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BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Honorable Berkley Bedell U.S. House Of Representatives

Congressional Attention Is Warranted When User Charges Or Other Policy Changes Cause Capital Losses

Using a case study, GAO modeled how capital losses (diminished asset values) can result from increases in user charges. In this case, GAO demonstrates how farmland values decrease as the price of irrigation water increases. GAO considered whether farmland owners should be compensated for these losses and described different compensation mechanisms that could be used if compensation were to be made.

GAO broadened the findings of the case study to discuss other capital loss situations and remedial actions that the Congress could take.

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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

PROGRAM ANALYSIS
DIVISION

B-203865

The Honorable Berkley Bedell
House of Representatives

Dear Mr. Bedell:

Increasing user charges for products and services provided by the Government is sometimes justified. Those who benefit from Government activity would pay for what they get and the wasteful overuse caused by undercharging would be eliminated. However, in some cases user charge increases cause decreases in the value of assets owned by individuals and businesses. Such capital losses make it difficult to increase user charges, especially if the individuals and businesses are not compensated for their losses. But there are ways of determining when, how much, and to whom compensation should be paid. And this is what we do in this report. As you requested, we show how increases in user charges cause capital losses and also show how the resulting compensation issues can be resolved. These guidelines should be useful to the Congress and Federal agencies when they consider changing public policies.

As you requested, we use an irrigation project as a case study. We first present our findings from an analysis of increased irrigation water prices in the Columbia Basin Project (CBP) in Washington State. 1/ We then discuss our general observations on considerations that need to be weighed in a more general approach to the problem of capital losses resulting from imposing higher levels of user charges. The results from our case study analysis and the general guidelines are contained in appendix I and the complete details on the case study may be found in appendix II. Our work was done in accordance with GAO's current "Standards for Audit of Governmental Organizations, Programs, Activities, and Functions."

1/Irrigation water prices are designed to return capital, operating, and maintenance costs of the CBP that are allocated to irrigation (other activities, like hydropower production, also bear part of these costs). Our use of the term "user charge" in the case study refers to these cost-based irrigation water prices.

THE COLUMBIA BASIN PROJECT

An irrigation project is a good choice for showing how increases in user charges cause capital losses and how to resolve the resulting compensation issues. The efficiency and equity issues, methods for estimating capital losses, and alternative compensation mechanisms that are demonstrated in the case study can all be applied to other user charge/capital loss situations.

The water price charges and compensation payments we discuss are purely hypothetical. No recommendation is made for or against them since many issues, like the original intent of Reclamation policy to subsidize and promote small family farming, must be addressed in any decision to increase irrigation water charges.

Changing the price of irrigation water would be an improvement for two reasons. First, present pricing schemes are inefficient since water use is charged for by acre rather than by unit of water. (Water revenues are partly intended to repay irrigation project construction costs, which are allocated by acre.) Pricing irrigation water this way causes farmers to use more water, and to use it wastefully. They pay the same amount no matter how much they use. Second, the price that water would get in some alternative use is often higher than the charge irrigators pay. Allowing the price of irrigation water to increase by selling it on the open market would allocate this water to its most valuable use. Both of these conditions exist in the Columbia Basin Project, which is why we chose it for our case study.

To analyze how higher irrigation water prices would affect farmers in the CBP, we used a model that translates income decreases into decreases in farmland values--that is, capital losses. We first estimated today's net returns to farmland in the CBP and then estimated farmers' net incomes with higher water prices, allowing for the fact that farmers could partially offset higher water costs by changing crop mixes and irrigation techniques. We then used data on past land sales to see how farmers' net incomes are reflected in the value of the CBP farmland. Using this information, we translated the income reductions caused by higher water prices into farmland value decreases--that is, potentially compensable capital losses. We estimated these losses for all farming operations in the CBP. We made less rigorous estimates for the capital losses that particular groups within the project would suffer.

THE CASE STUDY RESULTS

After studying the Columbia Basin Project, we concluded that increasing the price of water presently used in irrigation would create benefits that would exceed associated losses. There is a strong demand in the Pacific Northwest for water to produce electricity, which in turn would be used by industry and individual consumers. The water now used to irrigate farmland in the Columbia Basin Project would have more value if it were taken out of producing crops and put into producing electricity. We have calculated the effects that this change would have on farmland values in the CBP and have figured out ways to offset these capital losses.

Those who use water to produce electricity would be willing to pay $3.33 per acre-inch for the irrigation water now used in the CBP, much more than the maximum of $2.50 that farmers would be willing to pay (see pp. 25 and 26). If farmers in the CBP were charged the potential market price for the water they now use ($3.33 per acre-inch), they would all give up irrigation. The water they formerly used would be bought by electricity producers for a total price tag of $963 million (p. 25).

The total decrease in farmland values caused by selling CBP irrigation water at its market price would be $912 million. The value of farmland would fall by an average of $1,700 per acre, but there would be a lot of differences in capital losses suffered by different farmers, for a number of reasons. For one thing, the natural quality of farmland in the CBP varies, basically because rainfall varies. Those who are now most dependent on irrigation to water their crops would suffer greater capital losses than would those who enjoy more rainfall. Land that is naturally drier would be less productive than other land in the absence of irrigation water. Consequently, land value decreases would be greater for drier land than for higher quality land. We estimate that the difference could exceed $200 per acre (pp. 19 and 20).

Capital losses could also vary by the size of farming operations, for two reasons. First, large operations use irrigation water more efficiently than do smaller operations, giving them higher present land values. We estimate that the value of an acre of farmland in large operations is about $1,300 more than the value in the smallest operations. If land values without irrigation water were the same for farming operations of all sizes, then per acre capital losses for large operations would exceed losses for small ones by the same $1,300. However, large operations tend to be located in areas that receive little rainfall. Their land values without irrigation water will tend to be lower than for small operations, which means that their capital losses will exceed losses for small operations by even more than $1,300 (pp. 20 and 22).

Capital losses would also differ among farmland owners in the CBP depending upon the form of land ownership. Because most farmland is owned by individuals and families, capital losses would be borne almost entirely by individuals and families. Also, farmland leasing is uncommon in small operations but becomes more common as operation size increases. Thus, small farmland owners would have less opportunity to shift capital losses to tenants than will the owners of large operations (pp. 22 and 24).

JUSTIFICATION FOR COMPENSATION

Before discussing the criteria used to determine whether compensation should be paid, it is important to note that compensation itself does not increase the costs of a loss-creating action. In the case of the CBP, losses from increasing the price of irrigation water will exist whether compensation is paid or not. The only thing that paying compensation does in this situation is to shift losses away from farmland owners and onto someone else. This principle holds in all situations where a government action creates capital losses. Paying compensation does not make the action more costly, it simply redistributes the burden.

The fact that capital losses would be different for different farmland owners in the CBP is one justification for compensating these losses. A common public policy equity goal is that the relative welfare (wealth) positions of those affected by an action should be the same both before and after the change. Satisfaction of this goal prevents the benefits or burdens of government actions from being distributed capriciously or disproportionately. Compensation for capital losses in the CBP could offset the relatively large losses that some groups would suffer. It could either completely eliminate all losses or else be distributed in such a way that all farmland owners suffered the same percentage wealth decrease. In this way, the relative welfare positions of farmland owners would be the same before and after the irrigation water price increase.

Compensation can also be justified on equity grounds if a government action imposes disproportionately high losses on those with little wealth. Whether this would be a problem in the CBP depends on the burden capital losses place on poor farmland owners and tenant farmers. We could not determine if this would be a problem in the CBP since we could not obtain any information on farmers' wealth.

Compensating capital losses can also be justified on equity grounds if the government disappoints reasonable expectations. Individuals and businesses sometimes act on the belief that government policies will remain unchanged and suffer losses when a change occurs. Buying farmland in the CBP on the belief that irrigation water will continue to be sold at 33 cents per acre-inch is one such action, while farmland value decreases resulting from the government's selling the water at its market price is one such loss. Whether compensation is justified depends on whether the expectation of no change in the price of irrigation water is reasonable. In this case it is, since the price of irrigation water sold in the CBP is set by contract and farmers are justified in expecting the government to fulfill its contracts. However, increases in user charges that are not set by contract present more difficult problems. Whether compensation is justified depends on a number of considerations, such as the frequency with which charges increased in the past and the extent to which subsidies are capitalized into asset values. These and other factors will vary from one situation to the next.

One such factor is whether present asset owners made their purchase before or after a subsidy was capitalized into their asset's value. A landowner in the CBP who bought farmland after the irrigation subsidy was capitalized into the land's value received little or no benefit from this subsidy. This is not true for a landowner who purchased CBP farmland before the irrigation subsidy became capitalized. Unlike later purchasers, these landowners benefited from the irrigation subsidy that increased the value of their farmland. Compensating these landowners for increasing the price of irrigation water would be difficult to justify. There is no such double compensation problem with landowners who paid for the irrigation subsidy when they bought their farmland.

Besides these equity considerations, other issues must be addressed in deciding whether to compensate capital losses in the CBP (or in other situations). One of the most important issues is the effect compensation has on government activity. On the one hand, requiring compensation can be beneficial if it forces the government to recognize the costs that its actions impose on private parties. Compensation can also facilitate the adoption of desirable actions that would otherwise be blocked by the political opposition of potential losers. On the other hand, requiring compensation can prevent the adoption of desirable actions, particularly if the administrative costs of paying compensation are high.

A second non-equity issue that must be addressed is the effects compensation has on the behavior of private parties. One consideration is that compensation may either aid or inhibit desirable productive activity. For example, businesses may only undertake the expensive development of a new pesticide if they know that their costs will be reimbursed should the government later decide that the pesticide is too hazardous and ban it. Conversely, it may be true that businesses will only insure that a pesticide is safe if they know that any losses from developing a hazardous pesticide will go uncompensated. Which of these countervailing effects predominates will vary from one situation to another.

COMPENSATION MECHANISMS

There are a number of ways compensation could be provided for capital losses in the CBP, if such compensation were justified. Some of these ways use monetary transfers while others do not. One monetary approach is to use revenues from selling water to electricity producers to compensate farmland owners. In that way, the beneficiaries of the government's action compensate those who lose. This is feasible because the beneficiaries will still be better off as a result of the action since the value of the water they get is $963 million. Total capital losses suffered by farmland owners (and hence compensation) would be only $912 million. Another approach is to allow farmland owners to claim capital losses as deductions from taxable income or as tax credits. A third is to use government debt. Government securities that have a face value equal to the capital losses being compensated could be given to farmland owners. Alternatively, these securities could be sold on the open market, with the revenues collected being paid to farmland owners. This approach could be combined with the first by using revenues from the sale of water to electricity producers to pay off the securities.

There are also a couple of nonmonetary ways of dealing with capital losses in the CBP. One would be to simply delay the irrigation water price increase. This would reduce farmland owners' losses but would also reduce the benefits enjoyed by electricity producers and consumers. A better approach would be to enact legislation giving irrigators legal title to the amounts of water they currently use, which they could then sell to electricity producers. The desirable transfer of water to its more highly valued use would be made while farmland owners would simultaneously receive compensation from the beneficiaries of the transfer. Because of these advantages, we think this would be the best compensation approach in the case study situation. Its only disadvantage is that farmland owners might be overcompensated by $51 million, the difference between the $963 million they would get from selling water to electricity producers and their total capital losses of $912 million.

There is one consideration, however, that may lessen our concern with overcompensation. Our estimate of potential capital losses in the CBP is similar to loss estimates made in situations where compensation is presently given for government actions, such as eminent domain. Loss and compensation estimates are based on the decreased market value of private property affected by an action. It is often true, however, that owners value their property higher than the market does. If owners lose their property because of some action, their estimate of their loss will exceed an estimate based on market value. Compensation, as it is usually estimated, would be inadequate. Such may be the case for some farmland owners in the CBP, such as those who would be put out of business by the water price increase. To the extent that such problems exist we would be less concerned with the possible "overcompensation" associated with giving irrigators legal title to the water they use.

GENERAL GUIDELINES

As requested, we also developed general guidelines for the Congress to use in a variety of capital loss situations. We studied current judicial and political arrangements that deal with losses and compensation to determine their adequacy. We also examined the effects of compensation on potential recipients' behavior, the adequacy of existing compensation measures, and the considerations determining whether capital losses should be compensated. The guidelines such as the public policy equity goals from the case study discussion are all relevant to the general case, so we need not repeat them here. Some other general considerations do, however, warrant discussion.

Our examination of judicial remedies for government created capital losses led us to conclude that, although they have some merit, they would not apply in many situations. For someone who suffers a government created capital loss to get relief through the courts, the government must have legally taken property. Legal conceptions of "takings" and "property" exclude many types of losses, such as those that would occur in the case study situation. By increasing the price of irrigation water, the government would not be interfering with the property rights of farmland owners. Even though the value of their farmland would have decreased, owners would still be free to use it in any way they chose, exclude others from using it or sell it. Because these elements of property rights would be unaffected by the water price increase, the resulting capital losses could not be legally considered takings of property. So, farmland owners and others who suffer capital losses from user charge increases could not turn to the courts for relief.

Even when government created capital losses fall within the courts' jurisdiction, there is no guarantee that losses will be handled consistently. The courts have been criticized for (among other things) defining takings too narrowly, applying legal precedents inconsistently, and considering situations ad hoc.

Some people might argue that the political process adequately compensates for capital losses by bestowing offsetting benefits on those who suffer losses. This argument is questionable, however, because the benefits conferred on people by government activity are usually small relative to highly concentrated losses. For example, farmland owners in the CBP are affected by many government actions, particularly those relating to agricultural policy, such as price supports, deficiency payments, set-asides, etc. They are affected less directly by other actions: international trade agreements, changes in welfare coverage, national defense, etc. They receive benefits from some of these actions. It is very unlikely, however, that these benefits would be sufficient to offset the $912 million in losses that the CBP farmland owners would suffer as a result of the government's increasing the price of irrigation water. These losses are simply too large relative to any political windfalls that we could reasonably expect to occur either by chance or by design.

There are a number of ways to provide compensation directly, all of which involve legislative action and some of which the Congress has used when government actions caused losses. When justified, compensation can be provided by discrete legislative actions that address only one particular type or instance of loss. When future capital losses are possible, but as yet undetermined, they can be provided for in open-ended legislation. Discrete actions have been used by the Congress, either in the form of private bills that identify compensation recipients by name or in public bills that simply identify classes of businesses or classes of people who are eligible for compensation. Both discrete and open-ended actions can be either specific or general. Specific actions provide compensation for losses caused by particular, identifiable government actions, such as the banning of a registered pesticide because it is a health hazard. Losses from just such a ban were covered by an open-ended, specific legislative action. There are no examples (in the United States) of general statutes that would compensate losses resulting from broadly defined types or classes of actions, such as the government's granting a permit and later revoking it.

The capital losses identified in the case study could be compensated by a discrete, specific public bill, assuming compensation were justified. The losses can be accurately calculated and are caused by one, identifiable government action. Potential recipients are too numerous to mention by name, however. Obviously, other situations could call for different types of legislative remedies.

Open-ended statutes offer the best solution to the capital loss problem. The drawback of discrete legislation is that it is an *ad hoc* approach to a general, ongoing public policy problem, and *ad hoc* approaches are inefficient. A better approach would use open-ended legislation to deal with capital losses as a regular part of the legislative process. Such legislation could specify the criteria justifying compensation and the types of compensation available in different situations. This approach forces the government to recognize the potential costs of its actions before the fact rather than after. It also gives the government greater flexibility to correct undesirable situations by inhibiting the creation of potential capital losses in the first place. Thus, had farmers in the Columbia Basin Project always known that the price of irrigation water could be increased at any time (like private sector prices) then the present subsidy would not have been completely capitalized into land values. The government would be better able to sell irrigation water on the open market because farmers would have invested less (perhaps nothing) in the continuation of artificially low water prices.

CONCLUSION

As a result of our review of existing methods for dealing with capital losses, it is our opinion that the guidelines developed in this study will be useful to the Congress and Federal agencies. Capital losses are a widespread public policy problem that would benefit from more active and systematic attention by policymakers. The situation addressed in our case study is but one instance of the problem. As you requested, we did not obtain agency comments regarding either this case study or the general guidelines we present. If you have any questions or comments about our findings we would be glad to discuss them with you at any time.

Sincerely yours,

Morton A. Myers
Director

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RESULTS OF CASE STUDY ANALYSIS

INTRODUCTION

The capital loss problem identified in the request arises because expected future income accruing to asset owners is "capitalized" in an asset's market value. This means that investing this market value at current interest rates would yield an annuity equal to the expected flow of income. When a user charge increase reduces asset owners' expected future incomes, capital losses result. 1/ One such user charge is the price of irrigation water. An increase in this price can decrease farmers' expected future incomes and, hence, the market value of their irrigated farmland.

The creation of capital losses by government actions is not limited to user charge policy. For example, enforcing anti-trust policy changes the value of shares stockholders own in different firms. Regulatory changes in the airlines and in trucking create gains for some firms and losses for others. Changing tax laws can raise or lower asset values. Urban renewal and highway construction affect asset values beyond that of property taken under eminent domain. Enforcing health and safety regulations and even busing have been cited as changing capital values. 2/

Examining the case study

An irrigation project is a good choice for showing how increases in user charges cause capital losses and how resulting compensation issues can be resolved. The efficiency and equity issues, methods for estimating capital losses, and alternative compensation mechanisms that are demonstrated in the case study are all applicable to other user charge/capital loss situations. The water price changes and compensation payments are purely hypothetical, however, with no recommendation for or against them. The case study is also a good context for making some of the abstract concepts associated with capital losses and compensation more concrete.

Efficiency and equity issues

Changing irrigation pricing practices in a way that would create capital losses can probably be justified. For one thing, present pricing schemes appear to be inefficient. Water use is charged for by acre rather than by unit of water, because water revenues are partly intended to repay irrigation project construction costs, which are allocated by acre. (88:27)* This

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1/All footnotes can be found at the end of this appendix.

*All sources appear in appendix III. The first number in parentheses corresponds to the source's number in the appendix; the second number is the page number.

kind of pricing scheme does not encourage the efficient use of water. For another, irrigation water prices are probably too low, because water revenues do not cover the government's cost of constructing the projects and because the opportunity cost of irrigation water (i.e., its value in some alternative use) is, in some cases, higher than the charge irrigators pay. Economic efficiency would be improved if prices were allowed to allocate water to its most valuable uses. 3/

These inefficient pricing schemes suggest another good reason for analyzing irrigation projects. The efficiency gains from a water price change would be greater than the capital losses, since water is valued more highly in uses other than irrigation. Because of this, the gainers could fully compensate the losers and still be better off from the change. The amount by which they would be better off is the price society now pays to maintain the original goal of Reclamation policy--to subsidize and promote small family farming. Allowing CBP irrigation water to be diverted to electricity production constitutes a decision that this goal is not being fulfilled to an extent sufficient to justify its costs.

The case study also gives us the opportunity to analyze a number of equity questions. Changing irrigation water prices would raise several issues, especially since farmers purchase their land expecting that the existing pricing scheme will continue. (70:933) Questions of horizontal, vertical, and transition equity are all involved. 4/

A general definition of horizontal equity, sometimes seen as an element of due process, is that "equals should be treated equally." (120:70, 121:293) Horizontal equity relates to capital losses created by government actions in two ways. It can concern only people who are affected adversely by an action; it is violated if one is hurt more than another although both had been in the same initial welfare (wealth) position. (50:334) It can also compare the effect of an action on one who is harmed with the effect on one who benefits; it is violated if a loss is imposed on one in order to benefit another.

Vertical equity has to do with the distribution of capital losses to people with different wealth endowments. Usually, it is thought to be seriously violated when capital losses are concentrated more heavily on individuals with little wealth. Such losses are viewed either in absolute terms or in terms proportional to people's wealth. Higher proportional but lower absolute losses among the relatively poor can violate vertical equity.

Transitional equity has to do with "entitlements to certainty that pre-existing rights and endowments sanctioned by a social contract will continue undiminished." (56:322) The basic issue is the fairness of losses to some when the community changes its rules and institutions. Central to the principle of transitional equity is the expectation that existing rules ("rights and endowments") will continue. Changes that asset owners can foresee and account for do not violate transitional equity, but unforeseeable and therefore unexpected changes do. This, of course, raises the difficult problem of distinguishing foreseeable from unforeseeable changes. 5/

Description of the project and our analysis

To perform our case study analysis, we chose the Columbia Basin Project (CBP) in Washington State. This project was initiated in 1933 with funds allocated under Title II of the National Industry Recovery Act and is located primarily in Adams, Franklin, and Grant counties. The CBP encompasses almost 2.5 million acres, 1 million of which may receive authorized irrigation water. At present, slightly more than half a million acres are irrigated.

In 1933, the CBP was the largest U.S. reclamation project that had ever been undertaken. When the first project water was delivered in 1948, 586 acres were irrigated. There were many large holdings of nonirrigated land of 1,000 to 3,000 acres. Latest available data show that only about 20 operations are larger than 1,000 irrigated acres and about half of the landholdings are smaller than 160 acres.

In 1973, about 65 percent of all operations were small family farms and there were no operations owned by outside corporations. Now, most of the largest farm operations in the CBP are incorporated or owned jointly by unrelated partners. Those that are owned jointly by family members are smaller, and those that are individually owned are smaller still. Leasing is widespread throughout the project.

Revenues from water charges do not cover the government's cost of constructing the Columbia Basin Project. According to 1978 data, landowners currently repay about $131 of a total construction cost of about $1,500 per acre. The landowners are subsidized because they repay construction costs without interest over a 50-year repayment period that does not begin until they have been using the water for 11 years. 6/

To analyze the effects of alternative irrigation water pricing schemes on the expected future net incomes of farmers in the CBP, we used a capitalization model to translate income decreases into decreases in farmland values--that is, capital losses. We estimated these losses for all farming operations in the CBP. We made less rigorous estimates for the capital losses that particular groups would suffer within the project.

Using a linear programming model, we first estimated the net returns to farmland in the CBP and then estimated net incomes under alternative water pricing schemes, allowing for the fact that farmers could partially offset higher water costs by changing crop mixes and irrigation techniques. We gathered data on past land sales to estimate the degree of capitalization of project benefits into land values. Using this degree of capitalization, we translated the discounted present value of income reductions into farmland value decreases--that is, potentially compensable capital losses.

A broader view of capital losses

The case study addresses one instance of a broad public policy problem. Our analysis is expanded to encompass a number of areas of government actions besides user charges, and general conclusions are drawn on how capital losses have been handled and how public policy regarding losses could be improved.

The creation of capital losses by government action deserves congressional attention. Adverse equity and efficiency outcomes are likely to be substantial if we merely let losses fall where they may or allow public policy to be biased by political opposition because of the potential for uncompensated losses deriving from a particular policy decision.

Our discussion of the broader view of capital losses provides a general background for this issue and is intended to provide a framework for whatever action the Congress may choose to take. We do not argue for more compensation of capital losses, nor do we argue for less. Any policy that may be developed for dealing with capital losses should reflect a similar objectivity. At the same time, however, it should be recognized that compensating for capital losses generally does not increase the cost to society of any government action. For the most part, compensation simply redistributes existing costs away from some asset owners and onto others.

THE CASE STUDY

This section presents our case study analysis. We begin by describing alternative methods for estimating capital losses and the linear programming approach we used in this analysis. This approach was necessitated by various practical considerations, the most important being the cost of collecting the data needed to use another method. The linear programming approach also provides flexibility in representing the farmers' responses to changes in the price of irrigation water.

We next apply equity and efficiency criteria to determine the compensability of capital losses that would be created by increasing the price of CBP irrigation water. Most of our capital loss estimates address the horizontal equity criterion. We show how losses would vary by land class, size of operation, and form of ownership.

We address the vertical and transitional equity criteria qualitatively but perform additional calculations to determine compensability under the criterion of economic efficiency. Our estimates indicate that the benefits of increasing water charges in the CBP would outweigh the corresponding capital losses.

Finally, we describe alternative compensation mechanisms and suggest which would be most useful in the case study situation. The preferred methods involve government borrowing and cash payments, revenues from the sale of irrigation water, and the transfer of water titles to present users. The advantages and disadvantages of these mechanisms are discussed in relation to the case study.

Methods for estimating capital losses

Capital losses from an increase in the price of irrigation water in the CBP can be measured in three ways, only one of which we used in our analysis. The two that we considered but did not use--the comparable sales method and the "before and after" test--are similar in their data requirements, but they are also alike in being prohibitive, for reasons we will explain. Therefore, we adopted the capitalization method.

In the comparable sales method, the market value of a property affected by government action is determined by the prices at which similar properties sell. It is most useful when the action completely destroys the property value. 7/ Had we used this approach in the case study analysis, we would have compared the market values of properties in the CBP with the market values of similar properties outside the CBP. Land values are higher within than without the CBP because of irrigation water and its associated subsidy. By comparing sales prices of similar properties, we could have estimated the differences traceable to irrigation and, hence, the capital loss that would result from an increase in water price. 8/

The "before and after" test also estimates the effect of government actions on property values by observing market price differences. Rather than using comparable properties at the same point in time, however, it depends on observations of the values of the properties before and after the action. Changes in values measure the capital losses. The drawback of this approach, as with the comparable sales method, is that it requires an active market in the assets in question. Price observations must be continuously available, as on a stock market, if the price differences are to accurately reflect the effect of government actions. 9/ Infrequent sales make it difficult to isolate the cause of price changes. Many things besides government actions affect asset values, and over time they can mask the effect of a government action. Measuring compensable losses by this test is impossible in such circumstances.

From our survey of data sources in the CBP, we decided that the costs of using the comparable sales method of estimating capital losses would be too high for the case study exercise. We decided not to use the "before and after" method because no changes in water prices have actually been put into effect. Even if they had been, land sales in the CBP probably do not occur often enough.

The capitalization method for estimating capital losses can be applied to income producing properties like the farmland in the CBP, and we used it. First, we calculated changes in future annual incomes accruing to property owners because of the government action--in this case, changing irrigation water price. The property owner's capital loss is then simply equal to the discounted present value of the future income changes. 10/

The calculations were performed in a linear programming model that represents the behavior of a typical farmer in the CBP. It is a system of equations which, given the price of irrigation water and other variables, is solved to determine the farmer's net income and the returns received on farmland ownership. Returns to farmland change as the price of irrigation water changes. In the process, the typical farmer maximizes his/her net income by altering crop mix and irrigation techniques. The linear programming model mimics the behavior that actual farmers would display if irrigation prices were changed. It is explained in more detail in appendix II.

Potentially compensable capital losses in our case study may be underestimated for two reasons. First, our capital loss estimates are based on the market values of income producing farmland and, hence, do not include nonmarket values that the people in the CBP have attached to their property. Some farm owners do not even consider selling their land regardless of market prices, for various personal reasons. Some estimate of nonmarket values might be made, but the information requirements are beyond our scope. (86:590-91) Second, if the capitalization of irrigation benefits into land values were incomplete, we would further underestimate compensable losses, although indications are that this is not a significant problem.

Compensability in the case study

Because irrigation water in the Columbia Basin Project is sold under contract, increasing its price would constitute breach of contract and, therefore, there is no question that compensation would be legally required. Consequently, in analyzing the case study, we have abstracted the equity, efficiency, and other compensability considerations from the CBP contracts. These considerations apply to similar situations in which contracts do not exist. Increasing user charges for inland waterways would be an example.

Equity considerations

Determining compensation for capital losses in the case study could address horizontal, vertical, and transitional equity.

Horizontal equity would pertain if the various land classes, forms of ownership, and tenure arrangements were affected differently. Vertical equity would arise if the burden of capital losses were to vary by size of farming operation. In our loss estimates, we address these concerns. Answering transitional equity questions, however, does not require numerical estimates of capital losses.

Compensation intended to achieve horizontal equity can do so by maintaining relative wealth positions among farmland owners and restoring their positions relative to those who gain from a diversion of irrigation water to hydropower production. Maintaining relative welfare positions among farmland owners requires identifying the sufferers of the different capital losses created by a change in the price of water. Capital losses will not be the same for all landowners because decreases in land values will differ by quality of land and size of farming operations and because the effects on landowners' wealth will differ by form of land ownership (whether incorporated or unincorporated) and by tenure arrangement (whether farmland is leased and, if so, how much and on what terms). For these reasons, horizontal equity is likely to be violated if capital losses resulting from an increase in the price of water are not compensated for or if a uniform amount of compensation per acre is awarded to all losers.

Land values vary in the CBP because of differences in rainfall and, incidentally, soil quality across the project. Areas that are sandy, shallow, and steep tend to have less rainfall and, thus, lower value than other areas in the CBP. These differences exist whether or not water is available, but the differences are diminished by irrigation. The narrowing of land value differences has been particularly fostered by recent advances in irrigation technology, like the center pivot system, that make farming possible on land of poor quality.

This is important for compensation analysis because it causes the owners of lower classed land to experience greater capital losses as the price of water increases. When land values fall as water price increases, farmers convert to dryland farming (i.e., they do not irrigate but rather rely solely on rainfall). Land that is of better quality with greater rainfall will be of higher value under dryland farming than land that is of poorer quality where rainfall is lower. Operations on land of poorer quality find it economical to continue buying irrigation water at higher prices because the value of what they can produce under dryland farming is relatively low. Any water price increase above that just sufficient to convert areas of high quality to dryland farming will lead to different capital losses across land classes. The differences in loss will become more pronounced as the price increases, with the greatest difference occurring at the price that converts all land to dryland farming.

We have calculated capital losses for three land classes in the CBP under the case study condition that irrigation water is priced at its value in hydropower production--$3.33 per acre-inch--causing all areas to convert to dryland farming. 11/ We have also used the linear programming model's result that farmers convert to dryland wheat farming when the price of irrigation water reaches $1.75 per acre-inch. This is associated in the model with a dryland value of $492 per acre, which we assume represents Class 1 land. Finally, all irrigated land is assigned a current value of $1,980 per acre, as estimated by the model. (This somewhat overstates capital loss differences, but it is necessary because of data limitations and does not invalidate the analysis.) Given the relative dryland values observed in 1978 (see table 1 and table 8, which is in appendix II), we find that these conditions lead to the estimates shown in table 2. Horizontally equitable compensation would have to recognize these different capital losses by land class.

Table 1

Land Values by Land Class in 1978

Land class	Raw land value per acre	Land value as a % of class 1
1	$290	100
2	280	97
3	150	52

Table 2

Estimated Dryland Values and Capital Loss by Land Class

Land class	Land value without irrigation water per acre	Capital loss per acre
1	$492	$1,488
2	477	1,503
3	256	1,724

Capital losses might vary also by size of farming operation. One study of irrigation benefits found that larger farming operations receive greater benefits per acre than smaller ones because of economies of scale in irrigation farming, as shown in table 3, which we have adapted from that study. (43:148) If this is also true in the CBP, then a water price increase could cause greater capital losses per acre in large operations than in small ones. With irrigation, land values will be higher in the large operations than in the small ones, but they will be the same without it. If irrigation water in the CBP were priced at its opportunity cost, all operations would convert to dryland farming and different capital losses would result.

Table 3

Direct Irrigation Benefits by Acre for Non-CBP Farmland

Number of irrigable acres	Direct irrigation benefits per acre
1-80	$280
81-160	660
161-240	670
241-320	700
321-400	700
400+	720

We have estimated how capital losses in the CBP might vary by operation size if water were priced at its opportunity cost of $3.33 per acre-inch. The average farm size is estimated to be 160 acres and to have a land value with irrigation of $1,980 per acre. Land values without irrigation are estimated at $273 per acre for all operation sizes. Operations of different size are assumed to have the same relative irrigated land values as were found in the aforementioned study. We used these relative land values for non-CBP farmland (table 3) to estimate "irrigation benefits as a percentage of average size" for CBP farmland (table 4). Since the average farm size in the CBP is 160 acres, we first had to estimate the direct irrigation benefits per acre for that size farm from table 3. Simple interpolation yielded $665. Dividing direct irrigation benefits for each size class by $665 yielded irrigation benefits as a percentage of average size. Assuming these percentages applied to the CBP, we multiplied them by $1,980 to estimate the irrigated land value for each size class shown in table 4. Capital losses per acre were then calculated by subtracting $273 from these values.

Table 4

Estimated Capital Loss by Operation Size in the CBP

Number of acres	Irrigation benefits as a % of average size	Irrigated land value	Capital loss per acre
1-80	0.42	$ 832	$ 559
81-160	0.99	1,960	1,687
161-240	1.01	2,000	1,727
241-320	1.05	2,079	1,806
321-400	1.05	2,079	1,806
400+	1.08	2,138	1,865

Our estimates are based on the assumption that land classes are distributed uniformly across farming operation sizes. In the

CBP, however, the smallest farms tend to be located on the best land, exacerbating the relationship between capital loss and operation size. That is, smaller operations will experience smaller relative capital losses because of their size and also because they have land of higher quality. Horizontally equitable compensation payments would have to account for both.

Maintaining relative welfare positions among landowners who suffer capital losses also requires recognizing their different ownership and tenure arrangements. Information and budget constraints prevented us from estimating for these. An important consideration in making such estimates is the ability of the landowners to pass their losses on to others, such as tenant farmers. Estimating how much they may thus mitigate capital loss requires knowing the local markets in a way that is beyond the scope of our study. We can, however, discuss some of the factors that could create different effects, and we can estimate direct capital losses for different ownership and tenure arrangements.

Table 5 presents estimates of total capital losses that would accrue to land held in various forms of ownership. The estimates are based on the distribution of land by ownership category in the East Columbia Basin district which, for lack of more data, we apply to the entire CBP. (114:table 19) In table 5, we have assumed an estimate of total capital losses of $912 million. Associating capital loss directly with acreage owned, we find that almost the entire burden of an increase in irrigation water price in the CBP would fall directly on individuals and families. The amount of farmland under incorporated ownership is relatively low.

Table 5

Capital Loss by Form of Ownership

	% of capital losses a/	Capital loss
Individually owned	10.8	$ 98,496,000
Owned jointly with spouse	74.5	679,440,000
Family multiple	11.3	103,056,000
Trust	1.3	11,856,000
Nonfamily multiple		
More than 10	0.3	2,736,000
Fewer than 10	1.1	10,032,000
State or local government	0.4	3,648,000
Nonprofit	0.2	1,824,000

a/Equal to percentage of acreage owned.

Table 6 shows the relationship between capital loss and tenure arrangement. The data on the percentage of operated acres leased by irrigable acre are for the East Columbia Basin district, although we have assumed them to be applicable to the entire CBP.

(114:table 3) For each acreage category, the percentage of capital losses is assumed to be equal to the percentage of total acres. Capital loss estimates are based on landowners' bearing the full burden of increased irrigation water prices. The table shows that almost one-fourth of all capital losses accrue to small operations, where relatively little land is leased. Larger operations, where leasing is more prevalent, have proportionally smaller losses. For operations of intermediate size, the relationship between leasing and capital losses is mixed.

Table 6

Distribution of Capital Losses and Leasing by Operation Size

Number of irrigable acres	% of operated acres leased	% of capital loss
1-160	15.3	24.0
161-320	31.5	32.1
321-640	53.1	27.3
641-960	42.4	
961-1280	14.1	16.6
1280+	65.0	
	37.3	100.0

All that this information tells us is that capital losses are greatest where landowners are least able to pass increased water costs on to tenant farmers. Whether or not different capital losses among landowners will actually result from different degrees of cost-shifting depends on the local market for leased farmland. In general, tenants will bear a higher proportion of the costs--and, thus, capital losses will be lower--as the price elasticity of demand is lower in the market for leased land and the price elasticity of supply is higher. Increased water costs will be translated more fully into capital losses if these elasticities are high and low, respectively.

The effect of increased water prices will also depend on specific leasing arrangements and the nature of water charges. Under a crop-share lease, which is most prevalent in the CBP, with water priced as a fixed charge the landlord may absorb a greater share of an increase; at the other extreme, tenants may bear a greater share under cash-rent leases with water as a variable cost. Since we do not have information on this market, we do not know if capital losses would vary across landowners as a result of different degrees of leasing. Horizontally equitable compensation payments would have to account for this possibility, however, just as they would have to account for differences of land quality, operation size, and form of ownership.

Horizontal equity is also concerned with restoring the relative positions of gainers and losers. People and firms who consume hydroelectric power and use water for recreation would gain from an increase in the price of irrigation water. Their evaluation of the additional power and recreation services produced by water diverted from irrigation would exceed their associated payments. Restoring their initial positions relative to those who suffer capital losses could be achieved by the gainers financing the compensation payments. For the case study, we discuss this under efficiency considerations in the next section and in the section on alternative compensation mechanisms (pp. 40-41). In principle, horizontally equitable compensation payments of this kind are called for in the case study, because the argument for the justifiability of a price increase is that water is more valuable in uses other than irrigation. Pricing water at its opportunity cost would allow others to benefit by its diversion from the CBP. If the principle that "beneficiaries should pay" holds true, then they should compensate the losers.

Compensation designed to achieve vertical equity would improve the positions of the less wealthy landowners in the CBP relative to their more wealthy counterparts. For the more wealthy landowners, compensation payments would decrease relative to capital losses. Unfortunately, information on the relative wealth of landowners in the CBP was not available to us, and we have not been able to estimate the relationship between capital losses and their wealth or to determine compensability under the vertical equity criterion.

Whether or not capital losses warrant compensation on the basis of transitional equity depends on the reasonableness of irrigators' expectations that existing water prices will remain the same. By purchasing water at existing prices, farmers are not acting contrary to the public interest, and they have no reason to expect a price change on public interest grounds. Consequently, the determining factor for compensability would be the extent to which government actions foster the belief that water prices will remain unchanged. Aside from water contracts, nothing in the government's behavior would foster an expectation of constant price. The price of irrigation water is no different from the price of any privately supplied product. Price increases in the private sector are not viewed as being inequitable disappointments of consumers' expectations, and the same standard should apply to publicly supplied products. Hence, compensation on the basis of transitional equity is not called for if prices for public products behave the same way as privately set prices. 12/

Finally, whether or not capital losses warrant compensation depends upon when owners made their purchases. If landowners in the CBP bought their farmland before the irrigation subsidy was capitalized into land values, then they benefited from this subsidy. Decreasing their land values by increasing the price of irrigation water does not constitute a true capital loss for these landowners, so compensating them is difficult to justify.

This is not the case, however, for landowners who bought after the irrigation subsidy was capitalized into land values. They paid for this subsidy when they bought their land and suffer losses when the subsidy is eliminated and their land values fall. While this distinction between original and subsequent landowners is important for determining compensability, we could not obtain the requisite land sale information in the CBP.

Efficiency considerations

Economic efficiency is concerned with allocating society's productive resources in a way that increases well-being as much as possible. Doing this requires adopting only actions whose benefits exceed their costs. Capital losses may mean that government activity is inefficient in one of two ways. First, ignoring capital losses can lead, in some cases, to government actions that are inefficient or pursued inefficiently. For example, changes in zoning laws that do not account for their negative effects on property values can be inefficient. Second, the possibility of capital losses can prevent the adoption of actions that would be efficient. For example, a change in irrigation prices might be efficient but avoided because of an associated capital loss.

Increasing the price of irrigation water would be justified if it helped divert water to more highly valued uses, like hydropower production. Our case study and other indications support the view that CBP water is more highly valued in other uses. (123:25) This assessment ignores any "public benefit" that may be derived from maintaining CBP farming operations since there is no way to assign a value to such benefits. If the diversion of water to hydropower production did occur, compensation would probably be useful as a means of insuring that new users would benefit more than irrigators would lose. This would occur if new users were to finance the compensation.

The value of water in hydropower production in the Pacific Northwest is approximately $3.33 per acre-inch, which, according to our case study model, exceeds the value of water in irrigation. In all the scenarios we tried for the model, the average farm operation did not purchase irrigation water when it was priced at its opportunity cost. In fact, in all cases but one the net returns to land from irrigation farming became negative at water prices higher than $2.50 per acre-inch.

Table 7 presents the results of the most likely scenario. The results depend on the following assumptions--that no water is used in irrigation at prices higher than $2.50 per acre-inch, that the value of irrigated land at the present price of water ($0.33 per acre-inch) is $1,980 per acre, that the value of farmland falls to $273 per acre as the price of water rises, that the discount rate for capitalizing the value of water diverted from irrigation to other uses is 10 percent, and that the value of all water diverted to other uses is $3.33 per acre-inch. Given

Table 7

Capital Loss and the Capitalized Value of Water Diverted from the CBP

Water price per acre-in.	Land irrigated 1,000 acres	Irrigation water in. per acre	Land value per acre	Capital loss per acre	Capitalized value of diverted water
$0.25	534	55.2	$2,043	$ --	$ --
0.33	534	54.2	1,980	--	--
0.50	534	52.0	1,875	105	73
0.75	534	52.0	1,711	269	73
1.00	534	48.9	1,407	573	176
1.25	475	47.6	1,103	877	219
1.50	475	47.0	799	1,181	240
1.75	475	47.0	492	1,488	240
2.00	475	43.0	415	1,565	373
2.25	475	39.7	336	1,644	483
2.50	475	39.7	273	1,707	483
$3.33	0	0	$ 273	$1,707	$1,805

these conditions, the total capitalized value of water diverted to new uses is $963 million, while total capital losses in the CBP are $912 million, although our analysis of capital loss by land class indicates that total capital losses would be less than this, at $893 million. 13/

All this indicates that pricing irrigation water at its opportunity cost promotes economic efficiency. New users who buy the water could compensate losers completely and still be better off. This may not be what happens, however. The value of water in other uses represented in these calculations is the present price water would sell for if it were sold on the open market, but it is possible that not all the water diverted from the CBP would be worth this much. The value of additional water could fall as more water was diverted, causing its total capitalized value to be less than $963 million. Consequently, compensating capital losses is justified on grounds of efficiency if the intention is to insure that the contemplated price change is, in fact, economically efficient.

An additional consideration that justifies compensation payments is that they facilitate the adoption of the potentially efficient increase in the price of irrigation water. Political opposition to a price change would be reduced if all capital losses were compensated. The only efficiency argument against compensation would be the administrative costs of measuring individual losses and making payments. We have not estimated these costs, but they are likely to be small relative to the probable efficiency gains of a price change. On balance, compensating capital losses would be justified on efficiency grounds.

Additional considerations

That farmers in the CBP might mitigate their own losses is a possibility that must be recognized in estimating capital losses if overcompensation is to be avoided. The possibility of landowners reducing their capital losses by passing higher water costs on to tenants has already been discussed. (See also 18:17) Farmers in the CBP would be unable to pass higher water costs on to consumers because they cannot influence the market priccs of the agricultural products they sell. They could offset higher water prices in other ways, however. They could switch to crops that use less water than the crops they currently grow. They could alter their irrigation methods to use water more efficiently. The case study model, specifically designed to account for such operational changes, indicates that the average farmer would make adjustments to rising water costs in order to maximize net income. This is shown by the fact that as water prices rise, the reduction in net returns to land are less than the associated increase in water expense.

It appears that, on balance, compensating the capital losses that would occur in our case study is justifiable. Horizontal equity could be violated by not compensating. Different landowners could experience capital losses of varying intensities, and compensation would be called for to restore their initial relative welfare positions. Compensating landowners could also restore their positions relative to water users who would gain by an increase in the price of irrigation water. Having this group finance compensation would also help insure that the price increase was economically efficient. In addition, the compensation would facilitate the adoption of the efficient action because the political opposition of the landowners in the CBP would probably be reduced.

Compensation mechanisms

General tax revenues obviously provide one means of paying compensation. Others may be monetary or nonmonetary. Monetary mechanisms are either tax related--as in benefit charges and tax write-offs--or involve the use of government debt. Nonmonetary mechanisms use delay or award property rights.

Monetary mechanisms

Benefit charges place part of the burden of financing compensation on the people who benefit from a government-created loss and are justified on the grounds of horizontal equity. (48:99, 65:787, 122:57-58) The amount of compensation that is financed by a benefit charge should equal the total value of benefits that accrue to the identifiable beneficiaries of the government action. The balance (less than or equal to the "public" benefits) should be financed by general tax revenues or perhaps by some other mechanism. (49:320)

Tax write-offs constitute another compensation method. Capital losses can be compensated for by allowing them to be claimed as deductions from taxable income or as tax credits. This method has precedent in congressional attempts to ameliorate government-created losses. It has been used for compensating for capital losses resulting from motor carrier regulatory reform. 14/

Another monetary means of compensating for capital losses uses government debt. Government securities can be given directly to the people being compensated or they can be sold on capital markets, the compensation being paid from the revenues that are thus raised.

Nonmonetary mechanisms

One way of reducing capital losses from a government action is simply to delay the action. This works because losses that are pushed farther into the future will be more heavily discounted in the capitalization process. The method has been suggested in connection with both tax reform (38:128, 39:98-99) and regulatory change. (1:58-59, 98:52-53)

Nonmonetary compensation may also be made by awarding property rights. That is, a government action that creates a capital loss by destroying or impairing property rights may redress the loss by awarding other, similar rights in compensation. For these rights to be of value to the recipients, however, there must be an active market on which they can be traded. If none exists, the government may have to create one.

One example lies in the suggestion made in a study of water use in California that efficiency could be promoted by allowing farmers to sell the title to use their water allocations. Water districts would have to create a market in water property rights by providing ultimate users with clear titles to the water use. Also, prohibitions against water transfers would have to be removed. (80:IX; see also 9:191-93, 24:1055-56, 91:348) This scheme, intended to promote efficiency rather than to compensate farmers for lost water rights, would actually do both.

Choosing the appropriate mechanism

In the CBP, a benefit charge as a monetary approach to financing compensation might be used as horizontally equitable and economically efficient. It would not be used in the form of an excise tax added to the price of water sold to hydropower and other users. Instead, the actual revenues generated by such sales would be used. It is likely, however, that this mechanism could not be used alone. Because the revenues generated from water sales would accrue over time while the capital losses requiring compensation would be immediate, the benefit charge would have to be used in conjunction with some other mechanism that could cover present capital losses.

Tax write-offs could be used to provide compensation to the farming operations that remained in business after the water price increase. These would be primarily operations on high quality land that is well suited for dryland farming. As we showed earlier (see pg. 21), they would probably be the smaller operations and suffer the smallest capital losses per acre. Tax write-offs would be useless, however, for landowners bankrupted by a water price increase. Decreases in net returns caused by a price increase would immediately decrease farmers' annual cash flows. (We show this in appendix II.) Since this could hinder their ability to meet their debt obligations, some landowners might have to sell. Given this possibility, tax write-offs would probably not be a good compensation method in the case study situation.

Government debt could be used as a method in lieu of general tax revenues. Revenues generated by water sales could be used to finance this debt. This combination has much to recommend it, in terms of both horizontal equity and economic efficiency.

Among the two nonmonetary compensation mechanisms, delay is not a good choice in the case study situation. Increasing the price of irrigation water would be justified only by the excess of gains over losses generated by diverting water to more highly valued uses. The present value of these net benefits is estimated at $52 million. 15/ This would be reduced by delay, and so would the rationale for any water price increase. Since other useful compensation alternatives exist, if we reject this mechanism we also do not face the possible inequity of imposing uncompensated losses on landowners. The availability of alternative mechanisms further reduces any justification for using delay.

Awarding property rights to the property owners who suffer capital losses is the other nonmonetary compensation mechanism, and in the case study situation it would require transferring title to existing water allocations to present users. (80:IX) They could sell their water allocations on the open market, automatically receiving compensation in return. The one advantage and the one disadvantage are both related to the question of economic efficiency.

As we pointed out in our discussion of efficiency considerations, an irrigation water price increase might not be economically efficient because of uncertainty about the nature of the demand for water on the open market. The uncertainty would not be a problem if water titles were transferred to present users. They would sell their allocations on the market only if the revenues they received were to exceed the value they placed on water in irrigation. That is, only economically efficient exchanges would take place. In the process, landowners would be fully compensated for their capital losses. They would also be compensated for any nonmarket values they attached to their properties. All this constitutes the advantage of this mechanism.

Its disadvantage is that the more economically efficient is the reallocation of irrigation water to other uses, the more likely it is that landowners would be overcompensated for their capital losses. This is because they would retain all net benefits created by the reallocation. However, in the CBP, it is likely that this disadvantage would be outweighed by the advantages of transferring water titles to users. Consequently, awarding property rights is the other of the two compensation methods we prefer in the case study situation.

Conclusions

We conclude from our case study analyses that increasing the price of irrigation water in the CBP would create capital losses and that compensating these losses would facilitate the efficient reallocation of water to more productive uses. Furthermore, compensation would not violate any equity goal.

Also, the awarding of property rights to those who suffer capital losses is a useful compensation mechanism. It simultaneously promotes efficient changes in water use, satisfies equity goals, and automatically provides adequate compensation to those who suffer losses. In fact, it may overcompensate losers, which is the only drawback of this compensation mechanism.

Generalizing from our case study situation, we conclude that government controlled resources can be efficiently reallocated without violating equity criteria. With efficient changes, gainers can completely compensate losers and still be better off. The Congress may want to investigate current user charge policies to identify situations where efficient changes could be made. If so, potential capital losses should be estimated in each situation, and the mitigation of these losses by various compensation mechanisms should be considered. Particular attention should be given to awarding property rights to potential losers.

COMPENSATION: CRITERIA AND ALTERNATIVE METHODS

This section generalizes beyond the preceding discussion. Principles are presented for determining the compensability of capital losses, the amount of compensation needed, and the methods available for providing it without regard to the specific policy change causing capital losses. In particular, we show how the general equity and efficiency principles we defined earlier yield, on closer scrutiny, specific compensability criteria. We also show that self-mitigation of losses and the expense of compensation must be recognized in determining the compensability of capital losses. We delineate the elements of adequate compensation and we discuss several compensation mechanisms. We show why indemnifying people and firms who suffer capital losses from a government action is both equitable and efficient but that the method used most often to estimate compensable losses does not fully indemnify them because it does not count the nonmarket values that owners attach to their property. We also show that monetary and nonmonetary mechanisms for paying compensation can complement or substitute for the mechanism of general tax revenues in a variety of ways. We discuss the advantages and disadvantages of each mechanism.

Principles of compensability

The equity and efficiency considerations discussed in the case study embody general compensability criteria that can be applied to many situations. These general criteria are examined more closely here and are used to delineate the advantages and disadvantages of compensation. Additional considerations, the self-mitigation of losses and the expense of compensation, are also discussed.

Equity considerations

Remarking on how economic reforms inflict losses that generally go uncompensated for, one author has said that "economic progress has accumulated a roll of victims, sufficient to give all sound policy a bad name." (54:711) Similar sentiments have been expressed about more limited instances of loss, as when the elimination of taxi medallion restrictions has been described as inequitable. 16/ Equity statements of this kind may point out the need to examine the effect of public policy actions, but they are not helpful in distinguishing compensable from noncompensable capital losses. To do this, it is necessary to study equity principles closely and develop the underlying compensability criteria.

Horizontal equity--Compensation based on horizontal equity does not necessarily restore individuals to their initial welfare positions, since only relative positions matter under this equity criterion. Compensation can be used to restore initial relative positions among losers. However, equilibrating compensation payments for property taken may vary from recipient to recipient, even if the market value of the properties are the same, because different people value similar things differently. Horizontally equitable compensation must vary correspondingly. (66:248)

The welfare of losers relative to gainers can be maintained if the gainers compensate the losers. This notion is manifest in the argument that beneficiaries of government actions should pay for them, an argument that the Congress has voiced in connection with a number of regulatory actions. 17/ While changes in the position of losers relative to gainers are obvious, changes in relative positions among losers may not be.

Vertical equity--Compensation for capital losses is more justified the smaller is a loser's wealth and the larger is the loss relative to it. The absolute size of the loss is secondary. It is presumed that a person's ability to sustain a loss without compensation diminishes at lower wealth levels and with larger relative losses. Concern for vertical equity has been expressed in congressional discussions of regulatory losses, although the discussions were about businesses rather than individual people. 18/

Transitional equity--Not all uncompensated transitional losses are viewed as being inequitable. The capitalization of expected future income into asset value reflects whatever risk is associated with that income. The greater the risk is that actual income will be different from what is expected, the lower the price of the associated capital asset will be, assuming investors are averse to risk. An investor willing to assume the risk by buying the asset is awarded a higher rate of return in exchange. Consequently, capital losses that do occur are not commonly viewed as unfair.

This is true when capital losses in the private sector result from some market change, as when consumer tastes change. 19/ It would also be true of similar capital losses resulting from government actions. Losses that occur from a policy change are fair if the risk of the change can be incorporated into asset prices. If a policy change cannot be foreseen, however, this discounting of asset prices is impossible, and the associated losses are not fair. 20/ This is because the asset owners bear the burden of the loss without ever having enjoyed the offsetting benefits of reduced asset prices and higher rates of return. Unforeseeable changes violate transitional equity because they impose losses for which asset owners did not and cannot bargain. 21/ Transitional equity, then, is concerned with the foreseeability of government actions--that is, with the reasonableness of expectations that existing rules will remain unchanged. The more reasonable the expectations, the stronger the case for compensation.

The reasonableness of expectations, in turn, comprises two elements. One is the nature of the situation that is changed by government action. If it obviously conflicts with the "public interest" or with some aspect of social policy, then expectations of its continuing are not reasonable. Compensation can fairly be denied for losses that occur in such situations. 22/

The other element of reasonableness of expectations is the degree to which government action fosters the expectation that a situation will continue unchanged. The more actively the government contributes to such expectations, the more justifiable it is to compensate for capital losses created by the government's changing the situation. This aspect of compensability participates in a number of regulatory cases in which people or firms were engaged in some behavior that the government subsequently prohibited. Arguments over compensation for the resultant losses centered on whether the government had required the original behavior, recommended it, or merely allowed it. 23/

In summary, one might say that the reasonableness of frustrated expectations forms the grounds for compensability under the transitional equity criterion. Capital losses are compensable to the extent that the government actions that create them are unforeseeable. This, in turn, depends on the nature of the initial situation and the government's responsibility in creating expectations of change.

A problem with this equity criterion, however, is that its central concepts--the foreseeability of changes, the reasonableness of expectations, the government's fostering of expectations--are vague and subjective. Separating compensable from noncompensable losses on the basis of these concepts requires that arbitrary lines be drawn, in the manner of the judicial "taking" criteria we will describe. Transitional equity can be used to justify compensation practices having widely different degrees of generosity. This does not invalidate the criterion, but it does mean that the criterion should be applied cautiously. Since it will probably continue to be used to determine the compensability of losses, recognizing the elasticity of its concepts would be beneficial. If possible, they should be made more concrete. 24/

A final equity issue concerns whether asset owners made their purchases before or after a government action increased their asset's value. Compensating a capital loss created by reversing this action is justified if owners purchased their assets after their values were increased by the action. These owners did not benefit from the action since they paid for its benefits when they bought their effected assets. This is not true for asset owners who bought their assets before the government action increased their value. The "capital losses" they suffer by reversing the action merely place them back in their initial position. On balance, they have not been made worse off by the government's actions, so compensating them is difficult to justify. Those who pay for a government-provided benefit through higher asset prices are made worse off when the benefit is eliminated, and they suffer true capital losses.

Efficiency considerations

Two considerations of efficiency must be addressed in determining the compensability of capital losses. One is the effect of compensation on the efficiency of government actions; it can help insure that only actions whose benefits exceed their costs are adopted. The second is the effect that compensation has on the incentives of people and firms to minimize the social costs of their behavior. Also of concern is the efficiency trade-off between risk allocation and moral hazard--that is, the insurance aspects of compensation policy. Both sets of considerations contain arguments for and against compensation.

Government actions--Compensating capital losses caused by government actions can improve the government's efficiency in two ways. For one, paying compensation forces the government to recognize the nonbudgetary costs that its actions impose on private parties. When these costs are ignored, inefficient actions can appear to be cost-beneficial and, therefore, worthy of being adopted. 25/

Compensation can also improve government efficiency by facilitating the adoption of cost-beneficial actions that would otherwise be blocked by political opposition. If capital losses created by a government action are fully compensated for, then the people who experience them have no reason to object. 26/ In addition, resources currently employed in opposing efficient reforms could be diverted to more productive uses if the need for such political activity were eliminated.

Two efficiency arguments against compensating capital losses must be compared with these arguments for compensation. The first argument is that requiring compensation can, under certain conditions, prevent the adoption of efficient actions. This can occur for three reasons, the one most commonly cited being that the administrative costs of paying compensation can be high. These costs include expenses for measuring capital losses, identifying exactly who bears them, and maintaining the bureaucratic overhead of a compensation agency. 27/

Another reason given for compensation's preventing the adoption of efficient actions is that compensation costs may receive more weight than the benefits when the desirability of some action is decided. This might happen if an action that is actually efficient appears not to be because its benefits are more difficult to measure than costs. This problem is implied in arguments that have been made against requiring compensation in cases of public health regulation (cyclamates 103:19) and pesticides. (36:40046) The third reason efficient actions can be prevented is that requiring full compensation may open the door for individuals to exaggerate their losses so that, even if the action is in fact efficient, it may nonetheless be blocked by their claims. (81:407n)

The second argument against compensation's efficiency is that the government's means of raising revenue to finance compensation is itself inefficient. Most taxes reduce social welfare by distorting work, investment, or consumption incentives. The inefficiency of such distortions can be avoided, however, with a compensation mechanism that does not depend on tax revenues (as we point out in the next section).

In summary, one might say that whether or not paying compensation improves the efficiency of government activity depends on the situation. Most important is the cost of accurately measuring capital losses for specific individuals. These costs may be low in some cases but not in others. Losses are more justifiably compensable on efficiency grounds when the administrative costs are lower. Also, compensation requirements should be viewed skeptically if the benefits from an action are difficult to quantify (as with health and environmental regulations). Concern over the compensation of losses may lead to inefficient policy decisions when the benefits of actions are less obvious than their costs.

Incentives for private behavior--Some argue for and some argue against compensation because of its perceived effect on the behavior of people or firms that might or do receive it. Arguments for compensation claim that it is necessary in order to maintain incentives for productive behavior. It has been argued, for example, that government regulations creating uncompensated losses disrupt investment patterns and research and development because of the accompanying uncertainty and general demoralization. (94:793) The need for compensation as an offset to demoralization has been cited as a utilitarian criterion for compensation--namely, that compensation should be paid if its associated costs are less than the cost of the demoralization that results from not compensating losses. (9:182-83, 71:1213, and pp. 1215, 1239, 1241)

Others argue just the opposite. They argue that the fear of losses going uncompensated is necessary if cost minimizing and productive behavior are to be expected. This was a prominent argument against compensating losses created by product safety regulations, for example, and has been applied to research and development efforts. 28/ Which view is correct depends on the particular situation; neither view is necessarily always correct.

These arguments from expectations of private behavior apply most to situations in which the government regulates one group because of its potential effect on others, as in pollution regulation. The general goal of compensation in such situations is to minimize the sum of the nuisance costs imposed on some who are annoyed by others, the prevention costs incurred by those who abate the nuisance, and the government's administrative costs. (9:169) Minimizing the sum of nuisance and prevention costs requires placing liability on that group that has the greatest potential effect on these costs and is best able to reduce them. For example, it is usually cheaper for air polluters to reduce their emissions than it is for everyone else to suffer the nuisance or countervail it. Compensation should not be available for costs incurred by that group--the polluters, in this case. Identifying this "least cost avoider" may entail high administrative costs. Consequently, minimizing the sum of all three costs may, in some cases, require abandoning compensation analysis for some simple liability rule. (20:69, 30:315, 33:488 (and p. 509), 73:276-77, 89:182)

Two other aspects of compensation--risk spreading and moral hazard--must be kept in mind in making compensability decisions because of the way they affect private behavior and society's welfare. The adverse effect of capital losses can be minimized by reducing potential losses and by spreading them across a large number of people. The government's compensating for capital losses obviously does the latter but only at the cost of increasing potential losses. This countervailing effect results from the moral hazard created by insuring people against potential losses. The availability of future compensation encourages some people to put more assets into riskier situations, increasing the possibility of loss as the available compensation increases. (A similar argument has been made in relation to breach of contract. (92)) Determining the most desirable amount of compensation to make available, therefore, requires that the adverse effects of moral hazard be balanced against the beneficial effects of spreading risk.

Additional considerations

There are two more important considerations in deciding the compensability of capital losses. One is self-mitigation of losses. The other, the expense of compensation, is the single most important principle to remember in determining compensability.

Self-mitigation of losses--Some costs of government action can be offset by the people who nominally bear them. This is particularly true of operating costs imposed on businesses, which can pass at least part of an increase on to consumers. In determining compensable losses, it is important to take this shifting of burdens into account. This prevents overcompensating some and also helps identify others (such as those who receive a cost pass-through) who might deserve compensation. (48:57, 122:48-49)

The expense of compensation--It is sometimes argued that compensating government-created losses is undesirable as a policy because of its expense. (48:61) In opposition to this, it may be argued that measurement and administrative costs are associated with compensation but, ignoring moral hazard, these are its only costs. The compensation payment itself is not a cost. It is a redistribution of the costs already created by the associated government action. It is completely fallacious to argue that losses created by a government action should not be compensated because the compensation makes that government action too expensive. The costs of the action are the same, whether or not compensation is paid, and these costs must be borne by someone. A decision on loss compensability is really a decision on whether the government will bear the costs. (65:784n-85 (and p. 787), 94:797)

A common example is the government's taking property along a right of way for highway construction. The costs of the highway program are not lower if the government does not compensate the people and firms whose property is taken. Denying compensation to the displaced property owners merely shifts a large portion of the costs to them. The same principle holds in cases in which the costs of government action are not as obvious as in physical takings, as when government regulations impose capital losses on private parties. Compensating such losses only redistributes--it does not increase--the costs of these actions.

Adequate compensation and alternative methods

Compensation currently paid when the government takes private property under eminent domain typically fails to satisfy the above equity and efficiency criteria. There are ways of doing this however. The alternative compensation methods considered in the case study have advantages and disadvantages that are examined more broadly here.

The elements of adequate compensation

The law surrounding the taking situations and contract law use indemnification as the standard for determining what compensation is adequate for people and firms that suffer capital losses. Contract law justifies this on the grounds that it encourages efficient breach behavior. In taking situations, compensation is calculated on the basis of fair market value, but it fails to indemnify fully because only market prices are included in the calculation. The equity and efficiency goals of compensation will not be achieved unless the calculation includes nonmarket values.

Indemnification--The Supreme Court expressed the indemnification standard in taking cases in United States v. Miller (317

U.S. 369 (1943)). "The owner," it stated, "is to be put in as good position pecuniarily as he would have occupied if his property had not been taken" (317 U.S. at 373). The Court's intention was to achieve just compensation in accordance with its requirement in the fifth amendment to the U.S. Constitution. 29/ This is, implicitly, an equity goal. Similarly, the standard of compensation for breach of contract is "to put the plaintiff in as good a position as he would have been had the defendant kept his contract." (11:281; see also 6:278, 45:323) While an equity goal may be implied by this indemnification standard, its primary justification is to encourage efficient breach behavior. (11:281)

The efficiency goal for breach of contract is the same as that that we discussed earlier: Compensating for capital losses created by government actions is efficient because it insures the adoption of actions whose benefits exceed their costs. Similarly, requiring indemnification of the party injured in a breach of contract insures efficiency. Under an indemnification clause, one party to a contract will typically go back on its word only if it can make the other party just as well off as it would have been with contract fulfillment and still be better off itself. 30/

The only compensation scheme that will induce efficient breach behavior is one that protects the expectancy interest of the disappointed party. Expectancy interest includes the amount of money that the party would have received had the contract been performed. (4:495, 11:292, 92:478; see 11:282 for the contrary position) The alternative measures of reliance and restitution are available as compensation for breach of contract, but they are not efficient. (92:471 (and pp. 479-81)) One explanation of why protecting the expectancy interest is required for efficient breach behavior is that

> If recovery for breach of contract were limited to protection of restitution and reliance interests, a party could frequently profit through repudiation of one agreement and entry into another offering him a larger share of a smaller joint gain. (11:285)

Similarly, the goal of promoting efficient government action will be satisfied only by using a compensation scheme that protects the injured party's expectations. This is indemnification. Of course, the efficiency gain from indemnification must be balanced against the increase in potential capital losses that indemnification creates by way of moral hazard.

The argument for using the expectancy measure of damages for breach of contact is strengthened if the likely victim of breach is more averse to risk than the likely breacher, since this measure shifts the risk of damages from the victim to the breacher. (92:487-88) The efficiency argument for using the expectancy measure of compensation for government-created damages is strengthened in the same way. That is, the government is likely to be less averse to risk than anyone upon whom it imposes a capital loss.

Finally, protecting the injured party's expectations is consistent with the principle of transitional equity.

Fair market value--In taking cases, compensable losses are calculated as the fair market value of the property taken, which is defined as "what a willing buyer would pay in cash to a willing seller" (United States v. Miller (317 U.S. at 374)). Fair market value has also formed the basis of compensation in a numbr of congressional actions. (102:2, 107:1, 111:61; 21 U.S.C. 134a) While it might appear that fair market value indemnifies property owners for losses they suffer, in fact it does not. One study has described the problem this way:

> Most owners are unwilling to sell their holdings at the prevailing market prices, not because they are irrational or unreasonable, but simply because they value the particular properties more than other people.
>
> Despite assertions that compensations that ignore non-market values fully cover entitlements to economic reinstatement, this is simply not the case. The value of particular attachments of owners is just as much an economic loss as those attributes recognized by the market.
>
> Thus . . . for the vast majority of cases real losses accompany compensations that are limited to market valued losses. It seems likely that . . . most owners of property would be unwilling to sell at the current market price. (66:239-42)

In economic terms, the problem with the fair market value test of compensation's adequacy is that it does not recognize the property owner's consumer surplus. (56:327, 165:778) That is, compensation based on fair market value necessarily fails to indemnify because it ignores the values other than market value that most owners attach to their property and that, therefore, raise it above market value. It cannot possibly put property owners in a welfare position as good as the one they would have occupied had their property not been taken. The equity and efficiency goals of compensation policy will not be achieved by compensation equivalent to fair market value. 31/

Values higher than market value can be included in compensation payments in two ways. The simpler way is to add some amount to the estimated market value of a property. Its drawback is that it can overcompensate some property owners and undercompensate others. It may be equitable and efficient for the average owner but not for anyone else. Nonetheless, this method is used in both Canada and England as an improvement over fair market value. (10:91, 51:603-4)

The other way avoids the shortcoming of the first but is more complex. With this method, owners are not compensated at some independently determined price but, instead, their property is purchased. The advantage of this "free exchange" method is that compensation for individual owners can, in principle, equal their full evaluation of their property. The disadvantage is that some owners will hold out for even larger payments if they find themselves in a strategic bargaining position, as when they are the last to sell. This problem can be circumvented by imposing a price on all "hold outs" after some predetermined proportion of property owners have agreed to sell, but this solution sacrifices some of the method's equity and efficiency benefits. (66:244-6) Whether this or the first method is to be preferred depends on the situation.

Alternative compensation methods

The compensation mechanisms examined in the case study have features that must be considered in applying these mechanisms to capital loss situations. The first monetary mechanism examined, benefit charges, can take one of three forms, depending on who the beneficiaries are. If benefits accrue to property owners, as with land use regulations, special assessments can be applied to their property. The assessments reflect some portion of the increase in property value that is generated by the government action. (49:xlii) Increases caused by inflation and improvements that owners make to the property must be excluded.

A benefit charge may be an excise tax. (98:52) This may be applied when the beneficiaries are consumers of a privately supplied product that is closely related to the one affected by the government action. An example is the excise tax on motor fuels that is used to compensate people who lose property because of highway construction.

A benefit charge may consist of user fees. (9:209) User fees may be employed when the government itself supplies a product to identifiable recipients. For example, if constructing a recreation area requires displacing some property owners, compensation for their losses could be financed by charging an entrance fee to the area.

Both practical and theoretical problems are associated with using benefit charges to finance compensation. Practical problems encountered in the past are exemplified in the reclamation program's special assessments, called "betterment levies," against land value increases created by the program. Measuring increases generated by reclamation was hard, administrative costs were high, and passing the benefit levy on to land purchasers was easy to do. Indeed, this last difficulty negated one of the purposes of the betterment levy, which was to prevent speculators from obtaining windfalls through the availability of reclamation water. 32/

Excise taxes have two theoretical problems associated with them. We have already identified one as an argument against compensation's efficiency. That is, an excise tax can reduce social welfare by distorting consumption incentives. (99:678 (and p. 672)) Second, an excise tax cannot be used to finance compensation when the firms that bear capital losses must also nominally pay the tax. To the extent that the tax cannot be passed along to consumers, the firms finance their own compensation. 33/

Tax write-offs, in the forms of deductions and credits, constitute another monetary mechanism. One problem with deductions is that they only partially compensate for losses (unless more than the actual loss can be deducted). Another is that using deductions to compensate individuals may violate vertical equity, since a loss of any given size will translate into a larger tax saving for people with higher taxable incomes than others with lower ones. A problem with both deductions and credits is that they provide compensation only if taxes are owed. Compensation will be incomplete to the extent that the loss being compensated for exceeds tax liabilities. At the extreme, tax provisions are useless for compensating a person or a firm that has been bankrupted by a government action.

The use of government debt is a third monetary mechanism that was considered in the case study. As was stated there, government securities can be given directly to those being compensated or they can be sold on capital markets, compensation being paid from the revenues raised. From the government's perspective, these are equivalent, but recipients may prefer the liquidity of cash. One advantage of this mechanism, though, is that it lessens the horizontal inequities that result when taxpayers finance government actions whose benefits extend over many years, although this feature of debt financing may be seen as a drawback, given that it saddles future taxpayers with a debt they might not have imposed on themselves. (38:125, 56:330-31)

Nonmonetary mechanisms can also be applied as compensation. One such mechanism is delay of the government action that creates capital losses. As we said in the case study, delay has the advantage of reducing capital losses, but it has the coincident disadvantage of reducing the present value of gross benefits created by the delayed action. The present value of the action's net benefits may or may not be correspondingly reduced, depending on the timing of benefits and costs in the future. In addition, delay cannot be given the consent of the future generations whose behavior will be affected by institutions they will not have created. (56:330-31) Against these disadvantages must be balanced the advantage of reducing capital losses and the requisite compensation for them.

A second nonmonetary mechanism, one of the two preferred options in the case study, is the awarding of property rights. This mechanism is particularly useful when the loss creating action involves transferring the use of a publicly controlled resource from one group to another, as in the transfer of water from irrigators to hydropower producers in the case study situation. Awarding property rights to use of the resource to present users and allowing them to market the resource to others, simultaneously provides equitable compensation and promotes efficient resource reallocations. This mechanism may be applicable to many user charge situations and may also be useful for compensating other government created capital losses.

PRESENT APPROACHES AND POLICY CHANGES NEEDED TO COMPENSATE CAPITAL LOSSES

The broader implications of our case study analyses are presented here. We review the experience of the Congress and the courts regarding other government created losses, both to gauge the satisfaction of public policy equity and efficiency goals under existing approaches and to assess the need for congressional action. We examine how existing institutional arrangements determine whether capital losses resulting from government action warrant compensation. These arrangements are judicial and political. The judicial approach to compensability is wanting in its applicability because benefits destroyed by government actions are often not legally considered property. The judicial criteria used to determine the compensability of legally recognized losses are instructive but have limitations that must be recognized. The compensability of capital losses under political institutions is also questionable. Indirect compensation through logrolling is probably insufficient or unavailable for most capital loss situations. Direct political action--that is, legislation--is preferable, but some forms of legislative action are better than others.

The judicial approach

Under this approach, an individual or firm whose property had been taken by the government for public use would sue for compensation, citing the fifth amendment to the U.S. Constitution, which reads (in part) "nor shall private property be taken for public use, without just compensation." It is not clear, however, how widely applicable this approach is to capital losses. Nor is it clear how useful the judicial criteria for compensability are, even where the approach does apply.

Its applicability

The judicial approach provides a potential remedy for losses created by the government only if these losses have been determined to be "takings" of "property." Its applicability depends on the judicial conceptualizations of what "takings" and "property" mean. Property is viewed not merely as a physical entity but also as a set of intangible, legally sanctioned relationships among individuals that pertain to their use of things. 34/

The elements of these relationships that constitute property rights are three. Use is defined as the right to use property in certain ways and entails prohibitions that prevent its use in other ways. Exclusion is the right to prevent others from using property or to set terms under which they can use it. Disposition is the right to sell property rights. A taking involves some interference with these rights of property ownership. 35/

Given these views of property and taking, the judicial approach obviously applies to some situations in which capital loss results from government action. For example, the government's physically taking property under eminent domain (that is, its right to take private property for public use) affects all ownership rights and creates capital losses that are unquestionably compensable. For other types of government action, judicial compensability is not as clear, as when regulations modify property use in certain ways.

In some cases, the judicial approach would not apply at all. Motor carrier regulatory reform and changes in water prices in Federal irrigation projects are two examples in which the value of some asset (operating certificates and farmland) is diminished by government action, but in neither case does the government action destroy benefits that are legally considered property. Judicial action is therefore not available to remedy these capital losses. It is likely that judicial action would not apply to many capital loss situations, although the variety of cases to which it would apply might be larger under a broader definition of property and taking. (100)

The usefulness of its criteria

Even in cases for which the judicial approach applies, its ability to achieve consistently fair results is not clear. The predominate compensability criteria developed by the courts--physical invasion, diminution in value, balancing, and noxious use--are useful in many cases, but they have limitations. Taken together they yield results that are not necessarily fair or equitable, since the compensability criteria are based on distinctions that are either somewhat arbitrary or ethically questionable. 36/

Justice John Marshall Harlan stated the physical invasion criterion clearly in 1887 in the U.S. Supreme Court case Mugler v. Kansas (123 U.S. 623). He held that a taking that requires compensation differs from a police power action in that the taking permanently appropriates the owner's property. Compensation is required, he held, even if the purpose of the action is to abate a nuisance but only if the property has been physically taken.

Thus, it is the form, not the purpose, of an action that determines compensability. (25:118-20, 34:904) There is nothing inherently wrong with this criterion. Its applicability to the capital loss problem is limited, however, since many government actions that create losses do not involve physical takings.

Justice Oliver Wendell Holmes stated the criterion of diminution in value in 1922 in Pennsylvania Coal Co. v. Mahon (260 U.S. 393). He held that the difference between a police power action and a taking is one of degree, stating that "[t]he general rule at least is, that while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking" (260 U.S. at 415). Thus, compensation is required if a government action has diminished the value of property to a sufficient extent. 37/

This criterion raises the difficulty of determining how much must be lost before compensation need be made. Because the line separating compensable from noncompensable actions must be drawn arbitrarily with this criterion, decisions that are made for each particular situation are not necessarily consistent or just. (2:9, 71:1192) On the other hand, some believe that this criterion accords with the community's sense of justice and forces the government to account at least partially for the social costs of its regulation (9:175-177), although the criticisms of this criterion appear on balance to outweigh its advantages. Moreover, the tests that the courts use most commonly to determine compensability are the physical invasion and the diminution of value criteria, but the former emphasizes the form of government activity while the latter emphasizes its economic effect. Some believe that judicial decisions applying these theories are frequently contradictory, while others think that they are not.

The balancing test has been in use for more than 50 years; it was cited recently, in 1978, in Penn Central Transportation Co. v. City of New York (438 U.S. 104). Under this criterion, the loss that a government action imposes on individuals is compared with the public benefits that the action creates. The need for compensation is weakened the larger the public benefits are relative to private losses. 38/ The major problem with this criterion is that it trades the welfare of the people who bear losses for the welfare of society as a whole. This separation is artificial, and the comparison is ethically questionable. There is no ethical basis for allowing society to benefit at the expense of some minority within it. (34:905n, 71:1194)

The criterion of noxious use, embodied in nuisance law, holds that if the economic costs imposed on the community by a noxious use of property are unreasonable, then abating the nuisance without compensation is justified. This is so even if substantial private loss results. 39/ Applying this criterion depends on distinguishing between government actions that prevent or abate a public harm--that is, a nuisance--and others that produce a public benefit. Actions of the first kind do not require compensation but the others do. (25:218)

This criterion presents a problem in that "finding exercises of the police power to be valid if they prevent harm, but invalid and a taking if a public benefit results, perpetuates a meaningless distinction equally supportive of either side of the taking issue." (13:672) This objection to the noxious use criterion is based on the reciprocity problem that arises when a common resource such as air is used by conflicting interests. Each use imposes costs on the others, and there is no a priori reason to prefer one over another. 40/ A compensation decision based on the noxious use criterion is, therefore, arbitrary and can lead to inequitable and inefficient results.

Additionally, the noxious use criterion can produce inequitable results in the many instances in which total economic loss is not compensated for because what was lost has been redefined as nonproperty. (89:152n) Some courts, applying the criterion to innocuous land use, reason that any private land use may be forbidden if the prohibition promotes some conservation or environmental objective. (2:7-8) Basing compensation decisions on the noxious use criterion can also produce inefficient government actions, inasmuch as the government is excused from paying for the social costs of its regulation. (9:175) Moreover, automatically allocating liability to active parties, such as polluters, inherent in the noxious use concept, is not necessarily the most efficient decision.

The usefulness of these four judicial criteria for determining the compensability of capital losses is limited. As one commentator has put it, "the interpretation of constitutional guarantees against the taking (or damaging) of private property for public use continues to present a murky and confused area of the law, whose conceptual premises can be charitably characterized as uncertain." 41/ Specific criticisms of the judicial approach include the charges that takings are defined too narrowly, legal precedents are applied inconsistently, courts consider situations ad hoc, and the approach itself is diffuse, contradictory, haphazard, and inequitable. (2:3, 13:622, 122:49 (and p. 62)) It has been criticized for the limitations of its adversary process, which encourages the exaggeration of demands and disagreements. (79:356) And there is even some doubt about whether an appropriate loss compensation scheme can be derived from decisional law. (2:11)

Because the judicial approach does not apply to many of the types of capital loss with which we are concerned, we must turn to another approach to their compensability. In developing a policy, however, it is useful to examine the judicial experience even though there are problems with the compensability criteria. We must know what mistakes to avoid and what precedents to follow in devising an equitable and efficient policy. Therefore, the advantages and disadvantages of the judicial criteria and their application should be studied.

The political process

Capital losses can be compensated for by congressional actions both directly and indirectly. People who suffer losses from one government action can be compensated indirectly when they belong to a group that benefits from another government action while they can also be compensated directly through legislation aimed at their specific losses. In the rest of this section, we examine the principles for determining the effectiveness of indirect compensation, past experience with direct compensation, and the usefulness of direct compensation as a policy.

Indirect compensation

Two features of the political system important for indirect compensation to occur are majority rule and logrolling. By "logrolling," we mean the process of compromise among legislators that secures the adoption of actions that benefit different constituencies. Despite the pernicious associations the term has acquired, it can be viewed more benignly, as a mechanism by which groups in society who have different interests can make mutually beneficial agreements with each other through their elected representatives, and it is this view that we adopt.

To see how logrolling and majority rule can act as compensation mechanisms, it is necessary to look beyond individual losses resulting from individual government actions. No one government action stands alone; it is part of a group of government actions taken at the same time and of an even larger group of actions taken over some period of time. Each of these actions benefits some and hurts others, and this disparity is the source of indirect compensation.

Even the most strictly self-interested majority rule can compensate capital losses indirectly without ever explicitly attempting to do so. This is because any person may be a member of a minority group suffering losses from one government action while also being a member of a majority benefitting from some others. Balancing the costs and benefits from diverse actions, people might expect to come out ahead. 42/

Moreover, the government's providing indirect compensation through majority rule can be made less haphazard by use of logrolling. By this process of political exchange, people who have been hurt by one action can explicitly be compensated for their capital losses if they can secure the adoption of other actions that will benefit them. Trading votes allows the legislative process to use benefits from some government actions to mitigate adverse transitional effects created by others. (41:636, 56:331)

The question that we must ask, then, is whether these features of the political process--majority rule and logrolling--are adequate for achieving equitable and efficient compensation indirectly. Actually, the question is more specific than this and consists of several parts. That is, we must determine whether certain conditions that will facilitate this result actually hold. First, individuals with conflicting interests must differ in the importance they attach to issues; otherwise, there is no basis for trade and logrolling will not occur. (56:331) Then, the actions that balance one another must have diffuse rather than concentrated effects; logrolling in particular is useless as a compensation device if an action has bankrupted someone. (56:331-32) Coalitions must be not stable but changeable in composition. (76:220) Gains and losses should be distributed impartially throughout the population; when the distribution of costs and benefits is more random, any given individual is more likely to benefit from simple majority rule. (58:257-59, 76:222, 81:408-09) Finally, the political system must not be controlled to the benefit of some and the cost of others. (56:330)

It is beyond the scope of this study to determine whether or not these conditions are satisfied sufficiently to preclude the need for direct compensation. We believe that generally they are not, given past litigation and direct congressional action in response to uncompensated losses. The condition that is most likely to be violated is that of diffuse, rather than concentrated, losses; it is concentrated losses that are most likely to lead to appeals for judicial and congressional relief.

Direct compensation

In the past, the Congress has provided compensation for government created losses through various forms of legislation. Other countries also have experience in this area. Of the various legislative options at the Congress' disposal, open-ended provisions warrant more attention.

General experience with it--Congressional actions that deal specifically with losses created by government are either discrete or open-ended. Discrete actions address only one particular type or instance of loss produced by past government actions; that is, the legislation addresses no effect other than that particular loss. Open-ended legislative actions, on the other hand, provide for future and as yet undetermined losses. Within these two categories, subcategories are defined by how broadly an action will apply.

The two subcategories of discrete legislative action are represented in private and public bills. Private bills are compensation actions that identify beneficiaries by name. A prominent example is the "spinach case." In 1962, the Food and Drug Administration had erroneously described a load of spinach shipped from Colorado by the Mizokami brothers as being contaminated by a pesticide. When subsequent tests proved this description false, the Congress passed a private bill in 1964 giving jurisdiction to the Court of Claims to award compensation specifically to the Mizokami brothers. 43/

Public bills differ from private bills by identifying not specific recipients but classes of firms or classes of people who are eligible for compensation. The Congress passed such a bill in November 1978 that was vetoed by the President; it would have allowed the Court of Claims to compensate firms suffering losses from a 1977 ban on the use of Tris as a flame retardant in children's sleepwear. Aside from its characteristics as a public bill, this action differed from the Mizokami relief bill also by not admitting government error, a feature that formed part of the Justice Department's opposition to the bill. 44/

As with discrete actions, open-ended legislative actions may be either specific or general. Specific actions provide compensation to identifiable classes of people or firms that suffer losses from a specific government action or policy. There are a number of such legislative actions. The 1972 Federal Environmental Pesticide Control Act (Pub. L. No. 92-516) is a prominent example. It authorizes compensation to manufacturers or owners of a registered pesticide that has been banned by the Environmental Protection Agency as an imminent hazard. It was the first bill to authorize compensation before a specific product had been banned; compensation was previously provided for only after the fact. 45/

In countries in which the courts cannot on constitutional grounds invalidate government actions, compensation may be available through general legislation, as in England's Town and Country Planning Act of 1971, which establishes among other things the compensability of losses when the government has granted a permit and later revokes it. 46/ There are no such general statutes in the United States under which an individual harmed by a government policy action can attempt to recover damages. The only generally applicable government liability provision is the Federal Tort Claims Act of 1946 (28 USC 2671 et. seq.), which allows individuals to sue the government for losses resulting from negligence or other conduct that would be considered a tort under the law of the State in which the injury occurred. Most of the losses we are concerned with in this report are not tortious, and those that are, are exempt from liability under the "discretionary function" provision of the Federal Tort Claims Act, which states that the government is not liable for losses resulting from policy (as opposed to operational) decisions. 47/

Its usefulness as a policy--Both the judicial approach and indirect political processes are inadequate for compensating capital losses. Direct legislation is probably not, and it might be advisable to examine foreign governments' experience with open-ended provisions establishing compensability for general actions creating losses. There are, indeed, indications that U.S. courts would welcome legislative guidance in determining the compensability of losses. (25:236 (and p. 325)) Direct open-ended provisions might be preferable to discrete actions because they establish compensability in advance and thus reduce the need for discrete actions that resolve losses after they have occurred. (110:21, 111:35)

A number of benefits would derive from using general and specific open-ended statutes to determine compensability. For one, establishing legislative standards in advance would reduce the uncertainty that surrounds ill-defined judicial standards and political approaches that are haphazard, as with indirect compensation, or piecemeal, as with discrete legislation. It would promote efficient allocation of resources (42:1141) and more consistently distinguish compensable from noncompensable losses. (13:677) For another, the equity and efficiency of legislation would improve from the consideration of possible losses and their compensation as a regular part of legislative procedure.

Moreover, some capital losses could be prevented if the possibility of future compensation were provided for in legislative actions. This would be true even for actions that are equitable and efficient at the time they are taken. That is, congressional actions sometimes create expectations of future incomes that are capitalized into asset values and that become losses if the Congress later destroys the expectations it has created. If the need to compensate these losses were foreseen, they might never occur, since legislation creating expectations of future income would be reviewed more critically before it was enacted.

Conclusions

We conclude that the creation of capital losses from government policy changes is an ubiquitous problem and that existing judicial and political arrangements for handling such situations are inadequate. Direct congressional action, in the forms of specific and general legislative provisions, would overcome the shortcomings of existing arrangements. If such action is taken, the Congress could include capital loss and compensation analysis as a regular part of the legislative process. The Congress could improve the equity and efficiency of public policy by eliminating the impediments to efficient changes created by potential losses and by providing equitable compensation when it is warranted. The Congress may want to extend these efforts to uncapitalized losses as well.

NOTES TO APPENDIX I

1. A decrease in expected future income may or may not be fully reflected in an asset's market price. For decreased future income to be fully reflected in an asset's value, the asset must be salable (this excludes labor income, because it is not capitalized); losses must not be shifted, as to another phase of the production process (that is, in a production setting, if the asset is not the only fixed factor, losses will be shifted to other assets). (29:191-92; see also appendix II in this report) Also, the slope of the asset's demand curve must remain constant if it shifts, and the asset's supply curve must be perfectly inelastic. The last two conditions insure that consumer surplus in the asset's market will not change when the loss occurs. (5:174-76) (The numerical citations are each to a bibliographical reference as numbered in appendix III and pages in that reference--for example, 5 is the article by Roy W. Bahl and colleagues and 174-76 are the pages on which the topic will be found.)

2. Capital loss is discussed in connection with inland waterway user charges in 18; antitrust policy in 1, 16, and 32; general regulatory reform in 98 and 99; trucking in 17, 26, 60, 63; tax reform in 38 and 39; urban renewal in 65; busing in 56; miscellaneous regulatory actions in 19, 25, 79, 103-12, 122 (see the numbered reference list in appendix III).

3. The opportunity cost of CBP water has been estimated at $40 per acre foot. This water could be used to produce hydropower and to maintain stream flows for fisheries (November 16, 1979, letter from Norman K. Whittlesey, Department of Argicultural Economics, Washington State University). For a detailed analysis of Federal irrigation projects' costs and user charge revenues see, U.S. General Accounting Office, Federal Charges for Irrigation Projects Reviewed Do Not Cover Costs,(PAD-81-07, March 13, 1981).

4. In many cases, changing irrigation water prices would entail breach of contract. Loss compensation provisions are well established for such circumstances, however, and we have ignored water contracts for expository purposes.

5. Transitional equity has been raised in connection with antitrust enforcement (1:64) and tax policy (39:98, 56:329). See also 9:168-69 (and p. 195).

6. The information in the paragraphs above comes from the following sources. For the historical data on the CBP's authority, locations, and size, see 49:340, 113, 117:5, 118, 124:666. For the present-day incidence and distribution of ownership practices, see 114 (tables 1 and 3), 115, 116. Our information on family farms and corporations in 1973

comes from a January 4, 1980, telephone conversation with Jim Cole, CBP Project Manager.

7. This is the case, for instance, in eminent domain situations. The courts prefer this method for determining fair market value in taking cases. (27:819, 53:309)

8. See 86:583. The analysis would actually have been more complicated than this. We would have used multiple regression analysis to explain land values outside the CBP as a function of a number of explanatory variables. Using the coefficients obtained in these regressions, we would have estimated "without water" land values for properties within the CBP. The difference between these estimated land values and actual land values would have measured the capitalized value of irrigation water. This, in turn, would have given us the basis for our capital loss estimates.

9. See 38:125-26 and 1:63. The former source points out that a sample of asset prices can be used to measure capital losses for all assets concerned, provided adjustments can be made for inherent value variations across units. The procedure is similar to that described in note 7. "Before and after" tests proposed as measures of compensable losses from land use regulations are discussed in 9:225-6 and 48:69 (and pp. 116 and 119).

10. The courts often use this method of estimating compensable losses when the comparable sales method is not applicable, and at least one government agency has used it for estimating compensable losses inflicted by one firm on another. (27:819-20, 38:125-26, 53:315, 65:776, 69:691-92, 86:587)

11. We used the observations for 1978 given in table 8 of appendix II for the latest land value estimates for various land classes. The 1978 data contain three land classes. For estimates of the distribution of irrigable acreage by land class, we used data in the table showing four land classes for 1963; we assumed that the distribution did not change significantly between 1963 and 1978, and we combined 1963 classes 3 and 4 into one for comparability with the 1978 data.

Land Classes and Applied Construction Charges for 1963

		Land class			
	Unit	1	2	3	4
Range of charges	$/acre	174-184	136-143	97-102	58-61
Ratio to class 1	%	100	77	55	33
Annual construction charge	$/acre	3.48	2.71	1.93	1.16
Irrigable acres	$	27	40	29	4

Source: U.S. Bureau of Reclamation, 1968.

12. That public prices do not always resemble privately set prices, even in the absence of contracts, is exemplified by inland waterways, over which transitional equity conflicts can result from public pricing, as the following arguments for and against inland waterway user charges show: "From the waterways industry standpoint, huge non-Federal investments have been made by private industry for waterside industrial plants and transfer facilities . . . . Thus, the argument goes, it is unfair for the Federal Government to now withdraw from its longstanding 'partnership' with industry. On this point, it has been argued that the mistake of not imposing user charges in the first place should not be compounded by continuing the error in the future. This position, argues waterway interests (sic), disregards the acceptance of the principle of risk taken by non-Federal interest in port development and the non-Federal dollars committed to existing facilities." (18:37)

13. They can be used to calculate total capital losses for the entire CBP. Combining land classes 3 and 4 in the CBP, we have the acreages shown in table a below. Given the capital losses per acre as displayed in table 2, this distribution of land by class leads to the figures in table b below, with an overall total of more than $839 million in capital losses. This estimate can be compared with the estimate of $912 million, which assumes that all land values fall to $273 per acre, the level at which net returns to irrigation approach zero in the case study model.

Table a

Irrigable Acres by Land Class, 1963

Land class	% of irrigable acres
1	27
2	40
3, 4	33

Table b

Total Capital Loss by Land Class, 1963

Land class	Total capital loss
1	$214,272,000
2	321,642,000
3, 4	303,424,000
	$839,338,000

14. The trucking industry's proposal is in 17:1 and 60:1. For the congressional precedents, see 17:3-4. Tax write-offs have also been made available for expenses incurred in complying with various regulations, as for pollution control

facilities. It is not clear whether these provisions were intended to compensate for losses or to encourage desired behavior. (62: Sections 169(a) and 190(a))

15. We estimated the present value of total benefits at $963 million and capital losses at $912 million, the difference being $51 million. The present value of net benefits could be greater than this. If the estimate is correct, net benefits could be $963 million minus $839 million, or $124 million.

16. Objection to this action would be justified because "deregulation without compensation would inflict severe transitional losses on those who own franchises" (56:328). See 9:210-11, 17-1, and 122:48-49 for similar arguments in other contexts.

17. See 9:199, 122:57-58. Congressional expression of this argument occurs in a pesticides control bill (36:40049) (and p. 40052), 65:3148), the predators case (84:23390), and the banning of cyclamates (104:23). When the benefits of a government action accrue to the public as a whole, the beneficiaries "should pay" argument implies financing from the general treasury. (79:362)

18. See 36:40051, which relates to the pesticides case, and 111:111, which relates to Tris; more general are in 49:155 and 71:1192. England and New Zealand compensate homeowners and small businesses from presumably vertical equity motivations; see 49:251 for a discussion of these provisions and the difficulties associated with them.

19. A good explanation of this aspect of transitional equity is given in 14:132-33: "Changes may occur through shifts in tastes, introduction of new techniques, or growth in the supply of basic resources. These are normally considered to be the means through which an economy 'progresses' or 'grows.' Changes of this nature are, however, different, philosophically, from those which are deliberately imposed through collective action. And this distinction is important. The free-market economic order is organized on the assumption that shifts may occur in the fundamentally exogenous variables. Imperfections of knowledge about the possible shifts in these underlying variables are incorporated with the appropriate offsetting entrepreneurial rewards and punishments. Any attempt to secure compensation for all losses would surely destroy the system. But changes imposed by collective action are different, and the uncertainty involved in attempts to predict such action cannot be discounted or offset in the ordinary market structure." See 71:1216 for another similar statement.

20. See 48:56-57. 56:326 states that "In determing whether compensation must be considered an ethical requirement, the

ability of individuals to anticipate change and adjust their behavior to curtail potential losses is crucial."

21. This is essentially the view adopted by Dewey in arguing that current stockholders deserve compensation for the government's destruction of monopoly power. These stockholders have not benefitted by the monopoly power, he argues, because the future stream of monopoly rents was capitalized into stock prices. Current stockholders receive only a normal rate of return. In arguing thus, he assumes that antitrust action is completely unforseeable and that current stockholders receive no risk premium. (32:98) For supporting points of view, see 9:196, 17:2, 56:324 98.54; for contrasting sentiments, see 7:351, 37:520.

22. Hochman states that "Failing direct or indirect compensation, the fairness of a rule change is unambiguous only if the pre-existing rule was clearly inconsistent with the social contract or 'constitution' that underlay it" (56:323). This aspect of compensability has been discussed in the context of government action as a normal business risk. Some argue that it is and that, therefore, compensation is not warranted (110:13, 122:50), while others argue that this view is too "facile" (56:340n). Arguments on the compensability of losses from government regulatory actions have cited the issue of the behavior of those who are regulated relative to the public interest; for examples from the cyclamates case, see 103:20, 104:127; from Tris, 122:47. For general statements on this issue, see 9:217, 14:131, 122:51.

23. It has been argued in the Tris case that the government had required behavior that it later prohibited. (110:13, 111:5-7, 122:46) The milk case contains arguments of the government's having recommended an action. (35:16663 (and p. 16749)) Instances of the government's allowing behavior that is later prohibited are cited in the cyclamates case and in regulatory reform of the trucking industry, although this assessment would be disputed by some who would likely characterize the government's role as recommending an action in the cyclamates case (103:5-6, 104:22-23 (and pp. 67, 120, 125)) and as perhaps recommending an action in the trucking case (17:2).

24. Two other equity notions are the "first in time" criterion and the criterion of government error. In the "first in time" view, compensation should be paid for the diminution in value of pre-existing property uses caused by the introduction of a new activity (9:193-95 (and pp. 182, 191)). Under the criterion of government error, losses resulting from erroneous government actions are compensable. For citations of this as an argument for compensation, see the Tris case (110:13), the spinach case (122:47-48 and 78 Stat. 1195, Priv. L. No. 88-346 (1964)), the Marlin Toy case (108:1, 122:48), and generally (122:52). For citations of

this as an argument against compensation, see the pesticides case (36:40046 (and p. 40048)) and the Tris case (111:43).

25. For detailed discussions, see 98:53 and, particularly, 15:161. 15:91 states that "The unanimity test is, in fact, identical to the compensation test, if compensation is interpreted as that payment, negative or positive, which is required to secure agreement. Moreover, if decision-making costs are neglected, this test must be met if collective action is to be judged 'desirable' by any rational individual calculus at the constitutional level." Other statements of the efficiency of compensation requirements are given in 14:137 and 15:186. On the desirability of compensation regarding regulation, see 48:48, 49:xxxi, 122:49.

26. The lack of compensation has been offered as an explanation for the failure to adopt some environmental changes. (91:347-48) The advantages of compensation as facilitating the adoption of desirable public actions has been noted in a number of places. (38:124, 48:55-56, 49:xxxi, 56:325, 98:51 (and p. 54), 122:49-50)

27. For a discussion of how decisionmaking costs constrain the optimal decisionmaking rule to less than unanimity, see 15:85-86. See also 15:94-96 and 76:221.

28. The argument was used in the case of cyclamates (103:17), Tris (110:13, 111:35, 112:7), pesticides (84:23392, 106:74), and milk (35:16665), and it has been applied to research and development efforts (84:23392, 103:17, 106:74). For a general statement, see 122:50.

29. This opinion is cited in 65:782, which adds that "the object of just compensation is not merely a conversion of an asset ('property') into its monetary equivalent, but indemnification of the owner." It is apparent that the Court's measure of adequate compensation was the injured party's "compensating" rather than "equivalent" variation. This is consistent with the view of appropriate compensation measures expressed in economics literature. (72:129-30) Other theories of just compensation are cited in 52:274-78.

30. This accords with the concept of the unanimity test of adequate compensation expressed in economics literature, which is "that set of payments required to secure the agreement of all parties to the proposed change" (14:128n).

31. A closely related issue is the denial of compensation for profits lost because of some government action. In both the Tris and the cyclamates cases, compensation, had it been paid, would have specifically excluded any profits that the firms might have made on the banned products. (110:1-2, 111:3-4, Tris; 104:61, cyclamates) Damages for breach of contract protect the expectancy interest by including lost

profits in compensation. (6:289 and Uniform Commercial Code, secs. 2-706, 708(1)-(2)) For discussions of the inefficiencies resulting from failure to recognize consumer surplus in compensation, see 51:609 and 66:242-43. For the equity consequences, see 10:65-66 (and p. 69) and 66:242.

32. These problems are discussed in 49:xxxvi. Special assessments have also been difficult in England, where the basic problem with betterment recapture was a minimal public sense of grievance over nonrecapture. (49:144 (and p. 498))

33. The second problem arises when the beneficiaries of a government action are consumers and the loser is a firm supplying a product to them. The consumers and the firm will share the burden of an excise tax applied to that product. The firm's share is related directly to the market elasticity of demand and inversely to the market elasticity of supply. Consumers will bear the entire burden of the tax (and, hence, finance the compensation) only if the first elasticity is zero or the second is infinite.

34. See 89:150 (and p. 152), 100:491. See also 42:1139, which defines property rights as "the sanctioned behavioral relations among men that arise from the existence of things and pertain to their use. . . . The prevailing system of property rights in the community can be described, then, as the set of economic and social relations defining the position of each individual with respect to the utilization of scarce resources."

35. See 30:309, 125:643. Another element of property rights is the expectation that existing relationships will continue unmodified; see 31:347, 71:1203 (and pp. 1211-12). The values of things depend on their associated bundles of rights and the satisfaction of expectations concerning their continuance; see 42:1139-40. Expectations are central to capital losses.

36. Three additional compensation criteria that have been used in recent decisions are (1) whether or not the government action in question encroaches on the owner's "right to exclude" (Kaiser Aetna v. United States) (444 U.S. 164 (1979)), (2) whether or not the action violates "distinct investment-backed expectations" (Kaiser Aetna and Penn Central Transportation Co. v. City of New York (438 U.S. 104 (1978)), and (3) whether or not the action deprives owners of "primary expectation" regarding the use of their property (Penn Central). Our conclusions regarding the applicability and usefulness of judicial compensability criteria are not altered by consideration of these three additional criteria.

37. At another point in this decision, discussing the extent of diminution, Holmes said: "When it reaches a certain magnitude, in most if not all cases there must be an exercise

of eminent domain and compensation to sustain the act" (260 U.S. at 413). One congressional committee has used this criterion in discussing the need to compensate owners of motor carrier operating certificates devalued by regulatory reform; referring to the Motor Carrier Act of 1980, it said that "Should it become apparent that the effect of this legislation has been to substantially erode the value of operating rights, then appropriate relief for such result should be considered, as early as possible" (109:4).

38. See 25:137. According to 57:283-86, the Supreme Court cited three earlier decisions to support its position in Penn Central that no compensation was required: "the cases cited were interpreted as examples of public purposes which justified private losses. When the substantial benefit of historic preservation was weighed against what the Court viewed as a minor loss to Penn Central, the conclusion that no 'taking' had occurred was inevitable."

39. See 119:16. The noxious use criterion was used in an 1853 Massachusetts case, Commonwealth v. Alger (7 Cush. 53), in which Justice Shaw wrote that "every holder of property, however absolute and unqualified may be his title, holds it under the implied liability that his use of it shall not be injurious to the equal enjoyment of others having an equal right to the enjoyment of their property, nor injurious to the rights of the community . . ." (see 25:112).

40. This reciprocity problem was first considered extensively by Coase in his discussion of nuisance questions, in which he said: "The question is commonly thought of as one in which A inflicts harm on B and what has to be decided is: how should we restrain A? But this is wrong. We are dealing with a problem of a reciprocal nature. To avoid the harm to B would inflict harm on A. The real question that has to be decided is: should A be allowed to harm B or should B be allowed to harm A? The problem is to avoid the more serious harm . . ." (22:2). For applications of Coase's views to loss, see 19:39-40, 20:67, 22:13 (and pp. 19 and 44); for counterarguments, see 73:278-80, 79;360-61. One writer states that when uses of a common resource are incompatible, any of the uses can be either prohibited or maintained without compensation since none is a priori to be preferred. He also warns that discrimination against public rights will occur if conflict resolution in favor of diffuse interests requires compensation but resolution against them does not (89:160, 163).

41. 65:765-66. Other general statements on the inadequacies of these criteria are in 25:196 (and pp. 266-67), 71:1184. Less formal discussions on criteria implicit in specific judicial decisions are on objectives of regulation (25:197, 119:14-15), broadness of benefits (25:199 (and p. 323), 119:10),

government enhancement (25:200-01), suitability of regulation (25:204), and severity of economic effect and fairness of legislative choice between police power and eminent domain (119:10).

42. See 58:257-59, 76:221-22, 81:408-10, 122:51. One author has said that "majority rule, applied in a succession of issues, is itself a means through which transitional inequities are reduced" (56:332). A similar argument has been advanced for why it is fair, under the right circumstances, not to compensate losers from a particular action (71:1223), although this has been criticized as being unrealistic (9:185). Finally, the judicial theory of "average reciprocity of advantage," applied to legislation creating regulatory losses, is relevant. The validity of such legislation can be sustained in this theory on the grounds that the property owner suffering a loss is compensated by sharing in the general benefits created by regulation (119:5).

43. Priv. L. No. 88-346, 78 Stat. 1195 (1964); 112:4 and 122:47-48 also describe this case. In another major example, a private bill was introduced to compensate Marlin Toy Products, Inc., after the firm allegedly suffered losses when the Consumer Product Safety Commission erroneously included two of its toy products on the Banned Products List in 1973. A congressional report recommended that this relief be provided but it has not yet been passed into law. (108:1, 122:48)

44. See 111:43 and, for other references to the bill and the situation it addresses, 110:1-2 (and p. 13), 111:3-4, 112:7, 122:46-48. Similar situations arose in the cranberries case (112:4, 122:47) and the unsuccessful attempt to provide compensation for the banning of cyclamates (103:5-6, 104:27 (and p. 61), 112:7, 122:51).

45. Similar provisions are (1) the Agricultural Act of 1970 (Pub. L. No. 91-524), which authorized compensation to beekeepers who suffered losses from pesticides registered by the Department of Agriculture (59:3468); (2) 7 U.S.C. 450, as amended, which authorizes the Secretary of Argiculture to compensate dairy farmers who are ordered to remove milk and other products from the market because of their being contaminated by pesticides approved by the government (35:16749); (3) 21 U.S.C. 134a(d) and (e), which authorize the Secretary of Agriculture to compensate owners of animals destroyed in order to prevent communicable diseases from spreading; (4) the Highway Beautification Act of 1965 (23 U.S.C. 131), which authorizes compensating sign owners for the taking of their signs and property owners for the taking of their right to display signs on their property. Another provision that the Congress did not pass would have compensated farmers and ranchers whose livestock is killed by predatory animals. The bill was written because in 1972 the President and the Environmental Protection Agency

banned the use and interstate shipment of poison for controlling predators, and farmers and ranchers claimed that they had become dependent on the existing predator control program and would suffer losses from the ban. (102:1, 107:1)

46. 25:270. Similar provisions in Australia, Canada, and New Zealand are discussed in 48:97-98 (and p. 119) and 49:500. An excellent example of authority being vested in a state agency is the Australian Soil Conservation and Land Utilization Act of 1958, which provides that an agency can determine land use in designated areas and then compensate the land owner or occupier for economic loss. (48:82) Property owners in such countries appear to be at least as well protected from government interference with their property rights as their U.S. counterparts, despite their weaker legal position. (2:340-44).

47. 122:47. One reason for this exemption was the concern of the Congress that permitting suits challenging regulatory discretion would render regulatory power ineffectual. (112:1-2)

COLUMBIA BASIN PROJECT CASE STUDY

In this appendix, we present our estimates of the potential effect on farmland values of increasing irrigation water prices in the Columbia Basin Project (CBP) in central Washington State. These estimates, the background data, historical information, and the analysis that appear in this appendix were all supplied by Dr. Norman K. Whittlesey, Department of Agricultural Economics, Washington State University, Pullman, Washington. A linear programming model was used to estimate the change in returns to farmland and then, with an investment analysis model, this income change was translated into a change in the price of irrigated farmland. These calculations were performed for various water prices, including the present price and the higher opportunity cost of the water currently used in irrigation.

In the first part of the appendix, we summarize briefly the history of the CBP before describing the linear programming model and its estimates of returns to farmland for various water prices. A brief discussion of the investment analysis model follows this, along with estimates of farmland values for different water prices and alternative assumptions about the capitalization process. In the last section, we summarize the results of our analysis.

COLUMBIA BASIN PROJECT HISTORY

Statutory origins and the establishment of farm sizes

The Columbia Basin irrigation project began with allocation of funds under title II of the National Industry Recovery Act of June 16, 1933, although the project was specifically authorized by the Rivers and Harbors Act, which was approved on August 30, 1935. The Rivers and Harbors Act authorized the construction of a high dam to provide power, flood control, irrigation, recreation, and water storage in the Columbia Basin.

This dam was the Grand Coulee Dam, whose construction as a low dam had begun in 1934 with money appropriated from the State of Washington after President Franklin Roosevelt had recommended the allocation of $63 million in public works administration funds for its construction.

The initial directive in planning the settlement of the CBP was given by the Anti-Speculation Act of May 27, 1937, and this, in turn, was amended by the Columbia Project Basin Act of 1943, reauthorizing the project and bringing it under the provisions of the Reclamation Project Act of 1939. The CBP received its first water in 1948 for 586 acres. In 1979, more than half a million acres were being irrigated with project water.

The Anti-Speculation Act limited the acreage that could be held in private ownership by any one owner to 40 irrigable acres while it set minimum acreage at 10 acres per farm unit and specified restrictions on the sale of land in the project. All irrigable land in excess of 40 irrigable acres held in private ownership by one owner was designated as "excess" land and, therefore, could not receive project water. No one who refused to sell excess land at prices set by the Secretary of the Interior would receive water for the land. Owners of excess land were required to execute a valid recordable contract for receiving irrigation water from the project. Spouses were considered separate people and each was allowed to hold up to 40 irrigable acres or together a couple could hold 80 irrigable acres of community property. If excess land was sold at a price higher than its appraised value, the difference between that value and the sale price was to be paid to the U.S. Government.

These restrictions thus provided the 1937 Act with a legal framework for limiting acreage and preventing speculation. However, some analysts of the Act thought that the productive capacity of the land had not been considered when the size of farm units was fixed. Therefore, an amendment included in the Columbia Basin Project Act of 1943 allowed a range from 10 to 160 acres. The 1943 Act also subjected the project to the provisions of the Reclamation Project Act of 1939 and required that disposal of excess land had to follow the existing Bureau of Reclamation rules.

The 1939 Act has been interpreted by the Department of the Interior as authorizing the government to subsidize irrigation development with excess revenues from electrical power sales. Under this interpretation, farmers paid only a fraction of the total construction costs of irrigation development. This act also provided that the obligated payment for the irrigation distribution system had to be made in 40 years, but payment of construction charges for water delivered to any given block of land did not have to begin until 10 years after water had first been delivered to it. Finally, the 1939 Act also authorized the United States to allocate portions of the total project cost to flood control and navigation (these costs did not have to be reimbursed).

After World War II, changes in market outlook, technology, and the costs and prices of farm commodities justified another look at the constraints on farm size in the CBP and, accordingly, the Bureau of Reclamation, the State College of Washington, and the Bureau of Agricultural Economics of the U.S. Department of Agriculture studied them. They recommended that farm sizes be larger than those initially proposed for the project. However, because farm sizes still had to conform to the purpose of the Columbia Basin Act--which was to establish farm units of sufficient acreage to support the average family at a suitable level of living--the new recommendations did not differ significantly from what was already in effect. It was still considered desirable that a single unit not contain more than 80 acres of Class 1 land unless a larger acreage was made necessary by difficulties of topography or cultural features. As of 1973, almost one-fourth (23.5 percent) of the farms were 80 acres or smaller but the remainder ranged from 80 to more than 2000 acres in size.

Changes in water charges

The history of repayment methods and contracts for most reclamation projects is complex, and the CBP is no exception. In general, the repayment contracts of the CBP have been based on the Reclamation Project Act of 1939 and the Columbia Basin Project Act of 1943. In the beginning, then, the Bureau of Reclamation estimated construction cost obligations to irrigation blocks by using the "normal and percentage" formula (although it never clearly explained the formula). Initially, these obligations averaged $85 per acre and were repayable over 40 years at no interest after a 10-year development period for the block. The charge of $85 per acre was for construction costs only; operating and maintenance costs were added to that amount. The $85 charge was also intended to cover all drainage costs up to $8 million, beyond which the farmers would be responsible for the cost of all drainage.

Each district's share of the $85 per acre charge was determined by considering the relative productivity of the land in that district. Annual installments of the construction cost obligation averaged $2.125 per acre. Annual charges for operation and maintenance of the irrigation works averaged $5.50 per acre for the development period or the first 10 years. These charges were graduated so that 70 percent of the average annual estimated 10-year cost per acre was to be paid in the first year, 80 percent in the second, 90 percent in the third, and 100 percent the fourth. In the fifth and succeeding years of the 10-year development period, the annual charges increased such that the allocable costs for operation and maintenance for the development period for land within a given block could be repaid in 10 years.

In 1968, responsibility for operation and maintenance of the irrigation works was transferred to the irrigation districts. Landowners were required, in return, to pay to the Federal Government that portion of the construction costs that had been allocated to irrigation; their payment was based on their ability to pay. Landowners were also required to pay the irrigation district for the annual cost of operating and maintaining the facilities in that district. By 1979, these charges ranged among districts from $10 to $14 per acre, excluding costs for district functions and capital repayment to the Bureau of Reclamation. In 1980, the average total payment among districts for all water costs was approximately $18 per acre.

Differentiation of land values

Government policy in directing the CBP intended initially to provide land to as many people as possible but created very small farms, many of which were incapable of sustaining adequate family incomes. As a result, the rate at which farm units were consolidated during the first decade of the project was quite high. The inadequacy of farm income probably tended to depress land values during this period as well.

There has always been a strong presumption in studies of the CBP that land value is a function of land class. As many as 22 land classes were identified in the project's early days, but over time these were consolidated into the four that are recognized for most purposes today. In recent years, distinctions among land classes have been blurred even more by the advent of center pivot irrigation systems, which give farmers the ability to manage irrigation water on the sandy, shallow, and steep lands that constitute primarily the lower land classes. The distinction of four irrigable land classes is still maintained, but the range of market value from Class 1 to Class 4 has narrowed.

The four classes provide a good basis for estimating land value, although lands of the same class do not necessarily have the same value because of variation in rainfall across the project area. Land where rainfall is greater can produce dryland wheat and is considered more valuable than land where rainfall is less and that can be used only for grazing. Among the three districts in the CBP, the East Irrigation District has the highest proportion of tilled land, the Quincy Irrigation District has very little tilled land, and the South Irrigation District has some tilled land and some sagebrush grazing land.

Table 8 presents a review of estimated land values, payment capacities, and water charges for the CBP from 1945 to 1978. The farm sizes are those generally considered necessary to support a typical farm family and vary with land quality--the smallest farm is always on the best land. The table shows rather clearly, too, that the farm sizes identified in the CBP as adequate to provide income for the average farm family gradually increased over time.

In the early years of the project, land values were established meticulously for a wide range of classes, but the distinctions became much less important over time. Today, most farmers, economists, and land appraisers speak only in terms of average land values. It is still true that land in Class 1 has the higher market value, other things being equal, than land in Class 3, but the difference is much narrower than it was 35 years ago.

MODELING PROCEDURES AND RESULTS

Statement of the problem

Land that is irrigated has greater value than land that is not. Farmers in the CBP have gained some pure profits because of the capital subsidies for the water delivery systems. The profits are reflected in the amount by which the value of irrigated land

Table 8

Estimated CBP Land Values
and Their Weighted Averages 1945-78
(in Dollars per Acre)

	Percent of total	Farm size in acres	Land value: Raw	Land value: Irrigated
1945				
Class 1	29	50	$ 25.00	$ 55.00
1, 2T, 3T	28	60	19.00	46.00
2S	23	80	9.00	35.00
3S	20	160	5.00	20.00
	100		$ 15.64	$ 40.88
1953 a/				
Class 1	26	57	$ 32.50	$ 250.00
2	33	78	13.00	200.00
3	27	100	7.50	150.00
4	14	100	7.50	150.00
	100		$ 15.82	$ 192.50
1960				
Class 1	22	68		$ 450.00
2	38	82		300.00
3	15	105		150.00
3-4 b/	25	115		120.00
	100		$100.00	$ 265.50
1968				
Class 1		68		
2		82		
3		105		
4		115		
			$150.00	$ 550.00
1971				
Class 1	29	160		
2	20	160		
3	17	160		
1975 c/				
Class 1		233		
2		233		
3 normal		233		
3 sandy		310		
			$250.00	$ 800.00
1978				
Class 1		233	$290.00	
2		233	280.00	
3 normal		233	150.00	
3 sandy		310		
				$1,000.00

Source: Data for all years are from U.S. Bureau of Reclamation studies for 1945, 1953, 1960, 1968, 1971, 1975, 1978. Dryland values for 1975 are from a 1976-77 study. Irrigated land values for 1978 were estimated from budget studies representing 1976-77 and 1979. Data were not shown for empty cells.

a/These 4 land classes were consolidated from 22 classes.

b/The composite Class 3-4 comprises 60 percent Class 3 and 40 percent Class 4.

c/Class 3 deferred and bypassed lands in the CBP are generally classified as sandy; Class 3 lands in the East High Project are termed "normal."

exceeds the value of nonirrigated land. The capitalization of profits from farming into land values is not straightforward, however. Permanent changes in profit levels from farming result, in the long run, in changes in land values, although the relationship between these two phenomena may be quite complicated and difficult to substantiate.

In this section, we estimate changes in annual returns to land that could result from charging more for water delivered to farms in the CBP. The higher water charges could be designed with the purpose of recapturing more of the capital costs for irrigation water delivery facilities in the CBP than has happened in the past. An alternative motivation for increasing water charges to farmers might be to adjust them to reflect the increasing opportunity cost of water if, by being left in the Columbia River, it were to produce hydropower. (124)

Linear programming model

Farmers in the CBP today produce about 40 different major crops, although any single farm seldom produces more than three or four crops at one time. At least three major types of irrigation system dominate the CBP--gravity flow, side roll sprinkler, and center pivot--although individual farms normally have only one or at most two systems. When these characteristics are combined with farm sizes, soil types, slopes, locations, managerial abilities, available labor, machinery, and equity positions, the number of farm types necessary to represent all farms in the CBP becomes quite large.

More importantly in choosing an appropriate model, any single farm composed of a unique set of all such characteristics as exist in the CBP could actually change substantially in the long run because of its need to adjust to higher water charges. In response to higher water costs, a farm might change its management levels, its crops, or even its irrigation systems. Moreover, it is apparent that land values are determined not by the management options employed at a given point in time on any single farm but by the expectations of potential landowners who assume that an optimum combination of all options is available to that farm.

Given this complexity, we chose a single linear programming model to represent irrigated agriculture in the CBP because it provides the most realistic estimates of changes in farm income and land value that would result from higher water charges. The model reflects average yields, soils, production costs, and managerial abilities given seven major crops that reflect crop alternatives that are available to farmers in the region. Gravity, side roll, and center pivot irrigation systems are included in the model in their present mix and so is the long run option of changing the mix in response to higher water charges.

The seven crops in the model represent all those currently available to CBP irrigated farms. The current acreage of each crop and the range of potential adjustment for each crop are shown in table 9. These crops actually occupy about 80 percent of total land in the CBP. Orchard and vineyard crops are not included in the total land constraint of the model, because their acreages are so small and their production and irrigation methods are so specialized that they were not believed significant in establishing land values.

Table 9

Current and Allowable Acreages of Seven CBP Irrigated Crops

	Current	Upper bound a/	Lower bound a/
Alfalfa	171,000	200,000	110,000
Wheat	141,000	200,000	65,000
Corn	65,000	100,000	25,000
Potatoes	60,000	60,000	0
Beans	45,000	45,000	15,000
Seed peas	30,000	35,000	15,000
Pasture	22,000	500,000	20,000

a/These are assumed values, but are consistent with the existing constraints in the CBP.

The seven crops in table 9 are assumed to represent the water requirements and the profitability of all crops in the region. That is, wheat represents all small grain crops, potatoes represent all high value vegetable crops, seed peas represent all seed crops, and so on.

Crop yields in the model are an average of yields attained during the past 5 years in the CBP. The yield for each crop is probably less than what can be obtained consistently with good management. It is possible that higher water costs would force farmers either to use better management or to sell out quickly. To the extent that either occurred, the assumed yields may overestimate the effect of higher water costs on land values.

Crop prices in the model are an average of the prices that farmers received in the CBP during the past 3 years. The only exceptions are wheat and hay, whose prices increased above the 3-year average to a level believed to be more consistent with expectations for the future.

The estimated 1981 costs of production for CBP crops include land taxes but exclude the capital costs of land. Also excluded are all costs associated with obtaining and applying irrigation water. Thus, the net returns estimated in the model are returns to land and water. To obtain returns to land only, it would be necessary to deduct all costs for water--labor, energy, on-farm system, and water charges.

The profitability of crops varies widely. Potatoes, representing vegetable crops, show the highest level of profit among competing crops. This is consistent with the experience and expectations of farmers in the region. Using 5-year average yields and 3-year average prices, we expected to eliminate some of the short run disparity in net returns among crops. However, it was still necessary to impose acreage limits on each crop (as shown in table 9) to keep the crops within the bounds of historical experience.

The model uses three irrigation systems to represent the systems in the CBP. The gravity flow system is assumed to consist of concrete-lined head ditches and siphon tubes; automated gated pipe and tailwater pumpback systems are not included in the gravity flow system. The sprinkler systems used are the side roll and center pivot; solid set sprinkler systems are associated mainly with orchard and vineyard crops and so they are not included. The current acreage of the three irrigation systems is shown in table 10. The acreage of sprinkler systems was allowed to increase under some scenarios of this analysis.

Table 10

Annual Irrigation System Acreages and Costs
(in Dollars per Acre)

	Gravity	Side roll	Center pivot
Acreage			
Current	214,000	170,000	150,000
Upper limit	--	400,000	350,000
Costs			
Maintenance	$ 1.52	$10.14	$ 9.64
Interest on operating capital (6 months at 12%)	1.25	1.82	1.64
Depreciation and interest	20.69	47.19	54.67
Taxes and insurance	2.57	5.80	6.49
Total	$26.03	$64.95	$72.44

Source: T. A. Powell, B. L. Calkins, and K. H. Lindeborg, "Irrigation Costs for Southern Idaho," Progress Report No. 213, Idaho Agricultural Experiment Station, 1980.

The annual capital and maintenance costs of each irrigation system are also shown in table 10. Costs for the gravity flow system are slightly below those for new, well-designed gravity flow systems, but they are probably higher than the amortized cost of most existing gravity flow systems in the CBP because of the inflation associated with the construction costs of systems built after most present systems were in place. In fact, little, if any, new acreage in gravity flow systems is added each year and it has actually decreased rapidly in recent years as farmers have replaced these systems with side roll or center pivot sprinklers.

Center pivot sprinkler systems have grown most rapidly in recent years, partly because they reduce labor and management problems. Some crops that are especially sensitive to moisture such as potatoes are now grown almost exclusively under center pivot systems. Ultimately, however, the acreage of center pivot systems is restricted by the size and shape of the fields to be irrigated, as they are not generally adaptable to fields that are irregular or smaller than 40 acres. The ideal field size is a square 160 acres; a center pivot system with corner catchers can irrigate about 154 of the 160 acres. The model assumes an upper limit of 350,000 acres served by center pivots.

In the analysis of the model, we considered three separate sets of assumptions about how irrigation systems would be operated as water charges are increased. One set reflects current irrigation and pumping plant efficiencies and represents only the short run. The second set assumes that farmers might increase the application efficiency of water by improving irrigation management. This assumption requires 20 percent more irrigation labor for gravity flow systems and 10 percent more irrigation labor for sprinkler systems. Additionally, farmers would increase the efficiency of their pumping plants by improving maintenance, thus decreasing energy requirements and the total amount of water pumped.

The third set of assumptions represents a long run situation in which further improvements in application efficiency could be achieved with gravity flow systems by adding a tailwater pumpback facility. Sprinkler systems would be further improved in their pumping plant efficiency but, in addition, would be converted to low pressure application. These changes would reduce energy requirements substantially but would add to the annual ownership costs. The long run improvement of sprinkler systems would be more likely to occur in response to higher energy costs than to higher water costs.

Linear programming results

With the linear programming model, we estimated the potential effects of rising water costs on farm income, crop production, and water use. We derived six sets of solutions, each with a separate set of assumptions about irrigation systems acreage, irrigation management, and irrigation technology. Water cost was derived by parametrically pricing irrigation water diversions from zero upward in increments of $0.25 per acre-inch.

It must be emphasized that the model is a rather simple, aggregate model of CBP agriculture. In reality, many more crops are grown in the area than in this analysis and it does not consider any of the effects of farm size, tenure arrangements, or the farmers' ages, off-farm incomes, indebtedness, equity positions, or planning horizons. These and many other factors would influence the adjustments farmers would make to higher water costs and, ultimately, land values. No single model could accurately consider all that might influence land values when the price or pricing method of only one input like irrigation water is changed. Despite this procedure's shortcomings, it provides a reasonable estimate of the average effects on farm income when water costs are changed.

Water costs for all water pricing schemes considered in the linear programming model are determined by unit of water rather than by land area, thus providing an incentive to use less water as its cost increases.

Solution 1 represents the present conditions of irrigated farming in the CBP and is shown in table 11. In this solution, all land was irrigated until water costs reached $1.00 per acre-inch, or the equivalent of about $50.00 per acre. With water costs very low, irrigation methods minimized energy costs. As water costs rose, efforts to conserve water increased. The crops requiring the most water were assigned to the most efficient irrigation system.

Eventually the model was forced to reduce the acreage of crops, those consuming the greatest amount of water being the first to go. Wheat and beans, being relatively profitable crops and using less water than most others, remained profitable longer than all but potatoes. Potatoes were still profitable when water cost $2.50 per acre-inch, or about $90 per acre of potatoes. Corn, peas, and pasture crops were never really profitable in this analysis and remained constantly at the minimum allowable acreage. Alfalfa was profitable at low water prices but began losing acreage as water prices rose to $0.75 per acre-inch and reached the minimum allowable acreage when water cost $1.00 per acre-inch.

Until water costs reached $1.00 per acre-inch, all irrigable acreage was used and all the acreage of each irrigation system was used. The side roll sprinkler irrigation system was the first to be reduced as total crop acreage decreased and crops using less water than others were shifted to the less-efficient gravity flow systems. When water cost $1.75 per acre inch, the acreage of gravity flow systems began to decrease and the acreage of side roll sprinklers increased again as a means of conserving water. This trend continued to $2.25 per acre-inch, at which point the acreage of side roll sprinklers reached its upper limit.

The amount of water used per irrigated acre decreased continuously as water costs rose. This was accomplished in the model by adjusting irrigation systems use and crops. The actual

Table 11

Solution 1: Present Conditions a/

Water price per acre-in.	Land irrigated 1,000 acres	Water diverted in. per acre	Energy used kwh per acre	Irrigation labor hr. per acre	Net return to land per acre	Water cost per acre
$0	534	58.5	507	2.84	$120.26	$ 0
0.25	534	55.2	629	2.59	105.25	13.79
0.33	534	53.3	658	2.50	101.93	17.60
0.50	534	52.1	750	2.41	92.48	26.05
0.75	534	52.1	750	2.41	79.45	39.07
1.00	495	50.8	687	2.40	66.53	47.06
1.25	475	50.0	659	2.40	55.35	54.49
1.50	475	50.0	659	2.40	44.24	66.65
1.75	475	49.5	680	2.35	33.16	77.11
2.00	475	49.1	690	2.30	22.50	87.35
2.25	475	47.9	764	2.13	11.37	95.84
2.50	445	47.4	808	1.96	1.29	98.82

a/Calculations for net return to land and water cost per acre are based on total irrigable acreage; all the rest is for irrigated acres only.

response to higher water costs might be even more pronounced than Solution 1 shows, given that the model imposed minimum acreages on all crops except potatoes, thus placing a substantive lower limit on the amount of water to be used. In any case, actual water delivery to farms would be only 90 percent of what is shown in table 11.

Energy use shown in table 11 is consistent with the adjustment process described above. First, the crops using the most water were allocated to gravity flow irrigation systems. As the cost of water rose, these crops were shifted to sprinkler systems, raising the amount of energy use. When irrigated acreage was first reduced by eliminating side roll sprinkler acreage, total energy use declined, but it rose again as the crop acreage shifted to sprinkler crops.

The use of labor per acre followed this pattern of water and crop allocation. It was highest when crops were most profitably produced without regard to the cost of water. Labor use decreased as the model relied more on the less labor intensive sprinkler systems.

The net return to land shown in table 11 is the residual income per acre after deducting land taxes and all costs for production, management, and water. Only land investment costs (interest) are excluded. In general, as water costs rise, the reduction in net returns to land are less than the associated increase in water cost. This implies that farmers make some mitigating adjustments to rising water costs. In fact, the short run nature of Solution 1 probably understates the potential adjustments that would be made in such a situation.

The other solutions consider improvements in irrigation management and technology as well as a larger investment in sprinkler irrigation systems. Solution 2 considers an improvement in irrigation management and is summarized in table 12. The differences between these results and those of Solution 1 are very small. In general, slightly less water and less labor were used in growing crops and a bit more labor was used for water management.

Solution 3 in table 13 allows both low pressure sprinkler technology and improved management. There is little additional response to higher water costs compared to Solution 1. This is not surprising, however, because the improved technology of low pressure sprinkler systems is designed to save energy by reducing the operating pressure required of sprinklers, but it does not save water and, hence, does not aid farmers in adjusting to higher water costs.

Solution 4, in table 14, uses present technology and management but allows for an increase in acreage irrigated by sprinkler. The option of additional acreage was used to explain the increased use of water as side roll increased and center pivot decreased at low water costs. That is, most land was irrigated with only side

Table 12

Solution 2:
Present Irrigation Systems
with Improved Management a/

Water price per acre-in.	Land irrigated 1,000 acres	Water diverted in. per acre	Energy used kwh per acre	Irrigation labor hr. per acre	Net return to land per acre	Water cost per acre
$0	534	58.4	505	2.84	$120.27	$ 0
0.25	534	55.1	626	2.60	105.77	13.78
0.33	534	53.5	655	2.50	101.92	17.64
0.50	534	52.0	747	2.42	92.52	25.97
0.75	534	52.0	747	2.42	79.53	38.96
1.00	495	50.6	684	2.41	66.65	46.91
1.25	475	49.8	656	2.41	55.50	55.36
1.50	475	49.8	656	2.41	44.43	66.44
1.75	475	49.4	677	2.36	33.38	76.86
2.00	475	49.2	688	2.34	22.42	87.46
2.25	475	47.7	261	2.15	11.66	95.51
2.50	445	47.4	804	1.97	1.62	98.46

a/Calculations for net return to land and water cost per acre are based on total irrigable acreage; all the rest is for irrigated acres only.

Table 13

Solution 3: Present Irrigation Systems with Improved Management and Low Pressure Technology a/

Water price per acre-in.	Land irrigated 1,000 acres	Water diverted in. per acre	Energy used khw per acre	Irrigation labor hr. per acre	Net return to land per acre	Water cost per acre
$0	534	58.4	505	2.84	$120.27	$ 0
0.25	534	55.1	621	2.60	105.78	13.77
0.33	534	53.3	684	2.50	101.43	17.58
0.50	534	51.9	742	2.42	92.53	25.96
0.75	534	51.8	743	2.43	79.56	38.83
1.00	495	50.4	679	2.42	66.72	46.74
1.25	475	49.6	651	2.42	55.62	55.14
1.50	475	49.6	651	2.42	44.59	66.17
1.75	475	49.2	666	2.38	33.59	76.52
2.00	475	48.9	678	2.36	22.68	87.06
2.25	475	47.5	750	2.16	11.96	95.07
2.50	445	47.0	793	1.99	1.97	97.97

a/Calculations for net return to land and water cost per acre are based on total irrigable acreage; all the rest is for irrigated acres only.

Table 14

Solution 4:
Increased Sprinkler Irrigation
with Present Management and Technology a/

Water price per acre-in.	Land irrigated 1,000 acres	Water diverted in. per acre	Energy used khw per acre	Irrigation labor hr. per acre	Net return to land per acre	Water cost per acre
$0	534	61.2	506	3.46	$121.27	$ 0
0.25	534	60.4	523	3.32	106.05	15.11
0.33	534	51.2	710	2.25	101.95	16.90
0.50	534	49.4	728	1.80	92.92	24.68
0.75	534	49.0	733	1.75	80.65	36.77
1.00	534	49.0	733	1.75	68.39	49.03
1.25	475	47.8	652	1.96	56.79	53.14
1.50	475	47.1	674	1.80	46.26	62.87
1.75	475	47.1	674	1.80	35.78	73.35
2.00	475	43.7	786	1.27	25.67	77.76
2.25	475	39.7	987	0.72	16.57	79.48
2.50	475	39.7	987	0.72	7.74	88.31

a/Calculations for net return to land and water cost per acre are based on total irrigable acreage; all the rest is for irrigated acres only.

roll and gravity systems, but at a water cost of $0.50 per acre-inch, there was a major shift from side roll systems toward center pivot systems. The capital cost and the water use efficiency of irrigation systems are lowest for gravity flow and highest for center pivot sprinkler. By the time water costs reached $2.00 per acre-inch, gravity flow systems had shifted gradually to the side roll system. At $2.50 per acre-inch, only sprinklers were being used. The increased use of sprinklers explains why more energy and less labor were were used compared to Solutions 1, 2, and 3.

Solutions 5 and 6 are summarized in tables 15 and 16. They differ little from Solution 4. The only significant observation is that, for Solution 6, the net return to land remained positive until water costs reached $2.75 per acre-inch, while all other solutions provided a negative return to land at this price.

Selling water to farmers at a fixed rate per unit of water can encourage them to conserve water and it also recovers from them a higher share of water delivery costs. The effect that is desired can be achieved by choosing an appropriate level of water cost from Solutions 1-6. In no case, however, is it possible to get the full opportunity cost of water--about $3.33 per acre-inch--without the returns to land becoming negative. In short, the value of water used in irrigation is currently less than the value of water used for hydropower production.

LAND VALUE ESTIMATES

General considerations

We developed the land value model from the perspective of a person who both owns and operates a farm in the CBP, but many farms are owned by one person and farmed by another. Most of these arrangements are crop-sharing leases in which a landlord and a tenant share revenues and expenses in a given proportion. From the landlord's viewpoint, net returns to the farmland equal his or her share of total revenues minus his or her share of variable costs, minus all the fixed costs, minus the opportunity cost of his or her management activity, if any. Depending on the specific provisions of the arrangement, some of the variable costs may not be shared--that is, some of the operating costs may be paid completely by the landlord or by the tenant.

Determining net returns to farmland under a cash rental arrangement is easier. Net returns equal the cash rental minus the fixed costs, minus the opportunity cost of the landlord's management activity, if any. All the other components of the land value model apply to the landlord as they do an owner-operator, regardless of the leasing arrangement.

When the operator is not the owner but the tenant, the effect of changing water charges will depend on the specific leasing arrangement and the nature of the water charges, and the propor-

Table 15

Solution 5:
Increased Sprinkler Irrigation
With Improved Management a/

Water price per acre in.	Land irrigated 1,000 acres	Water diverted in. per acre	Energy used kwh per acre	Irrigation labor hr. per acre	Net return to land per acre	Water cost per acre
$0	534	61.2	502	3.89	$121.29	$ 0
0.25	534	60.3	517	3.32	106.10	15.08
0.33	534	51.1	705	2.25	101.98	16.87
0.50	534	49.2	721	1.82	93.00	24.59
0.75	534	49.0	728	1.82	80.74	36.74
1.00	534	48.9	731	1.76	68.49	48.89
1.25	475	47.6	649	1.97	56.93	52.96
1.50	475	47.0	671	1.81	46.43	62.66
1.75	475	47.0	671	1.81	35.99	73.10
2.00	475	43.0	801	1.22	26.16	76.55
2.25	475	39.7	970	0.76	16.99	79.39
2.50	475	39.7	970	0.76	8.14	88.21

a/Calculations for net return to land and water cost per acre are based on total irrigable acreage; all the rest is for irrigated acres only.

Table 16

Solution 6:
Increased Sprinkler Irrigation with Improved Management and Low Pressure Technology a/

Water price per acre-in.	Land irrigated 1,000 acres	Water diverted in. per acre	Energy used kwh per acre	Irrigation labor hr. per acre	Net return to land per acre	Water cost per acre
$0	534	61.2	502	3.46	$121.29	$ 0
0.25	534	60.3	505	3.33	106.11	15.06
0.33	534	50.4	709	2.07	101.52	16.64
0.50	534	49.3	711	1.88	93.01	24.65
0.75	534	48.9	727	1.83	80.75	36.64
1.00	534	48.7	731	1.77	68.54	48.74
1.25	475	47.5	649	1.98	57.01	52.77
1.50	475	46.8	671	1.82	46.55	62.44
1.75	475	46.7	658	1.82	36.15	72.76
2.00	475	42.3	797	1.18	26.45	75.24
2.25	475	39.6	933	0.81	17.37	79.22
2.50	475	39.6	933	0.81	8.57	88.02

a/Calculations for net return to land and water cost per acre are based on total irrigable acreage; all the rest is for irrigated acres only.

tion that each pays will fall between two extremes. At one extreme, as under a crop-sharing lease for which water is priced as a fixed charge, the landlord may bear the entire increase in water charges. At the other extreme, as under a cash-rental lease for which water is a variable cost, the tenant may bear the entire increase in water charges.

The investment analysis model in this discussion assumes the individual viewpoint of a farmer who determines a maximum bid price given personal expectations and understandings of the marginal tax rates, down payments, and so on. Different potential buyers will obviously prefer their own maximum bids for the same parcel; it is quite possible, for example, that six people will have six different maximum bid prices for the same parcel. In other words, farmland has no inherent, underlying value. Its value depends on circumstances and the expectations and characteristics of individual people.

Much of the farmland that is sold in a given year is on the market because its owner has retired or died. Other farms are held as investment assets and their owners are willing to sell at any time that a particular reservation price is met. Still other farm owners will not even consider selling their land, no matter what the market price, for various personal reasons.

On the demand side, many farmers buy farmland to add to their existing acreage. This is particularly true of farmers whose land is close to another farm that may come onto the market only once in a lifetime. People who think of farmland as an investment asset and a good hedge against inflation are another important group of potential buyers, at least in some areas. Demand for farmland among people with low incomes or no expertise in farming is, of course, very low.

While we recognize that different individuals in the market ascribe different values to the farmland, the investment analysis model does not show alternative land values. We calculated only one value of land for each set of assumptions about a given farmer's tax rate, expectations, planning horizon, and so on. This value is interpreted as the hypothetical market clearing price for farmland in the CBP.

It has been said that the value of irrigation water is reflected in land values if "the expected future stream of value received from the water which is <u>in excess</u> of the charges for water paid by the farmer." 1/ In other words, only the excess of benefits over payments for water will be capitalized into farmland values. In the context of our land value model, this "surplus" will be an increase in net returns to farmland. The expected annual change in net returns and the expected annual increase in farmland values may also be affected indirectly, and these would then be capitalized into farmland values.

The supposition that the surplus resulting from the purchase and use of irrigation water will be capitalized into land values rests on two assumptions. First, agricultural land is assumed to be the only fixed factor of production. If other fixed factors are present, part of the surplus may be reflected in their values. Second, it is assumed that there is some permanent future claim to the irrigation water. Providing water only one time has no effect on future net returns, and water benefits will not be fully capitalized into land values without a guarantee of water access. 2/ It must be added that any uncertainty regarding the quantity of irrigation water farmers will be able to obtain will undoubtedly be reflected in the value of irrigated farmland, and this uncertainty represents an additional factor in the real opportunity cost of capital.

Irrigation benefits affect land values primarily through changes in net returns. If farmers pay for irrigation water per acre, as they do now, then the water charge is essentially a fixed cost, determined by how much land they buy water for. Increasing this fixed cost does not change the marginal conditions that determine the farmers' optimal input-output combinations. Therefore, an increase in water charges will be followed by an equal decrease in net returns.

If farmers pay for irrigation water per acre-foot, then the water charge is essentially a variable cost, determined by how much water they put on their land. An increase in this variable cost will encourage some substitution of other inputs for the irrigation water; for example, a farmer might employ extra labor in an effort to minimize water losses. To determine the total effect of the change in water charges, net returns with the increase should be compared to net returns without the increase. Economic theory suggests that a change in a variable cost affects net returns less than an equal change in a fixed cost.

The with-and-without comparison will reflect the fact that owners of irrigated farmland will not realize a change in property values deriving from a change in water charges until after they sell their land. That is, a decrease in net returns resulting from a change in water charges will immediately decrease annual cash flows, which may in turn affect adversely the farmers' ability to meet their debt obligations, causing some to sell out.

Assumptions and procedures

Analyzing the linear programming model produced estimates of net returns to land for alternative costs of irrigation water. These estimates in turn allow us to estimate changes in land value resulting from changes in water costs. To estimate land values, we used the following equation:

$$P_o = A_{dn} \left[(NR_1)(1-t) \right] + A_{em} (I)(t) + (1 + e)_{-n} \left\{ P_n (1 + S)^n - \left[P_n (1 + S)^n - P_o \right] (0.4t) \right\}$$

where:

P_o = present value of farmland;

A_{dn} = present value of a \$1 annuity realized in n years and discounted annually at interest rate d;

d = interest rate used to discount land returns and equal to the investor's required after-tax real rate of return on the land investment plus the annual rate of general price inflation minus the annual nominal rate of increase in land returns;

n = number of years in the investor's planning horizon;

NR_1 = expected nominal before-tax returns to farmland in year 1;

t = average income tax rate on ordinary income;

A_{em} present value of \$1 annuity realized for m years and discounted annually at interest rate e;

e = interest rate equal to the investor's required after-tax real rate of return plus the annual rate of general price inflation and used to discount (1) income tax savings resulting from the deduction of interest payments and (2) after-tax value of land at the end of the ownership period;

m = number of years in the repayment period on the loan used to finance land acquisition;

P_n = price received for recent sales of comparable land;

S = nominal average annual change in land prices.

I = average amount of interest paid per year on the land loan and is computed as follows:

$$I = \frac{DP_o}{A_{im}} - L$$

where: D = proportion of land purchase price financed with debt capital;

A_{im} = present value of \$1 annunity for contractual interest rate i on land loan for m years in loan repayment period; and

L = DP_o/m.

To obtain the value of land, we computed the present value of future net benefits accruing to the land owner. These benefits include after-tax earnings from agricultural production, income at the end of the investor's planning horizon. To develop estimates of these benefits and associated land values, first we obtained estimates of current gross receipts, nonland costs, and returns to land per acre from the linear programming model, using different assumptions for irrigation costs, irrigation technology, efficiency of water use, and so on. Then we converted returns to land from the linear programming analysis to land values by the land valuation model.

Many assumptions could be made about the most important influences on land value. Since any set of such assumptions requires a look into the future, it is difficult to prove that one is better than another. For this reason, we developed three sets of base assumptions--including required rate of return, general price inflation, average income tax rate, financing terms, and change in land prices--for operating the land valuation model. The elements of each set and the three situations comprising them are shown in table 17.

The sets in Situations 1 and 2 are similar in most all respects but the length of the planning horizon. The first set of assumptions describes a long run situation in which the planning period runs as long as 25 years. This would be appropriate for people investing in land with no expectation of short run liquidation, typically an owner-operator. The set of assumptions in Situation 2 represents a short run situation in which the planning horizon is only 5 years long. This situation might apply to people investing in land but leaving the farming to others or to farmers nearing retirement. The only other differences are in the average annual rate of general price inflation and the average annual nominal rate of increase in land returns, both of which are 7 percent in the long run (Situation 1) and 8 percent in the short run (Situation 2).

In general, the assumptions for Situations 1 and 2 as shown in table 17 are intended to represent today's world, with water costs low and returns to land relatively high. The average income tax rate of 20 percent may seem large but probably does represent the land investors, who are major determinants of land values. The values of all the variables in table 17 are somewhat arbitrary, but a sensitivity analysis of them shows the effect of each on land values and, where possible, we used published, secondary data to estimate them. For example, the average ratio of debt to land purchase price was 71 percent for 1980 sales in the Pacific States, according to a publication of the U.S. Department of Agriculture, "Farm Real Estate Market Developments." The same publication reports that the nominal annual compound rate of increase in irrigated farmland prices in Washington was just under 8 percent for 1971-80; the annual compound rate of increase in the consumer price index over the same period was also just under 8 percent. When we converted land returns at today's water prices from the linear programming analysis to a land value based on our assumptions, we obtained values close to the current selling prices of land in the Columbia Basin.

Raising water costs would decrease farmers' returns to land. That is, the linear programming model shows that as water charges

Table 17

Assumptions for Three Situations in the Land Valuation Model

	Situation 1	Situation 2	Situation 3
Gross receipts per acre a/	20%	20%	0%
Total costs (except land) per acre a/	5%	5%	5%
Price of comparable land per acre	$1,700	$1,700	$1,700
Loan repayment period (years)	25	25	25
Planning horizon (years)	25	5	25
Average income tax rate	20%	20%	20%
Investors required after-tax real rate of return on land investment	5%	5%	5%
Average annual rate of general price inflation	7%	8%	7%
Average annual nominal rate of increase in land returns	7%	8%	0%
Amount of purchase price that is debt financed	70%	70%	70%
Interest rate on land investment loan	12%	12%	12%
Average annual nominal rate of increase in land price	8%	8%	3%

a/Gross receipts and total costs excluding land vary with the cost of water as shown in table 18.

rise from zero to $2.50 per acre-inch of water, net returns to land approach zero. Raising water costs substantially higher than what farmers pay today would, therefore, change their incomes and, hence, many of the assumptions they use to determine the value of their land. Therefore, the assumptions used for Situations 1 and 2 would not be appropriate if water costs were doubled or tripled.

Accordingly, we developed a third set of assumptions to represent a land investor's assumptions after experiencing a substantial increase in water costs. Table 17 shows that in Situation 3 reduced net income would lower the average tax rate to zero. The rate of increase in land returns would drop to zero, or perhaps become negative. And the rate of increase in land value would also diminish. Somewhere between current water costs and water charges of about $2.00 per acre-inch, a land investor's financial expectations would change from those of Situation 1 to those of Situation 3. Many assumption sets at water cost levels between these extremes could, of course, pertain.

Estimated land values

We calculated Solutions 1 through 6 from the linear programming model with water price at a constant average rate ranging from zero to $2.50 per acre-inch diverted, and the results of all six solutions are greatly similar. 3/ We chose Solution 5 for the land valuation model because it reflects the most realistic long run view of the CBP. (The gross revenue, total cost excluding land, and the net returns to land for this solution are shown in table 18.)

Table 18

Gross Revenue, Total Production Costs Excluding Land, and Net Returns to Land

Water price per arce-inch	Gross revenue per acre	Total cost per acre excluding land	Net returns to land per acre
$0	$512.88	$391.59	$121.29
0.25	512.88	406.75	106.13
0.33	512.88	410.90	101.98
0.50	512.88	419.88	93.00
0.75	512.88	432.14	80.74
1.00	512.88	444.39	68.49
1.25	466.47	409.54	56.93
1.50	466.47	420.04	46.43
1.75	466.47	430.48	35.99
2.00	466.47	440.31	26.16
2.25	466.47	450.48	16.99
2.50	466.47	458.33	8.14

The estimated land value associated with each level of water cost for Solution 5 under the assumptions of Situation 1 is shown in table 19. In this long run, relatively optimistic setting, land values equal about $2,239 per acre when water costs are zero. At a water cost of $0.50 per acre-inch, land values decrease to $1,882 per acre.

Table 19

Land Values Under Solution 5, Situation 1 (Long Run)

Water price	Land value	Change in land value
$0	$2,239	--
0.25	2,047	192
0.33	1,994	53
0.50	1,882	112
0.75	1,727	155
1.00	1,572	155
1.25	1,426	146
1.50	1,293	133
1.75	1,161	132
2.00	1,037	124
2.25	911	126
2.50	809	102

Land values in the CBP currently range from $1,500 to $2,000 per acre, with current water costs equivalent to about $0.33 per acre-inch. Using the assumptions of Situation 1 and Solution 5, this provides an approximate land value of about $1,980 per acre. It is probable, therefore, that we have slightly overestimated land values, most likely by underestimating total production costs. With production costs $20 per acre higher (at about 5 percent), our estimated land value would have been that which currently exists. Of course, a slight decrease in crop prices or yields or changes in a number of other assumptions in the land valuation model could also have resulted in an overestimation. In any case, it is the estimated change in land value associated with a change in water cost that is of the greatest interest, and this estimate is largely unaffected by the absolute level of land value.

The conditions of Situation 1 are long term, representing, for example, the attitudes of farmers investing in land for their own use and having planning horizons at least 25 years long. What about the investor who has a shorter planning horizon? Reducing the planning horizon has the effect of substantially reducing the change in land value associated with raising the water costs.

Table 20 shows what would happen under these conditions. The effects might be rather widespread immediately following a change in water costs, particularly if land owners believed that the change was temporary or that other factors such as higher crop prices or crop yields would eventually render the higher water cost insignificant. However, if an increase in water costs were not nominal but real and permanent, the long run view of land value would eventually prevail. Therefore, Situation 1 is more likely to represent the long run effects of higher water costs on land value in the CBP than is Situation 2.

Table 20

Land Values Under Solution 5, Situation 2 (Short Run)

Water price	Land value	Change in land value
$0	$2,080	--
0.25	2,014	66
0.33	1,996	18
0.50	1,958	38
0.75	1,905	53
1.00	1,852	53
1.25	1,802	50
1.50	1,756	46
1.75	1,711	45
2.00	1,669	42
2.25	1,626	43
2.50	1,591	35

If water costs were to rise precipitously, the assumption of Situation 1 would be inappropriate. A farmer with the very low returns to land shown by water costs greater than $1.50 per acre-inch would probably not be paying any Federal income tax. The farmer might expect returns to land to increase in the future, but the market price of land would be growing slowly. These pessimistic conditions are reflected by Situation 3 in table 17, the linear programming results of which are evaluated and displayed in table 21.

The assumptions of Situation 3 would be more appropriate if the cost of water were to rise to more than $1.50 per acre-inch. Thus, the land values in table 21 associated with water costs below this level are probably too low and would be better represented by the assumptions of Situation 1 (table 19). The lower land values of Situation 3 do reasonably reflect those expected as irrigated returns to land approach zero and the land reverts to its best alternative use of livestock grazing. Land that can be used for dryland wheat production would probably be put to that use as the price of water rose above $1.50 per acre-inch.

Table 21

Land Values Under Solution 5,
Situation 3 (Pessimistic Long Run)

Water price	Land value	Change in land value
$0	$1,161	--
0.25	1,042	119
0.33	1,009	33
0.50	939	70
0.75	843	96
1.00	747	96
1.25	656	91
1.50	574	82
1.75	492	82
2.00	415	77
2.25	336	79
2.50	273	63

We conclude that the estimated land values derived under Situation 1 are most appropriate when water costs are less than $1.00 per acre-inch, and the estimated land values derived under Situation 3 best represent results to be expected when water costs are more than $1.50 per acre-inch. Other, more appropriate assumptions would, of course, represent a transition from either of these extremes to the other.

Sensitivity of the land value model

All the land values in this study were derived under very specific assumptions for the operation of the land value model. In this section, we briefly test the sensitivity of each model parameter for the results of Solution 1 and Situation 1 as shown in table 22. We evaluated each parameter while holding all other parameter values constant.

Increasing the average tax rate reduces the imputed value of land when water costs are low. This effect diminishes as water costs increase. At the highest water cost level, increasing the average tax rate actually becomes a positive factor, thus raising land value. This phenomenon can be explained this way--when little income exists (that is, when water costs are high) increasing the tax rates has little downward influence on land values as long as farmers can continue to deduct their interest payments (which remain unaffected by changes in water costs). In any case, the average tax rate is a relatively weak force in determining land values. Other parameters are stronger.

For example, the assumed rate of general price inflation is a rather critical factor. A 1 percent increase here can depress land values as much as $150 to $300 per acre. A higher inflation

Table 22

The Effect of Selected Variables on Land Value Under Situation 1 and Solution 1

	Water price in dollars per acre-inch					
	$0	$0.50	$1.00	$1.50	$2.00	$2.50
Average tax rate						
20%	2,226	1,875	1,547	1,265	986	723
21%	2,217	1,869	1,543	1,263	986	724
Difference	-9	-6	-4	-2	0	+1
General price inflation						
7%	2,226	1,875	1,547	1,265	986	723
8%	1,925	1,610	1,315	1,062	812	575
Difference	-301	-265	-232	-203	-174	-148
Change in land returns						
7%	2,226	1,875	1,547	1,265	986	723
8%	2,391	2,002	1,638	1,326	1,017	724
Difference	+165	+127	+91	+61	+31	+1
Planning horizon						
25 years	2,226	1,875	1,547	1,265	986	723
26 years	2,228	1,870	1,536	1,250	965	697
Difference	+2	-5	-11	-15	-21	-26
Amount debt financed						
70%	2,226	1,875	1,547	1,265	986	723
71%	2,230	1,878	1,549	1,267	988	724
Difference	+4	+3	+2	+2	+2	+1
Interest rate on land loan						
12%	2,226	1,875	1,547	1,265	986	723
13%	2,251	1,896	1,567	1,279	997	731
Difference	+25	+21	+20	+14	+11	+8
Increase in land price						
8%	2,226	1,875	1,547	1,265	986	723
7%	2,080	1,728	1,400	1,119	840	576
Difference	-146	-147	-147	-146	-146	-147
Price of comparable land						
$1,700 per acre	2,226	1,875	1,547	1,265	986	723
$1,600 per acre	2,185	1,833	1,505	1,224	945	681
Difference	-41	-42	-42	-41	-41	-42

rate reduces the real (inflation adjusted) benefits from all three sources of return on which the land value is based.

The annual growth in returns to land is also important in determining land value. Of course, its effect is much greater when the returns to land are high--when water cost is low--than when the returns to land approach zero. When water costs $0.50 per acre-inch, the addition of 1 percent in the annual rate of growth in returns to land adds $127 per acre to the value of land. That drops to only $1 per acre when water costs $2.50 per arce-inch.

The length of the planning horizon does not affect land value much. Its effect is positive when water is free but increasingly negative as the water cost rises. To state this another way, we can say that as water costs rise and the return to land falls below the discount rate (the required rate of return), lengthening the planning horizon increases losses and, therefore, reduces land value. This parameter, like most of the others, would provide different measures of sensitivity if the value of the other parameters were held constant at alternative levels, but the same relative effects would still be observed. For example, the effect on land value of lengthening the planning horizon would still have a negative trend as returns to land decreased, but it could be either positive or negative throughout or it could turn from positive to negative at a different point.

The amount of debt financing does affect the value of land positively but not significantly. Of course, the sensitivity of this variable is influenced by the interest rate paid on debt, the length of loan, the income tax bracket, and the discount rate. A higher interest rate increases income tax benefits and land values in the same way that additional debt does.

Reducing the expected annual increase in the price of land depresses the present value of after-tax capital gains and, therefore, reduces the land value. Under the assumptions outlined here, reducing the annual land price increase from 8 to 7 percent decreased the land price by $147. While that price decline is not affected by water costs, it would be influenced by the tax rate on capital gains, the required rate of return, the inflation rate, the planning horizon, and the price paid for the land.

Finally, the price of comparable land represents the starting point for computing capital gains in the valuation model. A lower price for comparable land means that capital gains will be less, resulting in a lower land value. Capital gains are reduced because, over a specified period of time, compounding a smaller land price at a given annual rate of increase in land prices results in a small total rise in land price. A $100 reduction in the price per acre of comparable land will reduce the estimated value of land by $41 per acre, regardless of the water price.

NOTES TO APPENDIX II

1. J. W. Millman. "Land Values as Measures of Primary Irrigation Benefits." Journal of Farm Economics, 41 (1959), 238.

2. The assumptions are from 33:191-93 and Millman, pp. 239-42.

3. The tables for Solutions 1-6 show a priori results for a water price of $3.33 per acre-inch; they are not from the linear programming model. The necessary constraints assumed for the model render it inoperative at the high opportunity cost of water.

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