom-South service area did not change in the model due to increased water prices.

One of the primary advantages of cost-based water pricing in the Folsom-South service area would be to establish a mechanism for efficiently utilizing the existing agricultural land and allocating project water supplies. For example, Sacramento County farmers would demand considerably more water than WPRS is planning to supply at low project water prices, but virtually all of the land would be placed into alfalfa production. If this large water demand is not met, limited new land development will occur in Sacramento County at low project water prices. At higher water prices, project water demand decreases, less new land is developed, and 45,000 acres is shifted from alfalfa production to corn and irrigated barley. Similarly, water use and potential land development decreases in San Joaquin County at higher water prices, and over 22,500 acres are shifted from alfalfa to dry beans production.

In addition, our analysis disclosed a large WPRS misallocation of project water between Sacramento and San Joaquin Counties. Despite considerably more undeveloped acreage in Sacramento County, WPRS is planning to allocate 385,000 acre-feet of project water to San Joaquin County and only 160,000 acre-feet of project water to Sacramento County. Therefore, minimal new land development will occur in Sacramento County at lower water prices unless substantially more water is made available to that county. At higher water prices, however, the natural forces of supply and demand resolve any imposed water allocation inequities.

DALLAS CREEK PARTICIPATING PROJECT

UPPER COLORADO RIVER STORAGE PROJECT

The Dallas Creek Project, authorized in 1968 and scheduled for completion in 1983, is located in west-central Colorado within the Upper Colorado River Basin. The project area stretches along the Uncompahgre River as it flows north from its source in the San Juan Mountains to its merging with the Gunnison River.

The irrigable lands lie at elevations of 5,600 to 7,350 feet above sea level. The frost-free season averages about 127 days annually and varies from about 148 days at the lower end of the valley to 112 days in the upper reaches of the project area. Production of beef cattle is the chief agricultural enterprise.

Within the Uncompahgre Basin, about 104,000 acres are presently under irrigation. This includes 69,000 acres in WPRS' Uncompahgre Project and 35,000 acres under private development. The irrigated farmlands produce feed crops and a variety of cash crops. The feed crops include alfalfa, meadow hay, pasture, and small grains. Other crops include malt barley, shelling corn, pinto beans, onions, and fruit.

The Dallas Creek Project is sponsored by the Tri-County Water Conservancy District which was formed in 1957. Under Colorado statutes, the District has the power to levy taxes, the right to acquire and sell water, and the right to plan, finance, construct, operate, and maintain water resource projects.

The Federal Government contracted with the District on January 14, 1977, for repayment of the irrigation obligation and all project costs allocated to municipal and industrial use, including interest during construction.

GENERAL PROJECT INFORMATION

The Dallas Creek Project involves construction of Ridgeway Reservoir on the Uncompahgre River to increase water supplies for irrigation and municipal and industrial (M&I) purposes and to provide flood control. The reservoir capacity will be 80,000 acre-feet with inactive storage of 25,000 acre-

feet. The project does not include construction of distribution facilities. These already exist or will be constructed by the Tri-County Water Conservancy District or by the users.

For irrigation, the project will supply 11,200 acre-feet annually of supplemental water supplies; 10,300 acre-feet to the Uncompahgre Project service area and 900 to 2,850 acre-feet in the Colona and Dallas Creek areas. The Uncompahgre area contains 61,810 irrigable acres, but the acres that will actually receive project water are not known.

Effective precipitation in the project area during the growing season averages only about 4 inches, and farming is said to be practically impossible without irrigation. The project's existing supplies and requirements as estimated by WPRS are shown in table 15.

Table 15

Irrigation Requirements

	Existing supplies (acre-feet)			Remaining requirement (acre-feet)	
	Acreage	Per acre	Total	Per acre	Total
Colona area	750	2.65	1,990	0.24	180
Dallas Creek area	2,100	2.65	5,390	0.79	1,640
Uncompahgre project area	61,810	5.00	308,920	0.46	28,560
TOTAL	64,660	N/A	316,300	N/A	30,380

The Dallas Creek Project with its supply of 11,200 acre-feet for irrigation will satisfy little more than one-third of the remaining requirement. The small additional quantity of water on which repayment is based, however, is said to help satisfy the need for early and late season water through the storage and regulation of river flows.

M&I needs have become the major purpose for project water during the post-authorization period. In the 1966 feasibility report only 20 percent of the project supply was allocated to M&I use, that allocation is now 71 percent.

The Tri-County Water Conservancy District will sell M&I water mainly to the communities of Montrose, Delta, and Olathe, and for rural users. The piped water system for rural areas was constructed by the District several years ago in anticipation of the Dallas Creek Project. WPRS expects the population in the project area to increase at the rate of about 5 percent a year.

The Dallas Creek Project will enhance fishing opportunities on the Uncompahgre River, improve wildlife habitat, and mitigate wildlife habitat losses. To accomplish those objectives measures will be taken to maintain minimum flows, dual level outlets at the reservoir for flexibility in water quality and temperature control; construct an 8.2 mile deer fence along a highway; and acquire a wildlife range.

Recreational development will include an inactive pool of 20,900 acre-feet in the reservoir and facilities for picnicking, camping, boating, and hiking. Benefits were estimated at $730,000 annually based on 348,000 recreation days at $2.10 each day.

The project will also provide flood control benefits of $50,000 annually.

Project documentation

A feasibility report on the Dallas Creek Project was transmitted to the Congress in 1966. The project was authorized by the Colorado River Basin Project Act of September 30, 1968 (P.L. 90-537).

In preparing for construction a Definite Plan Report was written in 1974. That plan, however, included 24,000 acre-feet of water for steam power generation which the State of Colorado found objectionable. The plan was revised in 1975 to eliminate that allocation and add 10,300 acre-feet for supplemental irrigation of the Uncompahgre Project area.

Public hearings were held on the Draft Environmental Impact Statement in April 1976. These hearings revealed strong objection to a particular segment of the original plan. The segment was eliminated, and the change was incorporated in the most recent Definite Plan Report of November 1976. The elimination of that segment resulted in a substantial reduction in the project's size.

Following is a comparison of selected project data at authorization with the latest Definite Plan Report data.

Table 16

Comparison of Project Size

	1968 Authorization	1976 Definite Plan Report	
Reservoir capacity in acre-feet	164,925	80,000	
Water supply in acre-feet	75,300	39,400	
Irrigation	60,300	11,200	
M&I	15,000	28,100	
Recreation	-	100	
Irrigable acres	23,620	64,660	
Full service	14,900	-	
Supplemental service	8,720	64,660	
Private development	8,720	2,850	
Uncompahgre Project	-	61,810	a/

a/WPRS cannot determine the portion that will actually be served but has made an estimate of 18,000 acres.

In a letter of January 1977, the Department of the Interior advised the Congress of the significant changes in size and purpose. The Department concluded the changes were within the scope of authorizing legislation or the discretion of the Secretary of the Interior.

In terms of January 1976 prices, the estimated construction cost dropped from $83.4 million at the time of authorization to $54.4 million due to the diminished scope of the project. The benefit-cost ratio as estimated by WPRS declined from 1.65 to 1.48.

Allocations and repayments of the construction cost to the project's benefits are shown in table 17 according to the Definite Plan Report and the more current Project Data Sheet.

A contract is in effect with the Tri-County Water Conservancy District that obligates the District to repay WPRS for (1) irrigation costs in the amount of $2,025,000 in 50 annual installments, account charges of not less than $23,500 annually for 50 years, and ad valorem tax revenues of not less than $3,066,000 in a 50-year period, and (2) M&I costs and all allocated project costs, including interest during construction, with a maximum obligation set at $38 million. Based on the January 1976 Price Level the M&I obligation is $27,966,000. Interest is to be accrued on the obligation at the rate noted in footnote b/ to table 17.

Table 17

Cost Allocation and Repayments

Allocations	1976 Definite plan report	1979 Project data sheet
Reimbursable costs:		
M&I water	$24,612,000	$30,369,000
Irrigation	15,279,000	16,242,000
Subtotal	$39,891,000	$46,611,000
Nonreimbursable costs:		
Recreation	$10,100,000	$10,650,000
Fish and wildlife	1,773,000	1,952,000
Highway improvement	1,430,000	1,510,000
Flood control	1,206,000	1,281,000
Subtotal	$14,509,000	$15,393,000
Total Allocations	$54,400,000	$62,004,000
Repayment		
M&I Water a/		
Tri-County Water Conservancy District	$24,407,000	$30,164,000
Credits from Colorado River Development Fund b/	205,000	205,000
Subtotal	$24,612,000	$30,369,000
Irrigation		
Apportioned revenues from Colorado River Storage Project	$ 8,886,000	$ 9,849,000
Tri-County Water Conservancy District		
Ad valorem tax	3,066,000	3,066,000
Irrigators	2,025,000	2,025,000
Account charges	1,175,000	1,175,000
Credits from Colorado River Development Fund b/	127,000	127,000
Subtotal	$15,279,000	$16,242,000
Total Repayment	$39,891,000	$46,611,000

a/Construction costs allocated to M&I use would be repaid with interest at rate applicable at time of construction, assumed at 5.116 percent annually. At the assumed rate payments would also include $3,559,000 in interest during construction.

b/Credits toward costs of investigation.

Subsidy

The repayment of the expenditures allocated to the irrigation function does not actually cover all the costs. The Government would receive payments equal in value to the contracted scheduled if it had lent the irrigators (the Tri-County Conservancy District) $1.3 million at 7.5 percent interest for 50 years and had forgiven the payment of the remaining $14.9 million. The subsidy is 92.2 percent.

WPRS RATIONALE FOR THE PROJECT

WPRS has concluded that inadequate water supplies are a major problem in the project area because future residential expansion and industrial development could be threatened and full agricultural potential could be hindered.

If the Dallas Creek Project was not built, WPRS believes non-Federal entities would attempt single-purpose M&I water developments. These attempts would be made because of two conditions which exist in the Uncompahgre Basin: strong demands for increased water supplies and sizeable underdeveloped water resources.

The problems with developments by non-Federal entities, according to WPRS, are associated with the limited financing that would be available. There would be no assurance of minimum streamflows, an inactive reservoir storage, public recreation facilities, or mitigation of wildlife habitat losses. The alternative water developments could also result in significant esthetic changes.

WPRS considered alternative sources and uses of water in addition to 26 reservoir sites instead of the project that is planned. One of the major alternative plans was to import more water from the Gunnison River. This plan would cost much less and have a higher benefit-cost ratio, but WPRS rejected it on the grounds that it would not serve all the purposes of the selected plan. It would not improve water quality, provide improved flows for fish, or provide flood control. The reservoir would have little value for recreational purposes. Other major plans were rejected for economical, environmental, and other reasons.

In its Feasibility Report of 1966, which was the basis for congressional authorization, WPRS expressed the need for the Dallas Creek Project as follows:

> there is an urgent need for additional and dependable irrigation supplies to improve and

> stabilize the economy of the farmers and of related service industries. . . .
>
> Additional municipal and industrial water is needed to meet existing and anticipated needs of local communities and to provide a safe and convenient supply for surrounding rural areas. The need for additional water in the communities is accentuated by the population growth anticipated for them in the years ahead.

Developments since authorization have resulted in very basic changes. Originally, for example, 80 percent of the total water supply of 75,300 acre-feet was allocated for irrigation. In the 1976 Definite Plan Report, irrigation allocation was 28 percent of a total water supply that had shrunk to 39,400 acre-feet. The M&I allocation, on the other hand, has increased substantially since authorization. Developments leading to the current allocations for irrigation and M&I use are detailed in the following sections.

Irrigation problems and needs

Lands to receive irrigation water are an undetermined portion of 61,810 acres in the Uncompahgre Project area and 2,850 acres in the Colona and Dallas Creek areas. The Uncompahgre area will receive 10,300 acre-feet of water or 92 percent of the total annual irrigation supply of 11,200 acre-feet. All of these lands are presently irrigated. The Uncompahgre area now receives 308,920 acre-feet from one of the earliest WPRS projects. The other areas receive 7,380 acre-feet from private developments.

The current areas for irrigation are not the same as those identified in the 1966 Feasibility Report. The project acreage then consisted of 23,620 acres of which 14,900 were to receive full service and 8,720 supplemental service. These lands were in the southern portion of the project area. Currently most of the irrigation water is planned for use in the northern portion.

The 1966 Feasibility Report stated that agricultural lands in the northern portion of the project area were already adequately irrigated under WPRS' Uncompahgre Project. Water is conveyed to this area through a 6 mile-long tunnel completed by WPRS in 1909. In 1937 the Uncompahgre Project was enhanced with construction of the Taylor Park Dam which provides some regulation of Gunnison River flows.

WPRS has subsequently changed its position to state that the Uncompahgre Project area was not adequately irrigated.

The change followed an objection by the State of Colorado to a provision in a 1974 Definite Plan Report setting aside 24,000 acre-feet of water for steam power generation instead of for irrigation. Accordingly, the Definite Plan Report was reformulated in 1975 to eliminate the 24,000 acre-feet for industrial use and to add 10,300 acre-feet for supplemental irrigation of most of the Uncompahgre Project area. Public concerns and a request for less M&I water in 1976 caused most of the original project acreage to be eliminated from the final Definite Plan Report of November 1976.

WPRS stated in that Definite Plan Report that hydrology studies show an 8.5 percent shortage of irrigation water for the Uncompahgre Project area. The Dallas Creek Project will increase the supply by 0.16 acre-feet per acre so that the shortage will be reduced to 5.4 percent. Although the quantity is slight compared to the 5 acre-feet being supplied without the Dallas Creek Project, WPRS believes it will especially relieve early and late season shortages. More water at these times will improve the germination of crops in the spring and the maturation of long season crops.

Additional irrigation water for the Uncompahgre Project area apparently does not have the wide support from potential users that the original project had. WPRS stated that 90 percent of full-time farmers contacted in 1962 and 1963 expressed support of the project almost without exception. When it surveyed 40 farmers on the Uncompahgre Project in 1974 only 45 percent declared a need for more water.

It is not clear how the irrigation water will be distributed. The Definite Plan Report assumes that each of the 61,810 acres will receive a diversion of 0.16 acre-feet, but says it is not likely that all of that acreage would be served and that the exact acreage can not be determined until subscriptions are made. The Project Data Sheet of January 1979, however, states the project will provide supplemental water to 20,850 acres of presently inadequately irrigated land, which would mean that each area would receive a diversion of 0.47 acre-feet.

M&I water problems and needs

According to the Definite Plan Report of November 1976, the water to be made available for M&I purposes is 28,100 acre-feet annually or 71 percent of the total project supply. This is an 87 percent increase over the 15,000 acre-feet estimated in the 1966 Feasibility Report.

The Feasibility Report described facilities for domestic water as generally inadequate. It said additional M&I water

was needed to meet existing and anticipated needs of local communities and to provide a safe and convenient supply for surrounding rural areas. WPRS stated in the report it had independently determined the need which was based largely on a population forecast. The entire project supply was expected to be required by 1982.

The Definite Plan Report in 1976 explained that the Tri-County Water Conservancy District had increased its request for annual M&I water from 15,000 acre-feet to 28,100 acre-feet. The increase was supported by WPRS' projections of population through the year 2000.

In the 1966 report WPRS had adopted a forecast which projected a growth to 29,000 in 1970 and 60,000 in 2000. Though the U.S. Census recorded an actual population of only 22,412 in 1970, WPRS in 1976 projected an increase to 93,000 in 2000. WPRS' projection was based primarily on new connections of telephones, natural gas, and electric power from 1968 to 1972. WPRS set the future need for water at 300 gallons per day per capita in cities and towns and 180 gallons per day per capita for the rural areas.

In December 1976, the Assistant Secretary of the Interior questioned WPRS' population projection as being overstated and required firm M&I contracts. WPRS did not subsequently justify the projection but did provide contracts for sale of the water.

IRRIGATION REPAYMENT AND BENEFIT DETERMINATION

Calculations of net farm income

WPRS prepared 14 farm budgets in its analyses of the Dallas Creek project area to determine the repayment capability of farmers. The budgets represent the types of farming operations expected to prevail after allowing 1 year for development. Underlying assumptions include average managerial ability and a full water supply.

The bulk of the Uncompahgre area, at an elevation of about 5,600 feet, is depicted by ten budgets due to two distinct soil types as well as multiple land classes. Two basic farm operations--purchase calves with cash crops and range beef with cash crops--were budgeted for Mesa soil land classes 1, 2, and 3, and for Adobe soil land classes 2 and 3.

An example of WPRS' budgets is provided by a hypothetical farm of 145 acres of class 2 land in the Uncompahgre area. Sales of alfalfa, feed barley, straw, and shelling corn provide receipts of $13,960 and sale of calves amounts to $67,528

for a total of $81,488. Increasing this by $1,200 for farm privileges results in a gross income of $82,688.

Farm expenses include $45,954 for purchase of the calves, $5,502 for interest on the farm investment, and numerous other detailed expenses, making a total of $66,589. The difference is a net farm income of $16,099. Net farm incomes for all 14 budgets ranged from $14,877 to $17,232.

Whereas the 14 farm budgets used in the repayment analyses each represent a single land class, WPRS used composites of the land classes in its analyses of irrigation benefits. Only six budgets were required, therefore, to represent the basic farming operations in the area. In addition, WPRS assumed the development of fruit enterprises and included three budgets for orchards, making a total of nine hypothetical farms.

All of the budgets incorporate beef production as the major source of income. In terms of acreage, the primary crop in every budget is alfalfa. Barley grown for feed also ranks high in importance. Varying proportions of these two crops are fed to cattle with the remainder being sold. Other crops which produce significant income are malting barley, shelling corn, and sugar beets.

Primary data for the budgets were drawn from farm management surveys which record recent yields and other pertinent data reported by selected farmers in the project area. A survey of 80 farms taken in the original project area was supplemented by a survey of 40 farms in the Uncompahgre area.

WPRS used the survey data to estimate crop yields it expects farmers to achieve with project water. Because of the small amount of water to be delivered to each acre, 0.16 acre feet, WPRS believed it could not properly measure the incremental effects of project water on crop yields. As an alternative, WPRS prepared the farm budgets on the basis of a full water supply and derived acre-foot rates from that.

The 2,850 acres around Colona and Dallas Creek are at elevations of 6,300 feet to 7,350 feet above sea level. Farms in these areas are represented by two types of operations--one designated as beef with range and the other as cash crop with purchase calves. These are each budgeted for land classes 2 and 3 resulting in a total of four budgets.

The budgets for benefit analyses anticipate the farming operations that will exist 15 to 20 years after the development period. The major assumption in these analyses is that

the average farmer will be producing what the best farmers are now producing.

Reduction of net farm income to repayment capability

After calculating net farm income for each of the 14 farm budgets following a one-year development period, WPRS deducted returns to management, equity, and labor. The remainder was considered by WPRS to be the farm's payment capacity. WPRS recommended water charges, however, at 25 percent below that capacity to allow for contingencies.

Continuing the farm budget example cited earlier (see p. 82), the net farm income of $16,099 was reduced to a payment capacity of $5,005 by deducting a return to management of $2,665, a return to equity of $1,100, and a return to labor of $7,329. The return to management was computed by allowing $1.00 per hour of operator's labor. The return to equity is one percent of the farm investment and will allow the farmer to retire his debt. The budget estimates the farmer's labor input at 2,665 hours and allows a return of $2.75 per hour which extends to a total of $7,329.

WPRS summarized the 14 farm budgets according to land class as follows:

--Dallas Creek and Colona areas (land classes 2 and 3),

--Uncompahgre area of Mesa soils (land classes 1, 2, and 3), and

--Uncompahgre area of Adobe soils (land classes 2 and 3).

After deducting a $10 account charge that will repay the $1,175,000 noted in table 17 in addition to returns to labor, management, and equity, the 7 payment capacities ranged from $3,464 to $4,732. These were reduced by 25 percent for contingencies following which WPRS recommended water charges of $15 per acre for the Dallas Creek and Colona areas, $22 per acre for the Uncompahgre Mesa soils area, and $17 per acre for the Uncompahgre Adobe soils area.

The Project Data Sheet for fiscal year 1979 shows that the Dallas Creek project farmers' ability-to-pay price is $20.75 an acre. This is probably a weighted average for the three land classes noted above. The OM&R payment is shown as $0.34 and the construction costs payment as $20.41 an acre. The acre-foot-based OM&R payment is $0.62 because the annual estimated charges are actually $7,000, not the $22,000

one would expect if all 64,660 acres in the project contributed $0.34.

The acre-foot-based water charge for construction would be $3.96 based on the above information. The repayment schedules for the project, however, show that the direct water payments for irrigation water will be $3.62 an acre-foot. We could not reconcile the two figures.

In addition to the OM&R payments for $0.62 and $3.62 an acre-foot direct payment for construction costs, the irrigation facilities will be partially repaid from two other sources within the Tri-County Conservancy District. The district will charge everyone who buys water from the project an annual account charge, which is expected to bring in $23,500 a year, or $2.10 an acre-foot. The conservancy district will also pay 5 percent of a 2 mill district-wide property assessment tax toward the irrigation construction costs. This will bring in about $61,300 in an average year, or $5.48 on an acre-foot basis. The rest of the irrigation facilities cost--about 60 percent of the total allocated to irrigation--will be paid for from net power revenues from the Colorado River Storage Fund.

Our interpretation of payment capacity

If the actual costs of existing Federal water, including the costs of operation, maintenance, and replacement (OM&R) are subtracted from the recommended water charge, the remainder would be available for repaying Dallas Creek project costs and OM&R costs. In the next paragraph, the results of subtracting actual cost from the recommended water charge are shown for the Uncompahgre area on a per-acre basis.

In 1973, the base year used by WPRS for the farm budgets, existing irrigation water for existing Uncompahgre Project users was priced according to each irrigator's soil and land class with the highest price set at $8.63 for 5 acre-feet per acre. The prices included costs of OM&R. Deducting this charge from the recommended charges of $22 and $17 per acre for the Uncompahgre area farms leaves a minimum of $13.37 per acre and $8.37 per acre for payment towards the Dallas Creek Project costs allocated to irrigation and costs of OM&R.

WPRS, however, divided the recommended water charges by the total water supply to obtain acre-foot rates of $5.20 for the Colona area, $5.15 for the Dallas Creek area, $4.30 for Uncompahgre area Mesa soils, and $3.30 for Uncompahgre area Adobe soils. The average presented in the FY 79 Project Data Sheet is $20.75 ÷ 5.16 acre-feet, or $4.02 an acre-foot. The Uncompahgre farmers who receive 0.16 acre-foot of supplemental

water will therefore pay $0.69 ($4.30 an acre x 0.16 acre-foot) per acre for water applied to Mesa soil and $0.53 ($3.30 x 0.16 acre-foot) per acre for water applied to Adobe soil.

The following table shows that for the Uncompahgre area substantial portions of WPRS' recommended water charges will not have to be paid by the farmers.

Through this method, WPRS is in effect asking the farmer of Mesa soil to repay only $9.32 or less per acre for both old and new WPRS water compared to WPRS' recommended water charge of $22.00 per acre, and the farmer of Adobe soil to repay only $9.16 or less per acre compared to WPRS' recommended water charge of $17.00 per acre.

Table 18

Uncompahgre area

	Mesa soil	Adobe soil
Water charge per acre recommended by WPRS	$22.00	$17.00
Less maximum cost of existing supply (5 acre-feet per acre)	8.63	8.63
Remaining repayment capability per acre	13.37	8.37
Less WPRS charge per acre (0.16 acre-foot per acre)	.69	.53
Retained by farmer	$12.68	$ 7.84
Interest-subsidy price	$ 4.74	$ 4.74
Full-cost price	$16.69	$16.69

If actual cost for the existing Uncompahgre Project water is used as the without project condition to determine repayment capability for the Dallas Creek Project water, WPRS farm budgets demonstrate a strong potential for paying the full share of project costs without interest, $29.00 an acre-foot assignable to the Uncompahgre area (92 percent of the irrigation allocation). Even the Adobe soil farmers could pay the interest-subsidy price and increase net revenue. We did not determine whether Dallas Creek and Colona area private irrigators (8 percent of the irrigation allocation) could also repay

the interest-subsidy price because we did not obtain the costs of their existing water.

An additional subsidy to irrigators is the amount of interest that is not charged during the 50 years of repayment. If interest were charged at 7-1/2 percent, the annual repayment would be $1,161,089 or $103.05 per acre-foot, and the Uncompahgre area's 0.16 acre-foot per acre would be priced at $16.69 annually. As determined by the WPRS farm budgets, Uncompahgre irrigators could repay some, but not all, of the interest on the irrigation allocation.

MARGINAL ANALYSIS

WPRS did the farm budgets on a total water supply basis because they said the additional 0.16 acre-feet an acre from the Dallas Creek project for the Uncompahgre area would not yield a measurable extra crop growth. This means there would be no additional income to cover any increase in production costs. Therefore any positive price for the Dallas Creek water would lower economic well-being with the project compared to without-project conditions.

We did not attempt to verify whether or not the additional water would cause extra yield. WPRS admits that the water from Dallas Creek is a small amount but believes that it would help germinate and finish the crops in some years. In addition WPRS does not even know which acres will get the water. They presented to the Congress a figure of 20,850 acres in the annual Project Data Sheets, but do not actually know which crops on which acres will receive the water.

We know from our analysis on the Fryingpan-Arkansas Project (see p. 102) that the increased yield from an additional acre-foot of late season water will not increase the net income of an alfalfa crop, a major crop in the Dallas Creek project area. Therefore even if there was some increase in yield, the additional harvesting costs would just about balance the increased income leaving nothing to pay for the extra water.

CONCLUSION

Two conclusions are possible, depending on whether one accepts WPRS' or our analysis.

WPRS ANALYSIS

WPRS analytically comingled the water from two WPRS projects to come up with an average ability-to-pay price of $4.02 an acre-foot which they than applied

to just the Dallas Creek water. They ignored the fact that the existing project only charges a maximum of $1.73 an acre-foot including OM&R. If WPRS had actually priced the existing Uncompahgre water supply at $1.73 an acre-foot as a proxy for the without-project condition, the Dallas Creek water could have been priced much higher.

GAO ANALYSIS

WPRS' failure on this project to do with- versus without-project analysis is a serious omission and masks the actual situation of no demonstrable increase in output because of the project. Because of this lack of increased production, there would be no increased income to cover any increase in costs. We could therefore conclude that the farmers would not have paid the interest-subsidy price of $29 an acre-foot for Dallas Creek water, let alone the full cost of $104 an acre-foot. They would be economically better better off not to buy such small amounts of additional water at these prices.

Either conclusion indicates there was serious trouble in the justification of the irrigation facilities. If the WPRS analysis is accepted, then the 5.16 acre-feet applied to the Dallas Creek area (from both the Uncompahgre and Dallas Creek projects) should be charged $4 an acre-foot for construction costs. This would mean that the Uncompahgre water would have to go up substantially in price. If this can not be done, then the actual cost of the Uncompahgre water needs to be subtracted from the ability-to-pay estimate, leaving the Dallas Creek project water with about $52 to $80 an acre-foot ability-to-pay, which is more than enough to pay the interest-subsidy price of $29 an acre-foot.

The WPRS analysis which comingled the water from two projects fails from our point of view because the required with- versus without-project analysis was not done. If the additional 0.16 acre-feet had been compared to the area with 5 acre-feet, there would probably not have been any difference between the production with and without the project. Therefore the GAO analysis, if accepted, means that the Dallas Creek project water would provide no net national economic benefits, because it would not provide the farmers with any income to pay for extra water.

In short, if WPRS' ability-to-pay analysis is accepted, the farmers should be paying $17 to $22 an acre for all WPRS water, no matter what the source.

If that ability-to-pay analysis is viewed as flawed because it did not do a with-Dallas Creek project analysis versus a without-Dallas Creek project situation, then the failure of 11,200 acre-feet for 64,600 acres to grow any more of any already irrigated crop means the farmers would not have paid a full-cost price, or an interest-subsidy price; and they would be better off without the water from the Dallas Creek project at any price.

FRYINGPAN-ARKANSAS PROJECT

The Fryingpan-Arkansas Project is a WPRS transmountain diversion in Colorado designed to furnish 79,500 acre-feet of water annually to the Arkansas Valley. The water will be used to provide supplemental irrigation to a service area of 280,600 acres, to generate hydroelectrical power, and to supply municipal and industrial uses. Surplus water from the upper reaches of the Fryingpan and Roaring Fork Rivers will be diverted east across the Continental Divide to the Arkansas River Basin.

The city of Pueblo is the center for the varied industrial development of the basin. Agriculture, however, is the most important industry of the valley. More than 87 percent of the land area, including timberland, is used for grazing. Cultivated lands comprise 10 percent of the basin and about one-fourth, or 322,000 acres, of that land is irrigated.

Many irrigated crops are grown successfully in the Arkansas River Valley when water supplies are adequate. In the higher elevations hay, tame pasture, and small grains predominate. They are marketed chiefly through livestock. The foothills area in Fremont and Pueblo Counties, in addition to general irrigated crops, produces fruits, vine, and truck crops. Below Pueblo the principal irrigated crops are alfalfa, corn, and dry beans. Cantaloupes, onions, cucumbers, pickles, tomatoes, and red beets are highly successful truck crops.

PREPROJECT IRRIGATION CONDITIONS

The main agricultural part of the eastern slope project area is in the semi-arid zone with 11 to 16 inches of annual precipation; 70 to 86 percent of the water falls during the April to October growing season. Dry farming was and probably will continue to be practiced extensively. Livestock grazing on the ranges and in the forests is also an extensive enterprise. However, both types of agriculture require large land areas, and dry farming is particularly susceptible to changes in the weather. General cultivated agriculture and specialty high-value crops, many of which are required to stabilize the agricultural economy of the area, require more water than typical dryland crops. Irrigation is the only means of providing a dependable supply of moisture.

Early irrigation in the Arkansas Valley coincided with available stream runoff. As ready markets developed, irrigation farming was expanded and demand developed for late

season water which could not be supplied by unregulated stream flow. Consequently, between 1890 and 1910, three reservoirs in the headwaters area and 11 off-stream reservoirs below Pueblo were constructed. In 1949, the John Martin Reservoir on the Arkansas River near Lamar was completed by the Corps of Engineers for conservation storage and flood control. It also has an irrigation storage space of 420,000 acre-feet. The 11 off-stream reservoirs have a capacity of 300,000 acre-feet, about 75 percent of the original capacity because of sedimentation. Eight privately owned transmountain diversion systems import about 48,000 acre-feet annually. More than 40 canals and ditches supply irrigation water to lands in the valley between Canon City and the Colorado-Kansas boundary.

WPRS' RATIONALE FOR PROJECT

WPRS stated the following arguments in House Document No. 187 1/ as justification for constructing the project.

--The waters of the Arkansas River in the Colorado portion of the upper Arkansas River Basin are overappropriated. Serious distress is caused to the economy of the basin in short water years through loss in crop production. Supplemental irrigation water supplies are needed. Municipal supplies, even after substantial acquisition of irrigation rights, are barely adequate to supply existing requirements. Additional quantity and better quality of water are critically needed.

--Normal uses of electrical energy would expand rapidly in the power market area if not restricted by a limited supply. Resource development would be encouraged if energy were available in plentiful supply.

--Floods in the upper Arkansas Valley threaten the loss of property and discourage investment. Sediment deposits choke channels, increase flood threats, and raise maintenance costs of extensive irrigation systems. Stream pollution threatens health and destroys fish habitat. Flood, sediment, and pollution control would lower costs and remove threats.

--The diversion area on the western slope of the Rockies has a plentiful supply of water, part of which could

1/The original feasibility study was printed as House Document 187 by the 83rd Congress in 1953.

feasibly be diverted without detriment to that area or to downstream users. Although all possible future water requirements for the entire western slope have not been fully determined, it is concluded that there is an adequate water supply from Colorado's allocated share of the Colorado River Basin water for the proposed initial development of the project over and above present and prospective consumptive uses within the natural basin of the Colorado River in Colorado.

--Introduction of transmountain water would have a stabilizing effect upon the agricultural production of the Arkansas Valley. No material change in the number of farms or in crop pattern is anticipated; however, higher average crop yields and increased feeding operations are expected.

WPRS considered no other alternatives to the transmountain diversion in House Document No. 187. The approved plan for the Fryingpan-Arkansas Project is basically the same as that contained in House Document No. 187. The project is located entirely within the State of Colorado. It is planned as a multi-purpose development which will furnish an average 79,500 acre-feet of water to the Arkansas Valley.

The Fryingpan-Arkansas Project includes the following principal features:

--a system of about 70 miles of canals and tunnels on the western slope for collecting and transporting water from Hunter Creek and tributaries of the Fryingpan River,

--the Ruedi Dam and Reservoir with a capacity of about 100,000 acre-feet on the Fryingpan River 14 miles above Basalt which will provide replacement water and water for other beneficial western slope uses,

--a 5.3 mile Fryingpan-Arkansas transmountain diversion tunnel,

--enlargement of the existing Sugar Loaf and Twin Lakes Reservoirs and the construction of Pueblo Reservoir for a total storage capacity of 777,000 acre-feet,

--facilities for diverting Arkansas River flows into the enlarged Twin Lakes Reservoir,

--two power plants and the adoption of a pump back storage and peaking power concept, and

--municipal water delivery facilities for furnishing additional water to Colorado Springs, Manzanola, Rocky Ford, LaJunta, Las Animas, Lamar, Crowley, Wiley, and Eads.

Water production

The diversion of water from the west slope to the Arkansas River Valley will annually add about 79,500 acre-feet of new water to the area. This water will be stored and released according to the needs of the irrigators and the cities. The irrigators will have about 32,325 acre-feet released from the Pueblo Reservoir each year. Return flows 1/ from the 32,325 acre-feet and the return flow from the 47,175 acre-feet of municipal and industrial (M&I) use will swell the total use by irrigators from the new water produced by the Fryingpan-Arkansas Project to about 118,000 acre-feet.

PROJECT COST

The initial stage of the Fryingpan-Arkansas Project was estimated by the WPRS to cost $147 million based on October 1949 prices. It had an overall benefit-cost ratio of 1.76 to 1.00 for a 100-year period as stated in the basic plan for the project printed in 1953 as House Document No. 187.

During the period 1953 through 1959, modifications and changes were proposed which resulted in the Reevaluation Statement of 1960. In it the estimated total construction cost of the project had increased to $169.9 million with the overall benefit-cost ratio dropping to 1.35 to 1.00 for a 50-year period.

As of December 1978, the Fryingpan-Arkansas Project was 62 percent complete as stated by a project official and almost all the irrigation facilities were finished. Total construction cost was estimated at $567.5 million in terms of January 1978 dollars. The direct benefit-cost ratio as of January 1978 was 2.5 to 1.0. (See pp. 98-99 for more about this ratio.)

1/When water is first released from the reservoir for irrigation, approximately 50 percent of the irrigation water will flow back into the river which then adds to the amount available to irrigators downstream. As this process is continued, however, the volume of return flows decreases.

Analysis done by us estimated that of the $55.4 million shown in budget documents presented to the Congress as the amount to be repaid by irrigators at the end of the repayment period, only $4.9 million will come directly from irrigation beneficiaries. The $4.9 million is composed of $0.5 million from direct water sales after annual operating expenses (OM&R) are paid and $4.4 million from the irrigators' share of an ad valorem tax. The remaining $78.1 million allocated to irrigation is contributed by power, surplus M&I repayments, and the ad valorem tax from non-farm property owners.

The ad valorem tax will be collected from all property owners in the Southeastern Colorado Water Conservancy District (see footnote 1, p. 96). The total collection for the first 32 years of the repayment period--from farmers and non-farmers alike--will go to help repay the M&I costs. From year 33 to year 50 all the ad valorem tax collections will be used to retire the non-interest bearing irrigation debt. We estimated that the farms in the Fryingpan-Arkansas service area will pay about 8 percent of the tax.

Subsidy

There is considerable subsidy--about 95 percent--for the irrigation users of this project. Of the $88 million allocated to irrigation, power revenues from the regional power account will repay $29.5 million without interest after a grace period of 50 years. The remaining $58.5 million is repaid by an ad valorem tax on all real property in a 9 county area; by irrigator's direct payments for water used, net of OM&R; and by surplus M&I payments. The ad valorem tax will repay $55 million with the payments starting 33 years after the project is complete. The irrigators will make direct payments of $0.5 million as well as part of the ad valorem payments over the project's repayment schedule of 50 years, and the M&I sales will contribute $3 million.

Because of the delays in payment and the payments from so many different sources, the subsidy calculation is complicated. The results are presented in summary form below, and in complete detail in a Technical Paper in Economics. 1/

1/Technical Paper in Economics, "A Guide to Subsidy Calculations", U.S. General Accounting Office, Program Analysis Division, Washington, D. C. 20548

Table 19

Irrigation Subsidy at Fryingpan-Arkansas
($ in thousands)

Payor	Cost allocation	Present value of repayments (7.5% discount rate)
Irrigators (direct)	$ 456	$ 394
(share of ad valorem)	4,396	241
Other ad valorem	50,558	2,767
Power revenues	29,538	794
Surplus M&I sales	3,008	164
TOTAL	$87,956	$4,360

WPRS REPAYMENT AND BENEFIT ANALYSIS

This section will describe the WPRS processes for calculating project repayment and benefits of the supplemental irrigation water. We believe the processes were unnecessarily complicated and subject to inaccuracy.

1949 repayment capability study

The original project agricultural economic analysis reported a net water repayment capability equal to $6.35 per irrigated acre 1/ for water delivered at the farm headgate. The farm budget method of analysis was used in studying Arkansas River Valley agriculture and establishing the repayment rate.

Three representative ditch boards supplied all the information needed for the preparation of seven budgets varying in farm sizes and operational types within the 322,000 acre service area. Four representative types were selected for the analysis. It was recognized that these budgets represented only rough preliminary studies and that operational

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1/We translated the costs from an acre-foot basis to an irrigated acre basis to be able to compare with our full cost analysis. We used .92 acre-foot of WPRS water as the additional amount needed to provide a full water supply. Therefore the payment capacity analysis for WPRS showed $6.90 an acre-foot payment capacity.

data accumulated from the farmers themselves could improve this first attempt.

The incomes and expenses of the four representative farm types reflected the future with and without project conditions on the economic equivalent of 921 farms and 144,450 acres. These acres are substantially less than the service area because WPRS assumes for analytical purposes that each equivalent acre will receive enough project water for a full supplemental supply. There was to be only enough water available to provide a full supply (regular water supplemented with WPRS water) for 114,450 acres. WPRS' farm budget analysis assumed that the representative farm would have a full water supply for all the representative crops, and therefore the average value for the increased production due to WPRS project is spread over high and low value crops.

What would actually happen if WPRS water was available is that farmers would estimate how much water they would have to irrigate with during the upcoming growing season, and make planting decisions accordingly. For example, those crops which require a full season's irrigation to produce, such as corn, would be planted to the fullest extent, and less water-sensitive crops, such as alfalfa, would be planted instead if late season water was expected to be in short supply. If the repayment analysis had reflected the actual value of the late season water to the farmer, only high value crops would have received WPRS water, which would have tended to raise the water repayment capability.

The original repayment analysis used 1939 to 1944 agricultural prices. Income sources included the crops and livestock receipts and the farm privileges and rent. Expenses included crop and livestock production costs, a family living allowance, and general expenses. The general expense included a substantial interest cost which was actually a farm investment cost. These incomes and expenses were summarized to calculate the water payment capability per farm.

The analysis resulted in net water payment capabilities ranging from $3.14 to $11.40 per irrigated acre for the four farm types. However, the project plan proposed that project water be sold at a single price. The farm type labeled "extensive agriculture" was deemed most representative since it accounted for 83 percent of all Arkansas Valley farms and was used to establish the single repayment rate. This farm type involves primarily hay production and livestock feeding. The net payment capability was equal to $6.35 per acre for water delivered at the farm headgate.

After making the 1949 rate determination equal to $6.35, WPRS was faced with updating the rate in later years. The following paragraphs describe these efforts.

1953 rate update

WPRS adopted farm price levels and price indexes for all agricultural economic studies in 1951 which were 50 percent higher than the levels used in the original project analysis. In 1953, the original project plan was updated using these higher prices. The original water payment capability equal to $6.35 per irrigated acre was increased to the acre-foot equivalent of $9.52 per acre in what became House Document No. 187.

1959 repayment capability study

The irrigation repayment capability was completely redone in 1959 for the current service area. WPRS again used equivalent acres and the farm budget approach which involved delivery of a full water supply to representative farms.

Budgets were prepared for farms served by six major canals representing about 225,000 acres of the service area after the organization of the water conservancy district. 1/ The total service area was reduced from 322,000 to 280,600 acres. The farm budgets were adjusted to reflect changes in cropping practices, yields, prices, expenses, and farm sizes. The data used in the 1959 analysis resulted from interviews with "representative farmers" served by the six canals. These updated farm budgets indicated water payment capabilities ranging from $7.10 per irrigated acre for the Catlin Ditch to $16.88 per irrigated acre for the Bessemer Ditch. The high payment capacity farms under the Bessemer Ditch are very intensive vegetable-producing types totaling less than 9 percent of the area's acreage. Fort Lyon Canal, the largest ditch whose farms produce mostly feed grain and livestock forage, had a water payment capacity of $11.19 per irrigated acre.

1/The Southeastern Colorado Water Conservancy District, founded in 1958, covers all or part of nine counties. It includes the large cities of Colorado Springs and Pueblo. The District has the power to levy taxes and presently charges an ad valorem tax of four-tenths of a mill on property values. This will rise to one mill after the project is operating and these revenues will help pay for both M&I and irrigation allocations of project construction costs.

WPRS used the original 1949 approach including living and investment cost allowances. The Fort Lyon Canal farm budget's water payment capacity, less 20 percent, becomes $8.95 per irrigated acre. This canal was deemed most representative, and its net water payment capacity of $8.95 per acre approximated the 1953 updated rate of $9.52 per acre. Therefore, WPRS officials decided not to use the 1959 payment capacity reanalysis.

Current repayment capability

WPRS continues to use the net payment capacity of $9.52 an irrigated acre as determined in 1953. In current documents, however, WPRS feels that "Payment capacity and water charges cannot be expressed in overall per acre or AF (acre-feet) amounts." 1/ This opinion becomes justified when their underlying payout schedules are examined. The WPRS is going to directly charge for two types of water and the farmers will also be indirectly charged as part of the Conservancy District on an ad valorem tax basis.

The two types of water are winter water and project water. The former is offered as an optional program for the irrigation district where the farmers can let the WPRS store the winter flood surges for release just prior to spring planting. If this option is not accepted they can continue to turn the flood waters onto their fields as the surges occur and let the water be absorbed into the soil. If the WPRS option is accepted, the farmers would be charged $2.25 an acre-foot. WPRS estimates in its payout schedules that project water will be used and that the farmers will pay an average of $136,531 a year for the winter water.

The project water is the water transshipped from the western slope and is an addition to the summer water flow of the Arkansas River. This water is to be paid for at $5.40 an acre-foot, which will bring in an estimated average of $188,971 each year.

The ad valorem tax, as described earlier, is paid by all property owners in the nine county Conservancy District and is based on assessments of value. We estimate that the farmers in the irrigation district will pay a maximum of 8 percent of the expected average annual amount of $1,362,872.

1/ Water and Land Accomplishments, Federal Reclamations Projects: Project Data, Statistical Appendix III, November 1978, p. 120, and Project Data Sheet for Fryingpan-Arkansas Project, February 1978 Budget Hearings.

To try to compare the $9.52 an irrigated acre payment capacity (see page 96) to the actual expected repayment streams requires some assumptions. The first is that an irrigated acre requires about 0.92 acre-feet of water to be added to existing irrigation to provide full irrigation. This translates to the WPRS acre-foot payment capacity of $10.35. The $325,502 that WPRS estimates it will collect directly from the farmers each year, either as payment for winter water or project water, can be expressed in acre-feet by dividing by the project water amount of about 32,300 acre-feet. 1/ This calculates to $10.08. Given the erratic quality of the data and the age of the payment capacity estimate, we think WPRS' payment capacity price is consistent with the scheduled repayments.

The ad valorem tax is not collected by the irrigation district and is not on an acre-foot basis. Our explanation on p. 93 describes that the farmers will pay a maximum of $4.4 million over 50 years or an average of $88,000 a year. On an acre-foot basis, this is about $2.72.

The operation and maintenance charges are estimated to be $316,891 a year. On a project water acre-foot basis this is about $9.81. This leaves only $0.27 an acre-foot for the farmers to contribute towards any of the construction costs from their water payments.

The farmers in the area expect to continue to pay the interim price of $5.40 an acre-foot for project water when a final contract is signed. If the winter water program is not well subscribed to or if maintenance costs rise, that figure may have to be substantially increased.

Benefit calculations

The farm budget is also used to calculate economic benefits. Our review of the Fryingpan-Arkansas Project was not intended to include benefit analysis. We uncovered, however, one situation regarding benefit estimates which deviated so far from the normal practice that we mention it here.

1/The project water yield is subject to fluctuation in estimates. We have tried to use the data that was presented to the Congress in February 1978. We have seen acre-feet estimates between 32,200 and 40,400. The winter water program is not a sure source of income. Therefore, we believe that since about $325,500 will have to be paid directly by the irrigation district, the project water yield is a good unit to use for comparative statistics.

The benefit calculations in the original 1949 study and the 1959 update were taken from the income estimates in the various farm budget analyses. The benefits presented to the Congress during the fiscal year 1979 appropriation hearings, however, are not based on the Fryingpan-Arkansas farm budgets. The benefits are instead based on benefits estimated for WPRS' proposed Narrows Project 150 miles to the north. A further anomaly is that the cost allocations were done using the 1960 benefits.

The direct benefit-cost ratio using the 1960 irrigation benefit data was 1.4 in contrast to the direct benefit-cost ratio of 2.5 reported in the fiscal year 1979 hearings. The increased benefit-cost ratio based on another project's benefit estimates has heightened the economic worth of Fryingpan-Arkansas as presented to the Congress. Not choosing to use these borrowed benefits to update the cost allocations has serious implications for reimbursable costs of the project. The reasonable approach would be to use consistent benefit estimates for all purposes.

OUR ANALYSIS

The previous section described WPRS' analysis and processes. This section describes the simpler marginal analysis approach which we think matches the area farmer's buying decision process. We believe this approach is more appropriate for calculating supplemental water payment capability.

GAO estimates of higher cost water

The project costs allocated to irrigation totaled $88 million in the fiscal year 1979 project data sheet. We calculated full cost irrigation water prices and a price which would continue the interest subsidy based on the fiscal year 1979 project water release schedule.

WPRS is expecting repayment from the Water Conservancy District for the annual released total of 79,500 acre-feet of new water, of which 32,325 acre-feet is for irrigation. Farmers, however, will benefit from deliveries of project water releases and return flows which should total about 118,000 acre-feet (see p. 92). Therefore, we calculated full cost irrigation water prices based on the 118,000 water delivery total, which will provide supplemental water at 0.92 acre-feet an acre (see p. 94) to about 128,000 acres.

The prices noted in table 20 would be much higher if we had used the released totals of 32,325 acre-feet of supplemental water. We concluded that the irrigation district

would charge the irrigators based on use of return flows as well as direct releases so 118,000 acre-feet was used.

Marginal analysis

In the next pages, we outline our approach to realistically estimate the effect of higher priced supplemental irrigation water on the farmer and its results.

A local university extension service official stated that project water will probably be used in late July and early August after the snow runoff ends. The project water with its storage and timed release is most valuable to area farmers who are without enough water to finish crop development. The official believes the typical Arkansas River Valley farmer will evaluate the supplemental water buy based on the revenue margins gained through the project water application. We agree because irrigation water is the same as any other production input in that supplemental water purchases will be based on the expected increase in net revenue brought about because of the water.

Table 20

GAO Price Estimates

Form of repayment	Price level a/ (irrigated acre)
Interest subsidy	$16.21
Repay construction costs b/	13.74
Pay annual O&M costs	2.47
Full cost (7.5% interest)	$52.37
Repay construction costs	49.90
Pay annual O&M costs	2.47

a/Price each year using 128,000 irrigated acres. (Convert to acre-feet by multiplying by 1.088.)

b/$87,956,000 allocated to irrigation repaid over 50 years without interest, or $1,759,120 annually.

We calculated expected crop yield increases because of the project's supplemental delivery of late season water using farm extension service production estimates. Yield increases used are conservative and allow for production risk factors. To indicate the sensitivity of the analysis to different prices, we used two price levels: the southeastern Colorado average for 1973-77 as the typical price and a pessimistic price 20 percent below that.

Table 21

Late Season Water Crop Yields

Crops	1973-77	80% of 1973-77
Corn, grain	$ 2.47/bu	$ 1.98/bu
Corn, silage	17.30/ton	13.84/ton
Sorghum, grain	2.21/bu	1.77/bu
Alfalfa	52.67/ton	42.14/ton

Additional expenses, except for the supplemental water charge, subtracted from the additional revenue resulted in the net marginal revenue available for the water purchase. The following table shows the net revenue margins, without including water as a cost, calculated for the two commodity levels.

The farmers' decision to buy or not to buy the supplemental water will be based on their evaluation of the expected revenue margin against the required additional risk and effort. Table 22 shows the variations in net revenue for each crop. If the farmer only had enough water to "finish" the grain corn--28 percent of total crop--the net revenue before paying for water would be between $44 and $59 based on our assumptions. This could not entice the farmer to purchase the water priced at the full cost of $52 per irrigated acre.

The grain crops--corn and sorghum--could, however, generate enough additional revenue to cover the additional production cost and pay for the water if the interest subsidy were continued. Corn--about 43 percent of the field crops--would yield $38 to $51 an acre, more than enough to cover the price with interest subsidy of $16 an irrigated acre. More supplemental water, or a farming decision to finish both the corn and sorghum crops would yield a weighted net revenue of $34 to $46. These net revenues are inadequate to repay full cost prices for water, but could cover the project water with a price that continued the interest subsidy.

Table 22

Revenue Margins

Crops	Percent of total farm	Typical yield increase per acre	Expected revenue margin per acre a/	Pessimistic revenue margin per acre a/
Corn, grain	28	30 bushels	$59.10	$44.40
Corn silage	15	3 tons	36.90	26.52
Sorghum, grain	6	10 bushels	7.10	2.70
Alfalfa	46	0.3 ton	.80	(2.36)
Total for typical farm	95	N/A	$24.10	$16.54
Total for corn and sorghum	49	N/A	$45.94	$33.80
Total for corn	43	N/A	$51.35	$38.15

a/Price calculated before water charges.

The representative farm would not receive enough project water to finish the grain crops and also put late season water on alfalfa. 1/ In any case, late season irrigation of alfalfa yields little or no net revenue for payment towards water costs. To put project supplemental water on alfalfa would lower average net revenue, and such a farming decision does not seem probable at our price levels.

Other considerations

Area farmers will be evaluating the project water purchase over a 50-year repayment period. A local university extension service official believes area farmers will require

1/There are 280,000 acres in the project service area, but only enough supplemental water to bring 128,000 acres (45.7 percent) up to a full irrigation supply.

the estimated extra income to be twice their extra investment before buying project water. If true, this would indicate that area farmers could commit themselves to put water on corn and sorghum, which could add between $33.80 and $51.35 to the farmers' extra income. This would be more than double the interest-subsidy price for project water.

During this review, our interviews with farmers, agency personnel, and an extension service official indicated other considerations which may effect the farmers' decision. Some of these considerations which would tend to support acceptance at the interest-subsidy price of $16 an irrigated acre are

--the current market value for surplus project irrigation water is about $11.00 to $16.50 for each delivered acre-foot,

--the Arkansas River is over-appropriated and very little, if any, surface flow reaches the Colorado-Kansas border,

--the State water engineer restricts increased ground water pumping during periods of inadequate irrigation,

--the only current, feasible supply of late season irrigation water is from the project,

--the area water and power utilities will and do purchase irrigation water usually without concern for price,

--the smaller valley communities are dependent on the health of the local agricultural economy, and

--the timing and adequacy of the supplemental project deliveries make the water very valuable to some area farmers who have paid as much as $50 per acre-foot.

There are, however, some other considerations which would tend to discourage acceptance at even the interest-subsidy price:

--Late season periods are not always without irrigation water.

--Area farmers have no control or influence over market prices and can not pass added costs on to crop purchasers.

--Area farmers could reduce water demands by planting more corn and sorghum and not irrigating as much alfalfa and pasture.

--The project area has many marginal farms.

If faced with a project at either of the two higher prices hypothosized in this study, we believe area farmers would support the Fryingpan-Arkansas Project only at the interest-subsidy price of $16 per irrigated acre. Even at the full cost price of $52 an irrigated acre, we believe area farmers would like to have the project water during dry periods. In the very few years of high late season river flows, higher water charges would lessen supplemental irrigation water purchases and project water might be completely unsold.

CONCLUSIONS

WPRS' farm budget approach to calculating water repayment capability for the Fryingpan-Arkansas Project is inadequate and unrealistic. WPRS could charge Arkansas River Valley irrigators significantly more for project water than its current interim rate of $5.40 per acre-foot.

The Fryingpan-Arkansas project is the only new source of supplemental irrigation water for area farms. The value of the late season deliveries is enough to cover all the additional expenses and water prices of up to $19 to $25 for an irrigated acre (half the potential revenue) if corn is the crop which receives the water. This would leave about $20 more profit an acre than in the absence of the project.

The interest-subsidy price of $16 an irrigated acre would be economically advantageous to the Arkansas River Valley irrigators. The full cost price of $52 an acre would not be, as the additional expenses of irrigation would be greater than the additional revenue.

NORTH LOUP DIVISION

PICK-SLOAN MISSOURI BASIN PROGRAM

PROJECT DESCRIPTION

The project lands are located in five counties in central Nebraska. Corn production and livestock feeding are the most important sources of income for the farmers. There has already been extensive private irrigation development in the project area by pumping directly from available ground water supplies. Irrigated cropland is used predominantly for the growing of corn.

The North Loup Division will be a multipurpose project serving the functions of irrigation, recreation, and fish and wildlife. WPRS studies show that 70,000 acres of land with irrigation suitability would benefit in varying amounts from the development of the project. The plan would service 53,000 acres with direct surface water. Half the service area is currently irrigated from ground water supplies. These lands would benefit by eliminating the cost of bringing ground water to the surface. The other 26,500 acres in the service area would be used for dryland farming without the project. In addition, the project will also enable private ground water irrigation development to 17,000 acres outside the service area which could not be sustained without this division.

The project provides for the construction of two dams and related reservoirs, a diversion works, pumping plants, 162 miles of canals, and 212 miles of a lateral distribution system. The project is designed to divert and store water from the Calamus River and the North Loup River. Water will be regulated in the reservoirs and released as needed to the canal system, providing about 80,000 acre-feet a year to the farmers.

Alternatives to the proposed project were suggested including different locations for the dams, use of ground water, and no Federal development, but all were rejected by WPRS. WPRS selected the dam locations considered most practical and economical. WPRS rejected use of ground water on the basis of studies which indicated that more usage would jeopardize the quantity and quality of the remaining ground water. WPRS rejected the no-development alternative because it would not fulfill the economic and social needs of the people who are dependent upon the introduction of project water for their livelihood. WPRS recommended the project be

built to stimulate and restore a viable local economy and provide the amenities associated with the social well-being of the residents. WPRS studies indicated a new source of water was needed to augment declining ground water supplies to maintain or increase present agricultural productivity.

WPRS has determined that after construction is completed in 1990, the farmer will be able to harvest 152 bushels of corn on an irrigated acre compared to 48 bushels on dryland, an increase of 104 bushels per acre. WPRS has also projected that by the year 2010 the difference in yield will have increased to 134 bushels.

In its analyses, WPRS has also estimated that the number of livestock fed would increase when the farmer converts from dryland to irrigated farming, thus increasing farm income. WPRS made these upward adjustments to maintain the same relationships between the crop production and livestock production programs that existed prior to the project.

Benefits anticipated from the project will be derived almost exclusively from irrigation. Recreational facilities to be provided under the project include picnic areas, camping areas, and boat ramps. Fish and wildlife benefits to be provided are the fencing of a heron rookery and the planting of wildlife habitat.

A feasibility report was issued in 1959 and a definite plan report was issued in 1978. During this period, costs, benefits, and repayment abilities have continued to escalate.

WPRS' farm budget analysis performed in 1974 established an upper limit on the farmer's payment capacity. The U.S. Government in 1976 entered into contracts with the local districts providing for annual construction cost payments of $9.90 an acre, representing about 21 percent of nominal costs. The irrigators are also obligated to pay all operation and maintenance costs--$6.60 an acre per year in 1976 and currently $8.20 per year.

The definite plan report estimated that total costs were $135.6 million in 1978. A slightly higher total--$136.8 million--was presented to the Congress in the fiscal year 79 budget hearings. Not all of the total is allocated to irrigation. (See table 23 for reimbursable cost data.)

Table 23

Repayment of
North Loup Unit
(millions of $)

	Allocated	Repayment
Reimbursable	$131.6	$131.6
Irrigation	131.6	27.3
Power	--	104.3
Non-reimbursable	$ 5.2	$ 0.4
Recreation	1.1	0.4
Fish/wildlife	1.1	--
Other	3.0	--
TOTAL	$136.8	$132.0

Source: FY 79 Budget Presentation, WPRS Project Data Sheet for North Loup.

From this table it appears that the irrigation allocation of $131.6 million is scheduled to be repaid. There is, as with all WPRS projects, considerable subsidy in this seemingly full repayment. We calculated the subsidy as 98 percent. 1/ The subsidy includes the interest-free repayment and the long repayment periods--the power repayment will occur after a 50-year period. The Federal Government would get a stream of payments equal to the present payment schedule if they lent $2.9 million at 7.5 percent and gave the irrigators the remaining $128.7 million.

We made our analysis to determine the farmer's reaction to a project where the water would cost considerably more than the yearly ability-to-pay price of $18.10 an acre--full cost recovery with interest would be about $185 an acre while a price which would continue the interest-subsidy would be about $56 an irrigated acre. In the following two sections we describe WPRS' repayment capacity analysis and point out analytical problems we had and then describe our own analytical approach.

1/The discount rate used was 7.5 percent.

WPRS' REPAYMENT ANALYSIS

The farm budget analyses of the North Loup Division prepared by WPRS compared the anticipated physical and economic conditions of the area both with and without the proposed project. The benefit analysis budgets prepared for the year 2010 demonstrate the economic feasibility of the project after it has been in operation for about 20 years. The repayment analysis budgets based on projections to the year 1990 determine the farmer's ability to pay project costs at the start of operations. These budgets were based on many projections and assumptions which affect farm income and expenses. Some of the factors that have a large affect on income are the size of the livestock program, crop yields, farming practices, labor requirements, investment requirements, and the size of the farm.

The net farm income as determined with each of the budgets is shown in table 24.

In 1974, WPRS determined irrigation benefits and payment capacity by comparing net farm income achievable with the project and without the project. The benefits came from farm budgets for the year 2010 and were $24,891 per farm or $146.42 per irrigated acre. These benefits were used to compute a direct benefit cost ratio of 1.9 to 1.0. On the other hand, the payment capacity as determined by WPRS of $19.40 an acre is relatively low. Increased net income of $5,221 from farm budgets for the year 1990 was the starting point for the repayment analysis. Deductions were made from this amount to compensate the farmer for the increased labor required with irrigation and also to provide a monetary incentive for the farmer to undertake the project. Thus, payment capacity was $2,639 per farm or $19.40 per irrigated acre.

The details of WPRS' analyses are summarized in table 25.

In 1978, WPRS prepared revised farm budgets to update its irrigation benefit analysis. These budgets, based on changing conditions and assumptions, projected a $42,589 difference in net farm income in year 2010 or a direct irrigation benefit of $250.52 per acre. Since contracts were entered into with the local districts in 1976, WPRS no longer prepared revised budgets of the farmer's ability to pay.

Table 24

WPRS
Farm Budget Analysis

	(Year 1990) Repayment analysis		(Year 2010) Benefit analysis	
	with project	without project	with project	without project
Gross farm income a/				
Corn	$30,263	$12,768	$ 46,375	$18,326
Alfalfa	5,373	5,187	7,874	7,262
Wheat	3,389	3,389	4,942	4,942
Pasture	1,560	1,560	1,950	1,950
Cattle	37,714	25,142	104,760	41,904
Hogs	3,102	3,102	4,654	4,654
Farm perquisite	720	720	720	720
TOTAL	$82,121	$51,868	$171,275	$79,758
Expenditures				
Crop-seed	$ 1,117	$ 837	$ 1,391	$ 1,053
Fertilizer	3,265	852	4,178	1,229
Dry, store, and haul	1,643	882	2,494	1,258
Insecticide	2,030	-	3,474	2,142
Herbicide	2,030	-	3,474	2,142
Crop insurance	2,222	-	3,710	1,649
Livestock-purchases	26,077	15,675	60,563	24,225
Feed	9,477	7,400	21,790	11,403
Trucking	816	545	2,072	879
Other	884	754	2,931	1,340
Power and machinery	4,286	4,177	4,562	4,282
Hired labor	-	-	2,040	-
Interest	11,122	9,418	16,095	11,688
Property taxes	2,412	1,939	3,371	2,409
Miscellaneous	1,550	1,420	1,809	1,629
	$68,931	$43,899	$133,954	$67,328
NET FARM INCOME	$13,190	$ 7,969	$37,321	$12,430
Increased Income	$5,221		$24,891	

a/Includes crops fed to livestock by farmers.

SOURCE: 1978 Definite Plan Report.

Table 25

Payment Capacity vs. Benefits

	Irrigation benefits	Payment capacity
Net farm income with project	$37,321	$13,190
Net farm income without project	$12,430	7,969
Increased income attributable to project	$24,891	$ 5,221
Allowance to permit farmer to retain 10 percent of the increased income	N/A	$ 522
Allowance to compensate farmer for his additional farmwork	N/A	$ 2,060
Total benefits/payment capacity per farm	$24,891	$ 2,639
Number of irrigated acres with project	170	136
TOTAL (benefits/payment capacity per irrigated acre)	$146.42	$ 19.40

Our review of WPRS' farm budgets

We reviewed the benefit and repayment analysis budgets for consistency and reasonableness to evaluate WRPS' computation of the farmer's payment capacity.

Our review indicated that WPRS understated the size of the livestock program in its "with project" repayment analysis. A WPRS official stated that the size of the livestock program used in the budget was established to maintain a proper relationship between the quantity of grain produced and the quantity of grain fed to livestock. Also, WPRS wished to maintain a balance between farm receipts derived from livestock production and farm receipts derived from crop production. Unfortunately, the size of the livestock program selected by WPRS for 1990 with the project failed to meet either test. We adjusted the number of stocker-feeder steers

to a more appropriate level consistent with WPRS' own criteria thus increasing payment capacity by $29.87 an irrigated acre, or $4,062 per farm, to $6,701.

WPRS was also inconsistent in its farm budgets for the purchase of insecticides, herbicides, and crop insurance. We made reasonable adjustments to these cost items based both on current farming practices and future trends. Our adjustments further increased payment capacity by $16.55 an irrigated acre, or $2,251, to $8,952. WPRS also had a clerical error in its computations that had reduced payment capacity.

The net impact of all adjustments increased payment capacity from $19.40 to $67.46 per irrigated acre. These adjustments are summarized in table 26.

Table 26

Adjustments to Repayment Analysis

	Payment capacity	
	Per farm	Per irrigated acre
Amount per WPRS	$2,639	$19.40
Our adjustments:		
Understatement of livestock program	4,062	29.87
Inconsistent projections for purchase of insecticides, herbicides, and crop insurance	2,251	16.55
Clerical error	222	1.64
Amount as adjusted	$9,174	$67.46

The adjusted farm budget shows the sensitivity of repayment capacity, which is a residual value, to minor changes in income or expense items. WPRS acknowledged that there is considerable judgment exercised in the prepartion of these budgets. Thus, WPRS is in a position to fine-tune its repayment calculations over a wide range of values by slight changes in data or assumptions.

We do not believe the WPRS budgets as presented in their studies are a good indicator of the farmer's ability to pay for project water. WPRS determined that the irrigators had

the capacity to pay only about 21 percent of nominal project costs. After we made several reasonable adjustments of WPRS' farm budgets to eliminate error and inconsistencies, we determined that the analysis could just as easily have shown that farmers had the capacity to pay the interest-subsidy price which would return all the project costs on a dollar-for-dollar basis.

We believe the farmer's decision to either pay full cost or reject the project would not have been based on this budgetary approach, but would have been based on an analysis of marginal revenues and costs. This latter approach is one that would more typically be made by businesses or creditors when they are evaluating investment or borrowing decisions.

IRRIGATION WATER CONSIDERED AS PART OF AN INVESTMENT DECISION

The farmer who converted dry land to irrigated land would increase gross revenues by about $227 an acre if WPRS' assumption of increased corn yields due to irrigation is correct. The additional revenue is the result of increasing corn production by 104 bushels on each acre of irrigated land--from 48 bushels to 152 bushels, with the increased production valued at $2.18 per bushel. The farmer who would convert from ground water to WPRS water would not increase gross income, but would face different irrigation expenses.

The irrigated and dryland crop yields were those used by WPRS in its updated repayment budgets which were based on a study conducted jointly by the State and Federal Government. WPRS characterized its projections as reasonable and representative of the average productivity of the project lands as a whole.

An agricultural official indicated that many farmers in the area were receiving $2.18 per bushel for their corn under Government support programs. Corn prices fluctuate over a broad range and are at relatively low levels now in comparison to prices received during the past 5 years. For example, Nebraska corn prices in country elevators reached the $3.50 per bushel mark in 1974 when export demand was high.

Dryland to irrigated corn interest-subsidy price

The farmer will incur higher production costs for items such as seed, fertilizer, and harvesting to achieve the greatest yields possible with irrigation. Based on data tabulated by the University of Nebraska, we estimate these higher

costs for 1978 at $75.60 per acre exclusive of charges related to irrigation.

The farmer will incur on-farm distribution costs for water and these costs will vary depending on whether a gravity system or center pivot system is used. The gravity system is used when the land needs minimal grading or shaping. The on-farm distribution costs are estimated at $63.17 per acre for a center pivot system and $31.52 per acre, exclusive of land leveling costs, for a gravity system. The purchase of project water at the price which would continue the interest subsidy totals is $56.02. This includes an estimated $8.20 per acre to pay for annual operation and maintenance costs. (See table 27.)

Table 27

Dryland to Irrigation
Net Marginal Income--Irrigated Corn

	Gravity system	Center pivot system
Increased revenue	$226.72/acre	$226.72/acre
Increased production costs	(75.60)/acre	(75.60)/acre
Costs incurred for on-farm distribution of water a/	(31.52)/acre	(63.17)/acre
Project water price with interest subsidy	(56.02)/acre	(56.02)acre
Net Returns	$ 63.58/acre	$ 31.93/acre

a/Exclusive of land leveling costs. These costs will vary considerably from farm to farm. If the costs are excessive, the farmer would likely choose to install a center pivot system.

The net return which could be achieved with the interest subsidy price represents a good return to management and also provides for contingencies. We believe these returns are of sufficient magnitude and stability to entice the farmer to invest. Corn yields achieved with irrigation are relatively high and uniform. Government programs provide a floor on corn prices at about their current levels, eliminating the risk of losses attributable to declining prices. Further, there is a potential for much higher corn prices in the future due to reduced supplies or increased demand. Production and water distribution costs are subject to inflation, but corn

prices realized in the free market or under Government programs will likely keep pace with these costs over the long-run.

Full-cost price

The price of $185 an irrigated acre plus the increased expenses would overwhelm the increased gross revenue of $226 an acre and cause a net loss of $70 to $100 an acre because of the extra corn production. This situation would be unacceptable.

Private ground water to WRPS-supplied water interest-subsidy price and full-cost price

Other farmers, who own about 50 percent of the project farmlands, are presently irrigating from wells and would be asked to pay for project water in lieu of incurring their own pumping costs. It is presently less expensive to drill and operate one's own well than to purchase project water at either price postulated in this study.

We decided instead to look at the comparative costs when the project would be completed in 1987. We feel this is a valid deviation from the approach of implicitly assuming that income-cost relationships will tend to remain fixed so that one could use current costs and income. In this case, the pumping costs are expected to increase faster than the other cost elements, and the ratios of capital to operating costs are quite different for the two methods of getting water to the plants--WPRS water is quite capital intensive with low operating costs, while private well development is the reverse. Table 28 compares the estimated costs for 1978.

The project water costs are based on 50-year repayment of the $131.6 million allocated to the irrigation facilities at the North Loup Division. The project will cost more than $131.6 million when completed in 1987 since WPRS estimates the costs as if they were incurred today. For illustration, we estimated that the irrigation portion of the project would end up costing at least $160.2 million when complete. 1/ To make the initial comparison, we increased the private water costs by a flat 5 percent each year for investment and operating costs. These results are presented in table 29.

1/The assumptions are 5 percent increase in costs each year and a simple phased completion schedule which shows the project 88 percent complete in 1984 when WPRS says they will first deliver some water.

Table 28

1978
Project vs. Private Water Costs
(per acre)

	Project water		Private water
	Full cost	Interest subsidy	
Investment cost	$176.46	$47.82	$18.05
Operating costs	8.20	8.20	28.53
TOTAL	$184.66	$56.02	$46.58

Table 29

1987
Project vs. Private Water Costs at 5 Percent Increase
(per acre)

	Project water		Private water
	Full cost	Interest subsidy	
Investment cost	$222.88	$60.40	$28.00
Operating Cost	12.72	12.72	44.26
TOTAL	$235.60	$73.12	$72.26

This means that in the first full year of the project's operation, the farmer would be indifferent if the price were to include the interest subsidy. If there were any non-price considerations, such as dependability of supply and firm deliverability, or fewer on-farm maintenance problems, the WPRS water might have the edge.

We believe, however, that the information presented in Table 29 shows private water in the best light possible. When we raised the increase in costs to 7.5 percent for the project and the private costs, the project water with the interest-subsidy price increased from $73.12 to $82.50, while the private well costs went from $72.26 to $89.31. If the operating costs for both water sources--primarily energy--went up at faster rates than the investment costs, say 10 percent vs. 5 percent, WPRS project water comes out far ahead because its operating costs are lower.

Still, the farmer-irrigator faced with a decision to contract for higher priced water on a long term basis in 1978 for water which will be delivered in 1987 would face a decision which would have to be based on many factors beyond individual control. The answers do not seem clearcut as they were in the case of going to irrigated corn from dryland farming. The fear of dropping ground water levels and the expectation of rapidly increasing energy costs might be enough to swing the irrigators to the WPRS project even though the financial analysis shows indifference at the interest-subsidy price. Also, the lengthy construction and development periods provide farmers an opportunity to phase out of their private systems and start bringing project water online without incurring large or unexpected losses.

Ground water declines in parts of the project area have been documented and further declines are predicted. In one study it is indicated that it is only a matter of time before the aquifer is dewatered at the current rate of use. In a survey of farmers who own project lands that are presently irrigated, 46 percent reported their present water supply was inadequate. The most frequently mentioned comments on the questionnaire included:

--Well yields are dropping 20 to 35 percent.
--Wells had to be deepend and some went dry.
--Recharge is needed for continued underground supply.
--Water table is drastically lowering.

Thus, many farmers have inadequate water supplies now and this number will continue to grow if the project is not built. Accordingly, the continuation of a private pumping system is not a feasible alternative that can be decided wholly on economic grounds by many irrigators.

CONCLUSION

We conclude that the farmers would be willing to pay for WPRS water at a price which still included an interest subsidy. Budgetary analysis as performed by WPRS indicated a much lower "willingness" but is subject to a wide range of outcomes. We demonstrated that reasonable adjustments to the farm budgets would indicate that the farmer does have the capacity to pay a price which eliminates all direct subsidies except the interest subsidy.

The farmer who would be converting dryland to irrigated land under the project will greatly increase corn yields and this would generate additional income sufficient to pay project and other costs, if the price includes an interest sub-

sidy. Irrigation assures a relatively high and stable level of corn production and Government programs provide a floor on fluctuating prices. Also, future corn prices may exceed the floor price established under the Government programs, thus offering the farmer the potential to realize substantial profits from his corn production.

The farmers who are presently irrigating might achieve savings in pumping costs and would assure themselves of a continued water supply into the future. Payment for project water is deferred for about 15 years during the construction and development periods. During this time, private pumping costs are likely to surpass project water costs due to inflation and the dwindling supply of ground water.

The project at interest-subsidy prices would provide the farmers a sophisticated, low maintenance, capital intensive water delivery system. They would get an interest free loan of over $130 million to pay for a worryfree distribution system.

We further conclude, however, that a price of $185 an acre--the full cost of the WPRS water with interest--would be uneconomical for the farmers.

OROVILLE-TONASKET UNIT EXTENSION

CHIEF JOSEPH DAM PROJECT

The approved Oroville-Tonasket Unit extension will be a closed pipe, pump driven distribution system. It will replace the 68 year old open canal and flume, gravity flow system. 1/ The existing irrigation district straddles the Okanogan River for 25 miles between Oroville and Tonasket in north-central Washington. The new WPRS built system will serve 9,320 acres, as well as 680 acres not now in the district.

The unit is the third case of Federal assistance to the district. Previous assistance was by the Works Progress Administration which replaced some of the district's facilities in 1940-42 and by WPRS which lent the district $2.6 million in 1964 for major rehabilitation of a tunnel and the main canal. One condition of the 1964 loan was that the district would make other necessary repairs to the gravity flow system. 2/

A flood in 1972 required emergency repairs which depleted the district's financial reserves to such an extent that they could not meet the terms of the 1964 loan. WPRS explained that through additional Federal funds for a replacement system "The threat of irrigation system failure and loss of water supply to 10,000 acres will be eliminated . . . ." 3/

WPRS PLAN

In deciding the best way to eliminate danger of an irrigation system failure, WPRS explored three alternatives: rehabilitation of the old system and two almost similar plans for new construction. The costs (as estimated by WPRS) and the benefits were about the same. WPRS recommended the new

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1/Public Law 94-423, September 28, 1976. Oroville-Tonasket is a part of the Chief Joseph project.

2/Public Law 87-762, October 9, 1962. The district contracted in 1964 to repay $52,149 each year for 50 years, without interest.

3/U. S. Department of Interior, Oroville-Tonasket Unit Extension, Feasibility Report, WPRS, Boise, Idaho, May 1975, pp. 75.

construction option which would provide the water with enough pressure to irrigate with sprinklers.

This new system will consist of eight small independent distribution systems. Each would pump water from local streams and deliver to the orchards. Thirteen relift pumps will maintain pressure in the system. The distribution pipe, measuring 4 to 33 inches in diameter, will total 110 miles.

Apples make up 90 percent of the crop on irrigated acreage, and the cropping pattern in the valley is not expected to change after the WPRS project is constructed. A new irrigation system will merely be a different way to transport water to the apple trees.

Almost all of the project costs--95.5 percent--are allocated to irrigation facilities. Other small cost allocations include 0.1 percent for municipal use and 4.4 percent for fish and wildlife enhancement. The costs allocated to irrigation and municipal purposes are reimbursable, while the fish and wildlife costs are not. The latter function is made possible by removing an old hydroelectrical dam, and is completely independent of the irrigation project.

Project costs

The following table compares the original 1975 cost estimates to the estimates made in the Executive budget presented to the Congress for fiscal year 1979. As of December 1978 there had been no repayment contracts signed between the Oroville-Tonasket Irrigation District and WPRS, nor had any actual construction begun. The project is expected to take 6 years to complete.

As shown in table 30, the construction costs allocated to irrigation will be repaid by irrigation and power revenues. Any increase in project costs allocated to irrigation seem to be borne by the power revenues. No interest is charged on the irrigation repayments whether from power funds or the irrigation district. The project repayments fulfill the legislated requirement of full reimbursment while still providing considerable subsidy to the irrigators.

We estimate the subsidy at 92 percent. The Federal Government would be in the same financial position if it simply lent $3.0 million with 7.5 percent interest for 50 years and gave the orchardists the remaining $35.9 million. The large "grant element" of this Federal investment stems from the interest free nature of the reimbursement and the long time period for repayment. For example, in the Oroville-Tonasket project the irrigators are scheduled to repay

$11.2 million in 50 years with equal installments after the project is completed. The present value of these payments, which bear no interest charge, is only $2.2 million. The remaining $27.5 million will be repaid, again with no interest charge and after a grace period of 50 years, by revenues from the Federal Columbia River power system. The present value of these repayments is only $0.5 million. 1/

Table 30

Oroville-Tonasket
Project Costs
($ in millions)

Project	May 1975 a/ Allocation	May 1975 a/ Repayment	January 1978 b/ Allocation	January 1978 b/ Repayment
Function				
Irrigation	$33,289	$11,214	$38,746	$11,214
Power	-	22,075	-	27,532
M&I c/	112	112	132	132
Reimbursable	$33,401	$33,401	$38,878	$38,878
Fish & wildlife	1,604	-	1,880	-
Other d/	496	-	932	-
Indian lands e/	210	-	245	-
Non-reimbursable	$ 2,310	-	$ 3,057	
TOTAL f/	$ 5,711	$33,401	$41,935	$38,878

a/Feasibility Report, op cit, p. 74
b/Committee on Appropriations, Subcommittee on Public Works, Public Works for Water and Power Development and Energy Research Appropriation Bill, 1979, U.S. House of Representatives, February 22, 1978, p. 319.
c/Will be repaid with interest.
d/Preinvestigation costs are a major item.
e/The 60 acres of Indian land in the project are exempt from repayment as long as the land remains in their ownership.
f/These totals differ from the various totals in the sources. Our adjustments were made to present consistant data, and are: (1) Interest-during-construction costs which will not be reimbursed are not included. (2) Irrigation power suballocation repaid as annual operation cost is excluded.

1/The payment streams were discounted at 7.5 percent.

WATER AND THE ORCHARDIST

WPRS: Its approach to pricing water

WPRS approaches the task of pricing water to the irrigators as though it is unrelated to the cost of supplying the water. Its interpretation of legislation since 1939 has been to charge the irrigator a price for project water which reflects an ability to pay. This ability-to-pay estimate is made by calculating the increase in net income to a representative farm because of the WPRS-supplied water and then subtracting a fixed amount for owner income and return to risk and management. The difference is the basis for the price at which the irrigator will sign the contract.

Net income is derived from farm budgets. 1/ We examined the single farm budget done by WPRS for the Oroville-Tonasket Tonasket project and found that we were able to use some of the production expenses and estimates of yields. We were unable, however, to use the results of WPRS' farm budget to estimate the effect of charging higher prices for WPRS water. Our basic problem was conceptual: WPRS assumes that the grower is assured a fixed level of income with the project, and that the price of water is not a production expense. In contrast, we assume that water is a production expense and that an irrigator's income is the difference between revenue and expense.

The representative farm shown in table 31 has 30 acres in trees and 1 acre in farmstead. The average size of orchards in the Oroville-Tonasket area is less than 20 acres. WPRS only considered orchards between 10 and 160 acres, even though a great many holdings are smaller than 10 acres. The exact effect of such discrimination is uncertain.

The farm budget in table 31 represents the situation with the WPRS project in place. No farm budget was done for the area without the project even though WPRS regulations call for such without-project analysis. WPRS rationalized this omission by assuming that the area would return to nonproductive sagebrush without the project.

We found no support for this assumption nor does it seem reasonable. Since the ramifications of such an invalid assumption bears on the national economic benefits of the project, not the price of WPRS water to the irrigator, we did not pursue the issue.

1/See chapter 3 for a fuller description of the farm budget.

Table 31

Oroville-Tonasket Unit Extension
Farm Budget-1973 Conditions
(31 acres)

Gross Income		$39,360
Apple sales a/	$37,300	
Farm privileges	2,060	
Expenses		$26,855
Interest on investment b/	$ 7,610	
Pick and haul apples	5,522	
Taxes and insurance	2,979	
Depreciation	2,509	
Spray	2,400	
Repairs	1,463	
Hired labor c/	1,044	
Production credit	825	
Miscellaneous	488	
Other	2,015	
Net Income		$12,505
Allowances		$10,481
Operator/family labor	$ 7,114	
Equity d/	2,113	
Management	1,251	
Payment Capacity (net income-allowances)		$ 2,024
Contingency allowance f/	405	
Ability-to-Pay (payment capacity-contingency)		$ 1,619

a/18,900 lbs/acre fresh at 7.7 cents lb., 8,100 lbs/acre for processing at 2.5 cents lb.
b/Orchard investment $169,080.
c/WPRS used $1,079 based on 469 hours. Computational error of 15 hours in total labor allocated to hired labor resulting in expense of $1,044.
d/1-1/4 percent of investment.
e/10 percent of net income.
f/20 percent of payment capacity.

SOURCE: Agricultural Economy Appendix, Feasibility Study, WPRS, Pacific Northwest Regional Office, Boise, Idaho, May 1975.

Ability-to-pay

The WPRS estimate for the Oroville-Tonasket project water price is $52.23 an acre (as adjusted by us in table 31) or $1,619 for the 31 acre representative orchard. This amount would cover the maintenance and operation charge, estimated at $23.50 an acre each year, leaving $28.73 an acre each year to pay off part of the construction costs. There is one problem with this figure; $28.73 x 9,500 acres x 50 years equals $13.647 million, not the $11.214 million shown as allocated to irrigation in table 31 (see p. 122). It turns out that the debt from the 1964 WPRS loan (see p. 118)--about $2.1 million remains--will be paid off out of the ability-to-pay price. Therefore, the amount per acre each year which is going to retire the $11.2 million irrigator's share of the Oroville-Tonasket project construction costs is only $23.61 and the actual project water price would be $47.11 an acre.

The ability-to-pay calculation is very sensitive to slight changes in the estimates and assumptions which lead to it. During our review of the farm budget, we found two assumptions used by WPRS analysts to calculate hired and owner-supplied labor, and apple yields which, when subjected to equally valid assumptions, radically change the ability-to-pay estimate.

Labor

WPRS estimated the required time of each work task on a 31 acre orchard. The labor figures totalled 3,562 hours each year. WPRS then assumed that the owner and family would work the 3,093 hours used to come to the $7,114 amount noted in the farm budget as operator/family labor. Such a division left the hired laborers with 469 hours of work worth $1,044.

We found, however, that many of the labor tasks noted by WPRS in the detail of their analysis are almost always done by hired labor. These jobs included pruning, thinning, moving irrigation pipes, and doing assorted support tasks during harvest. When we reallocated the hours assigned to hired and operator labor to reasonably represent conditions as reported in Washington State University reports 1/ the

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1/Farm Business Management Reports, Apple Production Costs for the Okanogen County Area of Washington (EM-3484, July 1971) and The Costs of Producing Apples on Semi-dwarf Trees in the Columbia Basin (EM-4200, March 1977), Cooperative Extension Service, College of Agriculture, Washington State University.

impact on ability-to-pay estimates was surprisingly large. The expenses noted in the farm budget in table 31 on p. 122 increased by 12 percent, which consequently lowered net income by 25 percent. This reallocation is important because net national economic benefits are estimated from the net income calculations of the farm budgets. The allowances for the farmer were consequently lowered by 32 percent, all of which would result in an ability-to-pay 15 percent greater than calculated by the WPRS.

These shifts in the farm budget occurred without changing the amount of labor recognized as required to produce 27,000 pounds of apples an acre. The farm budget is obviously sensitive to placement of costs on the accounting sheet. The more costs which can be counted as operator's allowances, the higher the net income and the lower the ability-to-pay.

Apple yields

The three parameters which determine the income from an acre of apples are the number of nonbearing trees, the percentage of yield sold as fresh apples, and the total yield of each acre. WPRS used single-value assumptions for each parameter noted above and arrived at a per acre income of $1,200 using 1973 prices.

Based on estimates from an expert in the area and from apple production reports mentioned above, we believe the WPRS assumptions are conservative and mask the wide variation possible between growers. For instance, the skill and management abilities of individual growers determine whether an orchard ranks on the high or low end of the ranges in yield and fresh apple production. If an orchardist is lax in pruning the trees or does not apply fertilizer properly, output will suffer. Conversely, a good orchardist can harvest twice the average yield.

To illustrate the sensitivity of WPRS calculations to slight changes in yields, we varied only one of the parameters--total yield--keeping nonbearing acres at 25 percent of an orchard and fresh apple production at 70 percent of total yield. When we increased total yield 10 percent, from 27,000 pounds to 29,700 pounds, gross income rose about 25 percent. Net income then rose about 50 percent. This occurs because additional production only requires picking costs, and the preproduction, or fixed costs, are spread over more production. The $200 increase in net income per acre would increase the orchardist's ability-to-pay by about $150. This is the same as a 300 percent increase in the

price, or ability-to-pay, of water--from $47 an acre to $190 an acre. The tremendous leverage possible by adjusting a beginning assumption, yield per acre, is quite evident.

We did not set out in this assignment to validate or change the WPRS analysis. It should be obvious, however, that changes in ability-to-pay estimates are possible with seemingly insignificant accounting changes, as with the labor costs, as well as with small changes to critical variables such as yield on irrigated orchards. In the next section, we present our analysis which treats water as a production input at both full cost and at a cost which would continue the interest subsidy. The results are dramatically different than the WPRS ability-to-pay estimates.

WATER AS AN EXPENSE

We analyzed the irrigator's reaction to the WPRS-supplied water as though the water would be priced either at full cost or at a level which included the interest subsidy. In this way, the cost of water is a fixed expense and the difference between gross income and all expenses is the orchardist's income.

The full cost of water to the irrigator has been calculated in two ways.

--One price--the interest-subsidy price--results when the total costs allocated to the irrigation function are amortized on a per acre basis over the 50-year repayment period with no interest charge. Although not a true full cost, it contains the restraints now present in reclamation legislation--no interest charges and up to 50 years to repay.

--The other price is the full cost as estimated above with an interest charge of 7.5 percent.

In our analysis, we estimate the existing payment for water by irrigators in the district, estimate the probable payments under both our values for WPRS water, and compare these as alternatives available to the growers.

Existing water price

At present the growers pay the irrigation district for the water they use. In 1977 this amounted to $36.39 an acre according to WPRS records. The water in the canal or flume must also be pressurized on-farm to flow through the sprinklers. These on-farm annual irrigation costs include electricity for the pump of about $5 an acre and the capital

costs for the pump of about $7 an acre. When these costs are totaled, the existing price which will be replaced by the WPRS ability-to-pay price of our prices is about $50 an acre.

GAO water prices

Under our approach, the cost to the irrigators for water would be about $106 an acre if the interest subsidy were continued and about $334 an acre if 7.5 percent interest were charged. These annual per acre charges are sufficient to repay the $38.7 million allocated to irrigation as of January 1978 and to pay the $23.50 per acre estimated to cover the annual operation and maintenance costs for the Oroville-Tonasket irrigation project. 1/

These two prices of $106 and $334 can be compared to the $50 estimated for the existing costs for water to the orchardists because the new project will deliver water to the grower under enough pressure to sprinkler irrigate. Neither assumed price includes the true cost of the power to pump the water out of the river and through the sprinklers. The irrigation district will pay a fixed rate for the power, but it will be less than the average generating costs to the Federal Government. Interestingly, the new WPRS system will require about three times the electrical power to transport water to the trees, as the new system pumps the water uphill, while the old system was gravity flow plus on-farm pumping. Without the additional subsidy from regional power users to the irrigators, the large increase in power needs of the project would increase the operating costs.

Alternatives facing the growers

The apple orchardists in the Oroville-Tonasket area have a deteriorating irrigation system. WPRS concluded that the system needed to be replaced and the members of the irrigation district apparently agree with them. The question we will try to answer is how they would view their alternatives

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1/The actual prices would be higher than the estimates noted above as the project will not be completed for at least another 6 years. At that time the total project costs will be about 30 percent higher than the costs presented in 1978. For our purposes, however, the analysis can be made with current estimates. This implies that all cost and price relationships will remain the same during the construction period. The Executive Branch has estimated completed project costs at $55 million.

if the price to be charged by WPRS continued the interest subsidy, or eliminated all subsidy.

To answer this question, we need to estimate the costs facing the irrigators with and without the project. The alternative to having WPRS provide a new irrigation system at whatever the price would be for the District to finance its own repairs or fund new construction. We did not make an independent estimate of how much rehabilitation would cost nor how much would be needed. However, WPRS estimated in 1971 that complete rehabilitation of the existing system was slightly more costly than replacing the system with a closed pipe. More recently they estimated that partial rehabilitation of the system--replacement of the 17 miles of wooded flume--would cost $9 million.

WPRS assumed in their feasibility study that the District could not finance the needed repairs. 1/ We are not sure what a workable rehabilitation program would actually cost, but we can estimate the size of a private loan obtained for per acre costs less than or equal to the two price levels postulated in this study.

We calculated how much improvement could be financed with a $10 per acre payment each year. With liberal commercial terms (20 years repayment and 7.5 percent interest), such a $10 payment would finance about $1 million in improvements for the district. The flume replacement program noted above would, therefore, cost about $90 more an acre if the work were contracted for all at one time. An increase of that magnitude would raise the existing charge of $50 an acre to about $140 an acre. Such a water charge would tend

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1/The conclusion which WPRS then draws from this assumption is that the area would return to unproductive sagebrush. We do not agree with this conclusion. At least 25 percent of the land in the existing irrigation district already receives water from river and lake pumps. Other lands lie near the Okanogan River and could be supplied water directly from the river. The better run orchards have high enough returns to be able to finance such independent systems. One estimate is that 25 percent of the growers in the Oroville-Tonasket region average 1,100 boxes an acre, compared to the overall regional average of 640 assumed by WPRS. Such yields would provide both the income and the incentive to discover some way to get the water from the river to the apple tree root zone even if the irrigation district could not efficiently provide the water to all orchards.

to lower the average farmers net return, but even according to the 1973 WPRS calculations the average orchardist would still be making a positive return.

We believe that if the district were actually faced with financing needed repairs themselves they would not throw up their hands and let the system disintegrate, but would work out an approach that would fit the abilities of the members.

WPRS project at higher cost compared to private financing

The project as proposed by WPRS for the Oroville-Tonasket irrigation district is a sophisticated, low-maintenance system which removes the burden of providing water pressure from the individual to the Federal Government. The pipes would be underground and the pumps would be remotely controlled. For this system, WPRS has calculated that the growers could afford to repay about $47 an acre when the project is completed around 1985. They are now paying about $50 an acre each year to get water to their trees and these costs will continue to escalate.

There is little doubt that the growers would rather have the WPRS system at a price of around $50 an acre then continue with their old system for basically the same price. The question we have tried to answer is how they would view the comparison between repairing the old system and paying higher prices for the new system. We arrived at our answer by concentrating on the cost comparisons, as the differences in gross income would be negligible.

WPRS project at $106 compared to repairing the old system

We believe that the irrigators would purchase water from the WPRS project if water would be priced at $106--the level which would recover all construction costs without interest. This conclusion rests simply on what $106 would be buying under each option. If the irrigation district decided not to take the Federal project at $106, they would be faced with some major repairs. The additional $56 which would bring their existing water charge up to the proposed WPRS price, would at most only finance $5.6 million in repairs. Given the sad state of the system as reported by WPRS in the feasibility report, such an amount would be inadequate. The flume repair alone would cost $9 million, so $56 an acre would not even complete that major repair. In contrast, paying WPRS the extra $56 an acre would purchase a new $39 million system.

WPRS project at $334 compared to repairs of the existing system

We believe that the irrigators would turn down the WPRS project if the water were priced at full cost. The additional $284 an acre which the WPRS project would cost would substantially erode their average net income--estimated at about $300 an acre in 1973 by WPRS--and substantial repairs to the old system could be financed for much less than $284 an acre.

The price of $334 an acre for water is extremely high in comparison to the existing charge of approximately $50 an acre and the possible returns from growing apples with the extra expense would not give any returns for the investment of time and money. The growers probably could not agree as a district to pay $334 an acre for full cost of WPRS water.

If the growers turned down the WPRS project at full cost and financed the repairs themselves, they could determine a least cost approach and get approximately $10 million worth of rehabilitation for about $100 more an acre. This kind of water charge would probably change the character of the area, as some of the less efficient orchards might be absorbed by the more efficient orchards. The irrigation district might also allow certain farmers who are served by the worst sections of the distribution system to opt out and pump directly from the river.

In case both the WPRS project at full cost and the alternatives are so expensive that they would render apple orchards unprofitable in the Oroville-Tonasket area, there would be severe economic displacement in the area. We do not feel, however, that WPRS adequately analyzed the situation without the project to rule out private alternatives to the WPRS project which would allow the system to continue to operate within the capability of the majority of the irrigators in the proposed district.

CONCLUSION

The Federal Government is going to subsidize about 90 percent of the costs of a replacement irrigation system for the Oroville-Tonasket Irrigation Districts. The proposed new distribution system is energy intensive, pump-driven, piped, and pressurized. The old works are gravity flow, open ditch which require that the water be pressurized by the irrigator to sprinkle irrigate. The old system is said to need extensive repairs which are beyond the irrigators' financial capabilities. WPRS has received authorization and appropriations to build the replacement system and will charge the

irrigators $47 an irrigated acre for the new system. The full cost of the system is about $334 an acre, while a price which would continue the interest subsidy would be $106 an acre each year for 50 years.

Our conclusion about the effects of charging one or the other of the higher prices depends upon the costs of getting the water to the trees. The agricultural production would be the same as the lands are now mature irrigated orchards. The option to paying higher prices for the WPRS project is, of course, to go into the private market for capital improvement financing or, at the lowest level, to increase repairs as part of the irrigation district's annual maintenance program. If WPRS were to build the project only if the irrigators would pay $106 an acre, the growers would opt for the WPRS project only if they could not do it themselves for less money. The same comparison can be made at the $334 an acre price which reflects the full cost of the WPRS project.

We conclude that the growers would accept the $106 water from the WPRS project. The existing price paid by irrigators to the irrigation district and for on-farm pressure is about $50 an acre and the doubling of the water price would purchase a new, low-maintenance system in the face of possibly large repair costs for rehabilitating the old system. At the interest subsidy price then, the Federal option bests the private option and the irrigators would be economically better off.

The other higher price--$334 an acre each year for full cost--would probably not be accepted as it would be a seven fold increase in a production expense. Such an increase would lower average returns to near zero if the 1973 WPRS analysis is correct. The private options which would be available if the WPRS water were priced at full cost would include financing repairs to the existing system, and abandoning the old system and allowing the orchardists to arrange for their own water.

If private financing were sought, the district would seek the least cost alternative and could probably do several rehabilitation/increased maintenance programs which would cost less than $334 an acre. If the district could not privately finance a system at low enough a price for all its members, we believe that many of the orchardists would make their own arrangements to take water from the river and irrigate their own orchards.

This latter effect could cause direct economic harm to the area. If smaller, less efficient orchards failed or sold

out to larger firms, those individuals would be harmed by not being offered the water at a subsidized price. The Congress should have been asked to decide if maintaining small or marginal orchards in the Oroville-Tonasket area is worth the high subsidy planned for this project. WPRS simply assumed that ruin would follow if no project were built. We question the lack of analysis which went into the assumption. If a rescue operation is needed to save small orchards or maintain all 9,500 acres in apple production, such an action could be decided on the merits, rather than clouding the issue by maintaining that the project will provide increased agricultural output greater than the costs.

POLLOCK-HERREID UNIT

PICK-SLOAN MISSOURI BASIN PROGRAM

The proposed Pollock-Herreid Unit lies on the east side of the Oahe Reservoir in northwestern Campbell County, South Dakota. Dryland agriculture has been the chief source of income in the Pollock-Herreid area since the first settlements in the 1860s. The area lacks an adequate ground water supply and farmers have only been able to irrigate about 4,000 acres of land using ground and surface water.

The area suffers from hot, short summers and erratic rainfall which averages only about 15 inches per year. The area's frost-free period averages about 124 days, but long summer days compensate for the short growing season and some crops grow rapidly in the area's subhumid climate.

Project area farmers produce crops of corn, barley, wheat, oats, and operate herds of feeder and dairy cattle. In 1964 the average project area farm consisted of about 1,000 acres with 53 percent used for raising crops and the remainder used for grazing cattle. According to a WPRS survey, project area farmers grow wheat and corn on about 49 percent of their cropland and the remaining cropland is used for flax, alfalfa, hay, oats, and other crops. According to one South Dakota State University official a single area farmer raises about 20 acres of potatoes, but has some difficulty marketing his product. In the drought year of 1974, county farmers averaged 10 bushels of corn and wheat per acre.

Drought has been a major limitation for South Dakota farmers since the earliest settlements. In one drought around 1890, some wheat fields produced only one bushel of wheat per acre and rainmakers attempted to increase rainfall with the use of explosives and gases. The drought increased interest in irrigation, but interest declined in 1896 as rainfall increased. Between 1909 and 1913 the State Experiment Stations introduced drought resistant grasses and forage crops including a Siberian strain of alfalfa which survived the drought of 1911. During this period durum wheat was introduced and continues to be an important crop because of its drought resistant characteristics. By 1915 homesteaders had begun adding feeder and dairy cattle to their cropping operations to increase their cash incomes during droughts.

Many remember the drought and depression of the 1930s in South Dakota. Drought caused low yields and depression pro-

duced low prices which caused farmers to lose their lands and homes. South Dakota suffered a severe loss of population to other States with better economic opportunities. During this period the Federal Government created conservation programs rebuilding South Dakota agriculture which prospered during the 1940s with excellent prices and favorable weather. Although South Dakota agriculture improved, the population of South Dakota has continued to decline and the 1970 population remained below the 1930 level.

In 1959, the South Dakota Legislature created a statewide conservancy district for the financing of local water resource projects. In 1960 the voters of a 15-1/2 county area including Pollock-Herreid voted to create the Oahe Conservancy Sub-District. The recent success of irrigation in other areas of the country combined with the drought years of 1974-75 has again created renewed interest in irrigation among South Dakota farmers.

WPRS' RATIONALE FOR GOVERNMENT INTERVENTION

WPRS plans to build an irrigation system to provide water for about 80 farms near the towns of Pollock and Herreid in Campbell County, South Dakota. The present WPRS proposal provides for diversion of water from the Oahe Reservoir by means of a pumping plant to supply on-farm sprinklers. The water supply system would include the use of Lake Pocasse as a regulating reservoir, a system of canals and laterals, relift pumping plants, and a drainage system. The canals would provide water by gravity to each farm and irrigators would install and operate their own sprinkler systems.

WPRS believes the proposed irrigation project would stabilize agricultural enterprises in the Pollock-Herreid area and prevent the outflow of population which has continued since the depression of the 1930s. According to WPRS, local farmers have continued to support the project and in 1968 an election for the expansion of the irrigation district was held and 100 percent of those voting favored increasing the district from 13,670 irrigated acres to the present 15,000 irrigated acres. Project farmers would help pay for the project up to their ability-to-pay over a 50-year period. WPRS has begun to discuss repayment contracts with the district's farmers, but no contracts between the U.S. Government and project farmers have been signed to date.

WPRS REPAYMENT ANALYSIS

In 1978 WPRS estimated the cost of the Pollock-Herreid project at $35.1 million. Operations, maintenance, and

replacement (OM&R) would cost an additional $166,000 per year which farmers would pay on a yearly basis without direct Government assistance. The OM&R costs will include pumping plant electrical energy expenses of 2-1/2 mills per kilowatt hour. The farmer will pay 30 mills per kilowatt hour for on-farm pumping costs. Energy will be provided by the Missouri River Basin Power Systems Transmission Division.

Table 32

1978 Estimates for
Pollock-Herreid Cost Allocations and Repayments

	Allocations	Repayments
Irrigation	$34,559,000	$ 3,397,000
Power	--	31,162,000
Muncipal and industrial water	65,000	65,000
Fish and wildlife	145,000	38,000
Other	353,000 a/	--
TOTAL	$35,122,000	$34,662,000

a/Represents preauthorization costs under Public Law 92-149 which authorized the project.

SOURCE: Senate Hearings before the Committee on Appropriations, Public Works for Water and Power Development and Energy Research Appropriations, Fiscal Year 1979, Part 3, pp. 849-851.

Irrigators and the Oahe Conservancy Sub-District are estimated to repay about $3.4 million or 10 percent of the total amount allocated to irrigation. The sub-district will repay $.50 per irrigated acre totaling $375,000 over a 50-year period. The sub-district will levy a one or less mill tax on the taxable property within their 15-1/2 county boundary and portions of the proceeds will finance the sub-district's $0.50 per irrigated acre obligation. The individual irrigators will annually repay $4.03 per irrigated acre over a 50-year period, repaying $3.1 million of the $3.4 million irrigation repayment. This $4.03 price is based on the WPRS' estimate of the irrigators ability-to-pay for the water. The remaining

90 percent of the construction costs allocated to irrigation (about $31.2 million) are to be repaid by Federal hydropower funds without interest commencing 50 years after the completion of construction.

The long payment schedules and the lack of interest result in a subsidy of 96 percent. This means the Federal Government would get payments of the same value by loaning $1.1 million at 7.5 percent interest for 50 years and giving the remaining $33.5 million away. The present value of the irrigators direct payments of $3.4 million over 50 years is $0.6 million, while the power revenues share of $30.8 million also has a present value of only $0.6 million because no payments are made until 50 years have passed.

Irrigators' ability to pay

In 1971 WPRS prepared farm budgets to determine the ability of local farmers to pay for the delivery of water to their farms. For purposes of analysis WPRS divided the project's lands into three categories according to the productivity of the soil: Class 1 contains the best soil, and Classes 2 and 3 contain poorer soils. WPRS computed a repayment capacity analysis for each category of land and created a weighted average from the three budgets.

Each farm budget includes both cropping and livestock operations. Livestock activities include cow-calf, feeder steer, and heifer, dairy, and hog enterprises. Cropping operations include corn for grain and silage, barley, alfalfa, pasture, oats, wheat, and potatoes. Although these 1971 farm budgets represent the latest published data, WPRS officials presently are working to update these farm budgets which were unfinished at the time of our review. The basic cropping and livestock patterns will remain similar to the 1971 budgets, but more emphasis will be given to potatoes as a cash crop.

The following table represents WPRS' 1971 budget for a farm with Class 1 soils.

The $3,772 payment capacity amounts to $18.86 an irrigated acre for a Class 1 farm. Similar calculations for Class 2 and 3 lands resulted in a weighted average of $16.90 an acre payment capacity. From this estimate WPRS subtracts a contingencies allowance to arrive at ability-to-pay figures. In 1971 the allowance was 25 percent, but has decreased as OM&R estimates have risen and is now about 11 percent. The $4.03 an acre to pay the irrigators share of costs has remained constant.

Table 33

Farm Budget--1971 Data,
Pollock-Herreid Unit
(1,000 acres) Class 1 Lands

Total Receipts	$52,740
Crops	$20,313
Livestock	31,227
Perquisites	1,200
Total Expenses	$34,190
Interest	$12,248
Crop	8,531
Depreciation and repair	6,127
Livestock	3,797
Taxes	3,375
Livestock purchase	3,370
Motor fuel	2,694
Labor (hired)	1,364
Other	(-) 7,961
(less) 6-1/2% of 65% of investment	
Net Income	$18,550
Allowances	$14,778
Family labor	$ 4,962
Management (10% of net)	1,855
Interest on investment (6.5% of 65%)	7,961
Payment Capacity	$ 3,772

SOURCE: Appendix D, Agriculture Economy, Feasibility Report, 1968 and Reevaluation Statement 1971, WPRS, March 1971 p. 81.

Higher costs of water

Based on 1971 data WPRS estimated the farmer had the capacity to annually repay the Federal Government $16.90 per acre for the delivery of about 1.3 acre-feet of water. The

interest-subsidy price, which would repay all construction costs but at no interest, would be about $57 per acre or $11,400 a year for a farmer irrigating 200 acres. The full cost price would be $181.11 an acre at 7.5 percent interest. Table 34 shows the difference this would make in WPRS' adjustments to net income. For purposes of illustration we limited our discussion to the Class 1 budget.

WPRS implicitly estimates that the $14,778 is a minimum level of income for this representative farm. Pricing water at the interest subsidy level would obviously lower that income by about half in this example. Full cost water would cause an annual loss of almost $18,000.

Table 34

Ability to Pay vs. Full Cost
(Farm budget framework)

	Ability to pay	Full cost	
		Interest subsidy	With interest
Net Income	$18,500	$18,550	$18,500
less water expense	(3772) a/	(11,430) b/	(36,220) c/
New net income	$14,778	$ 7,120	(-) 17,670

a/Does not include any contingency adjustment.
b/$46.08 to amortize $34,559,000 over 50 years, plus 11.07 OM&R.
c/$170.04 to repay $34,559,000 at 7.5 percent interest for 50 years, plus $11.07 OM&R.

OUR ANALYSIS

What would be the expected economic effect if farmers were asked to repay the project's full construction cost? Would farmers be able to afford a many-fold increase in the price of water in spite of the economic disaster predicted in table 34?

We approached the analysis in three ways: we looked at WPRS' farm budget from a cash flow basis, we looked at analysis done for a proposed private irrigation district, and finally we looked at the marginal revenue which can be attributed to irrigation.

Cash budget

A casual review of the WPRS budget would indicate that Pollock-Herreid farmers could not pay higher prices for the delivery of water to their farms, but a closer examination reveals that many of the expenses fail to represent actual cash outlays to creditors or suppliers. Deductions of the $14,778 of allowances from net receipts represent return on owner's equity, family labor, and returns to the farmer for his own management expertise. (See table 33.) If the farmer decided to make an investment in irrigation, he certainly might apply portions of this income towards this purchase.

WPRS computes interest expense by taking 6-1/2 percent of total farm investment which represents $12,248. This may be a valid expense for a farmer who fails to own any equity in his machinery or land. Other farmers who own all or portions of their land and machinery may consider this a noncash expense and could apply these dollars toward the purchase of water.

The removal of noncash expenses including imputed interest would allow the farmer to pay the interest-subsidy price for water with $10,207 left to pay for family living expenses, machinery, and land. (See table 35.) Based on this analysis, the farmer who owns most of his land and machinery outright might consider purchasing water from WPRS at this price, but a farmer failing to own his land or machinery probably would not find this an attractive arrangement. For the younger farmer the debt interest calculated by WPRS might be an actual cash outlay to a creditor. We believe WPRS should survey the approximately 80 project farmers to determine the actual interest expense the project farmers are currently experiencing and then determine how this factor affects the farmer's ability or willingness to repay project costs to the Federal Government.

A quick review of the U.S. Department of Agriculture's 1974 Census for Campbell County shows that only 40 percent of the operators had any farm credit. Of these that had credit in 1974, the amount owed averaged about $50,000. The interest expense was not presented.

Table 35

Pollock-Herreid Unit
1971 Class I Repayment Budget
(1000 acre farm with 200 irrigated acres)

	WPRS' farm budget a/	Our cash budget b/
Total Income	$52,740	$51,540
Total expenses, without a water charge	$34,190	$29,903
Net Income	$18,550	$21,637
Uses of Net Income	$26,208	$11,430
Water at interest-subsidy price	11,430	$11,430
Allowances to farmer	14,778	-
Apparent financial position	$(7,658)	$10,207

a/See table 33 for details.
b/Interest is deducted.

Other adjustments to WPRS' farm budget

WPRS assumes farmers will begin to grow potatoes on their irrigated land to pay for additional expenses and this assumption is reflected in their net income estimates. Presently, about 20 acres of potatoes per farmer are grown, but the potato processing plant is located 190 miles from the project in Clark, South Dakota.

According to South Dakota University officials, little potential exists for growing potatoes for a profit in the Pollock-Herreid area unless additional markets for potatoes can be developed in the area. Although at present prices potatoes might produce $1,000 per acre of gross income, storage costs of about $500 per acre would make potatoes a questionable crop in the Pollock-Herreid area. To avoid these high storage costs and make potatoes a profitable cash crop, project farmers would have to get a processor in Campbell County or develop new markets.

Limited potential exists for growing potatoes for a profit or for the establishment of a potato processing plant in the area, according to the Clark County potato processor. Transportation costs from the growing areas to the processing plants would be prohibitive and Campbell County is located too far from major population centers for the profitable location of a potato processing plant.

The subtraction of potatoes from WPRS' farm budgets and the substitution of corn on the irrigated acres decreases net farm income by about $4,700. Table 36 shows the difference this could make in WPRS' adjustments to net income.

Table 36

Class I Repayment Budget
(Minus Potato Income)

	Ability to pay	Interest subsidy price	Interest subsidy prices cash budget
Net farm income	$18,550	$ 18,550	$21,637
Potato Income	(4,700)	(4,700)	(4,700)
Irrigation Water	(2,914)	(11,400)	(11,400)
Family Labor	(4,962)	(4,962)	-- a/
Equity Allowance	(7,961)	(7,961)	-- a/
Management	(1,855)	(1,855)	-- a/
	$(3,842)	$(12,328)	$ 5,537

a/These are noncash items.

Review of other analysis

During our review we attempted to identify privately financed projects similar to the Pollock-Herreid unit to see how Pollock-Herreid farmers would react to increased water prices. Farmers participating in privately financed projects would pay full costs including interest for the delivery of water to their farms.

We found the Lake Andes-Wagner Irrigation District, located in Charles Mix County, South Dakota, which contains about 79,000 irrigable acres with farming operations resembling those in Campbell County. Since 1940 WPRS has considered building a Federal project in the district. After WPRS made the final study in 1971, the Congress discontinued further project funding. In 1974 local leaders hired private engineers and financial consultants to prepare a project feasibility study and on July 27, 1978, farmers voted not to construct the project. According to one South Dakota State University official, farmers vetoed the proposal because of the low price of corn. When the price of corn falls below the cost of production many farmers are unable to purchase additional equipment or water.

The proposed Lake Andes project would be profitable if corn prices would remain at $2.42 per bushel and if farmers could produce 135 bushels per irrigated acre. If corn prices dropped to $2.00 per bushel, project farmers would take a $13.00 loss per acre. Farmers would need to sell their corn at $2.19 per bushel to recover all their costs or break even on their dryland acreage. Project proponents estimated the costs and yields.

OUR MARGINAL ANALYSIS

If the profitable raising of potatoes is doubtful and corn represents Pollock-Herreid's most profitable irrigated crop, can project farmers pay higher prices with the profits from corn?

The profitability of corn depends upon its market price, which has varied considerably in the last several years. South Dakota farmers received $3.05 per bushel for corn in 1974, $2.45 in 1975, and only about $2.00 per bushel for their corn in 1978. Decreasing corn prices and increasing production costs made corn production a break-even situation for many farmers in 1978. Without receiving some profit on their corn, farmers are unable to purchase additional machinery or water. Some may not be able to pay for machinery or other production inputs purchased in previous years when farmers received higher prices. The reaction of Lake Andes farmers illustrates this point and Campbell County farmers would certainly find themselves in a similar situation.

To determine repayment capacities of Pollock-Herreid irrigators we constructed a simple business investment decision model. We compared the revenue from one acre of dryland to the revenue from one acre of irrigated cropland. We used yields, costs, and prices the project farmer might presently expect. Marginal net revenue allows the analyst

to determine how much a farmer might pay for water. Unlike WPRS, we believe the irrigator would plant only corn on the irrigated acres as it is the highest possible revenue producing crop.

The dryland corn figures are the baseline, or without project estimates. Analysis of the increases or decrease because of the switch to irrigation shows that even though all situations show a loss at $2.00 a bushel for corn, the farmer would lose less with dryland farming. At $2.20 for corn, the irrigated option at the interest-subsidy price would be preferred to either the dryland option or the other full cost irrigated price. If the irrigator could count on a minimum of $2.20 a bushel in real terms for the future corn crops, the WPRS project would be slightly ahead of dryland (baseline) if no interest were charged. This is readily seen from the table in that $8 an acre is better than $0 an acre. At prices above $2.20 a bushel the advantage to irrigation at the interest-subsidy price increases.

Table 37

Net Revenue One Acre Price
Bushel of Corn

	$2.00	$2.20	$2.40
Dryland 40 bu/acre	-$ 8	$ 0	+$ 8
Irrigated 125 bu/acre			
Interest-subsidy price	-$ 17	+$ 8	+$33
Full cost	-$141	-$116	-$91

Even with the slight advantage which would seem to fall to the WPRS project if the interest subsidy were continued, it is very difficult to say what a farmer would do if WPRS charged $57 an acre for the water to be delivered to the Pollock-Herreid area. The increased costs for irrigation are about $180 an acre. At $2.20 for corn, spending $180 more an acre, or $36,000 for an average farm in the Pollock-Herreid area, to go from no profit to $8 an acre profit is a very risky undertaking. It seems that the return would have to be higher than dryland under almost any plausible future conditions, which include the possibility of $2.00 for a bushel of corn.

CONCLUSION

We believe WPRS' repayment analysis is cumbersome and too complicated to represent the actual farmer's decisionmaking. WPRS has attempted to analyze hundreds of costs and prices farmers would face daily with or without irrigation. The manipulation of a few inputs such as yields, crops grown, and numbers of cattle raised would produce wide fluctuations in the repayment capacities of project farmers.

We believe the probability of project farmers developing a speciality crop such as potatoes is slight. If farmers could develop potatoes as a viable cash crop, repayment capacities in our analysis would be substantially higher.

Would farmers install on-farm sprinkler systems and pay full costs for WPRS water? Farmers are not likely to increase their fixed costs by $100 or more per acre without an excellent chance of increasing their net income, especially when they are unable to affect the prices they receive for their corn. Present corn prices and Campbell County yields fail to provide such an opportunity.

In the future farmers would be willing to pay more for water if the price of corn would increase, creating more profits and making more revenue available to pay for additional water.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

DEC 5 1980

Mr. Henry Eschwege
Director, Community and Economic
Development Division
General Accounting Office
Washington, DC 20548

Dear Mr. Eschwege:

We have reviewed the draft report transmitted by your letter of October 21, 1980, entitled "Farmers in Selected Areas Could Pay More For Federal Irrigation Water".

On page i of the draft report it is stated that, "Initially, Reclamation Law required that irrigation project construction costs be repaid in full, over the years much less than full repayment has become the norm." Full repayment of irrigation construction costs is made on all projects as required by law. The full payment may not come from the irrigators and full repayment of construction costs does not mean or imply repayment with interest which is a financial cost not required for irrigation. The law also provides that the repayment by water users is to be based on their ability to pay as determined by the Secretary of the Interior. The costs beyond the water user's ability is to be repaid primarily from power revenues. Reliance on power revenues to aid irrigation has, in one form or another, been a part of general Reclamation law almost since its beginning (See Section 5 of the Act of April 16, 1906, 34 Stat. 116, 117, 43 U.S.C. subsection 522; and Section 9 of the Reclamation Project Act of 1939, Act of August 4, 1939, 53 Stat. 1187, 1193, 43 U.S.C. subsection 485h).

GAO RESPONSE: Our objective was to postulate a charge to irrigators for Federal irrigation water which would repay more of the project costs. In our analysis, we used one charge which did not include the interest charge and one which did. The reason the subject of repayment is of concern is that the subsidy, which has grown over the years, has attracted attention every time the subject of water project construction is studied. Regardless of how the subsidy came to be (and the legislative background is outlined in chapter 2), we wanted to find out what might happen if the irrigators bore more of the cost or the full cost of the dams and canals which bring water to their lands.

APPENDIX II

When we estimated the present value of the repayments made from all sources to pay for the irrigation facilities construction costs, we found that it was less than 10 percent of the costs of all repayments (see pp. 36-37). WPRS calls the repayments of irrigation costs "full" because each dollar is eventually returned to the Federal Government. We believe the lack of interest charges and the long time periods before much of the repayment is made reduce the value of the repayments to a very low percentage of the costs.

Admittedly, irrigators pay less than full costs for water from Water and Power Resources Service (Service) projects. But if irrigators were required to pay the full irrigation cost even without interest, it is unlikely that many would be able to do so under the present method of allocating costs and determining benefits. Federal irrigation projects are very capital intensive, and their costs are usually beyond the ability of the water users to repay. These facts are clearly presented to the Congress as a primary basis for their consideration in approving and authorizing expenditures for such projects. An estimate of the full cost of water in the report and comparing it to the recommended water charge based on payment capacity would provide additional information and, therefore, improve the presentation.

GAO RESPONSE: We found that at the price which does not include interest charges, irrigators in four of the six projects studied could improve their net income. This is significant because these interest-subsidy prices are three to fifty times higher than the price WPRS is charging (see table 4, p. 26). Our recommendation to the Secretary of the Interior on pp. 41-42 that full cost prices be compared to the payment capacity prices is in consonance with WPRS' last sentence above.

Major steps have been taken recently by the Service to improve rates of repayment on irrigation projects in keeping with current administrative policies as reflected in the President's water policy reforms announced in June 1978. The Commissioner of the Service established new irrigation contracting policies in December 1978 which included, among other things, that all new long-term water service contracts shall contain provision for periodic 5-year reviews and adjustment of the rate for repayment of capital costs assigned to irrigation. Also, the contingency allowance or adjustment used for many years has been discontinued; 100 percent of payment capacity must now be used.

It is indicated on page 3-5 of the draft report that the General Accounting Office (GAO) wants " . . . the price of water to be a figure that reflects water's full cost, not merely an estimate of the farmer's ability to pay for it." If the Service were to use cost of water as the price, there would be no need to make the farm budget repayment studies. But the law

clearly indicates that the Congress wants the price to reflect the water user's ability to pay, and the Service's studies are done to make that determination.

GAO RESPONSE: The quote from the draft report is incomplete. The full quote (see p. 17) is "We wanted to change the price to a figure that reflects water's full cost, not merely an estimate of the farmers ability to pay for it." This is contained in the section on the analytical approach used by WPRS and how we could not use it to estimate the effect of full-cost water.

The draft states on page 3-12 that the "WPRS seems to want to guarantee the farmer's (sic) an income and therefore, reduces the price for Federal water so that the farmer's cost becomes low enough to realize that level of income." The Service's concern with the farmer's level of income is a requirement of law. The Fact Finder's Act of 1924 requires that the irrigable lands of each new project and new division of a project be classified by the Secretary with respect to their ability, under a proper agricultural program, to support a family and pay water charges. As discussed previously, the law requires that the water charges be based on the farmer's ability to pay. The farm budget analysis is designed to show net farm income due to the Federal irrigation water supply. From the increased net farm income, an amount must be deducted for the increased farm family labor, management, and equity due to irrigation which when added to the net farm income without the project, will provide the farm family with an adequate living allowance. The remaining increased net farm income is the amount available to pay for the water.

The Fact Finder's Act of 1924 was not included in chapter 2 of the draft report where other Reclamation laws are discussed. This is an important part of the body of law affecting the development of Service projects as the discussion above indicates.

GAO RESPONSE: The sentence quoted by WPRS has been deleted from the final report. However, the WPRS reliance on the Fact Finders' Act of 1924 to justify concern with the level of income deserves comment. The Fact Finders' Report, produced by a committee of special advisors on reclamation, resulted in Sec. 4 of the Second Deficiency Act of December 5, 1924 (Fact Finders' Act). The advisors' work was necessary because many reclamation farmers could not repay their obligations--due to depressed agriculture prices after 1920--even with the extension to 20 years granted in 1914 (see pp. 9-10). The recommendations enacted were that a detailed classification of project soils be made; that annual repayment be 5 percent of annual farm returns; that the new projects were feasible; that the new projects would probably return the costs to the United States; and that experienced settlers be selected.

WPRS' statement that the lands be classified with respect to their ability to support a family and pay water charges needs to be seen in light of the Act's requirement for overall project approval:

> "the Secretary . . . [shall secure information] concerning the water supply, the engineering features, the cost of construction, land prices, and the probable cost of development, and he shall have made a finding in writing that it is feasible, that it is adaptable for actual settlement and farm homes, and that it will probably return the cost thereof to the United States." (Section 4, Subsection B (43 stat. 702).

We did not discuss the 1924 Act in chapter 2 because for our purpose of highlighting changes in the repayment requirements on Reclamation projects, the Act was of minor importance. In any case, it was superseded in this respect by the 1926 Act noted on p. 10.

Because of the requirements of the Fact Finder's Act of 1924, the Service cannot limit its repayment studies only to acres in the farm actually receiving project water as suggested in the draft report. Payment capacity must be determined by comparative budget analysis of the total farm. The family-type farms budgeted are representative of future conditions with the project in operation, and future conditions without the project. The difference in net farm income between the two conditions is analyzed in terms of allowances for return to family labor and management, or family living, and for return to farm capital, in order to determine the residual available to meet water charges. Payment capacity is the maximum annual amount that water users will be able to pay for irrigation service out of farm earnings attributable to the increased water supply and project works. Payment capacity, therefore, does not encroach on earnings properly creditable to other factors. For example, net farm income without the project is not available for use as payment capacity; payment capacity is a part of the increase in net farm income shown by a comparison of conditions with and without the project.

The farm budgets for conditions with and without the project reflect the integrated use of the total resources of the farm in crop and livestock enterprises and thereby provides the best analysis of the farmer's ability to pay. Utilization of an enterprise analysis as suggested in the draft report would not provide sufficient information to determine water rates and assure that the project lands will be able to support a family and pay water charges as required by law.

Chapter 3 in the draft report does not explain correctly how payment capacity analyses are conducted. The benefit studies and the repayment

studies are separate studies based on different time periods. Therefore, assumptions regarding farm size, yields, and production inputs do vary. The farm budget studies for benefits, estimate conditions over a 100-year period with most projections made to year 20 or 25. The repayment analysis covers only 50 years and projections normally reflect anticipated results in the 10th year following construction.

GAO RESPONSE: We raise no concerns with the WPRS studies in this report. We fully understand how payment capacity and benefit analyses are made because of our review of the six projects. We describe the payment capacity in chapter 3 in enough detail so that the reader can understand its basic thrust and so that we can explain why it was not useful to us as we attempted our analytical approach. We wish to emphasize again that our focus was to determine the costs to the Government and to estimate what might happen if the recipients of Federal water were asked to pay more of the costs or the full costs of providing that water. We are currently looking into the legal issues.

On page 3-6 a general claim is made that new land to be irrigated by a project will be of lesser quality and produce lower yields than currently irrigated land. While this is true on some projects, on others it is not. Yield projections are based specifically on the soil and climatic conditions of each area under study based on detailed land classification data.

It is stated on page 3-7 that " . . . if 10,000 acres in a 40,000-acre project area are irrigated from other sources, any water added to that supply will be used to irrigate part of the unirrigated 30,000 acres." This is not a true reflection of the use of the supplemental water supplies often furnished by Service projects. Service projects provide three types of irrigation service: full, supplemental, and temporary. Lands receiving a full supply generally obtain all of their irrigation water solely from Service-built facilities. Irrigators receiving supplemental water service have an inadequate supply from non-Federal sources and must utilize the water from the Federal project to obtain full production. Any given acre could be irrigated with water from both sources. Temporary water service and the associated acreage fluctuates widely from year-to-year depending upon available water supplies and acreage under contract.

GAO RESPONSE: (The pages in the report referred to above are now pp. 18-19.) We are not sure what the focus of the two points above is in relation to the point being made by us. In the sections of chapter 3 under discussion, we point out how the WPRS analysis of the Auburn-Folsom project uses "equivalent acres" instead of the actual acres which they expect to be irrigated. The equivalent acres of farm budgets represent average conditions in the project areas. Much of

the Auburn-Folsom project area is already irrigated, and the WPRS water will be put on lands not irrigated with existing supplies. Regarding supplemental supplies, we are not sure what full production and inadequate supply imply, but we do know that farmers receiving some irrigation water will probably be applying that water where it will return the highest gain. This is consistent with normal business behavior and economic theory.

The report makes reference to "standard economic analysis" on page v. Some explanation of what is implied by "standard" would be appreciated.

GAO RESPONSE: This phrase has been removed from the digest. However, we explain our analytical approach in some detail in chapter 3. Our approach is standard in that marginal or incremental analysis is a standard practice in the economics profession for measuring the net value of additional effort and resources required to increase output. The present WPRS projects are not designed to produce new farms from raw lands, but rather to add a production input--water--to lands which are presently farmed. Marginal analysis is an appropriate, well-known tool to use in such conditions.

With reference to page IX of the summary concerning the Oroville-Tonasket case study, the report says: "Water and Power should consider many alternatives such as conservation pricing, improved irrigation practices, and private funding as alternatives to subsidizing a replacement system." The Oroville-Tonasket delivery system is in imminent danger of collapse. Neither of the first two alternatives are viable solutions to the problem. With respect to the North Loup and Auburn-Folsom projects, we agree that there ought to be licensing of wells as part of a ground-water management system. Although the establishment of ground-water codes is a matter of State, not Federal responsibility, experience has shown that the Secretary of the Interior can encourage States to improve their ground-water management.

GAO RESPONSE: The material is now on p. v of the digest. We refer the reader to the appendix material beginning on p. 118 for more about the Oroville-Tonasket project. Our inference from reviewing that project is that more and more projects will be suffering from aging. We want the Congress to consider more alternatives than replacement when and if they are asked for assistance. A deteriorating irrigation system is not rationale enough to subsidize a new system, nor is declining ground water reason enough to build dams and canals with Federal subsidies.

The last sentence on page 4-1 identifies soil conditions as a single factor causing some projects to "produce enough crops to turn a profit." The profitability of production in an area is a function of many factors including cost of water, climate, water quality, proximity to markets, etc.

GAO RESPONSE: We agree and on p. 23 changed the sentence to "With irrigation, farmers in some of the project areas could produce enough additional crops at low enough cost to turn a profit."

Table 4 following page 4-3 is misleading. The operation and maintenance (O&M) and construction charge components of the Service prices are shown separately and compared to the combined charges estimated by GAO. The comparison should show the total Service charge of $19.58 compared to the GAO estimates of $25.13 and $86.54. It would be better to use a separate column to show the O&M component in the tables.

GAO RESPONSE: We have included a separate column for O&M in table 4 on p. 26.

Footnote 1/ on page 4-9, makes reference to a table 2 of chapter 4, thereby calling attention to the fact that tables 1 and 2 are missing from the draft.

GAO RESPONSE: Tables in the draft and the final report are numbered sequentially from p. 1. Tables 1 and 2 are in chapter 3 (see table of contents).

Time has not allowed for a review of the appendix material or other project data contained in the report, but we hope that these comments adequately highlight the need for revision of the draft.

GAO RESPONSE: As noted elsewhere in this report, WPRS did not reply to the GAO draft with comments within the 30 days required by law. We felt that the comments should be included, however, so that the reader could assess their worth.

Representatives of the Service are available for consultation at your request.

Sincerely,

Larry E. Meierotto

Assistant Secretary for Policy,
Budget, and Administration

APPENDIX II

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

DEC 30 1980

Mr. Henry Eschwege
Director, Community and Economic
Development Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

We have reviewed your draft report entitled "Farmers in Selected Areas Could Pay More for Federal Irrigation Water" and find it to be of considerable interest to USDA. We agree with the GAO report conclusion. We also agree that Congress should know true project costs.

We have several comments which we feel should be addressed in the final report:

1. While a limited desk review cannot verify the detailed GAO analysis of the six projects, we agree that irrigators on Water and Power Resources Service (WPRS) projects do not pay the full costs for irrigation water. We believe that the report should discuss reasons for the low repayment, such as: (1) repayment capacities tend to be set at sufficiently low levels so that nearly all farmers can pay them; (2) the difficulty of incorporating in repayment contracts allowance for future increases in ability to pay for water stemming from projected productivity increases; and (3) economies of scale would have been different if hydropower had not been considered.

GAO RESPONSE: The objective of this report was not to explain why the price of water is so low (although all three reasons advanced by USDA are plausible) but to estimate what might happen if water prices to the farmers were higher.

2. We believe the use of terminology such as "Large subsidy given to irrigators" (page 6-2) is misleading and should be changed. The subsidy--the difference between project cost and repayment--goes only partially to the farmer because the value of the water to the farmer is often less than its full cost. It would be more accurate to refer to large subsidies

as applying to Federal irrigation projects or to federally-supplied water. Farmers could usually pay more than they are for project water. But in very few cases can the farmer pay the full cost.

GAO RESPONSE: The quote mentioned by USDA is now on page 43. However, whether the subsidy is called a "subsidy to irrigators" or a "subsidy to federally supplied water" is irrelevant--the subsidy is large. The size of the subsidy is apparent from the Fryingpan-Arkansas present-value analysis done for this report.

IRRIGATION SUBSIDY AT FRYINGPAN-ARKANSAS
($ in thousands)

Payer	Cost Allocation	Present Value of Repayments (7.5% discount rate)
Irrigators	$ 4,852	$ 635
(Direct)	(456)	(394)
(Ad valorem)	(4,396)	(241)
Other ad valorem	50,558	2,767
Power revenues	29,538	794
M&I sales	3,008	164
TOTAL	$87,956	$4,360

SOURCE: Table 19, Appendix I, this report.

The magnitude of the subsidy can be presented in many ways. (1) The total subsidy is 1-.05 (1-($4,360 $87,956)) or 0.95. (2) The irrigators' subsidy can be expressed as a share of total cost allocation which equals 1-.007 or 0.993 (1-($635 ÷ $87,956)). Thus, the irrigators are repaying a sum worth only 7/10 of 1 percent of the cost allocation or 14.6 percent of the amount actually repaid ($4,360 ÷ $635 = .146). We believe that using the total cost allocation rather than the total present value as the base is correct.

USDA's comment on the farmers only partially receiving the subsidy is conceptually correct: Full-cost water is too expensive for farmers to use it to increase their net income from additional yield.

3. On page 4-6 the first sentence reads "At the interest-subsidy price of $36 an acre/foot, the models indicated that farmers could increase their net income above the baseline conditions." The third paragraph, first sentence on the same page reads "We must conclude that at either the full-cost price or the interest-subsidy price, the Auburn-Folsom farmers could not increase their income above baseline conditions." We suggest this apparent conflict be corrected.

GAO RESPONSE: The probable misunderstanding has been corrected (see p. 27).

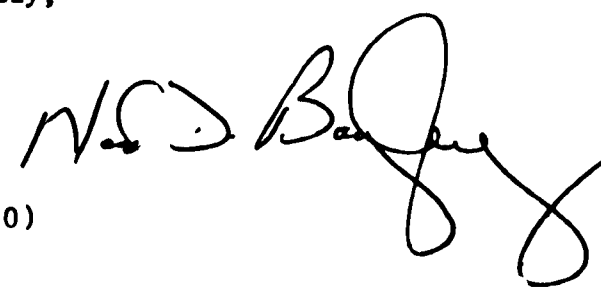
4. Water rights questions place some restrictions on what can and cannot be done with water. It is not evident that these limitations were considered in the analysis. We are not familiar with the specific States' water rights limitation for each project, but there are sometime beneficiaries downstream of projects who are not charged for the cost of water. Are all beneficiaries considered by the analysis, or are there others (public) who should share in the project costs? We suggest the report be expanded to address this aspect.

GAO RESPONSE: We approached the analysis as though the farmers who directly benefitted from the irrigation water would be required to pay. Without some marketing device to capture any commercial off-site gains, such as those to irrigators downriver who might benefit from return flows, the project costs could not be recouped from others. When dealing with the off-site effects from irrigation, however, there may also be disbenefits such as increased downstream salination and waterlogging, which would need to be considered.

5. We suggest that the report address the possibility of a variable water price over time that would more nearly reflect full-cost or ability to pay. With rising demands for agricultural output and increasing water scarcity, a fixed price for project water distorts price relationships and leads to waste and inefficient use. Periodic adjustment of water price is needed to reflect current conditions and support water conservation objectives.

GAO RESPONSE: We were not searching for the ideal pricing strategy. WPRS, however, mentions periodic 5-year reviews of ability to pay in its reply to our report (see p. 145).

Sincerely,



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