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National Resource Economics Handbook

Part 611 Water Resources Handbook for Economics

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Part 611 Water Resources Handbook for Economics

Contents:

Chapter 1	**Economic Analysis**
Chapter 2	**Agriculture**
Chapter 3	**Watershed Protection**
Chapter 4	**Urban Flood Damage**
Chapter 5	**Selected Evaluations and Benefits Procedures**
Chapter 6	**Costs and Cost Allocation**
Chapter 7	**Addendum, Supplements, Rehabilitation**
Chapter 8	**Wetland Economics**
	Appendixes
	Appendix A Miscellaneous Techniques
	Appendix B Investigation and Analysis Reports
	References
	Glossary

Chapter 1 Economic Analysis

Contents:

611.0100 Framework and standards 1–1

(a) Objective 1–1
(b) Economics and NRCS planning 1–2
(c) Evaluation standards 1–4
(d) Other evaluation considerations 1–9

611.0101 Application of economic analysis in project formulation 1–11

(a) Introduction 1–11
(b) Legal constraints 1–11
(c) Economics of project formulation 1–11

611.0102 Prices and yields 1–15

(a) Conceptual basis 1–15
(b) Agricultural prices 1–15
(c) Crop yields 1–16

611.0103 Annual equivalents 1–17

(a) Method 1—Worksheet 1–17
(b) Method 2—Spreadsheet 1–19

611.0104 Interest and annuity 1–21

(a) Compound interest 1–21
(b) Interest and annuity tables 1–21
(c) Definitions 1–21
(d) Example interest problems 1–24
(e) Discounting for lag in accrual of benefits 1–26
(f) Benefit lag examples 1–27

Tables

Table 1–1	An example of incremental analysis	1–12
Table 1–2	Interest and annuity tables	1–22
Table 1–3	Loan repayment schedule for repayment of $1,000 at 8 percent for 3 years	1–23
Table 1–4	One-time values, annual flows, and lag	1–26
Table 1–5	Discount factors at 6 and 8 percent rates for 50- and 100-year evaluation periods	1–28

Figures

Figure 1–1	Comparison of benefits and costs	1–13
Figure 1–2	Average annual costs and benefits worksheet	1–18
Figure 1–3	Method 2, PVCSTBEN computer spreadsheet for calculating average annual equivalents—costs and benefits	1–20

Examples

Example 1–1	Calculating annual replacement cost	1–8
Example 1–2	Indexing cost data	1–10
Example 1–3	Variable rate lag	1–30

Chapter 1 Economic Analysis

611.0100 Framework and standards

(a) Objective

The purpose of the Water Resources Handbook for Economics is to provide guidance for the economic analysis of water resource projects. Established economic theory and principles, and the economic concepts stated in the Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies (P&G) serve as the primary foundation for this document. P&G was issued March 10, 1983, by the Water Resources Council. The economist must blend the economic principles with a good sense of practicality. To encourage the economist to be creative and to allow for differences between projects, the handbook is not intended to be a "cook book." The first Economics Handbook for Water Resources was published in 1958 and then revised in 1964. Draft revisions occurred in 1974 and 1987.

(1) Federal objective plans
The Federal objective of water resource planning is to contribute to national economic development while protecting the Nation's environment (see P&G, chapter 1). Economic analyses of Natural Resources Conservation Service (NRCS) projects affecting water and related land resources are designed to quantify the contribution of each project to national economic development (NED). National economic development as defined in the P&G and, as used in this handbook, is the increase *in the net value of the national output of goods and services, expressed in monetary units.* Project plans may include monetary and nonmonetary benefits.

Water resource projects, which protect watersheds, reduce flooding, and provide for conservation, development, utilization, and disposal of water, contribute to NED in two ways:

- They alleviate problems affecting water and related land resources.
- They enhance opportunities to use these resources more intensively.

(2) Non-Federal objective plans
Plans developed for state and local entities will not be constrained by the Federal objective. Watershed protection projects should follow P&G except that they may develop a plan that may reduce NED benefits so that land treatment and other Federal, state, or local concerns are addressed. A full range of alternative plans should be systematically formulated to ensure that all reasonable alternatives are evaluated.

The National Watershed Manual (NWSM) Section 503.46(b) describes the NRCS Plan Formulation Requirements for land treatment measures. The recommended plan should be the most cost effective or least costly environmentally acceptable method of achieving the desired level of resource protection.

The plans developed for state and local concerns should be formulated to allow the decisionmaker the opportunity to judge the merits of the various alternatives.

Plan formulation should be a dynamic process. A number of obvious alternatives will be identified early in the planning process, perhaps at public meetings. As the alternatives become more clearly defined and new data are collected, additional plans may be introduced.

(3) Economics as a discipline
Economics is an important discipline in water resource planning. The economist's role includes coordinating physical data from many disciplines, establishing inter-relationships, drawing conclusions concerning the implications, and general problem solving thought processes. Prices and costs are usually added, but in some instances only nonmonetary conclusions are appropriate. Economics deals with the allocation of scarce resources and may concentrate on maximization, optimization, cost effectiveness, and least cost analysis. Also note that almost every evaluation tool used by the economist requires input from physical scientists.

(4) Related NRCS planning documents
(i) National Planning Procedures Handbook—
The purpose of the National Planning Procedures Handbook is to provide guidance in using the NRCS planning process to develop, implement, and evaluate resource plans (e.g., project plans and individual conservation plans).

***(ii) National Watershed Manual*—**The National Watershed Manual (NWSM) sets forth the minimum requirements for administering the Watershed Protection and Flood Prevention Act (Public Law 83-566). It relates the main parts of the law as well as other pertinent laws, Executive orders, secretarial memoranda, and regulations that affect administration and application of the Act (NWSM 500.00).

(iii) Economic and Environmental Principles and Guidelines for Water Related Land Resources implementation studies (Principles and Guidelines or P&G)—This document was developed to guide the formulation and evaluations studies of the major Federal water resources development agencies (NRCS, Corps of Engineers, Bureau of Reclamation, and Tennessee Valley Authority). It contains methods for calculating the benefits and costs of water resources development alternatives.

***(iv) Field Office Technical Guide*—**The Field Office Technical Guide (FOTG) is an essential tool for resource planning. It contains resource information, quality criteria for maintaining the five resources: soil, water, air, plants, and animals (SWAPA); Conservation Practices Physical Effects (CPPE); and Conservation Effects for Decisionmakers (CED). It should be an initial source for needed data and information.

Economics material is in Sections I and V. Section I(a) includes a reference list of economic material. Section I(b) contains cost data, such as cost lists for practice components, average state price for commodities, flat rate schedule for conservation practices, and amortization tables. Section V contains the various components of conservation effects.

(v) National Resource Economics Handbook for Conservation Planning (under development)**—** This future NRCS handbook is a guide for economic analysis of potential conservation options. It contains background information on useful procedures and techniques. Commonly used economic principles and quantitative tools are explained.

***(vi) National Resource Economics Handbook, Part 612 Water Quality*—**This NRCS handbook is a guide for Agency personnel who conduct evaluations of economic benefits of measures that reduce water pollution from nonpoint sources.

***(vii) Circular No. A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*—**This circular provides general guidance for conducting benefit-cost and cost-effectiveness analyses. It also provides specific guidance on the discount rates to be used in evaluating Federal programs whose benefits and costs are distributed over time. The general guidance will serve as a checklist of whether an agency has considered and properly dealt with all the elements for sound benefit-cost and cost-effectiveness analyses. It covers most Federal programs, but specifically exempted from the scope of this circular are decisions concerning water resource projects.

(b) Economics and NRCS planning

(1) P&G versus non-P&G requirement

All water resource projects receiving Federal funding must be completed under the P&G. A NED plan must be developed and shown in the planning report.

Watershed protection projects should follow the principles and guidelines even though the goal may not be development of an NED plan. A least cost plan or the most cost effective plan may be sufficient. The concept of cost effectiveness is relevant in that it implies efficiency. It may involve a given quantity of output for the least cost or vice versa, the greatest output from a given amount of funds, which is the NED plan.

(2) Level of intensity

The degree of detail used in the planning process varies with the type, complexity, method of assistance, and the objectives and limitations of client(s).

The number of significant digits for rounding off is typically a subjective decision. Outputs should reflect only the level of significance of the least precise input. For example, if inputs are accurate to the nearest $100, then the output should also be rounded to the nearest hundred.

(3) Planning water resource projects

The National Planning Procedures Handbook (January 1996) refers to the nine steps of resource planning. The P&G was written in 1983 with the planning process divided into six steps. While the number of steps may differ, the process is basically the same. Both documents guide water resource planning activities, as appropriate, within NRCS. In the National Watersheds Manual, these documents are used to describe how to evaluate flood prevention and land treatment watershed planning projects.

The nine planning steps assume that a request for assistance has been received. Marketing, promotional, and other information related activities that lead up to the request for assistance are not considered as part of the nine-element planning process.

***(i) Identify problems*—**The initial step in planning is to identify the problems. This requires a clear understanding of the resource conditions in the project locale. The economic significance of resource problems should be described in terms of specific state and local concerns as well as Federal objectives.

***(ii) Determine objectives*—**Project plans should describe resource problems and opportunities so that potential benefits can be readily recognized in quantitative and qualitative terms. This description should specify problems and desired effects or objectives that are identified by groups and individuals affected by the planned project. It should also identify resource objectives declared to be in the national interest by the Legislative and Executive Branches. National priorities for addressing these problems and opportunities change from time to time. Not all problems and opportunities will necessarily be expressed in monetary terms. Project action may be to protect an endangered species, or it may involve a rapidly growing gully that is not economically feasible to treat, but causes a social concern.

***(iii) Inventory resources*—**The third step in planning is collecting information and data on those resource conditions within the planning area that are relevant to identified problems, opportunities, and objectives.

***(iv) Analyze resource data*—**This handbook examines specific resource inventories and forecasts as they relate to flood damage (agricultural and urban), reduction of erosion and sediment damage, water quantity and quality, agricultural water management, recreation, and municipal and industrial water supplies and the impairment of activities associated with water quality and quantity.

***(v) Formulate alternatives*—**Economic analysis plays a critical role in the systematic formulation of alternative plans for water resource development. Each alternative plan may consist of a system of structural and/or nonstructural measures, land treatment, and other strategies or programs. These strategies or programs will help to alleviate specific problems or take advantage of specific opportunities associated with water and related land resources of the project area. An alternative plan is developed to maximize NED benefits for water resource plans. Other alternative plans may be formulated that reduce net NED benefits to further address other Federal, state, and local concerns not fully addressed by the NED plan. One alternate should minimize cost for achieving the sponsor's desired objectives. These additional plans should be formulated so that the decisionmaker can judge whether these other beneficial effects outweigh the corresponding NED losses. To do this each plan requires an economic analysis. Alternative plans, including the NED plan, are formulated in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability (see chapter 1, P&G).

***(vi) Evaluate alternatives*—**Four accounts are used to record the effects and to facilitate comparison of alternative plans. The national economic development (NED) account shows effects on the national economy. The environmental quality (EQ) account shows effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that cannot readily be measured in monetary terms. The regional economic development (RED) account shows the regional incidence of NED effects, income transfers, and employment effects. The other social effects (OSE) account shows urban and community impacts and effects on life, health, and safety.

***(vii) Make decisions*—**The final two steps in planning are comparing alternative plans and plan selection. The comparison of plans focuses on the differences among the alternative plans as determined in the evaluation phase. By comparing the changes that occur in the various accounts, the decisionmaker is aware of the tradeoff between alternative plans. After consideration of the various alternative plans and receiving public comments, the Agency decisionmaker selects a plan.

(viii) Implementation—Implementation includes the process of installing the conservation practices that make up the planned management system. Additional technical assistance is generally necessary, and plan revisions are occasionally warranted.

(ix) Evaluate plan—Resource planning is an ongoing process that continues after the plan is implemented. Followup is necessary to evaluate the success of the implemented plan. In addition, technology may be developed through field observation of practices that have been implemented.

(c) Evaluation standards

In this section basic assumptions and standards are reviewed that underlie fundamental procedures in project evaluation and benefit-cost analysis. Aspects covered include concepts and basic assumptions, pricing of goods and services, interest and discount rates, and period of analysis. The basic objective in economic evaluation is to compare the values produced or conserved with the cost of materials used for the project. Ideally, this comparison is made after full account is taken of all project effects. To make valid benefit-cost comparisons among water resource projects and among alternative plans for an individual project, uniform standards must be used for pricing goods and services. Also, consistent assumptions about the general economic setting need to be used. The effects of projects should be estimated in a uniform manner and should be ascribed to beneficiaries in a consistent way.

(1) Concepts and assumptions

(i) Expression in monetary and nonmonetary terms—PL-566 states that Federal financial assistance is contingent on the determination that project benefits exceed the costs. Thus, monetary and nonmonetary benefits should exceed monetary and nonmonetary costs. Beneficial and adverse effects take many physical forms, they accrue at different times, and they may be temporary or permanent. Economic analysis evaluates a particular effect, characterizes it as beneficial or adverse, and estimates to what extent it contributes to or detracts from project goals.

In a market economy, the price system is the principal device for allocating resources among competing uses. Theoretically, prices reflect the scarcity and importance of resources and services. They provide a practical means of expressing diverse physical outputs on a common value scale.

However, it must be recognized that values attached to goods and services by the market may not always accurately reflect values from a public viewpoint, and vice versa. The intervention of public policy often creates *imperfect markets*—ones that are influenced by such factors as subsidies, tariffs, and price supports. While it is extremely difficult to give precise quantitative expression to some of these considerations, the general principle that project services or products have value only to the extent that they are needed is inherent in any economic evaluation. Despite limitations of market prices as a measure of public value, they are essential for evaluating water resource projects.

Benefits and costs that cannot be expressed in terms of market prices also warrant consideration. Physical, biological, cultural, and aesthetic considerations that defy monetary measurement need to be weighed and described in a way that indicates their importance and influence on project formulation and evaluation. The nonmonetary effects should be displayed in measurable, quantitative terms. The use of qualitative measures is also encouraged where it contributes to the decisionmaking process.

(ii) Evaluation perspective—Evaluation must be made from a perspective that is consistent with the public intent of NRCS projects. A broadly inclusive accounting of beneficial and adverse effects is warranted when evaluating projects that involve substantial Federal investment. The evaluation must go beyond the perspective of those individuals who will be directly affected, for better or worse, by the project action. The effects of a project on individuals and on the public can seldom be evaluated completely. Comprehensive evaluations usually encounter problems of inadequate information or imperfect evaluation techniques. The task of the analyst is to:

- Determine the likely effects of a project.
- Identify the private and public interests in each project.
- Evaluate these circumstances as rigorously as analytical techniques and information allow.

(iii) Cost effectiveness—Within the limits set by legislation, policy, engineering standards, or other constraints, project measures included in any plan should be the most cost-effective. Practical options need to be tested. Total cost includes not only installation, but also operation, maintenance, and replacement. When the effective life of project options differ, discounting is done to provide a valid base for comparison of costs. The Conservation Options Procedure (COP) is designed for cost-effectiveness analysis.

(iv) Ascribing effects to a project—Using standard procedures for attributing effects ensures that projects are evaluated in a consistent and systematic manner. Comparing economic and other effects *with* the project to the effects *without* the project provide the basis for identifying and quantifying the achievements of alternative plans.

Costs are computed using market prices for materials and labor required. Market prices normally provide an adequate measure of the values these goods and services would provide in other uses.

Benefits of an alternative plan are the difference in the value of goods and services available from using the project area resources *with* the project and the values from using these same resources *without* the project.

Frequently, the with-project use of the resource requires the beneficiaries to install supplemental onfarm associated measures to achieve the benefits. In these instances the cost of these associated measures is subtracted from the project benefits.

A project will have only one future without-project condition. Each alternative plan will generate a future with-project condition.

(v) Economic trends and resource use—Evaluation standards and procedures use consistent assumptions about economic trends and expected levels of resource use. The assumption of a continuously expanding economy for both *with* and future *without* project conditions is reasonable for estimating future requirements for goods and services. Under this assumption, increasing amounts of goods and services are required to satisfy the needs of an expanding population and provide for higher material standards of living.

At the same time we can expect other competing uses to arise for the goods and services required by the project. As a result these project resources should be considered scarce in that all of them would have alternate uses either with or without the project. The opportunity cost is reflected in the price of the goods and services. Holding prices constant eliminates the need to consider inflation rates. Thus, constant price-cost relationships are assumed.

(2) Pricing project products and services

The price of goods and services used for evaluation should reflect the real exchange values expected to prevail while the project is being implemented and over its economic life. The general level of prices for outputs and inputs prevailing during or immediately preceding the planning period should be used for the entire period of analysis.

When changes in agricultural production are expected as a consequence of a planning effort, normalized prices prepared by the United States Department of Agriculture (USDA) are to be used. Current normalized prices are to be used in all economic evaluations covered by P&G. These normalized prices are compiled by the Economic Research Service and updated annually.

(3) Discounting and interest rates

Discounting is necessary to convert economic values, such as benefits and costs, that have been estimated as of the time of accrual to a common time basis (see 611.0104, Interest and annuity). Evaluations must take into account the interest rate and the time lapse between the project expenditure and the realization of project benefits. Project feasibility can be determined using either the capital values as of a common point in time, or by using the average annual or the average annual equivalent of these values. NRCS uses average annual or average annual equivalents for comparison and feasibility determination.

Project benefits and costs are converted to a common time basis by using the current Federal interest rate. This rate is determined annually in accordance with Public Law 93-251 using basic interest rate information furnished by the U.S. Department of Treasury. Compound interest and annuity tables for the current Federal interest rate are generated by state economists.

(4) Average annual values

Project benefits and costs are expressed in average annual terms for the period of analysis. These annual values are the amortized present values of implementation costs, operation and maintenance costs, and replacement costs. Present values are referenced to the beginning of project installation.

Average annual equivalents account for the difference in timing between when the cost of a project component begins and when the component's benefits begin. For example, consider a flood control structure. The investment begins with the initiation of construction, but the benefits may not be evident until the structure is complete and begins to fill with water.

(5) Period of analysis

The period of analysis, which is to be the same for each alternative plan, is the time required for implementation plus the lesser of:

- The period of time over which any alternative plan would have significant beneficial or adverse effects, or
- A period of time that may not exceed 100 years.

The economic life of projects is limited by such factors as deterioration, obsolescence, changing needs, and improvements in technology. Discounting for time, risk, and uncertainty also limits economic life. The limit of effective economic life is established at that point where the present worth of costs for extending the life of the project exceeds the present worth of the resulting benefits.

(6) Evaluation period

The evaluation period is the time over which project costs are amortized and annual benefits are determined.

(7) Evaluation reach

Reaches are necessary because of significant differences in areas of the watershed. They represent groupings of like problems (areas) that require similar treatment. The hydraulic reach is not a type of damage. Various disciplines (economist, hydrologist, soil conservationist) work together to determine the evaluation reach. Considerations that an interdisciplinary effort might use to determine reaches include:

- hydrologic conditions (primary consideration)
- farm buildings, bridges, roads
- land use—cropland and varying crops, pasture, woodland, urban, or other
- land characteristics—soil type, slope

(8) Water resource projects with negative net benefits

The following paragraphs review various interpretations and show that **net benefits must be positive for there to be a NED Plan.**

The question arises as to how we define a plan where there are no positive net economic benefits. For example, assume that a project has costs of $100,000, benefits of $85,000, net benefits of a minus $15,000, and a benefit to cost ratio of .85 to 1. Is there a NED Plan? Must net benefits be positive for there to be a NED Plan?

Principles and Guidelines define the NED Plan as a plan *that reasonably maximizes net national economic development benefits consistent with protecting the Nation's environment.*

How is net defined? By dictionary definition, *net* can be either positive or negative. By maximizing, we are seeking the highest or greatest possible value. This could be maximizing the positive or minimizing the negative. The positive connotation of net seems to be dominant in the dictionary definition. The word profit is often closely associated.

Examination of statements in P&G and in the Green Book (Federal Inter-Agency River Basin Committee 1950) implies that *net* should be defined as being a positive value. P&G states that "Contributions to NED are **increases** in the net value of the national output of goods and services, expressed in monetary units" and "Contributions to NED include **increases** in the net value." There would not be an increase in monetary value if the cost exceeds the benefits.

The Green Book states that maximizing the difference between benefits and costs means that all separable segments of a project should be added to the project plan as long as the extra benefits **exceed** the extra costs.

NED includes the concept of economic feasibility, which requires that the benefit to cost ratio be greater than one. Otto Eckstein (Eckstein 1958) states: "Feasibility is interpreted to mean that *the benefits, to whomsoever they may accrue, are in excess of the estimated costs,* following a requirement specified in the Flood Control Act of 1936."

From the above statements, it is concluded that you do not have a NED Plan if you do not have positive net benefits. The use of the word *net* in P&G implies a need for the benefits to exceed cost.

In a water resource project where a large number of structures and individual reaches or conservation practices are being considered, it is possible that the Incremental Analysis and Conservation Options Procedure (COP) might identify a small number of structures or elements that are feasible. This is the evaluation procedure for separable segments as stated above.

Even though these feasible elements may fall short of meeting the sponsor's goals, they theoretically would be the NED Plan. Judgment enters in. If this NED Plan does not come reasonably close to meeting the goals, it will not be a good NED Plan. The four criteria of completeness, effectiveness, efficiency, and acceptability should be considered.

An "exception" could be requested based on some other criteria. The exception plan would be the plan that meets the sponsor's goals with the least negative net benefits and should also be the most efficient plan. The plan report would not show a NED plan. The defunct NED Plan information should be kept in the working files for documentation.

Of the four P&G accounts, only NED is required. The regional economic development account does not need to be used.

(9) Replacement costs

Replacement costs are those costs incurred as a result of a measure or item physically wearing out. Many treatment measures have a different useful life than the project evaluation period.

Annual replacement cost has typically been calculated by:

- Developing a schedule of the initial installation cost and the replacements throughout the evaluation period.
- Calculating the present value of the replacement costs and adding these to the initial installation costs.
- Amortizing these values over the evaluation period.

If you have a large number of items with varied life spans, this can be time consuming and always increases the risk of error. Example 1–1 shows a shorter way to perform the calculations. One nice feature of the procedure in example 1–1 is that only the amount of cost incurred during the evaluation period is assessed to the project. Salvage value calculations for the values in existence beyond the evaluation period are not necessary when the item life does not divide evenly into the evaluation period.

Example 1–1 Calculating annual replacement cost

Given: You need to replace an item in year 25 of a 50-year evaluation period. The item is valued at $1,000 today, and the interest rate is 8 percent.

Solution: Typical method:

Annual value of installation cost = $1,000 x 0.08174 1/ = $82
Annual value of replacement cost = $1,000 x .14602 2/ x 0.08174 1/ = $12
Total annual cost = $94

Shortcut method:

Amortize the installation cost over both the expected life and the evaluation period, then subtract to find the annual value of the replacement cost of the item. Using the same item in the typical method, the annual cost would be calculated as follows:

Annual cost (expected life) = $1,000 x 0.09368 3/ = $94
Annual cost (evaluation period) = $1,000 x 0.08174 1/ = $82
Annual value of replacement cost (= difference)= $12

Also note that (1 + the PV of 1) times the amortization factor for the evaluation period equals the amortization of the item life. For example:

(1 + 0.14602 2/) x (0.08174 1/) = 0.09368 3/

1/ Amortization, 50 years hence, 8% interest.
2/ PV of 1, 25 years hence, 8% interest.
3/ Amortization, 25 years hence, 8% interest.

(d) Other evaluation considerations

(1) Onsite and offsite

Onsite and offsite problems and concerns are both important. Specific definitions of each can be difficult. Generally, onsite includes concepts that the problem and treatment are in the same area of the field, are controllable by the person being affected, are non-public, and have direct benefits. Offsite includes concepts that the problem and treatment are off-farm; the person being affected has no control over source of damage, are public, have indirect benefits, and are outside the project area.

(2) Risk and uncertainty

Uncertainty and variability are inherent and, therefore, important in water resource planning. Risk is defined as *situations in which the potential outcomes can be described in reasonably well known probability distributions.* Flood frequency is an example. Uncertainty is defined as situations where outcomes cannot be described in objectively known probability distributions.

Risk and uncertainty exist in estimates of depth-damage curves, structure values, content values, structure elevations, structure types, hydrology estimates, and crop yields. Linking intervals and probabilities to these variables helps decisionmakers in selecting a plan. More sophisticated models have shifted our analysis from the uncertainty side to the risk side, thus allowing for more informed decisionmaking.

Reducing risk and uncertainty may involve increased costs, loss of benefits, or both. Tradeoffs will be necessary and should be documented for the decisionmaker. Consequences of failure must be considered. The least severe consequence of a project may simply be a failure to solve the problem. At the other end of the spectrum is the possibility of creation of a potential hazard should the project fail.

The Corps of Engineers and the Environmental Protection Agency are using risk assessment models. Spreadsheet type risk assessment programs are used by these agencies and by private businesses.

Probability distributions may need to be developed, or subjects, such as Baysian statistics, may need researching. Fuzzy logic concepts provide the decisionmaker with a range of consequences or costs resulting from possible actions.

(3) Rural development

Water resource and watershed protection projects including ecosystem or total resource management planning are closely related to rural development. Completion of the environmental quality (EQ), regional economic development (RED), and other social effects (OSE) accounts identifies the contribution of the plan to rural development.

(4) Indexing

Indexing is the use of indices to update benefits and costs (see example 1–2). The correct index to use varies with the benefit or cost category being updated. The definition of each index should be known before using it. Each index series is associated with a base year that is specified as being equal to 100. The base will change over time, and conversion from an old to a new base may be necessary. The commonly used indices and applications are:

- Consumer Price Index (CPI)—benefits, recreation
- Prices received by farmers—ag benefits
- Prices paid by farmers—ag costs
- Composite construction cost—structural costs
- Construction cost composite fixed-weighted price—structural costs
- Engineering News Record (ENR)—structural costs

(5) Delphi method

The Delphi is a systematic way of collecting opinions from a group of experts. This method uses a series of questionnaires in which feedback of the group's opinion distribution is provided between questionnaire rounds while preserving the anonymity of the responses. It is an efficient tool for efficiently using the wealth of natural resource expertise and experience available to watershed planners. Economists and other disciplines can use it where quantitative models and methods do not provide timely and cost efficient measures of the problem or the effect of alternatives.

(6) Sampling

All NRCS activities require problem solving in some form. Specialists use the techniques learned in formal or informal training to answer questions and solve problems. One of the most fundamental steps in answering questions and solving problems is the collection of relevant data about the problem. Generally, the amount of information obtained is matched to the decision to be made.

A sample is basically a small collection of information from some larger aggregate, the population. The sample is collected and analyzed to make inferences about the total population as defined. What makes this process more difficult is variation in the population. Two broad classes of sampling are possible: collection by judgment and by chance. Collection by chance, called random sampling, is preferred.

A sampling scheme that represents the characteristics of the sample population should be used. A knowledge of the population and judgment tells if the sample is representative.

Example 1–2 Indexing cost data

Given: You need to update 1989 production costs to 1996 dollars. Production costs for growing watermelons were $2,500 per acre.

Solution: Use the prices paid by farmers index [1/] and select the appropriate values.

$$\frac{\text{index of desired year}}{\text{index of base year}} = \text{factor} \qquad \text{or} \qquad \frac{115^{\,2/}}{96} = 1.198$$

$$\text{factor} \times \text{base year price} \qquad 1.198 \times \$2,500 = \$2994.79$$

For evaluation purposes, production costs increased to $2,994.79.

1/ Prices paid (1990-92 = 100); prices paid by farmers
2/ Prices paid by farmers for commodities and services, interest, tax, and wage rates.

611.0101 Application of economic analysis in project formulation

(a) Introduction

(1) Benefit and cost measurement

Measurement of benefits and cost is essential in formulating and evaluating projects that will alleviate problems and realize opportunities. In the formulation stage, the analysts must evaluate the need for project development, determine the physical possibilities for project action, and establish the most practical solutions available for realizing the desired objectives.

(2) Project formulation and evaluation

Project formulation and evaluation, within the framework of the legal and policy constraints, are largely a process of weighing alternatives. The overall planning objective is to select the measures or combination of measures that will meet watershed needs and yield the greatest possible gain at least cost.

(b) Legal constraints

The Secretary of Agriculture is authorized to assist local organizations in the preparation of plans for preserving, protecting, and improving the Nation's land and water resources and the quality of the environment. Watershed project plans are formulated within the confines of a number of legal constraints. The important legal constraints are limits on the size of watersheds, size of floodwater retarding structures, and flood prevention storage capacity in individual structures (Watershed Projection and Flood Prevention Act, Public Law 83-566, as amended).

(c) Economics of project formulation

During project formulation, the potential physical effects of project measures must be evaluated so that cost-benefit comparisons can be made. Evaluation procedures described in this section illustrate the use of some of the important economic principles in project formulation.

(1) Determining watershed problems

Project formulation depends upon a clear statement of significant watershed problems. This step involves answers to a series of questions, such as:

- Is there a problem with flooding in the watershed?
- What is the magnitude of this problem in terms of reduced income and property damage?
- How does the problem limit future economic development?
- Is there a sediment damage problem?
- Where are the sediment source areas?
- What is the magnitude of sediment damages in dollars?
- Is there a need for irrigation or recreation development?
- What is the dollar value of economic loss sustained by agriculture because of irrigation shortages or excess surface or ground water?
- What are the costs facing the local community for development of future water supplies?
- What is the unmet or potential recreational demand in the area?

These and other economic and physical determinations will suggest solutions to watershed problems. At this stage, possibilities for the various physical solutions and their economic effects are evaluated in a preliminary way, and the obviously nonfeasible solutions are eliminated.

(2) Level of development needed

Economic analysis can help identify the resource needs of a given area and the potential for developing water and related land resources. The degree of development needed is directly associated with the potential of the area to be developed. In flood prevention, for example, the degree of protection will not be the same for all watersheds. Analysis of flood prevention should be tailored to the values to be protected and the cost of such protection.

(3) Evaluation unit

An evaluation unit is the analytical framework within which a solution to a water resource problem is developed. As such, it may be a watershed with a floodwater damage problem or a conservation treatment unit with an erosion problem. Being the analytical framework, it becomes the basic accounting unit for cost-benefit comparison and reporting.

(4) Incremental analysis for maximizing net benefits

From an economic viewpoint, the optimum scale of project development is the point at which the net benefits are at a maximum. Net benefits are maximized when the benefits added by the last increment of scale or scope of project development are equal to the cost of adding that increment. The increments to be considered in this way are the smallest increments for which there is a practical choice as to inclusion in or omission from the project. In watershed projects these increments generally occur as steps rather than as smooth curve increases.

(5) Order in which increments are to be considered

To ensure that net benefits are maximized, measures must be considered in a logical and consistent manner. This requires that the most cost-effective of the appropriate measures be added in turn. To determine the most cost-effective, each measure's costs and contribution to the problem solution are calculated with it as the first (or only) increment of development. The second increment then estimates these parameters by adding the remaining measures incrementally (single or in groups) to eliminate the remaining problem. The procedure is continued using the remaining measures against the remaining problem until it is no longer possible to increase net benefits.

Planners can use either of two alternative indicators to determine the order in which different structures are considered in incremental analysis. The first indicator is to run the ECON2 computer program (see 611.0202(h)(1)) for each structure individually. This develops a ranking system for the structures. The assumption that the relative value of individual structures remain unchanged will be accepted when structures are grouped (as outlined in the following paragraph) and the order for the incremental analysis is established.

The second indicator involves bringing individual structures into the incremental analysis on the basis of the cost per unit of area controlled. This cost-effectiveness figure is estimated by dividing capital installation cost by the area controlled. The structures will then enter the incremental analysis either individually or by group, beginning with those with the lowest cost and proceeding on the basis of increased cost per unit of area controlled.

In water resource projects where no more than three floodwater or multipurpose structural locations exist, all possible combinations of structure will be evaluated. Where four to eight structural locations exist, a combination of two structures can be considered as an increment; and where nine or more structural locations exist, the groupings may be increased to three structures. Structures will be grouped in accordance with the principle above.

Some water resource projects have the potential for many small structural locations. In these projects, larger groups may be formed with the concurrence of all disciplines and decisionmakers.

(6) First and last increment approaches

The analysis can be approached from either a first increment or a last increment.

(i) First increment approach**—**Plan elements are added to a plan until the added costs exceed the added benefits. An accurate analysis results only if the elements are added in decreasing order of efficiency. This is illustrated by the floodwater retarding structure data shown in table 1–1. In the table it has been determined that structure numbers 1 and 2 are the most cost-effective means of providing the initial level of flood prevention for an annual cost of $12,800 and will provide annual net NED benefits of $6,200.

To establish the point where net benefits are at the maximum, further increments are added to the basic system of two structures and their incremental costs and benefits determined. Adding structure number 3 increases the net benefits by $200. Structure number 4

Table 1–1 An example of incremental analysis

Structure	Total costs ($)	Incremental costs ($)	Total benefits ($)	Incremental benefits ($)	Net benefits ($)
1 & 2	12,800		19,000		6,200
1, 2, & 3	14,300	1,500	20,700	1,700	6,400
1, 2, 3, & 4	20,300	6,000	26,700	6,100	6,500
1, 2, 3, 4, & 5	27,000	6,700	31,800	5,000	4,800

increases net benefits by $100. By adding structure 5, costs are increased $6,700, but benefits only increase by $5,000. Thus, the last addition has gone beyond the point of maximized net benefits. The four-structure system maximizes net benefits and would be the upper limit that could be included on the basis of NED benefits alone.

(ii) Last increment approach—With the last increment approach, plan elements are deleted from a plan until the reduction in benefits exceed the reduction in costs. An accurate analysis results only if the elements are deleted in increasing order of efficiency.

With a small number of sites being considered for the final plan, last site incremental analysis can be used. Given a list of potential sites, establish the relative benefit contribution of each site, incrementally as a last increment with all the other sites. Then the best sites can be grouped into a core group, and the next best site can be incrementally added until the NED plan is identified.

(7) Benefit and cost graphs

The relationship between benefits and costs is shown in figure 1–1. The maximum benefit cost ratio occurs at point 1. Net benefits are at a maximum at point 2, and thus is the NED. This is where the change in benefits equals the change in costs. At point 3 total benefits equal total cost, and the benefit cost ratio is 1. This is also the point where the internal rate of return is equal to zero.

(8) Internal rate of return

Projects being implemented under the "program neutral" planning concept and by non-Federal agencies may not have as a goal the maximization of net benefits; i.e., a NED plan. The use of internal rate of return (IRR) as an economic indicator of a water resource project's feasibility has been suggested. IRR is defined as an estimate of the average annual rate of return (compound interest rate) that the investment will produce over the evaluation period.

It is that rate which just makes the net present worth of the project equal zero and the benefit-cost ratio equal one. In a sense IRR represents the average earning power of the money used in the project over the evaluation period.

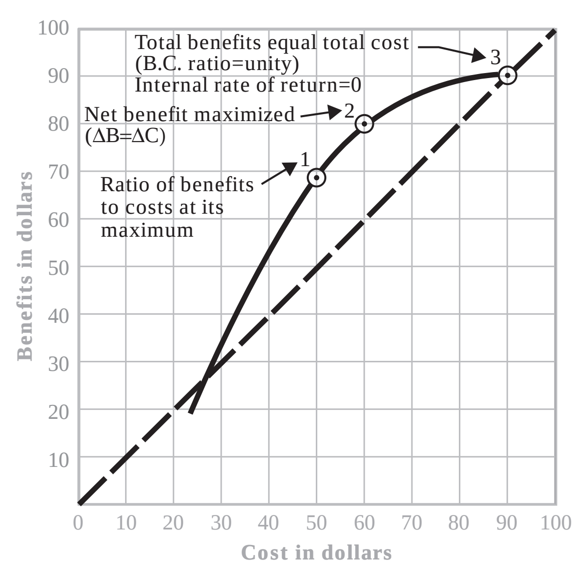
(i) Application of IRR—In theory, the IRR increases as total net benefits increase up to the point where net benefits are maximized (change in benefits = change in cost). However, this is obvious only where you have a continuous flow of homogeneous resources or parameters involved in a watershed project. In watershed projects, structures are of many different sizes (investment), flow of benefits including length in years and occurrence over time varies, and the relationship of OM&R to investment varies. Thus, there will not be a nice neat relationship between the flow and accumulation of benefits and the internal rate of return as alternatives are compared.

The IRR can be used to check the feasibility of alternatives once the alternatives are completed. It should not be used as the basis for an incremental analysis that is based on the maximization of net benefits.

The following factors affect the IRR, thus caution is required in using IRR. Also note that the relative magnitude of these factors can cancel each other out.

- Life of project—Longer life equates to a higher IRR.
- Investment amount—IRR is a product of rate of return and investment.

Figure 1–1 Comparison of benefits and costs



- Timing of cash flows or schedule of obligations—Early income equates to a higher IRR.
- Relationship of operation, maintenance, and replacement (OM&R) to initial investment—Higher OM&R to investment ratio equals a higher IRR.

(9) Economic analysis of a multiple purpose structure

In evaluating multiple-purpose structures, confirm that the structure is feasible in total and that each purpose meets the test of economic feasibility. The feasibility test for the structure is satisfied if benefits exceed cost. The determination of feasibility for the individual purposes requires that the benefits to a specific purpose exceed the separable cost of adding that purpose as the last increment to the proposed structure. This is described in more detail in Chapter 6, Costs and Cost Allocation.

(10) Socioeconomic information

Disadvantaged groups or communities in a watershed area may qualify for exceptions from the stated policies. Three commonly used indicators that measure the economic and social health of an area are property value, personal income, and unemployment. The recommended data are:

- Property values—housing values
  comparison: watershed area versus state
  source: Census Bureau
- Per capita income—median income
  comparison: watershed area versus nation
  source: Department of Commerce
- Unemployment rate—average unemployment
  comparison: watershed area versus nation
  source: Department of Labor

The Social Sciences Manual describes a number of other criteria that help define the economic and social health of an area.

(11) Investigation and analysis report

The Investigation and Analysis Report (I&A) provides an intermediary type explanation between the main report and the detailed support documents of the procedures used. The I&A should have an adequate discussion of the purpose, methodology, and information/data used in the economic analysis. Methodology should include the economic concepts, a comparison of future without and with project conditions. The values used and their source, price levels, and interest rate should also be included. In some instances small graphs or charts are appropriate to show the concept being used. The National Watershed Manual gives more detail on the I&A report, and appendix B of this handbook contains examples.

(12) Economic documentation

Economic documentation includes the same items that are in the I&A, but goes beyond the I&A in detail. The economic documentation should contain the work sheets for the economic evaluation. While the documentation is not necessarily a public document, it should be well organized and documented. This will be valuable in future years since projects often go on for many years involving supplements, reviews, and legal challenges. Anyone using the documentation in future years should be able to follow the economic analysis and locate necessary information. The economic documentation should contain an index and section/topic dividers plus an introductory paragraph stating the purpose of the study and of each section (see appendix B, exhibit B).

611.0102 Prices and yields

Natural Resources Conservation Service project alternatives for water and related land resource developments are evaluated using current prices. Agricultural components of these plans are evaluated using current normalized prices prepared by the U.S. Department of Agriculture. Instructions on crop yield levels and yield projections are stated in Section 2.3.3 of the Principles and Guidelines (P&G).

(a) Conceptual basis

The evaluation process should produce reasonable estimates of the aggregate benefits and costs of the project. Estimates of this type require using a set of price relationships that represent the period over which costs are incurred and benefits accrue. P&G suggests that current price relationships should be used. Therefore, price relationships observed in a recent time period are assumed to be the best estimate of future prices. In selecting the appropriate time period for price relationships, care should be taken to account for what may have been short-term abnormalities. Agricultural prices and costs are always influenced by highly variable factors, such as weather, insect infestations, sudden demand changes, and inflationary forces. An analytical procedure, such as the one described in the next section, adjusts for the short-term effects of these factors.

(b) Agricultural prices

(1) Current normalized prices

Current normalized prices are to be used in all economic evaluations of agricultural productivity covered by the P&G (section 1.4.10). They include evaluations of beneficial or adverse effects of project and program alternatives under consideration and appraisals of economic impacts expressed in terms of value of production or income.

Current normalized prices are distributed by the NRCS Resource Economics and Social Sciences Division (RESS) as an annual Memorandum to supplement this handbook. The Economic Research Service (ERS) computes the prices and supplies the data to NRCS.

The memorandum addresses numerous reasons for adjusting normalized prices as well as special circumstances requiring further price estimation. They include:

- Pricing commodities not included in the current normalized price tables.
- Determining price differentials within states.
- Determining price differentials to reflect product quality differences from the average represented by published price data.
- Adjusting to reflect the impacts of project or program actions on market prices.

Approaches to these and other special price problems must achieve consistency with the published estimates of current normalized prices.

Normalized prices have been developed and issued for the principal crops grown in the United States. Current normalized prices are derived from a 5-year moving average of historical data. The 1985 Food Security Act and the 1990 Food, Agriculture, Conservation, and Trade Act reduced the price influence of government support programs for most agricultural commodities. Thus, ERS changed computation methods to calculate and report 5-year moving average market prices as the current normalized prices beginning in 1993.

(i) Commodities not covered in price tables—If price data for commodities are needed, they may be developed by using a 5-year state average for each of the desired commodities. Keep price data on the same basis. For example, the ERS calf prices are based on the 800-pound calves sold to finishers, not the 400- to 500-pound calves sold from cow-calf operations. NASS and local newspapers normally keep price information on local markets.

(ii) Price differentials within states—State normalized prices are derived by multiplying the National normalized price by the average ratio of the State price to the National commodity price for the preceding 3-year period. For example, the 1996 National normalized price used a 1992 to 1994 market period to derive State normalized prices.

***(iii) Price differential to reflect product quality*—**Published data rarely provide a basis for deriving price estimates for particular quality attributes of a given agricultural product. Procedures for estimating such price differentials vary from one set of circumstances to another. The basis used for estimating such price differentials should be fully documented in review reports.

***(iv) Price impacts*—**As specified in the P&G, whenever implementation of a plan is expected to influence price significantly, the use of a price about midway between those expected with and without implementation may be justified. Special consideration should be given to price adjustments where a program induces an area to shift from deficit to surplus production.

(2) Forest product prices

Information on current prices for forest products can be obtained from the latest issue of **The Demand and Price Situation for Forest Products** (USDA Forest Service). To be consistent with the current normalized agricultural prices, the stumpage prices should be adjusted to reflect value added from harvesting.

(3) Pasture price

A current normalized pasture price is not developed by the U.S. Department of Agriculture. Pasture prices are seldom reported in crop statistics publications at the state level. Prices documented by actual data on pasture leases are available from farm real estate market development surveys conducted by agricultural economic departments at Universities. A 3-year average should be used.

According to P&G, pasture should be valued at the first opportunity to market. The first opportunity to market pasture is for a per acre or per animal unit month cash lease.

(c) Crop yields

(1) Current crop yields

Crop yields used in project evaluation will be current yields based on average management except in the case of future yields.

(2) Future yields

Current yields may be projected by future timeframe to reflect relevant physical changes resulting directly from problems addressed by the project. Adjust future yields to reflect relevant physical changes in soil and water management conditions.

(3) Yield consistency

Changes in yields, with and without the project, should be projected consistently with water management and production practices accounted for in the crop budgets.

(4) Base yields

The base for yield levels used in project evaluation will be the average yield for the previous 5 years as compiled by the National Agricultural Statistics Service (NASS) in cooperation with State agencies. These county average yields will be adjusted to specific areas (flood plains, upland areas) based on yield data for soils in these areas. These 5 years should be identical to those used for the agricultural prices.

County level yield data for individual soil map units is available in the NRCS county FOTG or in the published county soil survey.

611.0103 Annual equivalents

In NRCS water resource and watershed protection projects, the installation of structural measures and land treatment systems is scheduled over several years to permit effective and efficient use of the resources of NRCS and the sponsors. This results in individual measures or systems becoming operational before all component parts of the project plan are complete. Benefits gradually increase as additional measures and systems are completed. Discounting procedures (see section 611.0104) are used to convert actual costs and benefits to average annual equivalents. Although this section describes the average annual equivalents analysis, average annual analysis is sufficient for most planning purposes.

The P&G requires that NED costs be converted to an annual equivalent value over the period of analysis. The period of analysis is the equivalent of the installation period plus the evaluation period (see section 611.0100(c)). Installation, operation, maintenance, and replacement costs, and benefits will be handled in an identical manner to maintain consistency in the handling of both costs and benefits in project evaluation.

All costs and benefits are discounted from the year that they are incurred or accrued to the beginning of the period of analysis by converting them to present value equivalents. This provides identically discounted benefits and costs in terms of present values. When the present values have been determined, they are amortized over the period of analysis to establish average annual equivalents.

Annual equivalent values must be calculated for each evaluation unit. The worksheet for at least one identified evaluation unit, specifically for a multiple structure unit when there is one in the plan, is included in the I&A report. Annual equivalent calculations for all evaluation units are to be included with other project documentation.

Two methods for implementing this procedure follow. The first method uses a worksheet when calculations are done with a handheld or desk calculator. The second uses a computer and spreadsheet.

(a) Method 1—Worksheet

This method uses an average annual costs and benefits worksheet (fig. 1–2) for calculating average annual equivalent costs and benefits. The steps needed to complete the calculations follow.

Step 1—Using the average annual costs and benefits worksheet, develop a schedule of installation cost; operation, maintenance, and replacement (OM&R) costs; and benefits for the evaluation unit.

For installation cost, this schedule must correspond to the Schedule of Obligations shown in the project plan. Installation cost will be the annual increment of capital expenditures. OM&R costs and benefits will be average annual amounts. Cost and benefits figures are the corresponding amount for the specific year. Computations on all evaluation units will be for the full period of analysis. This will complete columns 1, 4, and 5 of the worksheet.

Where benefits have been determined for more than one benefit category, columns for each benefit category must be constructed; e.g., columns 5a, 5b, 5c.

Step 2—Determine the present value equivalent at the beginning of the period of analysis for installation costs; operation, maintenance, and replacement costs; and benefits.

Installation costs are converted to present value equivalents by discounting to the beginning of the period of analysis. OM&R costs and benefits are converted to present value equivalents by first determining the present value of the annuity they represent and then discounting to the beginning of the period of analysis. This information completes columns 2, 6, and 7 of the worksheet. All computations are done using the project discount rate. All annuities are for the useful life of the improvements or 100 years, whichever is less. This completes columns 3, 8, and 9 of the worksheet. Depending on Step 1, column 9 may be expanded to include 9a, 9b, 9c, etc.

Step 3—The present values are amortized over the period of analysis to determine average annual equivalent values for the plan report.

Figure 1–2 Average annual costs and benefits worksheet

Evaluation unit 3, 8% interest, 55-year period of analysis

Year	Installation expenditures			OM&R cost and benefits					
	Annual increment of capital expendtures (Column 1)	PV of 1 yrs. hence (Column 2)	Present value of capital expendtures (Column 3) (col 1 x col 2)	Annual increment of OM&R accrual (Column 4)	Annual increment of benefit accrual (Column 5)	PV of an annuity of 1 for 55 years (Column 6)	OM&R 1/ PV of 1 yrs. hence (Column 7)	PV of OM&R cost (Column 8) (col 4 x col 6 x col 7)	PV of benefits (Column 9) (col 5 x col 6 x col 7)
1	10,000	.92593	9,259						
2	10,000	.85734	8,573	418	2,000	12.31861	.92593	4,768	22,812
3	10,000	.79383	7,938	418	2,000	12.31861	.85734	4,415	21,122
4	10,000	.73503	7,350	418	2,000	12.31861	.79383	4,088	19,558
5	10,000	.68058	6,806	418	2,000	12.31861	.73503	3,785	18,109
6				418	2,000	12.31861	.68058	3,504	16,768
7									
...									
55									
Sum			39,926					20,560	98,369
Average annual equivalent 2/			3,241					1,669	7,986
				B:C ratio = 1.63:1					

1/ The calculation of a present value (col. 4 or 5 x col. 6) will determine that value at the beginning of the year; therefore, the PV of 1, years hence must be adjusted to account for this by shifting forward 1 year.

2/ Amortize for the period of analysis.

Step 4— The benefit cost ratio is calculated by dividing average annual equivalent benefits (column 9) by average annual equivalent costs (column 3 + column 8).

(b) Method 2—Spreadsheet

PVCSTBEN, computer spreadsheet for calculating average annual equivalents for costs and benefits, is used in this method. The steps that follow are for using LOTUS 1-2-3 template PVCSTBEN to determine the present value of benefits and cost over a specified period of analysis. Figure 1–3 is a sample printout derived from method 2. ***Note:*** Contact the NRCS, Resource Economics and Social Sciences Division, for assistance and copies of the LOTUS 1-2-3 template.

Step 1—Load PVCSTBEN template.

Step 2—Enter value of appropriate discount rate; e.g., 0.08.

Step 3—Enter number for the appropriate period of analysis; e.g., 55.

Step 4—As specified in the spreadsheet instructions, enter values for installation cost, OM&R costs, and benefits, respectively, for each year they are incurred or received.

Step 5—When all values (step 4) are entered, complete all calculations to generate the benefit to cost ratio.

Step 6—Save the contents of the new file.

Step 7—Print the worksheet in two phases to accommodate the lengthy results.

You may set up a worksheet similar to the one shown in figure 1–3 using something other than LOTUS software. The instructions included in the PVCSTBEN template can be modified to accommodate your software.

Figure 1–3 Method 2, PVCSTBEN computer spreadsheet for calculating average annual equivalents - costs and benefits

0.08 Percent (Discount Rate)
55 Years (Period of Analysis)

YEARS	PV FACTOR	COSTS	PV COSTS	OM&R	PV OM&R	BENEFITS	PV BENEFITS
1	0.92593	10000	9259	0	0	0	0
2	0.85734	10000	8573	400	343	2000	1715
3	0.79383	10000	7938	800	635	4000	3175
4	0.73503	10000	7350	1200	882	6000	4410
5	0.68058	10000	6806	1600	1089	8000	5445
6	0.63017		0	2000	1260	10000	6302
7	0.58349		0	2000	1167	10000	5835
8	0.54027		0	2000	1081	10000	5403
9	0.50025		0	2000	1000	10000	5002
10	0.46319		0	2000	926	10000	4632
11	0.42888		0	2000	858	10000	4289
12	0.39711		0	2000	794	10000	3971
13	0.36770		0	2000	735	10000	3677
14	0.34046		0	2000	681	10000	3405
15	0.31524		0	2000	630	10000	3152
16	0.29189		0	2000	584	10000	2919
17	0.27027		0	2000	541	10000	2703
18	0.25025		0	2000	500	10000	2502
19	0.23171		0	2000	463	10000	2317
20	0.21455		0	2000	429	10000	2145
21	0.19866		0	2000	397	10000	1987
22	0.18394		0	2000	368	10000	1839
23	0.17032		0	2000	341	10000	1703
24	0.15770		0	2000	315	10000	1577
25	0.14602		0	2000	292	10000	1460
26	0.13520		0	4000	541	10000	1352
27	0.12519		0	4000	501	10000	1252
28	0.11591		0	4000	464	10000	1159
29	0.10733		0	4000	429	10000	1073
30	0.09938		0	4000	398	10000	994
31	0.09202		0	2000	184	10000	920
32	0.08520		0	2000	170	10000	852
33	0.07889		0	2000	158	10000	789
34	0.07305		0	2000	146	10000	730
35	0.06763		0	2000	135	10000	676
36	0.06262		0	2000	125	10000	626
37	0.05799		0	2000	116	10000	580
38	0.05369		0	2000	107	10000	537
39	0.04971		0	2000	99	10000	497
40	0.04603		0	2000	92	10000	460
41	0.04262		0	2000	85	10000	426
42	0.03946		0	2000	79	10000	395
43	0.03654		0	2000	73	10000	365
44	0.03383		0	2000	68	10000	338
45	0.03133		0	2000	63	10000	313
46	0.02901		0	2000	58	10000	290
47	0.02686		0	2000	54	10000	269
48	0.02487		0	2000	50	10000	249
49	0.02303		0	2000	46	10000	230
50	0.02132		0	2000	43	10000	213
51	0.01974		0	2000	39	10000	197
52	0.01828		0	1600	29	8000	146
53	0.01693		0	1200	20	6000	102
54	0.01569		0	800	13	4000	63
55	0.01451		0	400	6	2000	29
56	0.01344		0	0	0	0	0
SUM OF PRESENT VALUES			39927.10		20703.91		97689.51
AVERAGE ANNUAL EQUIVALENTS			3241.200		1680.701		7930.235
BENEFIT-COST RATIO			1.611213				

611.0104 Interest and annuity

(a) Compound interest

Compound interest is earned for one period and added to the principal, thus, resulting in a larger principal on which interest is computed for the subsequent period. Formula 1–1 is used to determine compound interest.

$$(1+i)^n \qquad [1\text{–}1]$$

where:

n = number of periods
i = periodic rate of interest
1 = $1 (The formula results in a factor that is multiplied by the principal dollar amount.)

(b) Interest and annuity tables

The interest and annuity (I&A) tables are used in benefit-cost analysis when benefits are delayed for a significant period after costs are incurred; when benefits are not constant over the evaluation period; and when costs, expressed as capital or principal amounts, must be converted to an average annual cost. The conversion of costs and benefits of conservation to average annual equivalents without the help of I&A tables would involve the use of many difficult formulas and calculations. The tables were constructed to simplify the process by presenting coefficients developed from the formulas for use in much simpler calculations. A typical table has nine columns:

- Periods
- Future value of one
- Present value of one
- Future value of annuity of 1
- Amount of annuity for a future value
- Present value of annuity of 1
- Amount of annuity for a present value
- Present value of increasing annuity
- Present value of decreasing annuity

Table 1–2 presents the interest and annuity table for the 8 percent interest rate.

(c) Definitions

(1) Number of periods hence

The number of periods hence is the number of years in which calculations are considered. Many conditions influence the number of years used in an evaluation including:

- Benefit may last a year or indefinitely (perpetuity).
- Measures may have a short or long useful life.
- Period of evaluation may be set by policy.
- Individual may want to recover costs in a certain period.
- Costs or returns may occur over varying time periods or at varying rates for the same period.
- Landowner's or manager's planning horizon may dictate this period.

(2) Future value of 1 (compounding)

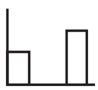
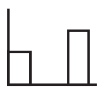
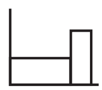
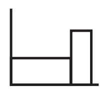
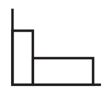
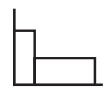
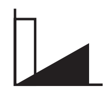
This is the amount that will accumulate when a given amount is invested for a given period of time and the interest is not withdrawn. The compound amount of $1 in 1 year is 1.0800, in 2 years is 1.1664, and so on. It is also the reciprocal of the present value of 1. Hence, to determine the compound amount of 1 in 25 years, if the appropriate factor is not known, calculate by dividing 1 by the present value of 1 factor (1/.1460) Thus, the compound amount of $1 in 25 years is 6.8485. The compound amount factor is shown in column 2 of table 1–2.

(3) Present value of 1

The present value of 1 is what $1.00 due in the future is worth today or the amount that must be invested now at compound interest to have a value of $1.00 at some given time in the future. It is also known as the discount factor. Use of present value of 1 determines today's worth of a given amount of money received or paid at some specified time in the future.

For example, the interest on $92,593 at 8 percent for 1 year is $7,407, and the interest plus principal at the end of 1 year hence is $100,000. Thus, the present value of $100,000 1 year hence is $92,593, or the present value $1 factor is 0.9259 ($92,593 divided by $100,000). (The present value of 1 is shown in column 3 of table 1–2.)

Table 1–2 Interest and annuity tables—8%

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increasing annuity	Present value of decreasing annuity
Graphic								
Formula	$(1+i)^n$	$\frac{1}{(1+i)^n}$	$\frac{(1+i)^n-1}{i}$	$\frac{i}{(1+i)^n-1}$	$\frac{(1+i)^n-1}{i(1+i)^n}$	$\frac{i(1+i)^n}{(1+i)^n-1}$	$\frac{(1+i)^{n+1}-(1+i)-ni}{(1+i)^n i^2}$	$\frac{(ni-1)+\frac{1}{(1+i)^n}}{i^2}$
Periods *(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
1	1.0800	0.9259	1.0000	1.0000	0.9259	1.0800	0.9259	0.9259
2	1.1664	0.8573	2.0800	0.4808	1.7833	0.5608	2.6406	2.7092
3	1.2597	0.7938	3.2464	0.3080	2.5771	0.3880	5.0221	5.2863
4	1.3605	0.7350	4.5061	0.2219	3.3121	0.3019	7.9622	8.5984
5	1.4693	0.6806	5.8666	0.1705	3.9927	0.2505	11.3651	12.5911
6	1.5869	0.6302	7.3359	0.1363	4.6229	0.2163	15.1462	17.2140
7	1.7138	0.5835	8.9228	0.1121	5.2064	0.1921	19.2306	22.4204
8	1.8509	0.5403	10.6366	0.0940	5.7466	0.1740	23.5527	28.1670
9	1.9990	0.5002	12.4876	0.0801	6.2469	0.1601	28.0550	34.4139
10	2.1589	0.4632	14.4866	0.0690	6.7101	0.1490	32.6869	41.1240
11	2.3316	0.4289	16.6455	0.0601	7.1390	0.1401	37.4046	48.2629
12	2.5182	0.3971	18.9771	0.0527	7.5361	0.1327	42.1700	55.7990
13	2.7196	0.3677	21.4953	0.0465	7.9038	0.1265	46.9501	63.7028
14	2.9372	0.3405	24.2149	0.0413	8.2442	0.1213	51.7165	71.9470
15	3.1722	0.3152	27.1521	0.0368	8.5595	0.1168	56.4451	80.5056
16	3.4259	0.2919	30.3243	0.0330	8.8514	0.1130	61.1154	89.3579
17	3.7000	0.2703	33.7502	0.0296	9.1216	0.1096	65.7100	98.4795
18	3.9960	0.2502	37.4502	0.0267	9.3719	0.1067	70.2144	107.8514
19	4.3157	0.2317	41.4463	0.0241	9.6036	0.1041	74.6170	117.4550
20	4.6610	0.2145	45.7620	0.0219	9.8181	0.1019	78.9079	127.2732
21	5.0338	0.1987	50.4229	0.0198	10.0168	0.0998	83.0797	137.2900
22	5.4365	0.1839	55.4568	0.0180	10.2007	0.0980	87.1264	147.4907
23	5.8715	0.1703	60.8933	0.0164	10.3711	0.0964	91.0437	157.8618
24	6.3412	0.1577	66.7648	0.0150	10.5288	0.0950	94.8284	168.3905
25	6.8485	0.1460	73.1059	0.0137	10.6748	0.0937	98.4789	179.0653
26	7.3964	0.1352	79.9544	0.0125	10.8100	0.0925	101.9941	189.8753
27	7.9881	0.1252	87.3508	0.0114	10.9352	0.0914	105.3742	200.8104
28	8.6271	0.1159	95.3388	0.0105	11.0511	0.0905	108.6198	211.8615
29	9.3173	0.1073	103.9659	0.0096	11.1584	0.0896	111.7323	223.0199
30	10.0627	0.0994	113.2832	0.0088	11.2578	0.0888	114.7136	234.2777
31	10.8677	0.0920	123.3459	0.0081	11.3498	0.0881	117.5661	245.6275
32	11.7371	0.0852	134.2135	0.0075	11.4350	0.0875	120.2925	257.0625
33	12.6760	0.0789	145.9506	0.0069	11.5139	0.0869	122.8958	268.5764
34	13.6901	0.0730	158.6267	0.0063	11.5869	0.0863	125.3793	280.1633
35	14.7853	0.0676	172.3168	0.0058	11.6546	0.0858	127.7466	291.8179
36	15.9682	0.0626	187.1021	0.0053	11.7172	0.0853	130.0010	303.5351
37	17.2456	0.0580	203.0703	0.0049	11.7752	0.0849	132.1465	315.3103
38	18.6253	0.0537	220.3159	0.0045	11.8289	0.0845	134.1868	327.1391
39	20.1153	0.0497	238.9412	0.0042	11.8786	0.0842	136.1256	339.0177
40	21.7245	0.0460	259.0565	0.0039	11.9246	0.0839	137.9668	350.9423
50	46.9016	0.0213	573.7702	0.0017	12.2335	0.0817	151.8263	472.0814
60	101.2571	0.0099	1253.2133	0.0008	12.3766	0.0808	159.6766	595.2931
70	218.6064	0.0046	2720.0801	0.0004	12.4428	0.0804	163.9754	719.4648
80	471.9548	0.0021	5886.9354	0.0002	12.4735	0.0802	166.2736	844.0811
90	1018.9151	0.0010	12723.9386	0.0001	12.4877	0.0801	167.4803	968.9033
100	2199.7613	0.0005	27484.5157	.0000	12.4943	0.0800	168.1050	$$$$$$$$

(4) Future value of annuity of 1 (amount of an annuity of $1 per year)

This is the amount that an investment of $1 per year will accumulate in a certain period at compound interest. It is the reciprocal of the sinking fund factor. The investment of $1,000 per year at 8 percent for 10 years has a value at the end of 10 years of $14,487, $1,000 x 14.4866.

(5) Amount of annuity for a future value (sinking fund)

A sinking fund is the amount accumulated for the purpose of paying a debt or for accumulating capital. It is the principal component of $1,000 in the foregoing example (as distinguished from the interest component). The sinking fund factor is equal to the amortization factor minus the interest factor (interest rate). The annuity necessary to accumulate a sinking fund of $1,000 in 3 years at 8 percent interest is $1,000 x (.3880 – .08000) = $308.00. Hence, the investment of $308.00 per year at 8 percent interest will have a value at the end of 3 years of $1,000. (The sinking fund factor is shown in column 5 of table 1–2.)

(6) Present value of an annuity of $1 per year

Present value of an annuity of 1 per year is also referred to as the present worth of an annuity or the capitalization factor. It is the reciprocal of the amortization factor. This present value factor represents the present value or worth of a series of equal payments or deposits over a period of time. It tells us what a future annual deposit of $1.00 is worth today. If a fixed sum is to be deposited or earned annually for “n” years, this factor can be used to determine the present worth of those deposits or earnings.

For example, the present value of an annuity of $1,000 per year for 10 years is $6,710 at 8 percent because $6,710 invested now will yield an annual income of $1,000 for 10 years ($6,710 x .1490). Since the present value of an annuity of $1 per year is the reciprocal of the amortization factor, the product must always equal 1. (The present value of an annuity of 1 per year is shown in column 6 of table 1–2.)

(7) Amount of annuity for a present value (amortization)

Amortization, sometimes called partial payment or capital recovery, is the payment of a financial obligation in equal installments over time. The interest rate and resulting amortization factor determine what annual payment must be made to pay the principal and interest over a given number of years. This is also referred to as the average annual equivalent cost. A common example of amortization is the calculation of mortgage payments on a house.

The amortization factor, column 7 of table 1–2, is the amount of the installment required to retire a debt of $1 in a given length of time. For example, if $1,000 is borrowed at 8 percent for 3 years, it would be necessary to pay $388.03 per year on the note (table 1–3).

(8) Present value of an increasing annuity

This is a measure of present value of an annuity that is not a constant increment over a period. When using this factor, it is important to note that the value of $1 (which is multiplied by the increasing annuity factor) is the annual rate of increase and not the total increase during the period. For example, an annuity increases uniformly over a 10-year period at which time it amounts to $1,000 per year. Hence, the annual rate of increase is $100. At the end of the first year, the amount of the annuity is $100 ($200 at the end of the second year, etc.). The present value of such an annuity is $3,269 ($100 x 32.6869).

The increasing annuity factor is applicable only to the portion of an annuity that is increasing. For example, if there is an increase in annuity from $500 to $1,500 over 10 years, the increasing annuity would be applied only to the $100 annual increment. The original $500 would be treated as a constant annuity. The sum of the two calculations would be the total value.

Table 1–3 Loan repayment schedule for repayment of $1,000 at 8 percent for 3 years

Year	Payment	Interest charge	Payment on principal	Unpaid balance
0	- - -	- - -	- - -	$1,000.00
1	$ 388.00	$ 80.00	$ 308.03	691.97
2	388.00	55.36	332.67	359.30
3	388.00	28.74	359.30	0.00
	$1,164.00	**$164.10**	**$1,000.00**	

(9) Present value of a decreasing annuity
This factor is used to determine the present worth of an annuity that decreases uniformly each year. The present value of a decreasing annuity is greater than the present value of increasing annuity of an equal amount. The reason for this is that a decreasing annuity has a high initial value whereas an increasing annuity has a high terminal value and when reduced to present value is subject to a greater discount. It is important to note that the value of $1 (which is multiplied by the decreasing annuity factor) is the annual rate of decrease and not the total decrease during the period.

(d) Example interest problems

The following problems illustrate the use of annuity factors:

Problem 1

Floodwater damage under present flood plain conditions is estimated to be $1,000 annually. However, streambank erosion (not evaluated as a floodwater damage, see problem 2) is gradually destroying the land on which the floodwater damage occurs. Hence, the average annual floodwater damage will not be as great 50 years from now as it is at present. The problem is to determine how much the average annual floodwater damage should be discounted to reflect this condition.

Given: The average annual floodwater damage 50 years hence will be $750.

Solution: The floodwater damage is made up of two annuities:
- constant annuity of $750 per year
- decreasing annuity of $250 in 50 years ($5 per year).

The present value of a decreasing annuity of $5 per year for 50 years is $2,360 ($5 x 472.0814). The annual equivalent value of the decreasing annuity is $193 ($2,360 x .0817). This is added to the $750 constant annuity.

Adjusted average annual floodwater damage = **$943.**

Similar problems may be solved in a similar manner, but the following shortcut may be helpful. The rate of discounting a decreasing annuity is equal to the present value of a decreasing annuity divided by the number of years times the present value of an annuity of 1 year. For this example, the discount value equals:

$$\frac{472.08144}{50 \times 12.2335} = .77179$$

Calculating other factors for the most frequently used interest rates and time periods saves considerable time.

Problem 2

The streambank erosion, mentioned in problem 1, is destroying land at the rate of 5 acres per year. The reduction in net income as a result of this loss is $25 per acre or $125 per year. This amount ($125) is not a constant annuity, but an increasing annuity; e.g., $125 the first year, $250 the second year, and $6,250 the 50th year. What is the annual equivalent streambank erosion damage?

Solution: The present value of an increasing annuity of $125 per year for 50 years is $18,978 ($125 x 151.8263).

The annual equivalent value of $18,978 is $1,551 (18,978 x .0817), which is the average annual damage caused by streambank erosion.

From the foregoing it is determined that the annual equivalent value of an annuity increasing at a uniform rate for 50 years is equal to the annual rate of increase x 12.410, or the value in the 50th year x .2482.

Problem 3

A recreation benefit is associated with a structure and surrounding recreation area. The benefit increases uniformly over a period of years and thereafter becomes constant. Determine the annual equivalent value (50-year evaluation period).

Given: The value of a benefit will amount to $3,000 annually after 14 years. During the first 15 years, the annuity will increase at the rate of $200 per year.

Solution: The present value of an increasing annuity of $200 per year for 15 years equals

$$\$200 \times 56.4451 = \$11,289$$

The present value of a constant annuity of $3,000 for 35 years deferred 15 years equals

$$\$3,000 \times 11.6546 \times .31524 = \$11,022$$

Total present value

$$\$11,289 + 11,022 = \$22,311$$

Annual equivalent value equals

$$\$22,311 \times .0817 = \$1,824$$

If the annuity increased the same as above, but thereafter continued in perpetuity, the annual equivalent value may be determined in the following manner: Multiply the present value of an annuity of 1 per year factor for the increasing period minus 1 year (in this case 14 years), add 1, and multiply by the rate of increase. For this example, the computation is:

$$(8.2442 + 1) \times \$200 = \$1,849$$

Problem 4

A hillside is converted to an orchard. This planting yields no benefit for a few years and then yields a continuing and constant benefit for the remainder of the evaluation period. What is the annual equivalent benefit?

Given: The value of the orchard is estimated at $1,000 per year after it becomes established and is ready for use. It is estimated that 5 years are required for successful establishment. What is the annual equivalent benefit (25 per year evaluation period)?

Solution: The present value of an annuity of 1 per year for 20 years times $1,000.

$$(\$1,000 \times 9.8181 = \$9,818)$$

Deferred for 5 years

$$(\$9,818 \times .6806 = \$6,682)$$

Amortized over 25 year life

$$(6,682 \times .0937 = \$626)$$

Problem 5

The average annual floodwater damage under present conditions is estimated to be $1,000 annually. A study of sediment problems indicates that channel aggradation will increase this floodwater damage to $1,500 per year in 50 years. What is the average annual damage due to channel aggradation?

Solution: The increase in damage in the 50th year is $500. From problem 2 we know that the annual equivalent value of an increasing annuity is .2482 x the value in the 50th year ($500), which equals $124. Hence the average annual sediment damage is $124. The floodwater damage is still considered to be $1,000 per year.

Problem 6

Installation costs are usually expressed in lump sum capital amounts and must be converted to average annual costs for benefit-cost comparison. How this is done for some typical situations is illustrated by the following.

Given: A structure costs $10,000 and its life is at least 50 years.

Solution: On the basis of an interest rate of 8 percent, the amortization factor to 50 years is .0817. Then

$$\$10,000 \times .0817 = \$817.00$$

Given: A structure costs $10,000, will last 50 years, and will be replaced at that time. The replacement will cost 50 percent more than the initial installation and will last 50 years.

Solution: First, determine the present worth of the second installation. The present value of $1, 50 years hence is .0213. Then $15,000 x .0213 = $320. The present value of the second installation is added to the initial cost and then amortized over 100 years:

$$\$320 + 10,000 = \$10,320$$

$$\$10,320 \times .08004 = \$826 \text{ annual equivalent cost}$$

(e) Discounting for lag in accrual of benefits

(1) Average annual equivalent

Why should we worry about the timing of benefits and costs of conservation? Benefits and costs must be considered in the same timeframe; otherwise we are comparing apples and oranges. A standard form has been developed called average annual equivalents. This term describes an annual flow that is not lagged and includes conservation benefits, average returns, average costs, and operation and maintenance costs.

The significance of average annual values or equivalents is that most businesses, including farming, have accounting systems that are based on average annual equivalents. Therefore, the costs and benefits of conservation, once converted to average annual values, can be added to the costs and returns of the farm business. Investigation and Analysis (I&A) tables are useful tools for converting benefits and costs of conservation into average annual equivalents.

(2) One-time values, annual flows (annuities) and lags

The benefits and costs of conservation do not necessarily occur at the same time. Certain costs and benefits may occur at one point in time while others occur over a number of years. Some occur today while others occur in the future.

Those values that occur at one point in time are called one-time values. Installation costs are an example of a one-time value. Values that occur over time are called annual flows or annuities. Annuities can be generalized into constant, decreasing, and increasing over time, depending on their characteristics. Many of the benefits from conservation fall into the annuity category.

A one-time value can occur today or at some point in the future. If it occurs at some point in the future it is said to be lagged or delayed. The replacement cost of a practice is a good example of a lagged one-time value. Annuities too can be lagged. If benefits from a terrace do not start until a year after installation, then those benefits are said to be lagged 1 year. Deferred grazing following range seeding is another common occurrence of a lagged annuity. Table 1–4 illustrates situations for one-time values, annual flows, and lags.

Table 1–4 One-time values, annual flows, and lag

One-time value	Annual flow (avg. an. equiv.)	Lagged values
Installation costs	Replacement costs	Conservation benefits, average returns, average costs
O&M costs	Replacement costs	Any value not starting this year

Any significant lag in the accrual of benefits should be appropriately discounted. Discounting is necessary to convert one-time or annual values over the project evaluation period. Discounting for lag may be done for either a one-time value (cost or benefit) or for a series of such annual values. The three most common procedures of discounting for lag in accrual of benefits in evaluating watershed projects are complete lag, straight-line lag, and variable lag rate. In some instances other procedures may be necessary (see 611.0104(f), Benefit lag examples).

(3) Discounting procedures

The following discounting procedures are recommended:

- Complete lag
- Straight line lag
- Variable rate lag

(i) Complete lag (with no buildup)—For a one-time value occurring in the future multiply the given value by the **present value of 1** factor for the appropriate years of lag. Thus, the future value is converted to a present value. The present value is converted to an annual equivalent value by amortizing it over the period of analysis.

For annual values occurring in the future:

- Convert the annual values to a present one-time or capital value. This is its capital value at the year when the annual values begin to accrue, which is also at the end of the lag period.
- Discount the present capital value for the period of lag.
- Convert the discounted value to an annual equivalent value by amortizing it over the period of analysis.

(ii) Straight line lag—This procedure should be used where there will be a uniform buildup of benefits until a full level is reached. Determination of annual equivalents in these cases involves increasing annuities and probably a constant annuity as a base (see 611.0104(f) (2)).

(iii) Variable rate lag discounting—In some instances the lag in accrual of benefits is uniform over the entire buildup period. Benefits may build up rapidly after installation and then taper off until full level is reached, or benefits may build slowly for several years and then increase rapidly to full level. These situations require that the problem be structured to deal with the various straight line and constant annuity segments. Care must be taken to properly account for each deferred component.

(f) Benefit lag examples

(1) Complete lag (with no buildup)

(i) A one-time value occurring in the future—If a 5-year lag is expected in a specific cost or benefit of $100, the factor .68058 (present value of 1, 5 years hence, at 8 percent interest) is applied to determine the present value, or $68.06. To convert to an annual equivalent value of a 50-year evaluation period, using 8 percent interest, multiply the present value by the appropriate amortization factor:

$68.06 x .0817 = $5.56

(ii) Annual values occurring in the future—If a 20-year lag is expected in an annual cost or benefit of $100 that will continue to accrue during the remaining 30 years of a 50-year evaluation period, determine the capital value of the 30 annual amounts by multiplying the factor for present value of an annuity of 1 per year for 30 years (11.25778) by the annual amount ($100):

11.2578 x $100 = $1,126

Discount the capital value of $1,126 to present value by applying to it the 20-year discount factor of .21445 (present value of 1, 20 years hence, at 8 percent interest):

$1,126 x .2146 = $242

To convert this amount to an annual value over a 50-year evaluation period, using 8 percent interest, multiply the present value ($242) by the appropriate amortization factor (.08174):

or $242 x .0817 = $20.

(2) Straight line lag

The following example is a straight line discounting of annual benefits:

Net returns per acre at full level	= $20
Acres to be benefited	= 1,000

Of the 1,000 acres, 500 acres will have benefits accruing at full level upon installation, and no discounting is required for these benefits. It is estimated that the benefits on the remaining 500 acres will reach full level in 10 years and that this benefit will build up at a uniform rate over the 10-year period.

This discounting may be done on either the total annual monetary benefits or on an annual per-acre basis. If done on a per-acre basis, the discounted per-acre benefit must be multiplied by the number of acres involved (in this example 500) to determine the total discounted benefits. This example uses the total benefits.

- For the 500 acres where benefits are at full level upon installation:
  500 ac x $20 = $10,000 annual benefit at full level

- A 3-step procedure is needed to determine discounted benefits for the 500 acres where benefits will build over a 10-year period.
  Step 1—Determine the capital value for the first 10 years:
  $10,000 /10 years = $1,000 increase per year
  $1,000 x 32.6869 1/ = $32,687 capital value for first 10 years

  1/ Present value of increasing annuity for 10 years, 8% interest.

  Step 2—Determine the capital value of $10,000 annually for the last 40 years of the 50-year evaluation period:
  $10,000 x 11.9246 2/ = $119,246 capital value delayed 10 years
  $119,246 x .4632 3/ = $55,234 capital value delayed 10 years

  2/ Present value of 1 per year for 40 years, 8% interest.
  3/ Present value of 1, 10 years hence, 8% interest.

  Step 3—Amortize the total capital values obtained in steps 1 and 2 to arrive at annual equivalents:
  $32,687 + $55,234 = $87,921 total capital value
  $87,921 x .0817 4/ = $7,187 discounted average annual benefit

  4/ Amortization factor for 50 years, 8% interest.

- To get the total benefits for 1,000 acres, add the full level benefits for the 500-acre full level area ($10,000) and the discounted benefits for the 500-acre buildup area ($7,187) to determine total benefits:
  $10,000 + $7,187 = $17,187

(3) Short-cut straight line method

Table 1–5 provides straight line discount factors that can be used directly. To illustrate, discounting in the above example can be done by selecting the factor for the 10 years at 8 percent from table 1–5 and applying it to full level benefits:

$10,000 x .719 = $7,187 discounted benefits
$10,000 + $7,187 = $17,187 total benefits on the 1,000 acres

The factors listed in table 1–5 are based on a 50- and 100-year evaluating period. Similar factors for other years can be calculated by using the procedure referred to in the footnote of that table.

Table 1–5 Discount factors at 6 and 8 percent rates for 50- and 100-year evaluation periods*

Years of lag	Evaluation period: 50-year 6%	50-year 8%	100-year 6%	100-year 8%
5	.887	.859	.839	.862
10	.768	.719	.780	.725
15	.668	.608	.685	.616
20	.585	.520	.607	.530
25	.516	.449	.541	.461
30	.457	.392	.485	.405
35	.407	.346	.437	.359
40	.364	.307	.397	.322
45	.328	.275	.362	.290
50	.296	.248	.332	.264

* These discount factors were developed by dividing discounted benefits by full level benefits. The lag example on the 500 acres with the 10-year buildup period, a full level annual benefit of $10,000 and a discounted annual benefit of $7,187. Thus, $7.187 divided by $10,000 equals .7187 (or .719), the discount factor for a 10-year lag at 8 percent interest rate for a 50-year evaluation period.

Discount factors for other interest rates, evaluation periods, or years of lag may be computed using the following formula:

([FB / L x PV of an Increasing Annuity for L years at i] + [FB x PV of an Annuity of 1 per year for EP-L years at i x PV of 1, L years hence]) x Amortization factor EP years / FB

where:		if:
FB	= full level annual benefits	FB = $10,000
L	= years of lag	L = 5 years
I	= interest rate	i = 8%
EP	= evaluation period	EP = 50 years
PV	= present value	

$$\frac{\left(\left(\frac{10,000}{5}\times 11.36514\right)+\left(10,000\times 12.10840\times .68058\right)\right)\times .08174}{10,000}$$

$$=\frac{\left(22,730+82,407\right)\times .08174}{10,000}$$

$$=.859$$

(4) Variable rate lag

Example 1–3 is for a 50-year evaluation period that shows a rapid initial build-up and then a tapering off of benefits.

Example 1–3 Variable rate lag

Assumed: Annual benefits at full level = $10,000
Benefits will reach full level in 10 years
Benefits will build up at the rate of $1,600 per year for the first 5 years and $400 per year during the next 5 years
Straight line build-up is assumed during each 5 year period. During the first 5 years, benefits will build-up at a rate of $1,600 per year to a level of $8,000 (5 x $1,600 = $8,000). During the next 5 years of the build-up period, benefits will increase by an additional $2,000, a rate of $400 per year (5 x $400 = $2,000) to the full level of $10,000.

Problem: Measure the capital value of four rates of benefit accrual as follows:

1 The value during the 5 year build-up period at $1,600 per year.
2 The value during the next 45 years at the $8,000 level, delayed 5 years.
3 The value during the last 5 years of the build-up period at $400 per year, delayed 5 years.
4 The value of the additional $2,000 (necessary to reach full level of $10,000) over the last 40 years, delayed 10 years.

Solution: Calculate the values:

1 $1,600 x 11.36514 1/ = $18,184
2 $8,000 x 12.10840 2/ x .68058 3/ = $65,926
3 $400 x 11.36514 x .68058 = $ 3,094
4 $2,000 x 11.92461 4/ x .46319 5/ = $11,047

Total the four capital values as calculated above and amortized to determine the discounted average annual benefit:

$18,184—capital value of 5 year period increasing at $1,600 per year
$65,926—capital value of $8,000 level for 45 years, delayed 5 years
$ 3,094—capital value of last 5-year period increasing at $400 per year, delayed 5 years
$11,047—capital value of $2,000, for 40 years delayed 10 years

$98,251—Total capital value during 50 year evaluation period

$98,251 x .08174 6/ = **$8,031**

1/ Present value of increasing annuity for 5 years, 8% interest.
2/ Present value of annuity of 1 per year for 45 years, 8% interest.
3/ Present value of 1, 5 years hence, 8% interest.
4/ Present value of annuity of 1 per year for 40 years, 8% interest.
5/ Present value of 1, 10 years hence, 8% interest.
6/ Amortization factor 50 years, 8% interest.

Chapter 2 Agriculture

Contents:

611.0200 General evaluation information for agriculture 2–1

(a) Conceptual basis of agricultural NED benefits 2–1
(b) Benefit categories 2–1

611.0201 Floodwater 2–3

(a) Considerations in damage appraisal 2–3
(b) Frequency method 2–4
(c) Steps in damage appraisal 2–11
(d) Damage reduction benefits 2–20
(e) Intensification 2–21
(f) Historical series method and income method 2–23
(g) Incremental analysis 2–24
(h) Agriculture computer programs 2–24
(i) Flood damage schedules 2–25

611.0202 Drainage 2–25

(a) Drainage benefits 2–25
(b) Evaluation units and incremental analysis 2–26
(c) Productivity 2–26
(d) Determining economic effects 2–27
(e) Drainage questionnaire 2–27

611.0203 Irrigation 2–28

(a) Irrigation terminology 2–28
(b) Planning setting 2–29
(c) Basic data 2–29
(d) Evaluation units 2–30
(e) Incremental analysis 2–30
(f) Changes in crop production inputs 2–31
(g) OM&R costs 2–31
(h) Reporting benefits 2–31
(i) Evaluating irrigation system failure 2–31
(j) Irrigation questionnaire 2–36

611.0204 Erosion and sediment **2–36**
(a) Types of damage 2–37
(b) Methods of evaluating land damage 2–37
(c) Improvements 2–41
(d) Railroads and highways 2–42
(e) Municipal and industrial water supplies 2–42
(f) Agricultural machinery 2–42
(g) Product quality 2–42
(h) Drainage and irrigation facilities 2–43
(i) Reservoir sedimentation 2–43

Appendix 2A—Blank forms **2–48**

Tables

Table 2–1	Damage-frequency relationship/average annual damage	2–8
Table 2–2	Calculation of cropland and pasture stage-damage relationship at 2-foot stage for Reach No. 1	2–8
Table 2–3	Flood volume and acreage flooded (Elkhorn watershed)	2–9
Table 2–4	Flood damage by overland flow in Elkhorn watershed	2–10
Table 2–5	Crop damage assessment by season and depth of flooding	2–14
Table 2–6	Example of data used to calculate damageable value per acre of flood plain	2–16
Table 2–7	Composite crop and pasture damage rate, per acre flooded, by depth of flooding	2–16
Table 2–8	Increment evaluation	2–30
Table 2–9	Reduced crop returns, annual area damaged, and annual reduced returns from land voiding and depreciation	2–37
Table 2–10	Composite per acre cost, returns, and loss on damaged land	2–39
Table 2–11	Summary of total average annual damage, without project	2–39

Table 2–12	Relation between damage, recovery time, and damage remaining after recovery	2–39
Table 2–13	Adjustment to determine values subject to recovery	2–40
Table 2–14	Annual rate of increasing damage	2–40
Table 2–15	Annual value of recoverable damage	2–41

Figures

Figure 2–1	Assessment subareas	2–2
Figure 2–2	Discharge–frequency curve	2–4
Figure 2–3	Discharge–stage curve	2–4
Figure 2–4	Stage–frequency curve	2–4
Figure 2–5	Stage–damage curve	2–5
Figure 2–6	Damage–frequency curve	2–5
Figure 2–7	Average annual damage computation model	2–7
Figure 2–8	Overland flooding in Elkhorn area	2–10

Examples

Example 2–1	Development of crop damage factors	2–17
Example 2–2	Procedure to evaluate irrigation system failure as a result of flooding	2–32
Example 2–3	Straight line method to determine damage to a reservoir	2–44
Example 2–4	Sinking fund method to estimate damage to reservoirs	2–44
Example 2–5	Cost of sediment removal method to estimate damages to reservoirs	2–45
Example 2–6	Sinking fund plus service loss method of estimating damage to reservoirs	2–46

Chapter 2 Agriculture

611.0200 General evaluation information for agriculture

This section provides procedures for the evaluation of agricultural benefits from water resource projects. See Principles and Guidelines (P&G), Chapter II, Section III, for more detail.

(a) Conceptual basis of agricultural NED benefits

The national economic development (NED) benefits are the value of increases in the agricultural output of the Nation and the cost savings in maintaining a given level of output. The benefits include reductions in production and in associated costs; reductions in damage costs from floods, erosion, sedimentation, inadequate drainage, or inadequate water supply; the value of increased production of crops; and the economic efficiency of increasing production of crops in the project area.

Most NRCS projects are not large enough to affect the total production or prices of a specific crop. Refer to P&G, Section III, Section 2.3.2, to determine if benefits from increased production efficiencies are applicable. Only benefits to nonbasic crops (see basic crops in next paragraph) may be considered for this locality benefit for increasing economic production efficiency.

Basic crops (rice, cotton, corn, soybeans, wheat, milo, barley, oats, hay, and pasture) are crops grown throughout the United States in such quantities that no water resources project would affect the price and cause transfers of crop production from one area to another. The production of basic crops is limited primarily by the availability of suitable land. Suitable land is land on which crops can be grown profitably under prevailing market conditions.

(b) Benefit categories

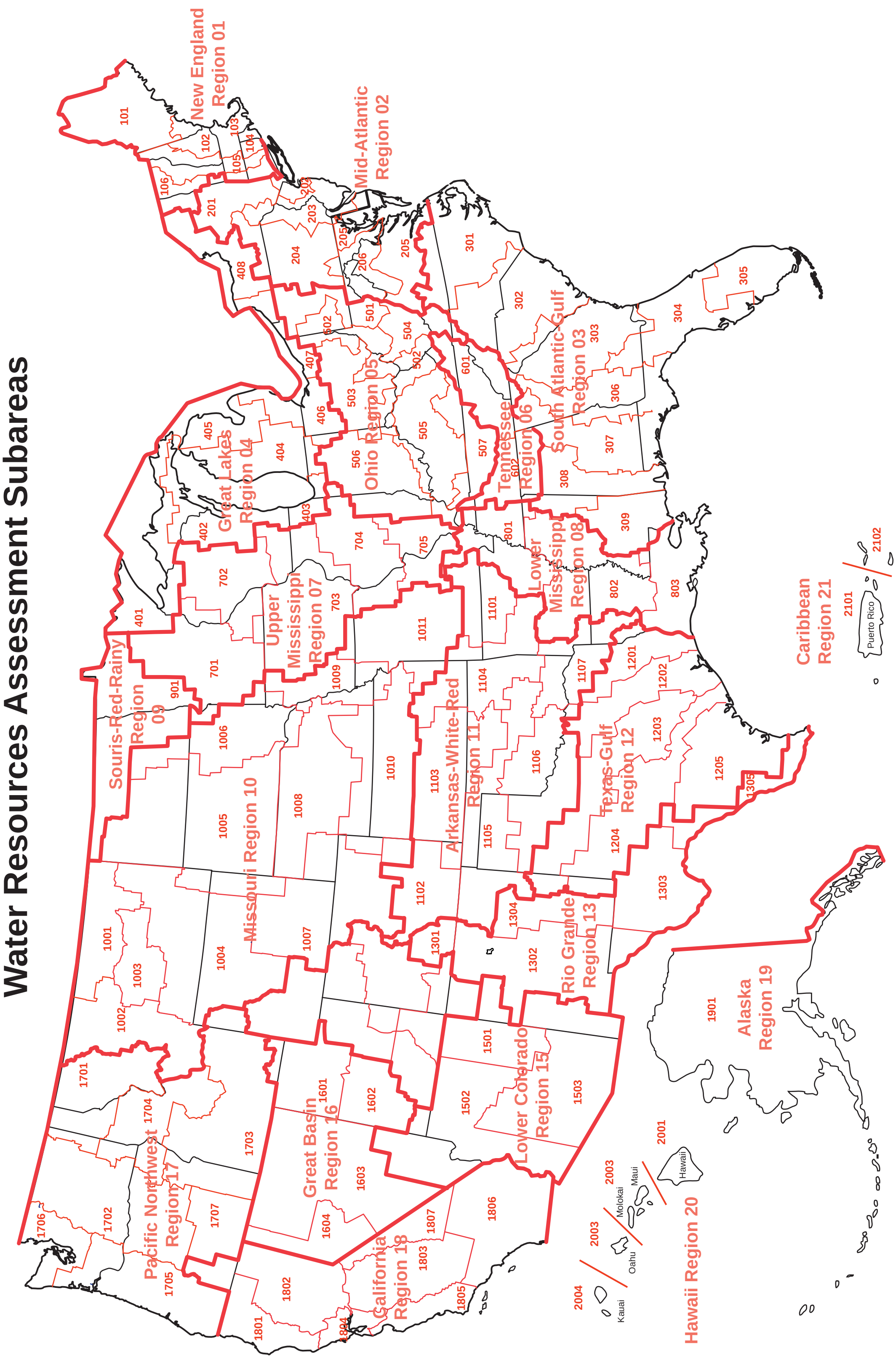
Agricultural benefits are divided into two mutually exclusive categories depending on whether there is a change in cropping pattern: damage reduction benefits and intensification benefits. See P&G Section 2.3.2(c) for more detail.

(1) Damage reduction benefits
Damage reduction benefits accrue on land where there is no change in cropping pattern between the with and without project conditions. Damage reduction benefits are the increases in net income that result from the project, as measured by farm budget analysis. These income increases may result from increased crop yields, decreased production costs, or both.

(2) Intensification benefits
Intensification benefits accrue on lands where the cropping pattern is changed. Efficiency benefits, a subcategory of intensification benefits, accrue from reduced costs of production. An example of a change in cropping pattern for NRCS evaluation purposes would be a change from native pasture to cropland. A change in crop rotation from wheat to alfalfa or some other crop is not considered a change in cropping patterns.

Intensification benefits are measured either by farm budget analysis or by land value analysis. Intensification benefits from increased acreage of basic crops and other crops constrained by the availability of suitable land in the Water Resources Council (WRC) assessment subarea (ASA) are measured as the net value of the increased production. Figure 2–1 shows the assessment subareas. Intensification benefits from increased acreage of other crops (except for acreage of crops to be treated as basic crops because they are land constrained) result when there are production cost savings. These production cost savings are called efficiency benefits and are measured as the difference between production costs in the project area and production costs on land elsewhere in the ASA. The ASA data are probably obsolete, and the WRC does not update subareas. Therefore, use the ASA data to derive intensification benefits with caution.

Figure 2–1 Assessment subareas



611.0201 Floodwater

This section tells how to estimate floodwater damages to agriculture and how to determine damage reduction and intensification benefits to agriculture from flood protection. Most of the section is confined to the application of economic principles to the problem and to the general methods of accumulating and analyzing data for evaluation purposes. Because of the diversity of conditions found across the Nation, no attempt is made to prescribe step-by-step procedural details that must be used in every case. General evaluation procedure steps are outlined in P&G, Section III, Section 2.3.5. Incremental analysis is an integral part of floodwater evaluation, especially for alternative methods of reducing the damages. Detailed description of incremental analysis is in chapter 1 of this handbook.

Methods outlined in this chapter for calculating average annual damage and for benefit adjustments are equally applicable to the appraisal of urban flood damages and benefits (see chapter 4).

(a) Considerations in damage appraisal

Damage appraisal for project evaluation involves a comparison of the damage that can be expected without the project and that which will occur if the project is installed. Proper appraisal requires a projection of physical and economic conditions during the life of the project.

Several methods may be used to project future conditions. The method used depends upon the given situation, but extrapolation of existing trends generally is not sufficient. The economist needs to gather and evaluate sufficient background data to form a basis for sound projections. Major assumptions and procedures used to project future conditions should be fully documented.

(1) Considerations in making future conditions projections

***(i) Flooding*—**As sediment fills a channel, flooding becomes more severe. It may become so serious that cultivation of most, or all, of the flood plain will be abandoned.

***(ii) Channel degradation*—**Channel degradation or bankcutting increases the size of the channel. Flooding may then be expected to become less frequent and less severe, but land may be lost from production. (If either of these conditions exists, the economist depends upon both the geologist and hydrologist for projections of physical conditions.)

***(iii) Agricultural trends*—**Developing agricultural trends may modify agricultural land use patterns in the project locale.

***(iv) Nonagricultural values*—**Nonagricultural values are changing constantly. Industrial and residential land uses may be replacing agriculture in the flood plain. Urban development in the upper portions of the watershed may result in larger areas being subject to floodwater damage.

(b) Frequency method

The P&G indicates that an estimate of the reduction of damages from water inundation is made on the basis of the change in frequency, depth, and duration of inundation. This section presents the Frequency Method of evaluation. The Frequency Method uses either of the following kinds of data:

- Channel and valley cross sections to establish floodwater depth and land area inundated for various peak discharges.
- Overland flow to establish the relationship between area inundated and floodwater volume.

Other damage estimation methods, historical series, and net income are described briefly at the end of this section. The last two methods have been used in past evaluations, and while they do not meet the frequency-depth/duration conditions specified in the P&G, they are mentioned to complete the presentation.

(1) Channel and valley cross sections

The Frequency Method establishes relationships between physical and economic flood characteristics and the probable frequency of flood occurrence. Physical appraisal establishes relationships between the characteristics of floods and frequency of their occurrence. These associations, generally expressed by means of graphs, include the following:

- Runoff related to frequency of occurrence, developed either by conversion of precipitation to runoff or from runoff as directly measured by stream gages.
- Runoff versus discharge in cubic feet per second.
- Discharge in cubic feet per second versus frequency (fig. 2–2).
- Discharge in cubic feet per second versus flood stage or elevation (fig. 2–3).
- Flood stage or elevation versus area flooded.
- Flood stage–frequency relationship as shown in figure 2–4.

Figure 2–2 Discharge–frequency curve

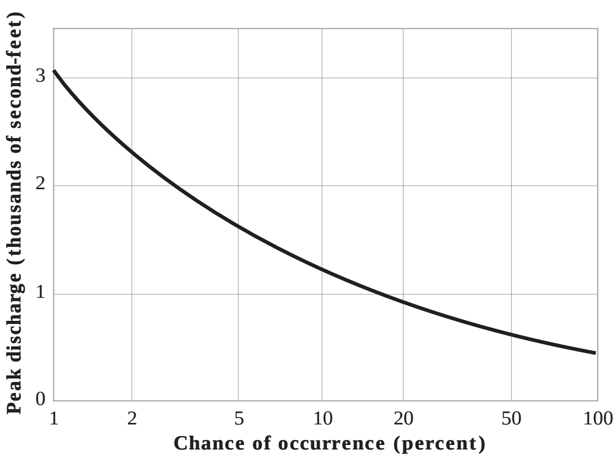


Figure 2–3 Discharge–stage curve

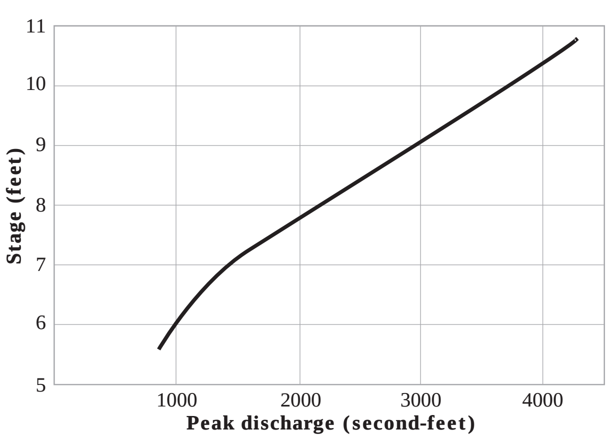
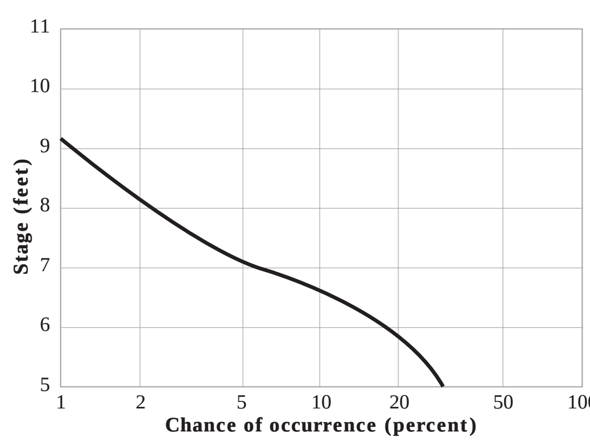


Figure 2–4 Stage–frequency curve



Economic appraisal estimates the monetary values for physical flood characteristics and frequency of flood occurrences.

- Flood stage versus damage (fig. 2–5).
- Discharge in cubic feet per second versus damage.
- Damage versus frequency of occurrence (fig. 2–6).

Figure 2–5 Stage–damage curve

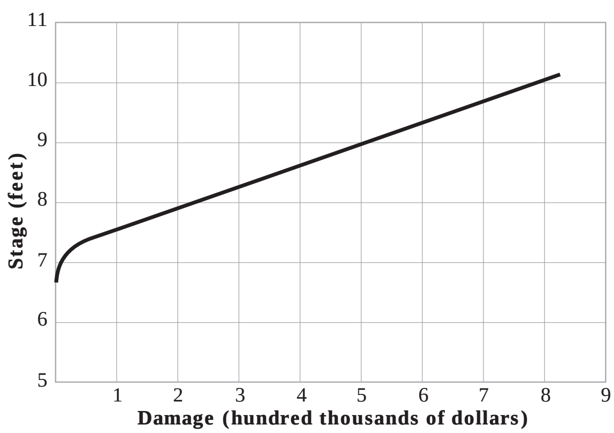
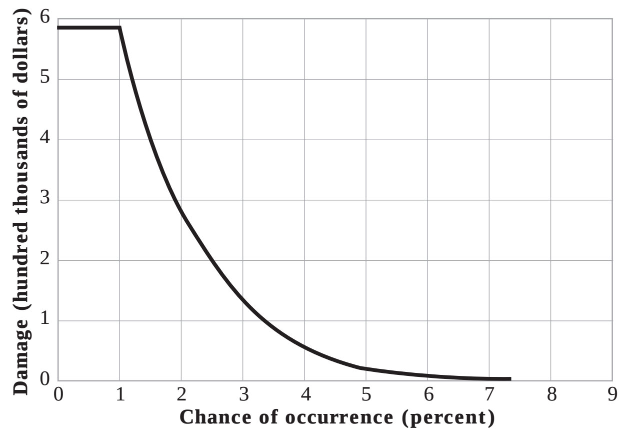


Figure 2–6 Damage–frequency curve



The average annual damage computation model (fig. 2–7) helps to understand frequency analysis. The following situations describe the Frequency Method of calculating average annual damages. Economists can use this information to predict average annual damages without having 100 years of historical data.

The modified curve (fig. 2–7) shows the reduction in damage (benefits) resulting from installing proposed project structures. The model shows that it would take about a 90-year (1.1 percent chance) storm, with project structures in place, to cause the same damages as the 40-year storm did under existing conditions.

Graph A shows that a storm causing floodwater to rise to the elevation of nearly 809 feet causes about $1,500,000 in damage. Sometimes the elevation and damage estimates are reported by local people, but they usually need assistance in calculating the average annual flood damage.

In graph B a hydrologist has determined that the storm would have produced 20,000 cubic feet per second of runoff for the flood water to reach the 809 foot elevation. Some factors involved in these calculations are the configuration of the river valley, the slope, and land use of the runoff area.

For graph C the hydrologist needs to calculate the percent chance of having a storm big enough to produce 20,000 cubic feet per second of runoff. That point is used along with data from other storms to construct the discharge-frequency curve. In this case about a 40-year storm (one that occurs on the average of every 40 years or about 2.5 percent chance of occurring at any given time) would be required to produce 20,000 cubic feet per second of runoff.

From the previous information, a damage-frequency curve (graph D) can be constructed revealing that the $1,500,000 from graph A was caused by a 40-year (2.5 percent chance) storm. The damage curve reveals the amount of damages expected from other storms, and the area under the curve, when measured with a planimeter, represents the total average annual damages for a particular locality. It includes the summing of the percentages of damage from all the storms.

The damage-frequency curve (fig. 2–6) is drawn through plotted values of corresponding damage and frequency. Average annual damage is determined from the damage frequency curve in this example through the following steps:

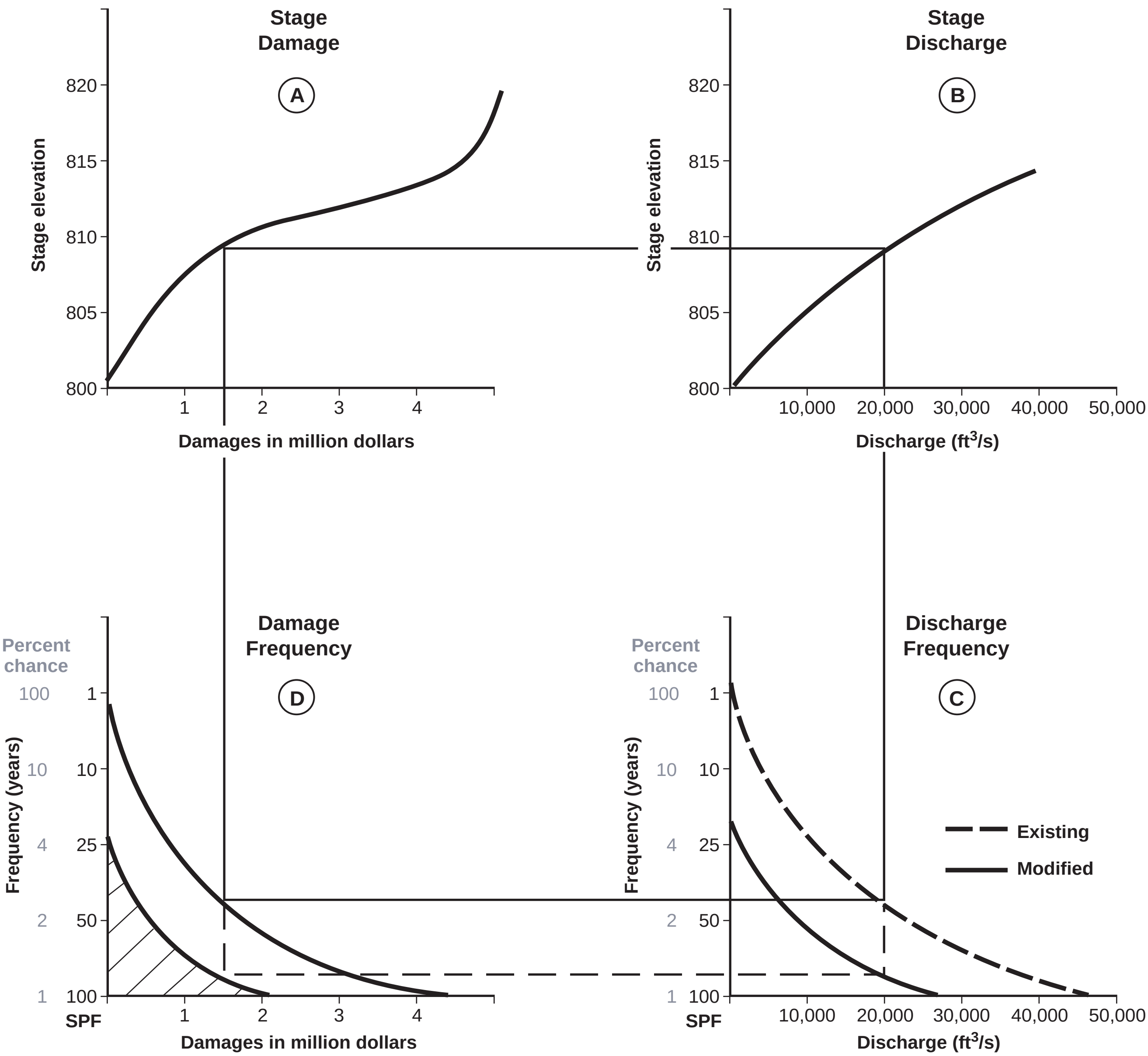
Step 1—Measure, in square inches, the area enclosed by the curve, for example, 13.7 square inches.

Step 2—Determine the product of the values of the abscissa and the ordinate at the point 1 inch from the point of origin. This value determined from figure 2–6 is:

abscissa x ordinate = damage per square inch

10% x $100,000 = $10,000

Figure 2–7 Average annual damage computation model



Notes: The average annual damages are the sum of the area under the Damage Frequency Curve.
The unhatched area below the existing damage frequency curve represents benefits.
The hatched area represents the residual damages under modified (project) conditions.
SPF is the standard project flood.

Step 3—Multiply the area, 13.7 square inches, (step 1) by the unit value per square inch of $10,000 (step 2) to calculate the average annual damage of $137,000.

The damage-frequency relationship can be converted to average annual damage by tabular procedures as well as by planimetering the area under the curve. Table 2–1 is an example using approximate numbers from figure 2–6. The tabular procedure in table 2–1 is used in the computer programs ECON2 and URBI (see 611.0201(h) and 611.0409). The difference in the frequency corresponds to the probability (0 to 1 = .01). Similarly, the average between the damages for subsequent frequencies yields average dollar damages ((580,000 + 580,000/2) = 580,000). The contribution to average annual damage is the probability times the average dollar damage (.01 x 580,000 = 5,800).

Because of difference in flood damage during different plant growth periods, the seasonal distribution of floods must be taken into account when evaluating damages to crops and pasture. The seasonal difference in flood damages and the relative frequency of flooding by seasons or months furnishes the basis for making an adjustment for crop and pasture damages.

Using the seasonal or monthly distribution of flooding, a composite acre value for each stage is developed and the damage is calculated for each period, generally by months of the growing season. The composite-acre damage for each period is then weighted by applying the probability that a damaging flood will occur. The weighted damage by periods is then totaled to determine the annual composite monetary damage (table 2–2). This calculation makes possible damage estimates by flood stages and permits the construction of a stage-damage curve for the reach.

When crops are flooded more frequently than once a year, the damaging effect of the succeeding flood is altered by the effects of the previous flood. Two 100 percent chance events occurring during a given crop year will produce less total damage than if they were to occur in successive years. Because of this, the crop

Table 2–1 Damage-frequency relationship/average annual damage

Frequency (% change of occurrence)	Damages ($)	Change in frequency (probability)	Average damage ($)	Contribution to avg. ann. damage ($)
0	580,000			
		.10		
10	580,000		580,000	58,000
		.10		
20	270,000		425,000	42,500
		.10		
30	140,000		205,000	20,500
		.10		
40	60,000		100,000	10,000
		.10		
50	20,000		40,000	4,000
		.10		
60	8,000		14,000	1,400
		.15		
75	0		4,000	600
Total average annual damage				**137,000**

Table 2–2 Calculation of cropland and pasture stage-damage relationship at 2-foot stage for Reach No. 1

Period	Damage at 2-foot stage per composite acre ($)	Percent chance of flood occurrence in any 1 year (%)	Weighted per acre damages ($)
January	0	5	0
February	0	5	0
March	.48	15	.07
April	1.35	15	.20
May	6.85	5	.34
June	20.00	5	1.00
July	56.00	5	2.80
August	61.00	5	3.05
September	32.00	10	3.20
October	15.00	15	2.25
November	1.80	8	.14
December	0	7	0
Total	**---**	**100**	**$13.05**

damage estimates must be adjusted to account for recurrence of flooding. A method developed to account for recurrent flooding uses the equation:

$$\frac{1}{Y} = 1.005 + 0.1193(X)$$

where:
Y = adjustment in crop damage
X = ratio of average acres flooded annually to the total flood plain acreage

Adjustments for recurrent flooding must consider project effects. The project can be expected to eliminate some recurrent flooding.

When the land use in the flood plain is stratified by the frequency of flooding, then the crop and pasture damages should be stratified by calculating the composite land use and damages for each stratum. Often, lower value crops are grown in the more frequently flooded areas close to the stream, while the higher value crops are grown in less frequently flooded areas. To avoid overestimating damages in this situation, each area must be evaluated separately with the appropriate composite land use.

To ensure that the estimate of damages and benefits do not exceed reasonable limits based on net income from crops in the flood free condition, the estimate will be limited to storms with a recurrence interval exceeding the 200 percent chance (.5 year) storm or greater.

(2) Overland flow

In some watersheds, tributary ephemeral streams discharge their floodwater into alluvial areas that do not have a defined channel to the main watercourse. These alluvial areas are generally flat or only gently sloping in both directions, and the floodwater spreads out until the flow eventually is dissipated. This condition, called overland flow, occurs where there is virtually no channel or where the possibility of lateral spreading is great.

Under natural conditions, these alluvial areas are spreading areas for runoff. Because of favorable topographic and soil characteristics, many of these alluvial areas have been developed into highly productive farming areas and in some cases into urban and suburban areas. The increasing value of property and the susceptibility of various areas to damage, together with the inability of individuals to protect their property because of the unpredictable path of flood flows, can create serious local flood problems.

Peak discharge and flood stage have little meaning in appraising potential damages from overland floods. When floodwater emerges from a confined section onto the alluvial fan or plain, the flood peak quickly flattens. As a result the area flooded is not a direct function of the peak discharge except as it may overtop diversion dikes built to direct its course away from a portion of the flood plain. More often the area flooded is related to the flood volume—the greater the volume, the greater is the area flooded.

This relationship is illustrated by the Elkhorn Watershed in Nebraska. Floodwater from this watershed flows from the Elkhorn Mountains onto a highly productive, gently sloping flood plain. Once the floodwater breaks through the highline irrigation canal, it spreads out over the farm land in relatively shallow, sheet-like flows except where it is concentrated or obstructed by railroad and road fills, ditches, or other constructed obstacles. The relationship between flood volume and acreage flooded is shown in table 2–3.

A large area of cropland in this watershed lies on the flood plain. Not all of the area is subject to flooding by a single flood (even a 100-year flood would inundate only about a quarter of the area), but most is subject to the flooding with slight changes in the flood flow paths.

Table 2–3 Flood volume and acreage flooded (Elkhorn watershed)

Flood date	Volume (acre-feet)	Cropland flooded (acres)	Acres flooded per ac-ft
August 1979	3,500	4,600	1.3
September 1996	7,000	7,500	1.1
September 1989	2,500	3,000	1.2
January 1991	5,500	7,000	1.3
July-August 1991	11,500	14,100	1.2
Total	**30,000**	**36,200**	**1.2**

In overland flow situations with relatively little ponding, farm damage per acre flooded appears to be relatively constant irrespective of the number of acres flooded. This is illustrated in table 2–4 for the Elkhorn Watershed for two floods, both of which occurred in August.

Because the flood in July and August 1991 was more than three times as large as the August 1979 flood, it was concluded that flood damage was proportional to the acreage flooded, which in turn was proportional to the flood volume. Hence, the hydrologist had only to determine a flood volume-frequency series to provide a basis for determining average annual flood damages over a normal hydrologic period.

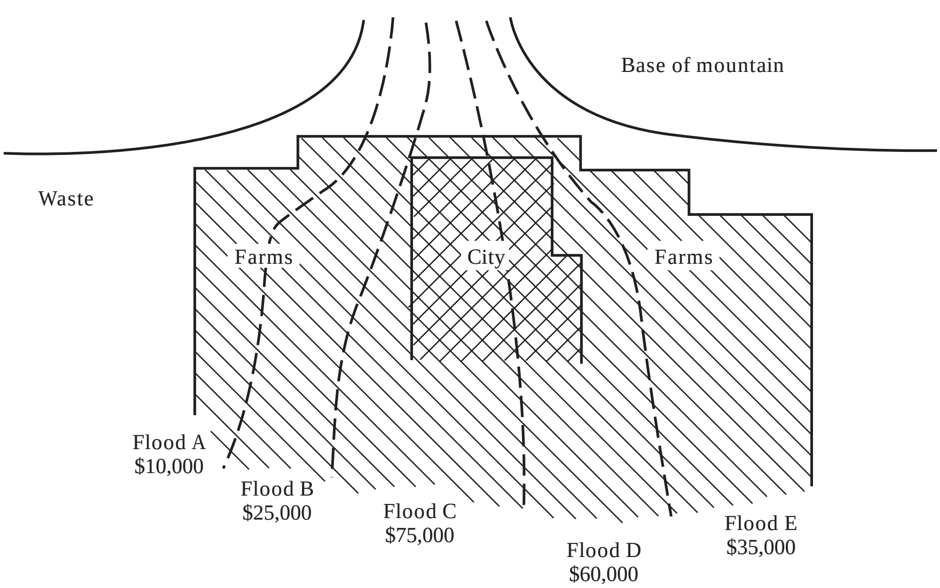
Table 2–4 Flood damage by overland flow in Elkhorn watershed

Type of damage	August 1979 flood	July-August 1991 flood
	- - - - ($ damage/acre) - - - -	
Crop	$28.75	$28.60
Land	8.89	10.14
Farm ditches	3.91	3.60
Miscellaneous farm damage	1.69	3.11
Total damages/acres flooded	**$43.24**	**$ 45.45**

Overland floods seldom follow the same path. During the interval between floods, even minor changes in the flood plain, such as small dikes, road and railroad fills, irrigation ditches, or even land leveling, have been known to alter the course of flood flows. Sediment deposition where there is an abrupt change of grade is also an important factor in altering their course. This unpredictability is not particularly important where there is homogeneity on the flood plain. However, many alluvial fans or other alluvial areas exhibit a wide variety of damage potential because of differences in kind and extent of development. If a flood strikes the developed area of the flood plain, serious damage may result; whereas, if it followed a path through an undeveloped area, little or no damage would occur. In such situations the mean damage resulting from a flood of certain size must be determined, taking into consideration the probability of the flood following any one of several possible paths. This problem is illustrated in figure 2–8.

Through the use of topographic surveys, aerial photographs, and maps of historical flood flows, flood paths A, B, C, D, and E in figure 2–8 are traced through the

Figure 2–8 Overland flooding in Elkhorn area



flood plain. Flood damages are determined from known relationships among damages, flood depths, and velocity. If a flood of the magnitude being studied has an equal chance of following each of the flood paths, then the probable damage from such a flood is equal to the mean value of the five alternatives, which in this example is $41,000 ($205,000/5). Similar studies made for floods of different magnitudes would furnish the basis for damage-flood volume curves.

In arid regions where the overland flow technique has been used most frequently, there are few floods in a 20-year period. The few gage records that exist indicate that even where floods are so infrequent, more than one flood generally occurs during 2 or 3 years of the 20-year period. However, recurrent flooding during a single year over the same year is unlikely because of the alternative paths the flow can take.

(c) Steps in damage appraisal

The steps necessary to appraise floodwater damages are:
- Selecting study areas
- Collecting basic data
- Analyzing damage

Understanding the appraisal principles involved provides the economist with a basis for making adaptations necessary to cope with unusual problems not contemplated in these steps.

(1) Step 1—Selecting study areas

To obtain statistically reliable data in watersheds covering only a few square miles, information on the entire flood plain may need to be obtained. However, a sampling procedure should be employed where practical and certainly should be used on all larger watersheds.

A careful reconnaissance of the area is needed to select a sample for detailed investigation. This allows sampling of major problems or conditions. Stereoscopic analysis of flood plain photographs are useful in this reconnaissance.

The selection and use of appropriate stream and flood plain reaches provide a means for:
- Identifying the location of damages and benefits
- Bringing the evaluation of hydrologic and economic data together for determination of stage-area-damage relationships
- Relating damage reductions or other benefits to works of improvement

In selecting the sample areas for detailed investigation, appraisers should direct their attention to these points:
- Important variations in flood plain characteristics and in land use should be considered.
- Both sides of the stream should be represented.
- Differences in channel size and valley width from headwaters to bottom reaches should not be overlooked.
- No portion of the flood plain should be deliberately excluded from the possibility of being drawn in the sample.
- Sample selection should facilitate evaluation of individual structures or groups of structures.

The sample size should provide a reasonable degree of statistical reliability. The required reliability depends upon the magnitude and complexity of the problem and potential solutions.

(2) Step 2—Collecting basic data

(i) Maps—Major land use on the flood plain may be mapped on aerial photos, overlays, or sketches, depending upon the need. The map should show improvements, such as roads, buildings, and bridges, subject to damage. Where urban and residential areas are subject to flooding, it is desirable to use a detailed map. Many towns and cities have maps that help fill this need. Land use capability classes and soil delineation also may be shown on the flood plain map. Crop distribution throughout the flood plain does not always need to be shown; however, it is desirable in a few representative sample valley sections. Locations of areas significantly affected by flood plain scour, deposition, and streambank erosion may be delineated on the map to complement the investigations of the geologist.

***(ii) Field information*—**Damage information often may be obtained directly from landowners on the flood plain. This information should be recorded on flood damage schedules rather than in separate notes. This ensures that comparable information is obtained from all respondents. Approved form NRCS-ECN-1 (appendix 2A) is used for collection of agricultural flood damage information.

Field damage information furnishes basic data for estimating likely or potential damage for all classes of agricultural property or provides the basis for making adjustments to standard damage data already developed. Many farmers will be able to give information about only one flood. This may be the most recent, the largest, or the most damaging. However, information should be obtained on as many floods as possible.

The proportion of cropland in the various crops should be as accurate as possible. Although normal crop rotations cause different crops to occupy a given field from year to year, the overall distribution should be reflective of crop patterns and sequences on the flood plain. Some cropland that is idle is expected. The division of the flood plain among cropland, pasture, woodland, and other uses can in some cases be determined by planimetering recent aerial photos of the flood plain. These data represent current land use and cropping patterns. Adjustments are made where these data do not represent future relevant physical and economic changes expected to influence land use and cropping patterns in the absence of the project.

Interviews with the farm owner or operator should be conducted primarily to obtain information about physical quantities rather than economic values. For example, farmers should be asked about the tons of fertilizer applied or the number of acres receiving custom field work, rather than the amount of money spent on such items. Otherwise, much time is required to determine what items the farmer has included in the value estimate and the price base used.

***(iii) Cost and price base data*—**Agricultural universities and persons knowledgeable of local agriculture can provide information on farming equipment and farming operations common to the area. The Cost and Return Estimator (CARE) crop budget system, available at each NRCS state office, provides information on costs of producing various crops. If a given operation, such as combining, is usually done on a custom basis, the custom price may be considered as a cost of the operation. Crop budgets can be developed using CARE or may be available in the FOTG or from other sources.

When cost data are from the varying sources, care should be taken to check its applicability to the watershed. The price base should be known so that price levels for production cost can be consistent with current normalized prices. A known price base is also necessary for updating. The economist should find out exactly what items the cost data include. Among these are interest charges and depreciation on equipment, labor (whether hired or unpaid family), and land cost.

Analyze production costs that can be expected to vary between the with and without project conditions. These may include the costs of equipment ownership and operation; production materials; labor and management; system operation, maintenance, and replacement (OM&R); and interest payments. If costs associated with project measures are included in the project cost analysis, exclude them from production costs.

Value purchased inputs at current market prices. Compute interest at the project discount rate. Value all labor, whether operator, family, or hired, at prevailing farm labor rates. Estimate management cost on the basis of the type of farming operation. The estimate normally is expected to be at least 6 percent of the variable production cost (the cost of equipment ownership and operation, production materials and labor, but excluding the cost of land and added capital improvements).

***(iv) Livestock production*—**In geographically isolated areas, increased livestock production may depend on installation of the water resources project. Where this can be demonstrated, net income from additional livestock production may be included as a benefit. The test for dependency is whether the livestock feeds can economically be transported into or out of the area. Benefits cannot exceed the delivered cost of the livestock feed if it was purchased for use in the project area. Such purchase prices would automatically include the costs of transporting the feeds into the area.

(3) Analyzing damage

Damage estimates are based upon data obtained in the field. To obtain an accurate appraisal of the effects of the project, raw data must be analyzed and processed before being correlated with information provided by the specialists.

The planner is faced with the problem of balancing the limitations imposed by a small data set with the cost and the time required to obtain and analyze more complete information. It may be necessary to adopt certain reasonable assumptions and to develop abbreviated procedures to keep planning costs within reason. When assumptions are made, they should be explicitly stated and explained in the evaluation. Appropriate risk analysis techniques may be used to express the possible effects associated with risk and uncertainty of assumptions.

(i) Crop and pasture damage—Floodwater damage sustained by crops and pasture depends upon the value of the crop, seasonal occurrence and frequency of flooding, and such characteristics of flooding as depth, velocity of flow, sediment load, and duration. Flood Damage Questionnaire responses can form the basis for estimating many of these factors.

Estimates of flood-free yields are obviously hypothetical figures. Flood plains of creek watersheds are so small that accurate yield data from secondary sources are seldom available. Basic data on the yields to be expected in the flood plain can be obtained from interviews, but these data must be scrutinized carefully. Data obtained from interviews may be biased since other events may have reduced the yield had a flood not damaged or destroyed the crop. Yield levels need to reflect fertility and farming methods in the area. Individual farm data on crop acreage and yields often are available from the Farm Service Agency (FSA). FSA information may be used to confirm general yield levels for the area. County yield data are available from the state crop reporting agency. Yields within the watershed will be adjusted to reflect productivity using base yield levels. Base yield data are available from soils information in the field office technical guide.

For future condition crop yields, the current yields with average management in the project area should be projected to selected time periods. Only yield increases caused by improved floodwater runoff conditions from the project should be included. Changes in yields, both with and without the project, should be projected consistently with the water management and production practices accounted for in the production cost analysis.

Crop damage factors are derived for each crop to relate the damage to the month or season and the depth or duration of flooding. Table 2–5 shows an example for estimating the percent damage to a given crop at the 3 feet and over depth increment of flooding, during a given month or season. Similar procedures can be used for other depths or duration of flooding and for other seasons or months. This procedure should be repeated for each of the crops on the flood plain.

General steps in calculating crop damage factors follow:

- Collect information on planting dates, all cultural practices, plant growth characteristics, maturity dates, and harvest dates of all crops, as well as effects of floodwater on the individual plants. This information is available from crop budgets, damage schedule information, and from crop experts.
- List all cropping alternatives available to the farmer with the last date the farmer would undertake replanting or a particular field operation. This is best done by preparing a simple matrix listing assumptions by crop, time period, and depth class that will be performed or not performed if the crop is flooded. The period to use can be biweekly or monthly depending upon the accuracy of the data and upon the significance of the actions the farmer would take if the crop floods. If biweekly periods are used, they should be summarized by month.
- Divide damage information into depth classes, such as 0 to 1 foot, 1.1 to 3 feet, and more than 3 feet. The depth classes depend on the type and nature of flooding.

- Calculate the damage factor as shown in the following procedure. Note that any cost saved as a result of the flood should be subtracted from the damage. For example, if the crop was completely destroyed by a flood, subtract harvesting and hauling costs since they would be saved. **Note:** Damage factors seldom include harvesting or hauling costs.

No flood: $(Q)(P) = V$

After flood: $(Q1)(P) + APC - ES - AVC = V1$

where:

Q = production per acre—no flood
Q1 = production per acre—after flood
P = price per unit of production
V = total value—no flood
V1 = total value—after flood
APC = added production cost necessitated by flooding
ES = expenses saved (harvesting and hauling expenses saved if no crop was made)
AVC = alternate value crop (Net value of the secondary crop that is planted after primary crop was destroyed. It is assumed this will take place after the latest planting date of the primary crop.)

The monthly percentage flood damage factor, expressed as a percent, would be V1/V.

Table 2–5 Crop damage assessment by season and depth of flooding (flood damage to cotton 3 feet deep and over, spring flood, Village Creek)

Schedule no.	Acres flooded (1)	Est. yield (2)	Production (3)	Per unit (4)	Total value (5)	Actual yield (6)	Production (7)	Per unit (8)	Total value (9)	Gross damage (10)	Exp. saved (11)	Alt. crop (12)	Add exp. (13)	Net damage (14)
		(lb)	(lb)	($)	($)	(lb)	(lb)	($)	($)	($)	($)	($)	($)	($)
72	40	450	18,000	0.386	6,948	0	0	0.386	0	6,948	2,782	916	0	3,250
121	10	420	4,200	0.386	1,621	0	0	0.386	0	1,621	262	0	0	1,359
114	8	430	3,440	0.386	1,328	133	1,064	0.386	411	917	212	0	10	715
Total	**58**	**---**	**25,640**	**0.386**	**9,897**	**---**	**1,064**	**0.386**	**411**	**9,486**	**3,256**	**916**	**10**	**5,324**

Damage per acre flooded: 91.79
Percent of damage: .54
Procedure: Column (1) x Column (2) = Column (3)
Column (3) x Column (4) = Column (5)
Column (1) x Column (6) = Column (7)
Column (7) x Column (8) = Column (9)
Column (5) – Column (9) = Column (10)
Column (10) – Column (11) – Column (12) + Column (13) = Column (14)

- The procedure is then repeated for each time period, for each crop in the flood plain. This results in a monthly set of damage factors for the particular depth category and crop. These damage factors can be used in ECON2.
- If the analyst is completing the evaluations by hand instead of using ECON2, then the next step is to adjust the monthly flood damage factors by the monthly rainfall distribution in the watershed. This computation results in a weighted factor that can be applied directly to the gross value of production of the individual crop.
- This weighted annual damage factor is then multiplied by the number of average annual acres within the 1.1- to 3-foot depth of flooding.
- This procedure is then repeated for each of the other flood depth classes studied. The damage values obtained from each of the flood depth classes are then added together to obtain the total average annual damage for the alternative.

In a single watershed, detailed information generally can be obtained for only a few floods. Therefore, schedules that can be obtained in most watersheds do not furnish adequate information to determine the percent damage factors for all months or seasons or for all depths or duration. Damage information previously obtained in similar areas may be used to supplement field data on a given watershed to indicate general relationships and to fill gaps where field data are inadequate. However,some basic factors on percent damage for each watershed may need to be calculated whenever supplemental damage factor data are being used. The supplemental data can then be adjusted to the flood plain under evaluation.

Major land uses may be determined from the flood plain map. Present crop distribution in the flood plain can be obtained by adding the present acreage column from the NRCS-ECN-1 questionnaires. The land use acreage for the year planning begins should represent present conditions. The acreage should be adjusted if there are obvious reasons for making adjustments to more nearly reflect normal conditions. For future cropping patterns, project the most probable cropping patterns expected to exist with and without the project. If project measures are designed to reduce damage or associated cost problems without changing cropping patterns, project the current cropping pattern into the future for both with and without project conditions.

In some watersheds land use is uniform throughout the flood plain. In others it may differ considerably between upper and lower reaches of the stream. Where this is the case, different land uses and crop values are to be used for the two (or more) reaches. In a given cross section, land use may vary significantly for elevations above the bankfull stage. The acreage inundated first may be woods or idle land in which there is little or no damage. This acreage should be evaluated separately from acreage where more substantial damages result from flooding.

Table 2–6 shows a method of calculating the composite damageable value per acre of flood plain when uniform land use is assumed. The damageable value of each crop (determined as shown in the table) can be multiplied by its percent damage factor and the products added to give the damage from flooding an average acre of flood plain to a given depth during each season. This is shown in table 2–7.

Table 2–6 Example of data used to calculate damageable value per acre of flood plain

Crop use	Percent in this use	Unit	Yield per acre of crop	Normalized price ($)	Damageable value per acre ($) 1/
Corn	6.3	bu	130	2.63	21.54
Cotton	6.3	lb	542	.595	20.32
Oats	10.5	bu	110	1.38	15.94
Wheat	6.6	bu	82	2.92	15.80
Hay	0.3	tons	3.5	72.11	0.76
Pasture	67.0	AUM	4.4	10.00	29.48
Noncrop	3.0	---	---	---	---
Total					**103.84**

1/ The damageable value per composite acre from each crop is the product of percent in that use, yield per acre, and price; i.e., for corn (.063 x 130 x $2.63 = $21.54).

Damages by depth for each season are then multiplied by the percent chance of flood occurrence for that season to develop weighted per acre damages for the composite acre land use.

Weighted damages per acre are then multiplied by acreage inundated for representative stages to develop stage damage curves similar to that shown in figure 2–5. Development of damage curves for seasons rather than one for each month is adequate in most cases.

Example 2–1 shows the steps in developing crop damage factors. The data obtained from the procedure in example 2–1 can be combined in tabular format.

Table 2–7 illustrates a procedure for watersheds where depth of inundation is more meaningful than duration of flooding. This is the situation on most watersheds. However, when water gathers on a wide, relatively flat flood plain, it may remain for a considerable time. If this occurs, duration may be the more important factor. Increments of duration may be handled in a manner similar to that illustrated for depth increments.

Table 2–7 Composite crop and pasture damage rate, per acre flooded, by depth of flooding

Crop	Damageable value per composite acre ($)	Depth: 0 – 1.0 ft %	0 – 1.0 ft $	1.1 – 3.0 ft %	1.1 – 3.0 ft $	3.1 or more ft %	3.1 or more ft $
Corn	21.54	26	5.60	35	7.54	47	10.12
Cotton	20.32	17	3.45	41	8.33	54	10.97
Oats	15.94	32	5.10	50	7.97	63	10.04
Wheat	15.80	33	5.21	50	7.90	63	9.95
Hay	0.76	20	0.15	23	0.17	36	0.27
Pasture	29.48	10	2.95	18	5.31	20	5.90
Total	**103.84**		**22.46**		**37.22**		**47.25**

Example 2–1 Development of crop damage factors

Step 1 Prepare standard crop budgets.

Step 2 Prepare a simple matrix listing assumptions, by crop, by 2-week intervals if significant (summarized by month), and by depth class, that will be performed or not performed if flooded.

Crop: cotton
State: Arizona

Summary by month	Value for each time	Operations by depth class: 0 – 1.0 No. of times	0 – 1.0 $ value	1.1 – 3.0 No. of times	1.1 – 3.0 $ value	3.0 + No. of times	3.0 + $ value
January							
Disk	4.00	1	4.00	2	8.00	2	8.00
Plow	4.88	---	---	---	---	1	4.88
Total cost			4.00		8.00		$12.88
Yield loss %			0		0		13.4%
February							
Land plane	2.26	---	---	1	2.26	1	2.26
Fertilize	19.10	.25	4.78	.50	9.55	1	19.10
(Disk)	4.00	1	4.00	1	4.00	1	4.00
(Plow)	4.88	---	---	---	---	1	4.88
Total cost			8.78		15.81		$30.24
Yield loss %			0%		17.8%		30.0%
March							
Pre-irrigation	10.00	---	---	---	---	1	10.00
Herbicides	6.25	1	6.25	1	6.25	1	6.25
Prep beds	1.79	1	1.79	1	1.79	1	1.79
Mulch	2.41	1	2.41	1	2.41	1	2.41
Prepare ends	0.41	1	0.41	1	0.41	1	0.41
(Plow)	4.88	---	---	1	4.88	1	4.88
(Disk)	4.00	1	4.00	1	4.00	1	4.00
Land plane	2.26	1	2.26	1	2.26	1	2.26
Fertilize	19.10	.50	9.55	.75	14.33	1	19.10
Total cost			26.67		36.33		$51.10
Yield loss %			17.8%		26.0%		50.0%

( ) = Operations completed in previous months that must be redone if flooded.

Step 3 Subtract from the damage, any cost saved as a result of the flood. For example, if the crop was completely destroyed by a flood, subtract harvesting and hauling costs since they would be saved.

Example 2–1 Development of crop damage factors—Continued

Step 4 The procedure for calculating damage factors can be summarized as follows:

No flood: $(Q)(P) = V$

After flood: $(Q1)(P) + APC - ES - AVC = V1$

$$\text{Monthly percentage flood damage factor} = \frac{V - VI}{V}$$

where:

- Q = production per acre minus (–) no flood
- Q1 = production per acre--after flood
- P = price per unit of production
- V = total value--no flood
- V1 = total value--after flood
- APC = added production cost necessitated by flooding
- ES = expenses saved (harvesting and hauling if no crop was made)
- AVC = alternate value crop (Net value of the secondary crop that is planted after primary crop was destroyed. It is assumed this will take place after the latest planting date of the primary crop.)

The procedure is then repeated for each month by 2-week time periods, if significant, (summarized by month) of the year that damage can occur and for each crop in the flood plain.

Step 5 Adjust the monthly flood damage factors by the monthly rainfall distribution in the watershed. This computation results in a weighted factor that can be applied directly to the gross value of the production of the individual crop. For example:

Cotton – flood depth 1.1 to 3.0 feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ftr 1/	.01	.33	.54	.57	.57	.34	.39	.43	.40	.39	.25	.08
%Rfl 2/	.01	.06	.07	.08	.11	.14	.18	.11	.09	.08	.06	.01
Prodt	.0001	.0198	.0378	.0456	.0627	.0476	.0702	.0473	.0360	.0312	.0150	.0008

Sum of production values = .4141

1/ Damage factor from step 4.
2/ Percent rainfall for the Midwest. It is the probability of a flood event, which may or may not coincide with a rainfall event because of soil moisture, frost, ground cover, or snow cover.

Gross value of production = $650.49
($650.49)(.4141) = $269.37 damage per acre for 1.1- to 3.0-foot depth of floodwater.

Step 6 The value determined in step 5 is multiplied by the number of average annual acres within the 1.1- to 3.0-foot depth of flooding. This procedure is then repeated for each of the other flood depth classes studied. The damage values obtained from each of the flood depth classes are then added together to obtain the total average annual damage for the alternative.

***(ii) Other agricultural damage*—**Other agricultural properties include physical improvements associated with various farm enterprises and the agricultural community. Measure benefits to such properties as reduction in damages in the future with the project compared to without the project. This section identifies key analytical steps in the evaluation. Benefits accrue through alterations in water conditions or the susceptibility of the property to damage.

Seasonal curves for other agricultural damages are not ordinarily needed. Damages of this type may not start until a relatively high flood stage is reached. For example, floodwater probably needs to be at least 2 feet deep before much damage to fences occurs. The sampling procedure used for estimating crop and pasture damage should be equally applicable to estimates of other agricultural damage.

Inventory damageable improvements— Identify the location, type, number, and value of other agricultural properties within the area that are subject to damage. This information is most easily obtained through interviews of farmers and field reconnaissance.

Determine damage to improvements— Gather historical data on damages to other agricultural properties, such as equipment, improvements, and agricultural enterprises.

Determine average annual damage to improvements— Use appropriate data to determine average annual damage to improvements. For example, use depth-damage relationships for each reach, integrated with hydrologic data, to develop average annual flood damages with and without the plan. Include consideration of the frequency and duration of the damage.

Calculate average annual benefits— The damage reduction benefit is the difference between average annual damages with and without the plan.

Where irrigation, drainage, or farm levee systems are subject to flood damage, they should be evaluated separately. For example, damage to an irrigation system might be as minor as ditch silting or washout of a siphon, but the inability to use the system before repair of such damage could cause loss of a crop.

***(iii) Damage to transportation*—**Transportation factors include roads, bridges, and railroads.

Roads and bridges— Estimates of road and bridge damage may be obtained from state highway engineers, boards of county commissioners, county engineers, or township trustees. Use only approved form NRCS-ECN-004 to collect damage information (appendix 2A).

Road and bridge data should be related to specific events and depths of flooding. The information is often incomplete for various reasons. A newly elected county commissioner may be unable to report on the expenditures authorized by a predecessor. The commissioner may keep general records that do not distinguish the part spent for ordinary maintenance from that spent for repairing damage. A road or highway district may phase maintenance, repair, and spreading costs over several years. Hence, the record of damages to roads and bridges may be inaccurate because of delayed maintenance or repair. For these reasons the flood damage schedule tells the enumerator to "Indicate the year repair was made if that year is other than the year damaged occurred."

Supplemental information, obtained from farmers and others provides a check on data acquired from official sources. Though local residents may have little information on costs, they can often pinpoint the location of major damage to bridges and roads. Furthermore, in some areas farmers cooperatively repair some damage to roads and bridges. When this is the case, the full cost of repairs may not be in public records.

In obtaining information on historical damage to a road and bridge, the facility's condition must be determined at the time it was damaged. Replacements may be better constructed and less subject to flood damage than the original facility. If this appears likely, damage estimates should be based on the new facility.

Railroads— Information on damage from severe floods to railroad property is usually available from railroad officials. Caution should be observed in obtaining this information to make sure that it is complete, particularly if only partial repair is made immediately after the flood and complete restoration is deferred. The question also arises with railroad damage as to whether there is segregation of normal maintenance and flood repair expenditures where less than major floods are concerned.

Ordinarily, it is desirable to obtain as much information as possible from local railroad officials to supplement that obtained from company headquarters. Local people generally can give information on the location of track and bridges damaged and an indication of physical damage. Such information can be correlated with published data and information previously gathered elsewhere.

(d) Damage reduction benefits

Flood prevention benefits to be used in economic evaluations are derived from damage appraisals. This section describes the determination of flood prevention benefits.

(1) Reductions in damage

Flood damages are lessened by reducing discharge or increasing channel capacity, which in turn reduces the area, duration, and depth of downstream flooding. Evaluation requires the determination of damages under nonproject conditions, as well as damages expected after installation of successive increments of structural or land treatment practices. The difference between damage without and with installation of any segment of the project constitutes the benefit from damage reduction creditable to that segment.

In addition to reducing ordinary physical damage, consideration should be given to the possibility that flood prevention measures may reduce the cost of operation and maintenance or lengthen the life of proposed or existing facilities. For example, a heavy sediment load in a stream may cause such extensive channel filling that the channel requires frequent cleaning. In this case benefits could arise from reducing the cost of cleaning. Economic benefits from reduced dredging must be supported by documentation that dredging is actually being done and adjusted to account for the fact that not all sediment that leaves the project area would be deposited in the dredged channel.

With-project discharge-frequency curves, prepared by the hydrologist, enable the economist to prepare with-project damage-frequency curves. Comparing these curves and the without-project or original damage-frequency curves determines benefits. With-project curves prepared by the economist and hydrologist are necessary for each kind or combination of measures being evaluated.

Damage reduction benefits from flood prevention measures generally begin to accrue as soon as the measures are installed. No discounting for time lag is required. If land damage from sediment deposition or flood plain scour preceded installation of flood prevention measures, analysis should reflect the time required for recovery. Likewise, if frequent flooding has restricted land use or required selection of crops less susceptible to flood damage, flood plain land operators generally wait until the effectiveness of the protection can be judged before they intensify land use or select different crops. Discounting is considered for such benefits when time lags exceed 2 years.

When reduction of land damage is used as a benefit, appropriate adjustments in estimates of other types of damage should be made. For example, when flood plain land is destroyed through streambank erosion, the estimate of crop and pasture damage during the life of the project must be reduced to take into account the smaller area that will remain to sustain damage.

A technical problem arises in the evaluation of benefits from waterflow control measures when determining the amount of acreage involved. Flood routing, the procedure used to determine damages under nonproject conditions, may be done before sites for floodwater retarding structure have been determined. When these sites are finally located, that part of the flood plain on which previous routing was made may be included within the pool area of the structure or structures. Unless adjustments are made, the difference between damages before and after project installation would include the damage within the pool area as a project benefit. Adjustments to the flood plain area may also be needed when channel improvement or floodways are planned.

(2) Future development in the absence of a project

As shown earlier in this section, project evaluation requires a comparison of conditions that would exist over the evaluation period without the project and those that can be expected with the project in operation. Where the damageable value base from which evaluation is to be made is different from the conditions of present use, the basis for the projected condition must be completely documented.

The most common approach to this problem is to estimate the eventual degree of change and the period over which the change will occur and to assume that the change will take place uniformly over time. This approach provides an annual increment of change that can be discounted to present value and used to adjust present conditions to average future conditions.

A simple average of the existing and eventual values for this purpose is unsound because deferred values are worth less than similar present values. Consequently, when damageable values are increasing, the greatest value will be at the end of the period and will receive the heaviest discount. The average annual equivalent values after discounting will be less than the simple average of values. The reverse is true if damageable values are declining.

(3) Increased income

A flood hazard often prevents the highest use of resources. Once the hazard is removed, uses of these resources may be more efficient. For example, flood plain pasture may be lightly used because of the hazard to livestock. Catch crops may be grown instead of high value crops in an effort to avoid the season of worst flooding. In these situations protection may allow land to remain in its original use, but income will be increased through more effective use of resources. Increases in net income that occur on protected flood plains as a result of changes in the cropping pattern are reported as intensification benefits (see P&G and section 611.0201(e)).

Changes of these types generally take place only after some lag in time, so calculated benefits should be discounted accordingly. Associated costs required to make such changes possible should be deducted from the gross increase in income.

(e) Intensification

Intensification benefits occur on lands where the cropping patterns or land use will change. This section illustrates some major problems most likely to be encountered in evaluating these benefits. The information is applicable to projects for flood prevention and agricultural water management.

(1) Agricultural benefits

Many areas of the flood plain land are abandoned or they are in low income-producing uses because of adverse effects of flooding. Reduced income from such a condition may be considered a type of flood damage. Installation of flood-prevention measures reduces the flood hazard sufficiently to induce a use more consistent with the land's productive potential. The difference between the net income now generated and that expected under improved conditions is the benefit from intensification.

(2) Nonagricultural benefits

Intensification-type benefits may accrue because of nonagricultural uses expected as a result of a project. Flood protection may permit commercial, industrial, or residential development of flood plain areas. In some cases such areas may be level and can be developed with less expense than nearby uplands. The development may take the form of a shift from agricultural to rural residential use or to suburban or urban use. Development of idle land may also be involved.

The preferred method of evaluating benefits of this type is to estimate the increase in income-producing potential of the land. If data are not available, an alternative method is to use the increase in the appraisal value of the land. These approaches apply when industrial, commercial, or residential development is concerned. In most instances the same type of development could take place elsewhere. If benefits are claimed for the project, development in the benefited area should have advantages over development elsewhere in terms of higher income, lower development costs, or both. Only the difference between the project area value and the other area value (net of developmental costs) can be considered a project benefit. When evaluation is based on land values, these values must be determined by qualified appraisers.

(3) Data necessary for evaluation

Identifying the areas to which benefits may accrue is essential. Physical, social, and economic factors govern the amount of change, the type of change expected, and when the expected change will occur. Information on at least the following factors should be obtained and evaluated:

- Agronomic potential of the land.
- Type of farming.
- Width and topography of the flood plain or area to be benefited.
- Need for various types of production, whether in agricultural products or in urban and industrial services.
- Degree of protection or service afforded by the planned improvements.
- The land use change supported by this degree of protection or service.
- Willingness, intentions, and financial and managerial ability of present and future operators to develop the land.
- Availability of markets for new products.
- Restrictions imposed by acreage allotments, marketing quotas, or zoning regulations.

For agricultural purposes the productivity of the land and its responsiveness to production inputs, such as fertilization, irrigation, or drainage, are highly important. If nonagricultural uses are being considered, such things as drainage, accessibility to transportation, stability as a building site, and cost of correcting any adverse conditions must be determined.

Increased mechanization enhances the desirability of relatively large, level fields for agricultural production. The same characteristics favor large-scale urban development. Hence, other things being equal, a relatively broad and level flood plain is more likely to reach a higher stage of development than one that is narrow and uneven.

It may not be physically or economically feasible for a project to meet all of the potential needs of the watershed. For example, an irrigation project probably will not supply full water requirements 100 percent of the time. Correct evaluation requires that sufficient information be obtained and analyzed to determine the proportion of demand that will be met by various levels of development, the production inputs that will be applied under each of these conditions, and the production that can be expected in each case.

The intentions of present operators do not necessarily indicate the extent of future enhancement. They are helpful, however, in determining the lag to be expected in reaching the full level of benefits.

Benefit calculations should be based on the effect of measures in reducing or eliminating existing restrictions on higher level uses. For example, determining the area subject to development after flood protection involves estimating the area flooded in each evaluation reach with and without the improvement. The relationship of flooding to land use is now indicated by difference in use under various frequencies of flooding. That is, if land flooded 1 out of 3 years is presently used for pasture, it and similar land will most likely be used for pasture in the future if flooded at the same frequency. If, however, the frequency is reduced to 1 out of 5 years, the land now in pasture may be converted to crops.

Calculations of net returns without and with the project take into account flood damages and the cost of conditioning or developing the land for a change in use with the project in place.

(4) Benefits from allotment crops

From time to time certain crops are under government acreage allotments or marketing quotas. Other crops may be in surplus supply, although not restricted by allotments. Extreme caution should be exercised in claiming benefits from increasing the acreage of these crops as a result of project installation. This applies to all intensification-type benefits described in this section.

(5) Adjustments in benefits

In nearly all cases of intensification-type benefits, the final benefit creditable to the project can be determined only after consideration of such factors as the rate of benefit accrual and the future with-project flooding. The time lag between project installation and full production requires appropriate discounting.

(i) Adjustments for lag in accrual—Intensification-type benefits seldom can be expected to reach their full value immediately after project installation. Time is needed to clear land or otherwise get it in proper physical condition after flood protection is provided. Time may be required for recovery from disturbance caused by land leveling and installation of onfarm drainage or irrigation systems.

In addition to delays caused by physical factors, there are delays stemming from management and financial limitations. Farmers may not have the capital to take immediate advantage of project facilities, and agricultural lenders may be slow to approve loans for new agricultural capital investments. Farmers may need time to discover the best production patterns and inputs needed for most profitable production. This may be especially true for new irrigation development because time is needed to learn when to irrigate and how much water and fertilizer to apply. In addition, a farmer may choose not to expand production at all.

(ii) Adjustments for future flood damage to higher value use—Water resource projects seldom provide complete flood protection to agricultural areas. As a result future floods cause damage on land that has shifted to higher use as a result of the project.

Damage can be calculated by evaluating the effect of flooding on the new damageable value with the project installed. The excess of this damage over that found when the original damageable values were used should be deducted from the gross benefit assigned intensification. This correction is important when agricultural values are involved. Nonagricultural enhancement is not ordinarily undertaken unless a high level of protection is provided.

(iii) Other adjustments to be considered—Adjustments of benefits may be needed when projects are developed for irrigation or drainage. In either case, through capital or other limitations some potential beneficiaries may fail to take full advantage of the project facilities. A common failure may be that onfarm installations are not maintained at full efficiency. An acceptable method of handling this problem is to examine the operation of a similar, nearby area where these improvements are in operation. On the bases of such analyses, potential benefits from the project are adjusted downward for the expected percentage of participation or the degree of effective maintenance.

(f) Historical series method and income method

Use of the historical series method and the net income method is restricted by the Principles and Guidelines. Therefore, they are described here only to complete the presentation of alternative evaluation methods.

(1) Historical series method

The historical series method uses an evaluation period for which the cumulative annual departures from normal precipitation are minimized. Essentially, this method rests upon the assumption that a sequence of events that has occurred in the past also may occur in the future. Floods of extreme magnitude (generally those with an expected recurrence interval of twice the evaluation period or longer) should be excluded from the series unless appropriate adjustments are made.

After the various categories of damage have been appraised for each flood during the evaluation period, under future conditions without the project, the damages should be summed and divided by the number of years in the period. The result is the unadjusted average annual damage. The figure is then adjusted for recurrent flooding or otherwise as needed to obtain the average annual damage. One method of calculating the adjustment is by making a flood-by-flood analysis.

Caution should be observed with regard to the evaluation period. It often happens that the period of record of stream gages or rain gages involves fractional parts of a year. Evaluation periods should comprise complete years, dropping all fractional periods from consideration. Unless floods occur annually, an error may be introduced by starting and ending the evaluation period with floods. For example, flood damages may be estimated for a period of 20 years (1977 to 1996 inclusive) where 7 floods occurred. An examination of the record (or other reliable sources) shows that the last flood previous to 1977 occurred in 1974. Hence the flood period covers more than 20 years.

The flood series should be adjusted by dropping from consideration small floods that occur so near in time to larger ones that restoration of damageable values would not have been possible in the interim.

Stage-damage curves are developed when the historical series method is used. With the dates and sequence of flooding available, separate curves generally are developed by months or seasons. When depth of flooding is the chief determinant of the rate of crop damage from a given flood, the hydrologist may develop curves that relate the acreage flooded at different depths to the flood stage. The acres flooded at different depths for each flood stage are multiplied by damage rates to provide the basis for development of the stage damage curve.

The historical series method generally shows that several floods occur during a single year while none occur in other years. In such cases it is incorrect to add the unadjusted damage to crops and pasture for each flood in the evaluation series and use the sum as the total damage. The first flooding during the year will reduce the value of the crops somewhat, reducing the potential for damage by a second flood in the same year. Some portion of the value may be restored between floods through replanting, but the yield of the late crop is generally reduced. One method of calculating these changes in value, and in resulting damage, is a flood-by-flood analysis. These calculations are laborious when an evaluation series includes a considerable list of floods.

The historical series method requires somewhat more work for the hydrologist and economist than does the frequency method. However, when flooding is frequent and the major damage is to crops and pasture, the historical series method allows a more precise approach to the adjustment of damages from recurrent flooding.

(2) Net income method

The net income method is theoretically sound, but is more likely to have practical difficulties. This method of evaluation of flood damage and the benefit from its reduction uses the estimated change in net income after project installation. This procedure is applicable where nearly all damage is to crops and pasture and the control of flooding after project installation will be almost complete. It is also used in most cases where benefits of flood prevention and agricultural water management are difficult to estimate separately.

The procedure consists of determining the land use, average crop yields, and net return without the project and comparing these with the flood-free yields, extent of cropping intensification, and net returns under project conditions. The difference in net return constitutes the flood damage. The increase in net return as a result of project installation constitutes the project benefit.

A major difficulty with this approach is estimating the average crop yield after project installation. How closely the flood-free yield can be approximated when protection is incomplete is uncertain. Another problem arises when determining additional production costs under these circumstances.

(g) Incremental analysis

Incremental analysis for evaluation of alternatives for flood control is explained in chapter 1, section 611.0101(c).

(h) Agriculture computer programs

Many of the evaluation procedures described earlier in this chapter have been computerized by NRCS. Agriculture related programs have been developed to calculate floodwater damages, land damages, and the value of agricultural production. User manuals or guides are available to assist in the use of each computer program.

(1) Floodwater damages (ECON2)

ECON2 computes average damages to crops and pasture, other agriculture damages, and damages to roads, bridges, and residential developments. The program permits the use of either the frequency or historical method. The evaluation may be based on flood depths or duration. Damages and benefits are computed for each cross-section, each reach, and each alternative.

(2) Land damage analysis (LDAMG)

LDAMG computes average annual damage caused by sediment and scour. Input requirements for economic and geologic data are the same as those needed for manual calculations.

(3) Value of agricultural production (VAGPR)
VAGPR computes future without-project returns for various crops and compares the returns with alternative conditions. This program is useful for evaluating intensification, irrigation, drainage, and erosion benefits for alternative plans.

(4) Cost and return estimator (CARE)
CARE is used to develop a crop budget for determining total revenue and itemized production costs.

(i) Flood damage schedules

The approved forms for recording information collected during field investigations for flood damages to agriculture (NRCS-ECN-1) and transportation or utilities (NRCS-ECN-004) are available in appendix 2A. Completed forms are retained in the project file as part of the supporting information for the economic evaluation. The confidential nature of the information collected from respondents in the watershed requires that their identity be protected (5 U.S.C. 552 (b)(4)). This requires coding the name and location of the respondent on the form. The key to the identity and location code(s) should be kept separate from the completed forms and not revealed to others outside NRCS.

611.0202 Drainage

This part of chapter 2 outlines evaluation procedures for drainage. Agricultural drainage involves the removal of surface and subsurface water that may inhibit crop production or restrict land use to low-valued crops. Drainage systems are designed to develop a soil-plant-water relationship that permits optimum plant growth and land use.

In some instances flooding and drainage problems are so interrelated that separation of effects and benefits is not analytically possible. Where this occurs, the evaluation should encompass both flood-prevention and drainage with benefits divided evenly between purposes (see P&G section 2.3.8(c)). Where physical data permit analytical separation of benefits, benefits should be estimated and reported separately.

(a) Drainage benefits

(1) Damage reduction benefits
Two results of excessive soil moisture in the root zone are reduced crop yield and reduced efficiency in the use of tillage and harvest equipment. The economic consequences of those damages should be measured as a reduction in net income. To estimate the scope of the problem and to evaluate alternative solutions, the economist should consult agronomists, soil scientists, engineers, and other appropriate specialists. The magnitude of the problem can be defined as the difference between present yield levels and production efficiencies and those that could be achieved in a situation free from water problems. Benefits claimed for a specific alternative plan should reflect the degree to which that plan alleviates the overall problem.

(2) Intensification benefits
Not only does excess soil wetness reduce yields and efficiency of farming operations, it may also limit the kind of crops that can be grown profitably. Farmers are expected to shift to more profitable crops when water problems have been reduced. Increases in net income that are generated by these cropping changes are reported as intensification benefits. The base for measurement is the net income level determined in the without-project evaluation.

(3) Adjustment of benefits

Fully effective drainage normally requires the installation, maintenance, and possible future replacement of onfarm systems. The annual cost of these measures is to be subtracted from calculated benefits as an associated cost.

(b) Evaluation units and incremental analysis

(1) Evaluation unit

An evaluation unit is a drainage channel system that outlets into a waterway not being improved by the project. Each unit requires separate evaluation and may also require incremental analysis as part of the evaluation.

(2) Incremental analysis

Incremental analysis is needed for:

- Each segment of an unbranched channel that serves a different land use; e.g., cropland, pastureland, and forest land.
- Each branch of a system serving hydrologic subareas.
- The segment of a channel that provides initial drainage to an area not now served.
- Multipurpose channels when consideration is being given to increasing capacity above that afforded by minimum NRCS regional drainage criteria.

The main channel of a system must be a part of the first increment. This increment may not be feasible by itself, but is essential for other increments to function properly. Of course, the system as a whole must be feasible.

(c) Productivity

(1) Land use and cropping system

Basic data on present and anticipated land uses and cropping systems for each major soil grouping are needed to measure the economic effect of various alternatives and incremental segments. Soil survey information can provide information on drainage characteristics and productive potential of different areas within the project boundaries. Farmer interviews provide data on cropping patterns and yield levels. Interview information should be supplemented with published information available from state crop reporting agencies for both cropping patterns and yields. Approved forms must be used to record interview information.

(i) Current land use—Information on current land use is needed to determine without-project conditions. Interviews and field inspections should be used to obtain this information. The economist needs to carefully identify conditions that are unique to a single year. Deviations in weather patterns can affect land use in areas with wet soils to a greater degree than in areas with adequate drainage. Data must be obtained for more than 1 year. Secondary sources should supplement interview data.

(ii) Future land use without the project—Future without-project land use requires substantiation when the analysis indicates a significant shift from current land use. Examples of supporting evidence are continued installation of onfarm drainage measures even though they may be less than totally effective; time series data showing a gradual shift in land use; and continuing deterioration of existing drainage systems, which necessitate shifts during the evaluation period. These determinations frequently require consultation with other specialists to measure the extent and rate of the change. When changes are projected, the economic analysis and evaluation must consider the rate at which the changes are being made.

(iii) Future cropping pattern without the project—Changes in cropping pattern also require substantiation. Cropping pattern changes that occur in modern agriculture often are in response to relative price changes, not changes in natural resource conditions. Agriculture prices used in project planning are current normalized prices, and these prices are used for the evaluation period. As a consequence, using historical cropping pattern to support cropping pattern change is at best risky. Cropping pattern changes should be restricted to expected changes in physical resource conditions within the project area; i.e., increasing salinity and decreasing depth to the permanent water table.

(2) Crop yields

Crop yields in drainage-project analysis are based on average management capabilities of the farm operators. Five-year average yields, as reported by Federal and State agricultural agencies, are assumed to reflect average conditions. Because these agencies report yield levels at the county level, the reported yields generally need to be modified to reflect specific conditions in the benefit area. Soils information is a recommended starting point in making these modifications. The basis for these adjustments is to be reported in the project plan (report) documentation.

(3) Production costs

Wet soils reduce the performance efficiency of farm equipment and prevent the timely completion of cultural operations. Each of these problems reduces crop yield and needs to be considered in developing yield changes described above. Crop production costs and farm revenues should reflect both effects of wetness. Where water resource projects only partly solve wet soil problems, equipment performance may not always improve and cultural operations will most likely not be optimally timed solely as a result of project completion. Analysts should clearly document assumptions about anticipated production cost changes that they attribute to drainage.

(4) OM&R costs of without-project condition

A projection of OM&R (operation, maintenance, and replacement) costs should consider the OM&R costs of farm systems and existing drainage system for the without-project condition.

(d) Determining economic effects

The economic effect of drainage installation is the product of acres benefited and benefits per acre. In determining size of the required channel, engineers establish the drainage area at various locations along the channel system; for example, at the outlet of the main channel or where a branch channel joins the main channel. Within this area some or all of the land may benefit from the proposed channel (some acres may benefit to a greater extent than others). The economist, in consultation with engineers, soil scientists, and others, must delineate the area benefited and establish the benefits per acre. Physical conditions need to be considered in estimating the income change that can be expected from channel installation. For example, certain soils are more productive than others, soil texture can affect the consequences of a given period of inundation, and topographic features may induce ponding effects that prolong saturation. Detailed information of this type takes time to collect, but it usually improves the quality of the evaluation.

(e) Drainage questionnaire

Approved form NRCS-ECN-006 is for recording information collected during field investigations of drainage problems. The completed form is retained in the project file as part of the supporting information for the economic evaluation. The confidential nature of the information collected from respondents in the watershed requires that their identity be protected (5 U.S.C. 552 (b)(4)). This requires coding the name and location of the respondent on the form. The key to the identity and location code(s) should be kept separate from the completed forms and should not be revealed to others outside NRCS.

611.0203 Irrigation

Irrigation evaluations are concerned with changes in agricultural production and production efficiencies. These translate to changes in agriculture because of yields, crop quality, cropping systems, and production inputs. The evaluation may reflect changes in operational efficiencies of the existing system.

For the most part irrigation projects can be grouped into three categories: new irrigation, supplemental supply, and rehabilitation of an existing system.

New irrigation projects usually intensify farming because of a change from dryland crops to irrigated crops. An analysis of new onfarm equipment and other changes in farm management and technology are a result of the irrigation project.

Supplemental supply measures provide more of the full-season water requirements than existing irrigation systems. Any changes in cropping systems, required equipment, management, and technology generally depend on the amount of supplemental water provided.

Rehabilitation projects are intended to sustain crop yields, to avoid damages to crops from system failure, or to reduce costs. Many irrigation projects provide for a combination of these; for example, they may provide supplemental water and rehabilitate the existing system. Finally irrigation projects may free some water for other beneficial uses, including downstream wildlife habitat or improved water quality through reduced return flows.

(a) Irrigation terminology

(1) Water supply, water rights, and water quality

Water supply is the amount of water available for irrigation development. It may vary by season and area, thereby requiring special attention to types of irrigation measures, selection of priority crops, and separate evaluation areas. Water supply is generally the most significant variable affecting land use and yield in irrigation projects. An essential step in the analysis is to determine, for a specified location, the availability of water supply for use with and without a project. Analysis requires data on year-to-year reliability of the water supply and monthly variation of the supply within the irrigation season.

Water rights are the legal ownership of the right to use water. The two broad types are riparian and prior appropriation. Water rights are set by state law and are unique to each state. They limit the amount of water available for a project. Water laws that affect the specific project area must be incorporated into the planning process.

Water quality for irrigation generally depends on the mineral content, sediment load, and temperature of the water, any of which can affect crop yields.

(2) Evapotranspiration

Plants vary in their demand for water. Evapotranspiration (consumptive use) includes the vegetative transpiration and surface evaporation losses from lands on which there is vegetation of any kind. Factors that influence consumptive use are climate, temperature, soils, wind, stage of development of the plant, and foliage. Data relating to the consumptive use of crops must be known before determining future land use and crop yields. Production functions relating irrigation water use and crop yields are available for many crops. Care should be exercised to ensure the changes in quantities and timing of the water supply are correctly related to changes in yield.

(3) Irrigation efficiency

Irrigation efficiency is an important indicator of problems and/or opportunities. It is normally defined differently for different parts of the system.

(i) Onfarm irrigation efficiency—Onfarm water-application efficiency is the ratio of the volume of water consumed (transpired, evaporated, or both), adjusted for changes in root-zone storage, to the volume of water delivered at the farm. Many factors, such as depth and texture of soil, topography, and type of crop, affect onfarm irrigation efficiency.

Improvements in efficiency level can be achieved through improved methods of water application or other water management practices. Because onfarm irrigation efficiency, crop consumptive use, and water supply are interrelated, each is important in considering project effects. The present onfarm irrigation efficiency must be determined. Future efficiency that can be achieved with and without the project must be estimated.

***(ii) Delivery or conveyance efficiency*—**Delivery (conveyance) efficiency is defined as the ratio of water volume delivered onsite to the water volume delivered to the system at the source.

***(iii) System efficiency*—**System efficiency is defined as the ratio of the volume of water consumed to the volume of water delivered to the system at the source. It is the combined effect of onfarm and delivery efficiency. Impacts of projects on both the onfarm and delivery efficiency are to be examined to determine their effect on total system efficiency.

(b) Planning setting

(1) With and without-project concept

The without-project condition, including conservation measures, is the condition expected to exist in the absence of an alternative plan. The with-project condition is the condition expected to exist with each alternative plan under consideration.

Agricultural income and production costs are determined for various conditions or levels of irrigation development or improvement, or both. Other resources associated with change in land use or acreage and in water quantity and/or quality should be included in the evaluation. The level of use to be evaluated initially is the without-project condition.

(2) Problem definition

The magnitude of the irrigation problem is the estimated difference between the net income that would be attained if the water resource problem were solved and the net income being achieved under existing conditions. Making this estimate requires estimates of yield and production costs under both water supply situations. In the with-project condition, project measures need to be considered to the extent they will be included in each alternative plan. For example, if sprinkler or drip irrigation is not considered in the alternative plan, it should not be considered in the with project projections.

(c) Basic data

(1) Data needs

Basic data needed in the evaluation of an irrigation project are cropping patterns, crop yields, prices, and crop production costs. Specific guidance on these components is offered in P&G Section 2.3.3. This information is necessary in irrigation evaluations for the full range of anticipated water supply conditions. Also, soils data for the present and proposed irrigated area should be collected and grouped according to similarities in crop adaptability and irrigation characteristics.

(2) Sources of data

The basic data required to plan and evaluate an irrigation project come from a number of sources. A key source of information is interviews with local residents, physical scientists, and experts from universities and State and Federal agencies.

***(i) Interviews*—**Interviews with farmers and other watershed residents are important for most project evaluations. Interviews need not be confined to farmers who are recipients of the water supply upon which work is proposed. Data collected in irrigated areas outside, but similar to the project area can help analysts establish base dryland and irrigated yields for specific soils. Data collected by NRCS soil scientists can provide information on crop yields and the relative productive capability of different soils. In addition, NRCS National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Management, can be used to derive detailed information on irrigation water requirements, by crop, for individual farms or for projects.

***(ii) Universities and Federal agencies*—**Many sources of crop enterprise budgets and production functions can be modified to reflect crop yields, water use, and production data in the area being studied. Analysts should consult the local college of agriculture, USDA's Economic Research Service, or USDA's Cooperative Extension Service for information and analytical tools of this kind.

(d) Evaluation units

Evaluation units are the basic elements for the economic analysis. When evaluation units encompass multiple purposes, multiple structures, multiple segments, or multiple practices, or a combination of these, incremental analysis is required.

Historically, arid-area irrigation projects have involved water storage for supplemental irrigation (with the possibility of recreation and flood prevention capacity in the reservoir), conveyance system improvements, and onfarm irrigation water management measures. This interconnected system is an evaluation unit. The different components are to be incrementally analyzed. In these projects separate hydrologic units interconnected by the conveyance system constitute a single evaluation unit.

In certain situations where resource paths are limited, the selection of the highest benefit per unit as the first increment may lead to adding compatible features that are inefficient. This possibility needs to be examined by analyzing complete sets of features against each other. Table 2–8 shows where path 1 had the increment with the highest benefit per unit selected as the first increment, but was the least efficient overall.

In projects to rehabilitate an existing irrigation system, each separate irrigation system originating at a diversion point is a separate evaluation unit.

Table 2–8 Increment evaluation

Increment	Path 1	Path 2	Path 3
1	5	4	3
2	3	3	3
3	2	3	3
4	1	2	3
5	1	1	3
Total	**12**	**13**	**15**

(e) Incremental analysis

Incremental analysis of irrigation systems can involve features, such as storage structures, either the operation of existing structures or the development of storage; canal structures; and onfarm irrigation practices and measures, including improved management of existing water supplies. As with any incremental analysis, the features should be ranked in the order of return per unit of cost. In some instances an incremental analysis may be appropriate on an evaluation unit basis after the different components are incrementally analyzed.

The first increment within an evaluation unit should be determined by analysis of each project feature as the first element in the system. The feature that returns the highest benefit per unit of cost is selected as the beginning of the system. The second increment is then to analyze remaining features considering that the first is in place. Again the most feasible is selected as the next feature of the system. This process is continued so long as additional features provide an increase in net benefits.

Onfarm measures are a separate incremental analysis to determine the land treatment system of management and structural practices. This system is then used as a single feature in the more general incremental analysis along with storage, conveyance, and canal structures.

When changes in the operation of an existing storage reservoir or the development of a new storage facility is being considered, the effects of other measures already in the irrigation system may change from iteration to iteration. This possibility needs to be examined and appropriate changes made.

Incremental analysis for rehabilitation of an irrigation system considers each major structure as a separate increment. In addition to the obvious damage reduction benefit from replacing a structure, an increased net income can result from the capability of the total system to safely handle increased flows. Analysis of the increased system capacity is best handled by considering the acreage uniquely served by each successive structure as we move down the system from the water source.

(f) Changes in crop production inputs

Changes in the irrigation system can be accompanied by significant change in farming practices in the area served. Costs associated with these changes, either increases or decreases, effect net income. When they occur, they must be accurately reflected in crop budgets.

(g) OM&R costs

A projection of OM&R costs should consider the OM&R costs of farm systems and existing irrigation system for the without-project condition. Existing structures that will, in all likelihood, fail before project implementation could begin are shown as repaired or replaced in the without-project condition.

(h) Reporting benefits

Benefits are reported as either damage reduction or intensification benefits. Where the cropping pattern is expected to be the same with and without the project, increases in net income will be reported as damage reduction benefits. Increased net income from areas where cropping is expected to change will be reported as intensification benefits.

(i) Evaluating irrigation system failure

Irrigation systems are subject to periodic failures because of deteriorating structures in the system or flooding that originates outside the irrigation service area. Example 2–2 analyzes an irrigation interruption caused by flooding.

(1) System damage related to erosion or sediment deposition

Sediment deposition or erosion may adversely affect the operation of certain field application systems. This generally occurs when field gradients or field ditches are damaged to the extent that irrigation water cannot be applied. Analysis of losses resulting from lack of water caused by erosion and sediment damage may be evaluated the same as described in the preceding steps. In addition, costs of restoring field gradients, ditches, and structures should be counted as a damage (see 611.0204(h)). The entire crop may be destroyed by erosion, sediment, or drowning. In this case damage should be computed as the total value the crop would have had if the crop would have been harvested minus the savings in variable costs. Additional farming measures to restore the land or provide additional weed control for the remainder of the season should be computed and added to the damage.

(2) System damage related to irrigation structure failure

For example, erosion may damage a canal as a result of failure of a drop structure. In addition to replacing the structure, certain other work would need to be done to the canal before the system could be returned to operation. However, if with replacement of the structure the normal accumulation of sediment would restore the canal bottom, no damage could be claimed. Keep in mind that the cost to replace the structure under emergency conditions may be more than the cost of normal replacement.

(3) Management damage related to irrigation structure failure

A claimable damage here would be the extra effort and costs incurred by the district to keep the unaffected portion of the system operational.

Example 2–2 Procedure to evaluate irrigation system failure as a result of flooding

Data needs:

Affected area

A failure in an irrigation system may affect the entire system or some part of that system. The irrigated area affected must be established. For example, a siphon failure will affect service area downstream. If a drop-structure fails, it may affect all downstream areas and also areas upstream if its purpose is to maintain water surface elevation for upstream takeouts.

The extent of the area affected by failures in a specific system should be substantiated from irrigation district records of previous failures. Considerations should include:

- Stop-gap measures used when a failure occurs—This information should be structure-specific and should be available, again from district records. Information on the cost of these measures as well as their effectiveness is needed.
- The length of the period the affected area will be without water—Where stop-gap measures are a possibility, this may be a relatively short period. Where these measures have limited effectiveness, the length of the service interruption for some part of the service area may be for the balance of the season or the time required to rebuild the failed structure.
- District records may indicate that failure is more likely in certain periods—Use this information to modify the seasonal probability. Anything other than a probability of uniform failure throughout the irrigation season would need substantiating.
- Most crop budget systems would probably limit seasonal breakdown analysis to months. Pre-irrigation and post-irrigation may extend the use season beyond the normal crop season.

Crop damage

Damage to growing crops is affected by the season of the break and by how long irrigation water delivery is delayed. Crop yield estimates must account for the period of interruption and the possibility that the interruption can occur at any time during the irrigation season. The cropping pattern in the area served by the system determines the number of crop yield estimates that will be needed.

The crop yield information should be reviewed with the land users in the irrigation system.

Duration of interruption of irrigation service

The economist needs to work with the engineer to determine the length of time needed to restore irrigation water delivery. They need to agree on the period of interruption for each type of structure in the system.

Some emergency repairs are possible. Where they are possible, they need to be identified. In these situations it may be possible to delay replacement of the structure until after the growing season.

Example 2–2 Procedure to evaluate irrigation system failure as a result of flooding—Continued

Damage computation:

In estimating crop damages caused by interrupted irrigation water delivery, the procedure that follows uses the monthly net irrigation requirement, monthly storm distribution, storm frequencies, and number of days required to restore irrigation water delivery. The procedure shows how this information is used to assess damage. It assumes a partial crop loss with harvesting carried out and that the crop responds equally to all increments of water.

Step 1 Specific conditions

Frequency at which canal loss can be expected = 6%
Number of days required to restore service = 15 days
Monthly storm distribution (percent of annual):

January	0	April	5	July	17	October	3
February	1	May	22	August	10	November	1
March	3	June	33	September	5	December	0

Step 2 Damageable value—Land use, yield, and gross income for the area served by the canal:

Crop	Land use (%)	Yield per acre	Price per unit ($)	Return per acre ($)	Composite acre return ($)
Corn silage	10	20 ton	7.00	140	14.00
Sugar beets	20	16 ton	15.00	240	48.00
Small grain	10	50 bu	1.10	55	5.50
Pasture	20	8 AUM	4.00	32	6.40
Alfalfa	40	5 ton	20.00	100	40.00
Total					**113.90**

Step 3 Consumptive use requirements minus effective rainfall, in inches, by months for the crops in the irrigated area.

Crop 1/	April	May	June	July	August	September
Corn silage	---	1.52	2.69	4.77	4.65	1.54
Sugar beets	2.00	2.44	1.99	4.01	3.95	2.57
Small grain	---	2.73	2.34	2.20	---	---
Pasture	2.20	2.73	2.34	4.39	4.30	2.82
Alfalfa	2.41	3.03	2.69	4.77	4.65	3.07

1/ Growing season:

Corn silage	May 15 to September 15
Sugar beets	April through September
Small grain	May to July 15
Pasture	April through September
Alfalfa	April through September

Example 2–2 Procedure to evaluate irrigation system failure as a result of flooding—Continued

Step 4 Composite acre water requirement

Crop	Use	April	May	June	July	August	September
	%	inches					
Corn silage	10	---	.15	.27	.48	.47	.15
Sugar beets	20	.40	.49	.40	.80	.79	.51
Small grain	10	---	.27	.23	.22	---	---
Pasture	20	.44	.55	.47	.87	.86	.56
Alfalfa	40	.96	1.21	1.08	1.91	.86	1.23
Total	**100**	**1.80**	**2.67**	**2.45**	**4.28**	**2.98**	**2.45**

Step 5 The sum of the monthly composite acre irrigation requirement = 16.63 inches.

Step 6 Value added per inch of irrigation water supplied = $113.90/16.63 = $6.85.

Step 7 Value added per month (in $):

April	May	June	July	August	September	Total
11.63	17.25	15.83	27.65	25.71	15.83	$113.90

Step 8 Valued added per day (in $):

April	May	June	July	August	September
.39	.56	.53	.89	.83	.53

Step 9 Damage per composite acre from a 15-day break (in $):

April	May	June	July	August	September
5.85	8.40	7.95	13.35	12.45	7.95

Step 10 Weighted damage per composite acre:

Month	Damage		Monthly storm distribution		Weighted damage
April	5.85	x	.05	=	0.29
May	8.40	x	.22	=	1.85
June	7.95	x	.33	=	2.62
July	13.35	x	.17	=	2.27
August	12.45	x	.10	=	1.25
September	7.95	x	.05	=	.40
Total					**$8.68**

Example 2–2 Procedure to evaluate irrigation system failure as a result of flooding—Continued

Step 11 Weighted damage per composite acre

Thus $8.68 is the weighted damage per composite acre per failure. The average annual damage from delay in water delivery is equal to number of acres served times damage per acre times the storm frequency required to cause the canal to fail. (This assumes that the breaks from more infrequent storms do not require more time to repair.) If this canal serves 1,500 acres, the average annual damages would then be:

1,500 acres x $8.68 x 6% = $781.20

(j) Irrigation questionnaire

The approved form for recording information collected during field investigations for irrigation problems is NRCS-ECN-005 (appendix 2A). Completed forms are retained in the project file as part of the supporting information for the economic evaluation. The confidential nature of the information collected from respondents in the watershed requires that their identity be protected (5 U.S.C. 522 (b)(4)). This requires coding the name and location of the respondent on the form. The key to the identity and location code(s) should be kept separate from the completed forms.

611.0204 Erosion and sediment

This part of chapter 2 reviews economic evaluation of land damage by sedimentation and by erosion other than sheet and rill erosion, which is described in chapter 3 of this handbook. Methods for estimating the monetary value of damage to the productive capability of land as a result of sediment deposition and erosion are described. Also included are methods for evaluating damage caused by sedimentation of irrigation and drainage facilities and reservoirs.

The method selected for evaluation must consider the time over which land damage will occur. Where permanent damage is occurring or is expected to occur, the method selected must reflect the significance of this permanent loss over time. Where damage is not permanent, and partial or full restoration of productivity is physically and economically feasible, monetary values of damage must be adjusted to reflect the degree and rate of recovery. Costs of nonstructural measures needed to achieve the rate or degree of recovery should be accounted for in the damage estimate.

A thorough evaluation of sedimentation and erosion damage requires an interdisciplinary team. Members of the team will vary with the type of problems encountered. Contributions from agronomists, soil scientists, biologists, recreation specialists, engineers, hydrologists, and possibly others are required to provide physical data needed for an evaluation.

The economist and geologist have a primary responsibility in seeing that evaluations are made from the appropriate point of view. For example, effects of alternative courses of action will reflect the without-project and with-project concept explained at the beginning of this handbook. In addition, the idea of basing physical and economic evaluations on expected future conditions should also be retained by all team members.

Examples in this section are worked out longhand so that the methodology can be understood; however, the Land Damage Analysis computer program (LDAMG) is available for computing damages for swamping, scouring, and sediment damage on flood plains. The program requires the same physical data that a hand evaluation requires, but it completes many of the manual calculations. The personal computer version of the program and the user manual are available from NRCS.

(a) Types of damage

(1) Erosion damage

Erosion damages are classified and evaluated under the headings of gully erosion, streambank erosion, and flood plain scour. Land may or may not recover from erosion damage. Generally, gully and streambank erosion are considered a nonrecoverable damage, whereas flood plain scour is generally temporary because partial or complete recovery of productivity is generally physically and economically feasible.

(2) Sediment damage

Sediment deposition on cropland and on growing crops reduces productivity. Deposition in drainage and irrigation ditches, natural channels, bays, estuaries and harbors, reservoirs, and road ditches causes damage that is expensive to remedy.

In some cases sediment is not detrimental. For example, muddy water is less erosive than clear water, most fertile flood plains developed over a long time as a result of nonaccelerated sedimentation, algal growth is inhibited by suspended sediment, and land derived pollutants, both chemical and bacterial, often attach themselves to soil particles, which can be concentrated and collected in relatively small areas.

(b) Methods of evaluating land damage

(1) Evaluating permanent damage to land

The following procedure may be used to evaluate erosion or sediment damage where productive capacity is essentially destroyed or where restoration of productivity is not normally considered feasible. The land use and cropping pattern (crop rotation) used in the analysis should reflect the most probable future condition. This condition should be determined by an interdisciplinary team.

Yield estimates used within the study are based on the average level of management.

The evaluation of damage is based upon annual physical losses as determined by the geologist. The geologist and economist are jointly responsible for determining the extent of depreciated lands adjacent to and associated with areas voided by gully erosion or streambank erosion or nonrecoverable areas damaged by sediment. The estimate of future damage will recognize various degrees of depreciation that may occur on lands immediately associated with nonrecoverable areas. For instance, lateral gullies formed from the main gully can establish a pattern that makes it necessary to abandon field cropping, but may permit use of the land as pasture or woodland or for recreation. These acres are a part of the depreciated erosion area. The geologist and economist will jointly determine such additional areas of land and the degree of depreciation resulting from the gullying process.

The net-income method should be used to evaluate damages by developing crop budgets for each crop and weighting the values to arrive at net income per composite acre. Benefits are the difference in net income from the undamaged or less damaged with-project condition and the damaged or without-project condition. Example data are shown in table 2–9.

Table 2–9 Reduced crop returns, annual area damaged, and annual reduced returns from land voiding and depreciation

Land use	Reduction (%)	- Per acre annual - net returns ($)	- Per acre annual - reduced returns ($)	- - Loss per year - - area damaged (acre)	- - Loss per year - - reduced returns ($)
Problem free	0	60.00	0	---	---
Depreciated 1/	70	8.00	52.00	.50	26.00
Depreciated 2/	90	3.00	57.00	.75	42.75
Voided	100	0.0	60.00	.75	45.00
Total	---	---	---	**2.00**	**113.75**

1/ Land use changed to a less intensive cropping pattern.
2/ Land use shifted to low grade pasture.

Suppose damage is expected annually without recovery over the evaluation period. The next step is to adjust the damage to reflect cumulative effects and then to convert to an average annual equivalent.

Annual reduction in net returns	$113.75
Present value of an increasing annuity factor at 8 percent for 100 years	168.10504
Present value, 100-year income stream	$19,122.00
Amortization factor, 8 percent interest, 100 years	.08004
Average annual damage	$ 1,531.00

The period of time and interest rate should be consistent with those used to reduce project costs to an average annual equivalent.

Additional onsite benefits may accrue to landowners where installation of land treatment measures is not physically feasible in the absence of stabilization measures. For example, unstable outlets for waterways frequently prevent the installation of terrace systems, surface drainage systems, and tile drainage systems. Where the analysis shows that net returns will increase on land protected by terraces and waterways, the increase can be credited to the gully stabilization structure. Where such benefits are claimed, care must be taken to see that cost of the interdependent land treatment measures is included as associated costs or as accelerated land treatment costs.

Evaluation of interdependent measures involves an analysis of net income differences resulting from the application of alternative conservation systems. The analysis calls for realistic projections of land use, cropping patterns, erosion conditions, and land treatment without and with each alternative. The projections are to reflect what is actually expected to occur. Use current yields and projected yields that reflect the physical changes resulting from erosion.

Assuming that 100 percent of the land use changes projected to occur in the interdependent areas will be a result of erosion problems is not reasonable. Therefore, documented shifts must be examined to account for changes expected to occur as a natural evolution of farming operations. Using Agriculture Census data or the National Resource Inventory (NRI), these adjustments can be made by determining the rate of change in land use that is occurring in the county and adjusting the change in the interdependent area to reflect the census information.

Documentation for conditions in the interdependent area should include interview data from farmers or analyses of available aerial photographs. It should also include summary data from conservation plans to determine land use. County data should show, by time periods, the basis for adjusting projected changes to account for nonproject effects. Projected land use for without and with conditions should clearly tie back to interview or photo data, and procedures should be fully described. If projections do not follow trends, a clear explanation and basis for the deviation should be provided.

(2) Evaluating land damage in areas subject to recovery

Two basic situations are frequently encountered when appraising land damage in areas that can recover. In the first situation the rate of new damage is approximately equal to recovery of productivity in old damaged areas. In the second the area damaged, or the severity of the damage, is increasing. In this case the benefit to be derived is from a reduction in the net rate of damage.

(i) Evaluation method where damage and recovery are in equilibrium—Data will be obtained from physical scientists on the total area damaged and the loss in productivity. The economist then estimates the annual net loss in income from this damaged area. To illustrate, a flood plain under undamaged conditions has 4,000 acres. On this undamaged land the annual composite acre gross value of production is $80.00 per acre, with production costs of $45.00, and a net return of $35.00 per acre. Table 2–10 shows an analysis of costs and returns in the area, by percent damage classes.

Next, the geologist has appraised the physical damage and provided the economist the data shown in the first two columns in table 2–11.

Table 2–11 shows that $26,195 is the total annual loss in net crop and pasture income from the 2,170 acres damaged in the 4,000 acre flood plain. If damaged land is not expected to fully recover or if recovery will extend beyond 1 year, appropriate corrections (discounting) in these estimates are necessary.

Where the nonrecoverable portion of the land damage continues after installation of a program, damage reduction benefits are confined to the recoverable portion. For example, for the 2,170 acres damaged, the geologist furnishes the data shown in table 2–12.

Table 2–10 Composite per acre cost, returns, and loss on damaged land

Yield reduction condition (%)	Gross production ($)	Cost of production [1/] ($)	Net return ($)	Loss from undamaged ($)
Undamaged	80.00	45.00	35.00	0
10	65.00	35.00	30.00	5.00
30	50.00	32.00	18.00	17.00
50	37.00	28.00	9.00	26.00
70 [2/]	22.00	18.00	4.00	31.00
90 [3/]	7.00	5.50	1.50	33.50

1/ Includes fixed and variable costs.
2/ Shifted to lower value crops.
3/ Low value pasture.

The recovery factor in the damage calculation can be adjusted using the data in table 2–12. Using the 50 percent damage class for illustration and going back to table 2–10, a net loss of $26.00 per acre is shown for the 50 percent damage rate. It also shows the net loss for the 30 percent damage to be $17.00 per acre. Therefore, $9.00 ($26.00 - $17.00) per acre is the value of eventual recovery for the 50 percent damage. Table 2–12 shows this area can recover in 15 years to the point where a 30 percent damage will remain.

Assuming a uniform recovery, the straight line discount factor at 8 percent for a 100-year evaluation period for 15-year lag is 0.315. Then, $9.00 x .315 = 2.84. The other values in the tabulation may be derived in a similar manner. In summary we arrive at the present values of damage as shown in table 2–13.

Table 2–11 Summary of total average annual damage, without project

Percent damaged	Acres damaged	Damage per acre ($)	Total damage ($)
10	1,200	5.00	6,000.00
30	600	17.00	10,200.00
50	300	26.00	7,800.00
70	60	31.00	1,860.00
90	10	33.50	335.00
Total	**2,170**	**---**	**26,195.00**

Table 2–12 Relation between damage, recovery time, and damage remaining after recovery

Percent damage	Years to recover	Percent damage after recovery
10	5	0
30	10	10
50	15	30
70	20	50
90	50	70

(ii) Evaluation method where the rate of damage is increasing and recovery is taking place—This method takes into account the fact that, in most instances, the period over which a given rate of damage can occur is limited by either the area subject to damage, characteristics of the land, or by the maximum decline in productivity and income expected.

The geologist will provide an estimate of the rate at which the damage is progressing, plus an estimate of the eventual limits to the damage in terms of the total area that may be affected. In addition to the damages shown in table 2–11, the area being damaged is increasing 20 acres per year and will continue until 200 additional acres have been subjected to damage. By damage classes the annual increase in damage is shown in table 2–14.

For the 10 percent damage category in table 2–14, 10 additional acres are being damaged annually at the rate of $5 per acre, or a total increase of $50 per year. This damage is similar to an increasing annuity. The present value of an annuity increasing by one per year for 10 years is 32.68691 at 8 percent interest. After 10 years (200/20 acres per year = 10 years, or the number of years required for 200 acres to be damaged at the assumed rate of 20 acres per year) the damage will stop increasing and will remain constant for the balance of the 100-year evaluation period, or for 90 years. Thus, we have the following:

Present value of the damage during the first 10 years

$ 50 x 32.68691 = $1,634

Future value, 10 years hence, of damage (10 x $50 = $500) during last 90 years of evaluation period, where 12.48773 is the percent value of an annuity of 1 per year for 90 years:

$500 x 12.48773 = $6,244

Present value of damage for last 90 years, where .46319 is present value of one 10 years hence:

$6,244 x .46319 = $2,892

The present value of the future loss on the area subject to increased damage is $1,634 + $2,892 = $4,526. The average annual equivalent value thus becomes

$4,526 x .08004 = $362

where:
.08004 = amortization for 100 years at 8 percent

Calculations using the same years and interest and discount factors for the 30- and 50-percent damage categories give average annual damages of $616 and $942, respectively. Thus, the loss because of increasing damage is $1,920 ($362 + $616 + $942).

A shorter method of arriving at the total would be to use the total annual rate of increase of $265 and follow through the steps shown for the 10 percent category. The actual calculation would be:

$265 x 32.68691	=	$ 8,662
$2,650 x 12.48773	=	33,092
$33,092 x .46319	=	15,328
$15,328 + 8,662	=	23,990
$23,990 x .08004	=	1,920

Table 2–13 Adjustment to determine values subject to recovery

Percent damage	Acres to recover	Recovered damages ----- per acre value ----- undiscounted ($)	discounted ($)	Total damages recovered ($)
10	1,200	5.00	3.41	4,092.00
30	600	12.00	5.56	3,336.00
50	300	9.00	2.84	852.00
70	60	5.00	1.08	65.00
90	10	2.50	.05	1.00
Total	**2,170**	**---**	**---**	**8,346.00**

Table 2–14 Annual rate of increasing damage

Percent damaged	New damage per year (acres)	Damage per acre ($)	Annual rate of increase ($)
10	10	5.00	50.00
30	5	17.00	85.00
50	5	26.00	130.00
Total	**20**	**---**	**265.00**

Note: Total new damage per year acres may include acres moving from one category to another. For example, the additional acres for 30 percent may have moved from 10 percent.

where:

32.68691	=	present value of increasing annuity for 10 years @ 8 percent.
12.48773	=	present value of annuity of 1 per year for 90 years @ 8 percent.
.46319	=	present value of 1, 10 years hence, @ 8 percent.
.08004	=	amortization for 100 years @ 8 percent.

The average annual loss is $1,920 on the 200 acres subject to damage and does not account for future production loss on areas already damaged. The next step would be to combine the production lost from table 2–13 with the additional damages. This is illustrated in table 2–15.

The annual recoverable damage plus recovery of land subject to increasing damage would equal preventable damage with a 100 percent effective program.

Where the rate of land damage is increasing, appropriate adjustments must be made in the damageable values to prevent double counting of damage on the same area. The adjustments are either in the estimates of crop and pasture damage from floodwater or in acres subject to damage. These adjustments can be made in several ways. One approach is to first convert all damage sustained to date (table 2–15) to equivalent acres of total (100%) damage. This can be done by multiplying the acres damaged column by the percent damaged column in table 2–13. The result is 501 acres.

Table 2–15 Annual value of recoverable damage

Percent damaged	Value loss in area already damaged ($)	Value loss in area subject to increasing damage ($)	Total ($)
10	4,092	362	4,454
30	3,336	616	3,952
50	852	942	1,794
70	65	---	65
90	1	---	1
Total	**8,346**	**1,920**	**10,266**

In terms of productive capacity, the 4,000-acre flood plain resulting from flooding is equivalent to 3,499 acres (4,000 - 501). The estimated annual equivalent damage will increase by $2,114 or 8.1 percent ($2,114 / $26,195) of the value of productivity lost on the **area already damaged,** as shown in table 2–11. This results in an additional 41 (501 x 0.081) acres totally damaged that will be lost during the 100-year evaluation period. Thus an adjustment in floodwater damages is necessary to account for the decreasing base.

Since this 41 acre equivalent area will not have a damageable value, no floodwater damage will be claimed. Then 3,499 - 41 = 3,458 acres. By taking the ratio of acre equivalents of undamaged land for **future without a program (3,458)** and **present without a program (3,499),** we get a factor of 0.99. The estimated annual floodwater damage can be adjusted by applying the factor 0.99. This adjustment is not necessary for the damage in equilibrium because flood-free crop yield should reflect scour and sediment effects in this area.

(c) Improvements

Gully and stream erosion often damage nonagricultural property, including streets and highways, culverts, bridges, and commercial and residential structures, as well as farm improvements and structures. Expenditures for temporary measures to protect improvements and facilities from gully and stream erosion are included in the average annual damage figure.

Where relocating buildings and facilities is feasible, the damage without the project can be estimated by determining the cost of relocation, including any loss in production of goods or services caused by the relocation. Data developed in accordance to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 help determine relocation costs. In the case of expected damage to highways, the cost involved in repairing the initial damage, plus the initial and future bridging costs during the time the gully enlarges to its maximum width and extent, is used as a basis for evaluating expected damage without a project. Where a significant period is expected to elapse before relocation, repair, or other expenditures brought about by gullying, appropriate discounting procedures should be employed.

The evaluation of expenditures for temporary measures to protect from gully and steam erosion is based on conditions expected to prevail with and without the project. In certain instances gully or streambank erosion can be expected to progress to the point that specific structures, businesses, facilities, or properties will be damaged or destroyed. Where relocating is not feasible or where property is irreplaceable, the damage can be considered as equal to the value at the time of loss, less the salvage value and discounted to present value.

(d) Railroads and highways

Local governments and railroad companies spend considerable sums for removing sediment to maintain transportation services and to protect investment in roads and structures. Most frequently the expenditures are made to remove sediment from road surfaces, ditches, culverts, bridges, and drainageways. The removal of sediment from bridges, culverts, and adjacent drainageways is generally done to protect structures, including road surfaces and roadbeds, from overflow or other types of floodwater damage. The extent of such expenditures may be treated as representing sediment damage to highways and railroads.

Average annual damage generally can be calculated by obtaining the sum of expenditures for sediment removal over a representative period of years and dividing by the number of years of record. The cost of removing sediment from drainageways should be separated from that of removing sediment from adjacent road ditches or surfaces. For road ditches, a major sediment source is from the road surface itself; ditch cleaning that is part of normal road maintenance should not be evaluated as a sediment damage.

Where additional cost is incurred for the removal of sediment originating from erosion at sources other than road surfaces, this expense should be estimated for the damage evaluation. The source of the sediment being removed must be known. Investigation by geologists should provide such information. Benefits of the project in reducing sediment damage can be estimated either through erosion control measures, waterflow control measures, or sediment traps.

(e) Municipal and industrial water supplies

Water used for municipal and industrial purposes may require large expenditures for sediment removal. The removal will prevent damage to pumps and other machinery or other water facilities and ensure good quality of the manufactured product. (Sediment damage evaluation considered here is not concerned with loss of reservoir storage capacity.) Generally, the monetary evaluation of sediment damage can be made by asking municipalities or industries about their expenditures for sediment removal. It may also be possible to secure estimates of damage to machinery and reduction in quality of product. In some instances water is treated to remove the sediment as well as to correct other conditions affecting use of water. In such instances only additional treatment costs made necessary because of sediment should be used in evaluating sediment damage. Adjustments must be made to account for the fact that not all sediment to be removed is coming from the project area.

(f) Agricultural machinery

In appraising sediment damage to machinery, expenditures for repairs and reduced life of the machinery can be used as the basis for estimating average annual damage. Where useful life of machinery is impaired, estimates of the value of machinery affected and expected life of the machine with and without sediment damage should be obtained from the owners.

(g) Product quality

Losses resulting from reduction in quality of product can be estimated by obtaining the increase in market price from the manufacturer that could be realized for the product without the adverse effects of the sediment content of water. Any additional costs of processing, distributing, and marketing the higher quality product should be deducted from the increase in value of the product.

(h) Drainage and irrigation facilities

(1) Drainage

This section applies to onfarm and drainage facilities for which the costs of operation and maintenance are not included in the cost of operating and maintaining project works or improvements.

Sediment deposition in open ditches reduces capacity and impairs drainage by submerging tile outlets and obstructing outlets from lateral ditches. The result often is a rise in the ground water table or prolonged inundation by surface water. In such cases drainage ditches are cleaned out periodically to maintain sufficient depth and capacity. Remedial measures that control sediment lengthen the period between cleanouts, thereby reducing maintenance costs.

Ditch cleanout often includes expenditures other than sediment removal. In some cases sediment is hauled from the excavation area, which requires that a spoil area be purchased. Any such costs should be included in damage estimates. Only those costs specifically related to sediment removal should be considered.

(2) Irrigation

Ditch cleanout costs also apply to irrigation ditches or canals. However, estimates of such costs may not fully reflect all damage if sediment deposition causes an interruption in delivery of irrigation water. Even short delays can cause severe damage to crops during certain stages of growth. Season, length of delay, and rainfall over the general area at the time of delay are factors to be considered. Generally, irrigation canals are not interrupted frequently. Because of this, historical records may not closely resemble existing conditions nor be useful in projecting damages.

The suggested procedure uses the monthly net irrigation requirement, monthly storm distribution, storm frequencies, and number of days required to restore delivery (see section 611.0204(a)).

(i) Reservoir sedimentation

Damages to reservoirs (and benefits) may be estimated by different methods, depending upon the amount of information that is available or can be obtained within the limitations of budget and other resources, the number of reservoirs to be evaluated, and the nature of the corrective actions taken to solve the lake sedimentation problems. The straight line, sinking fund, cost of sediment removal, and sinking fund plus service loss methods, or variations of them, are used to estimate the damages to reservoirs. The correct methodology depends upon the amount of information available, if a present loss in use is occurring, and the nature of any corrective actions taken. The future without project assumption also affects which method to use.

(1) Straight line method

The straight line or service loss method should be used when sedimentation of a reservoir is not causing a present loss in the value of the resource. By the service loss method, the benefit is estimated as the value of extension of service over time that can be expected as a result of the project. It is the difference in the present value of the annuity for the income flow without and with the project amortized over the evaluation period. Example 2–3 illustrates this method of estimating damages to reservoirs.

(2) Sinking fund method

This method begins with the assumption that there is a loss in the present value of the water being provided and that the water is being replaced each year with another source of water equal in cost to the original source. The average annual damage is estimated as the annual payment into a sinking fund which, at a given rate of interest, will accumulate to an amount sufficient to replace at the point of use the water supply displaced by sediment when the reservoir's useful life is terminated. The interest rate used is the current rate for discounting federally financed projects or the current rate available to non-Federal entities where no Federal assistance is provided. The average annual benefit is the difference between the average annual damages with and without the alternative being evaluated. Example 2–4 illustrates this method of determining damages to reservoirs

Example 2–3 Straight line method to determine damage to a reservoir

Given: The geologist determined that the reservoir has an expected life of 30 years without the project and a useful life of 50 years with the project installed. The economist established that this reservoir provides recreational values of $10,000 per year and will continue to provide $10,000 recreational values each year for 30 years without the project and for 50 years with the project.

Solution: The average annual benefit is:

- PV of services without project — $10,000 x 11.25778 1/ = $112,580
- PV of services with project — $10,000 x 12.23348 2/ = $122,330
- Difference — $122,330 – $112,580 = $9,750
- Average annual benefit — $9,750 x .08004 3/ = $780

1/ Present value of an annuity of 1 for 30 years, 8 percent.
2/ Present value of an annuity of 1 for 50 years, 8 percent.
3/ 100-year amortization factor, 8 percent.

Example 2–4 Sinking fund method to estimate damage to reservoirs

Given:

Useful life of reservoir without program	30 years
Useful life of reservoir with program	50 years
Replacement cost of water supply	$1,000,000
Annual payment without recommended program	$1,000,000 x .0088274 1/ = $8,827
Annual payment with recommended program	$1,000,000 x .0017429 2/ = $ 1,743

1/ Sinking fund factor for 30 years at 8 percent interest.
2/ Sinking fund factor for 50 years at 8 percent interest.

Solution: Annual benefit = Annual payment without – Annual payment with

$8,827 – $1,743 = $7,084

(3) Cost of sediment removal method

This method assumes that there is a loss in the present value of the water being provided and the sediment is being removed annually to stabilize the water supply so that another source is not needed. The average annual damage is the product of the number of cubic yards of sediment to be removed annually and the cost per cubic yard for removal. Costs for land rights to disposal areas are included in the removal cost. The average annual benefit is the difference between the average annual damages in the without alternative and the alternative being evaluated. In most cases only part of the sediment deposited is removed. The economist must be aware of this in calculating benefits for reduction of sediment removal. Benefits must be for only the actual volume of sediment removed. Example 2–5 illustrates this method of determining reservoir sedimentation damages.

(4) Sinking fund plus service loss method

The average annual damage is estimated as the annual payment into a sinking fund which, at a given rate of interest, will accumulate to an amount sufficient to replace at the point of use the water supply storage displaced by sediment when the useful life of a reservoir is terminated, plus the present average annual worth of all service losses that occur before replacement of the reservoir. The average annual benefit is the difference between the average annual damages with and without the recommended program.

Example 2–6 illustrates the sinking fund plus service loss method of estimating average annual damage to a reservoir. The information has been simplified for purposes of illustration. Thus, it assumed that service losses would begin immediately and would increase uniformly until an assumed date of replacement. In actual practice the time at which loss in service will begin, the rate that such losses will occur, and the point in time when the displaced water supply will be replaced must all be determined.

Example 2–5 Cost of sediment removal method to estimate damages to reservoirs

Given:	Volume of sediment to be removed annually without a project	540,000 yd^3
	Volume of sediment to be removed annually with a project	270,000 yd^3
	Cost of removal per cubic yard	$1.00
	Average annual damage without project	$540,000
	Average annual damage with project	$270,000

Solution: Average annual benefit = Average annual damage without project – Average annual damage with project

$540,000 – $270,000 = $270,000

Where removal occurs several years apart, all future costs should be discounted to present value and amortized over the life of the project.

Example 2–6 Sinking fund plus service loss method of estimating damage to reservoirs

Given:

- Useful life of reservoir without program .... 75 years
- Useful life of reservoir with program .... 100 years
- Replacement cost of water supply $1,000,000
- Annual payment into sinking fund for replacement in 75 years $1,080
- Annual payment into sinking fund for replacement in 100 years $290
- Annual increment of service loss without program $2,000
- Annual increment of service loss with program $1,000
- Present value of service loss 75 years hence without program ($2,000 x 330.04685 1/) .. $660,094
- Present value of service loss 100 years hence with program ($1,000 x 352.89063 2/) $352,891
- Annual equivalent value of services lost without project ($660,094 x 0.05483 3/) $36,193
- Annual equivalent value of services lost with project ($352,891 x 0.05404 4/) $19,070

1/ Present value of an increasing annuity for 75 years at 5 3/8 percent interest.
2/ Present value of an increasing annuity for 100 years at 5 3/8 percent interest.
3/ Amortization for 75 years, 5 3/8 percent interest.
4/ Amortization for 100 years, 5 3/8 percent interest.

Solution: Average annual damage without program = Annual payment into sinking fund for replacement in 75 years + Annual equivalent value of services lost without project

$1,080 + $36,193 = $37,273

Average annual damage with program = Annual payment into sinking fund for replacement in 100 years + Annual equivalent value of services lost with project

$290 + $19,070 = $19,360

Average annual benefit = Average annual damage without program – Average annual damage with program

$37,273 – $19,360 = $17,913

Appendix 2A Blank Forms

NRCS-ECN-1 **Flood Damage—Agriculture** 2–49

NRCS-ECN-004 **Flood Damage—Transportation—Utilities** 2–53

NRCS-ECN-005 **Irrigation Questionnaire** 2–55

NRCS-ECN-006 **Drainage Questionnaire** 2–57

FORM APPROVED
OMB NO. 40-R3809
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NRCS-ECN-1
(Rev. 4-77)
FILE CODE WS-14
Page 1 of 2

FLOOD DAMAGE - AGRICULTURE

This report is authorized by law (PL-83-566). While you are not required to respond, your cooperation is needed to make the results of this survey comprehensive, accurate, and timely.

Respondent ______________ Years on Farm ______________ Farm Location ______________ Watershed ______________ Reach ______________

Flood Date ______________ (Mo.) (Yr.) No. of Acres Flooded ______________ How frequently do floods of this size occur ______________ No. of Acres Flooded by largest flood ______________

Damage to Crops and Pasture From Flood of Above Date

Land Use	No. of Acres	Depth of Flood (Ft.)	Duration of Flood (Hrs.)	Expected Yield/Acre If No Flood	Yield/Acre After Flood	Alternate Crop & Yield/Acre	Additional Production Practices Performed Due to Flood	Production Practices Not Performed Due to Flood

Other Agricultural Property Damage From Flood of Above Date

Item	Type	Quantity	Depth of Flood	Estimated Damage (Dollars)

REMARKS

Estimated Land Damage From Flood of Above Date

Kinds	Acres	Productivity Loss	Remarks

Date of Interview ______________
By ______________

Agriculture Flood Damage Questionnaire

Instructions

The purpose of this questionnaire is to obtain information from landowners and operators to be used with other data in the evaluation of watershed problems and needs and project effects

List the name of the person being interviewed, the location of the farm or ranch and the name of the watershed under study.

Give the month and the year of a flood the respondent can remember. Show his estimate of the number of acres on this farm or ranch that were flooded by that flood.

Show the land use by acres of the area flooded when that flood occurred. Show the maximum depth of that flood and length of time flooding occurred. Show the expected yield for each land use if no flood had occurred, and the yield after the flood. If the yield after the flood was caused by delayed planting from a prior flood indicate with a star. Name the alternate crop and yield if applicable. List the additional production practices made necessary by the flood occurrence. List the production practices that did not need to be performed due to crop loss by flood. Use remarks section for additional space if needed.

List the other agricultural property by types damaged by that flood. Show the quantity flooded by depths of flooding. Show the respondent's estimate of damage for each depth, type or item and indicate which is the reference.

List the respondent's estimates of land damages.

List the normal land use of the total flood plain.

List the dates the farmer performs the indicated production practices when flooding is not a problem.

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OMB NO. 40-R3809
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NATURAL RESOURCES CONSERVATION SERVICE

NRCS-ECN-1
(Rev. 4-77)
FILE CODE WS-14
Page 2 of 2

LAND USE IN TOTAL FLOODPLAIN

Crop	No. of Acres	Usual Date for Production Practices				Date too late to Plant
		Land Preparation	Planting	Cultivating	Harvest	

1. What changes in land use have you made due to floods? __________
2. What changes would you make if the frequency of flooding were reduced by half? __________
3. How often do large floods occur? (If the flood described above is a large flood, change this question to small floods.) __________
4. During what seasons are floods most common? __________
5. In addition to the loss in yield described above, was there any damage to quality of crops? __________
6. What damage did this flood do to roads and bridges nearby? __________

Use other side for REMARKS.

FORM APPROVED
OMB NO. 0578-0007
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NRCS-ECN-004
(Rev. 6-84)

FLOOD DAMAGE - - TRANSPORTATION -- UTILITIES

This report is authorized by law (PL-83-566). While you are not required to respond, your cooperation is needed to make the results of this survey comprehensive, accurate, and timely.

Watershed__________ Reach__________ State__________ Interviewer__________ Date__________

Respondent__________ Institution Represented__________

Location of Damage __________ Item Damaged__________

Date of Flood __________

(1)	(2)	(3)	(4)	(5)	(6) Estimated Damages if Floods were:					
					Higher			Lower		
Depth of Water Related to Item Damaged (feet)	Type of Damage	Cost of Repair 1/ (dollars)	Other Damages (dollars)	Total Damages (dollars)	1'	2'	3'	1'	2'	3'

1/ Indicate the year repair made if other than year damaged__________

Bridge Information

(7) Location	(8) Size and Kind of Bridge	(9) Estimated Remaining Life of Bridge (years)	(10) Estimated Cost of Replacement (dollars)	(11) Estimated Life of Replacement (years)

Remarks

Explanatory Notes

1. Location of damage -- This may be by reach or other meaningful terms to identify where the damage occurs.

2. Respondent -- This would be the individual providing the information.

3. Institution Represented -- This may be the County Highway Department, railroad, utility company, etc.

4. Item Damaged -- Specify item and kind of item such as gravel road, steel bridge, main railroad line, electric generating plant, etc.

5. Column (1) -- This is to reflect the depth of water either over or below item damaged such as road surface, bridge deck, etc.

6. Column (2) -- This is to show whether damage consisted of washing out a bridge, eroding of abutments, gravel washed off road surface, flooding pumps, breaking utility poles, etc.

7. Column (4) -- This includes loss of business, wage loss, rerouting costs, emergency measures, cost of preventing damage, etc. Explain under remarks.

8. Column (6) -- This is not for a specific flood but is related to estimated damages if flood stages were either higher or lower. This estimate may be by respondent or technicians or both.

9. Bridge Information -- This data is to reflect without project conditions. This data may be useful if the replacement period and cost of replacement is affected by project conditions. It is most applicable to bridges in close proximity of structures.

10. Column (8) -- This is to show size of bridge opening and whether steel, timber, etc.

11. Remarks -- Use to clarify any data obtained or additional information not specifically covered.

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U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NRCS-ECN-005
(Rev. 6-84)

IRRIGATION QUESTIONNAIRE

This report is authorized by law (PL-83-566). While you are not required to respond, your cooperation is needed to make the results of this survey comprehensive, accurate, and timely.

Watershed ______________________ Reach ______________ State ______________

Respondent ______________________ Years on Farm ________ Farm Location ______________

Interviewer ______________________ Date of Interview ______________________

Soil Association or Group ____

1. What is your present method of irrigation? Border ☐ Corrugation ☐ Furrow ☐ Sprinkler ☐ Wild Flooding ☐

2. What crops, including acreages and yields of each, do you normally grow on your farm at present?

Crops	Normal Water Years		High Water Years		Low Water Years		Remarks
	Acres	Yield / Ac.	Acres	Yield / Ac.	Acres	Yield / Ac.	

3. What crops do you give priority consideration when irrigation water supplies are limited? ______________

4. How many additional acres of cropland would you irrigate if you had a dependable 80% water supply? ________ (Acres)
(If "None", go to question 7)

5. If a dependable (80%) water supply could be assured, what cropping patterns would you use and what results would you expect:

Crops (by Soil Group or Association)	Acres	Yield / Ac.	Remarks

6. What production practices, such as cultural, fertilization, water management, or other practices, would you need to follow over and above your normal ones, in order to attain these yields? (List each item in the following table)

Practice	Crop	Acres of Use	Remarks

7. What is the average annual operation and maintenance costs of your present irrigation system? $ ____________

8. What equipment do you now have?

Item Age

General comments and observations.

IRRIGATION QUESTIONNAIRE

Instructions

Watershed	- Give name of watershed as contained in the watershed application.
Respondent	- This is the person being interviewed and normally will be the person who lives on this farm.
Years on Farm	- Number of years the respondent has lived on or worked this farm.
Location	- Give the mail box address and preferably the legal description of this farm.
Interviewer	- Person conducting the interview.
Date of Interview	- The date this interview is being conducted.
Soil Association or Group	- Denote the soil group or soil association for which these data apply on this farm.
Question #1	- Check the block which denotes the type, or types, of irrigation being practiced on this farm.
Question #2	- Obtain estimates from the respondent on acres farmed and typical yields for normal, high, and low water supply years.
Question #3	- Obtain from the respondent his choices in determining which crops receive preference in rationing a short water supply.
Question #5	- For each soil group or association record the respondent's estimate of acres and yield for each crop.
Question #6	- This information will identify added cost items, over and above project costs, that will have to be incurred by the landowner to realize the full project effects.
Questions #7 & #8	- This information might indicate possible savings in costs as a result of installing the watershed project.
General Comments and Observations	- Specify any other pertinent information which has significance to the evaluation of the project irrigation measures.

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NATURAL RESOURCES CONSERVATION SERVICE

NRCS-ECN-006
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DRAINAGE QUESTIONNAIRE

This report is authorized by law (PL-83-566). While you are not required to respond, your cooperation is needed to make the results of this survey comprehensive, accurate, and timely.

Respondent ______________ Farm Location ______________ Reach ______________

Years on Farm ______________ Size of Farm ______________

Watershed ______________ Interviewer ______________ Date ______________

Problem Area Land Use						
Future Production Without Drainage			Future Production With Drainage			Remarks
Crop	Acres	Yield / Acre	Crop	Acres	Yield / Acre	

1. What are your drainage problems? ______________

2. How often are you unable to plant a crop due to lack of adequate drainage? ______________

3. How often do you need to make a separate planting due to lack of adequate drainage? ______________

4. How often are you unable to harvest a crop due to lack of adequate drainage? ______________

5. How much lime do you spread on problem area? ______________

6. Would you use a different type and rate of fertilizer with adequate drainage? Yes ☐ No ☐

7. If yes, what changes would you make? ______________

Remarks: ______________

Chapter 3 Watershed Protection

Contents:

611.0300 General information 3–1

(a) Technical and policy considerations 3–1
(b) Costs 3–2
(c) Benefits 3–3
(d) Interdependent gully erosion 3–4
(e) Threshold considerations 3–5
(f) Use of other studies 3–5

611.0301 Economic evaluation procedures 3–5

(a) Conservation effects for decisionmaking and case studies 3–5
(b) Onsite problems 3–8
(c) Offsite problems 3–8
(d) Conservation options procedure 3–8
(e) Incremental analysis procedures for land treatment 3–16
(f) Cost effectiveness and least cost analysis 3–21
(g) Land treatment watershed data needs 3–21

Tables

Table 3–1	Cost summary	3–3
Table 3–2	Net benefit summary	3–4
Table 3–3	Conservation options procedure summary	3–8
Table 3–4	Stage I conservation options, evaluation unit A	3–10
Table 3–5	Stage I cost efficiency, evaluation unit A	3–10
Table 3–6	Stage II net benefit analysis, evaluation unit A	3–11
Table 3–7	Stage III comparison of alternatives	3–12
Table 3–8	Incremental analysis for land treatment for treatment unit 2	3–19
Table 3–9	Incremental analysis using net benefits per acre as decision criteria	3–20

Figures

Figure 3–1	Conservation effects for decisionmaking	3–5
Figure 3–2	Conservation effects worksheet	3–7
Figure 3–3	Cropland erosion cross-section, percent of field by zone	3–8

Examples

Example 3–1	Conservation options procedure	3–13
Example 3–2	Incremental analysis using benefit to cost ratio	3–17
Example 3–3	Incremental analysis using net benefits per acre	3–20

611.0300 General information

Chapter 3 describes the economic evaluation procedures to be used in watershed protection or land treatment watershed projects. Depending on the particular project, soil erosion and water runoff cause an array of onsite and offsite problems.

Two procedures for economic analysis of these problems are presented: the Conservation Options Procedure (COP) and the Incremental Analysis Procedure (IAP). Both can be used to analyze systems of conservation practices in watershed and related project work.

The conservation options procedure uses cost efficiency, net benefits, and non-monetary impacts to evaluate conservation options. It should not be used for evaluation of flood control structural measures. This procedure is preferred for nonstructural evaluations.

The incremental analysis procedure identifies the national economic development (NED) plan by evaluating incremental benefits and costs of practices and combinations of practices. This procedure can be used for both structural and nonstructural evaluations.

These procedures develop alternatives from which a recommended plan is selected. The nature of this plan depends upon the purpose and sponsoring entity, but the acceptable benefits are the same for both procedures.

The economic evaluation developed for Federal, State, and local concerns should be sufficiently detailed so that the decisionmaker can judge both the monetary and non-monetary merits of the various alternatives.

(a) Technical and policy considerations

A federally funded water resource project plan focuses on the Federal objective of the development of a NED plan. It is defined as the plan that reasonably maximizes net economic benefits consistent with the Federal objective and with protecting the Nation's environment.

Plans for watershed protection projects may be developed that do not maximize NED benefits. These plans address land treatment and other Federal, State, or local concerns. A full range of alternative plans should be systematically formulated to ensure that all reasonable alternatives are evaluated. This includes the selection of combinations of measures within the alternatives.

The National Watershed Manual (NWSM) describes the NRCS Plan Formulation Requirements for land treatment measures. It states that the recommended plan should be the least costly and environmentally acceptable method of achieving the desired level of resource protection.

The treatment applied to each evaluation unit is determined in a practical manner by using COP and IAP techniques. This analysis is not limited to economic factors, but also includes physical, environmental, and other effects.

Watershed planners are encouraged to include monetary and non-monetary impacts in the evaluation of conservation options. Changes in the five natural resources (soil, water, air, plants, and animals) should be considered along with human resource considerations (economic, cultural, and social). COP incorporates these directly into the evaluation process.

Yield enhancement and efficiency gains may not be used to formulate watershed protection plans. These two items are not the primary resource problem being addressed. However, they might be considered as incidental benefits and may be used when computing net benefits for alternative plans.

A *practice* means an independent measure as listed in NRCS's National Handbook of Conservation Practices or a combination of interdependent measures. Measures are considered interdependent when application standards require the simultaneous installation of two or more practices for the unit to function as planned, or to prevent the practice under consideration from creating or magnifying another problem.

All practical land treatment practices that address the problem and are commonly used in the area are considered in the evaluation. Land treatment practices not adapted to a particular soil or crop normally should not be included in the analysis. For example, stripcropping is not appropriate for all crops or on all soils. Land use conversion that would require major changes in farm operation may not be accepted by farmers who historically have grown cash crops. This is not to say that the landowner's desires will govern the evaluation process; rather, common sense should be applied.

Depending on the planning purpose, the level of evaluation may be either a practice, conservation option, Basic Conservation System (BCS), Resource Management System (RMS), or Alternative Management System (AMS).

(b) Costs

This section provides an explanation of the costs that are used in both the COP and IAP. The economic evaluation often centers around changes in the variable costs; however, the items included in variable costs may change depending on the level of evaluation. All costs should be expressed in average annual dollars.

(1) Management practice costs

Management practice costs (MPC) are defined, for the purpose of project evaluation, as any added production input costs (APIC). MPCs are the costs of added inputs, such as insecticides, herbicides, or a no-till planter, plus any increase in the management costs. They are not the total net change in crop budget costs. The APIC caused by the conservation options are considered project costs in this procedure. When financial assistance (incentive payments) is provided for management practices, the amortized value of incentive payments (IP) should be included along with the APIC as a project cost. Management practice costs (average annual dollars per acre) are defined by formula 3–1 as:

$$MPC = APIC + IP \qquad [3\text{–}1]$$

where:

MPC = average annual management practice cost
APIC = average annual added production input costs
IP = average annual incentive payment cost

(2) Efficiency gains

Efficiency gains (EG) are the net change in budget costs. This change is the difference between added production input costs and reduced variable production costs, which include any reduction in management costs. Double counting costs should be avoided.

(3) Enduring practice costs

Enduring practice costs (EPC) are the sum of the amortized installation (I) cost, the amortized present value of the replacement (R) costs, the annual operation and maintenance (O&M) costs, and any APIC associated with an enduring practice. The I and R costs should be amortized at the relevant Federal water resource discount rate for the evaluation period or project life (25 years), not the period of analysis that is the sum of the evaluation period and the installation period. In addition, any APIC costs associated with an enduring practice should be included in the cost of that practice. Enduring practice costs (average annual dollars per acre) are defined by formula 3–2 as:

$$EPC = I + R + O\&M + APIC \qquad [3\text{–}2]$$

where:

EPC = average annual enduring practice cost
I = average annual installation cost
R = average annual replacement cost
O&M = average annual operation and maintenance cost
APIC = average annual added production input cost

(4) Technical assistance or project administration costs

Technical assistance (TA) or project administration (PA) costs should not be included when evaluating conservation options in the project formulation process. These costs are not applicable to individual conservation options, but they need to be included in the net benefit evaluation for alternative plans.

The cost components used in the Conservation Options and Incremental Analysis Procedures are summarized in table 3–1.

(c) Benefits

The starting point for the benefit analysis is the input from the physical scientists. Most beneficial effects fall into onsite or offsite categories.

(1) Onsite benefits

Onsite benefits include long-term productivity, concurrent damage reduction (now time damages), yield enhancement, and reduced variable production costs. A problem associated with calculating onsite benefits of conservation is the degree to which current normalized prices and standard crop budgets produce realistic estimates of absolute net income. Partial budgeting is used to solve this problem because it focuses on those budget items that tend to have a readily known market value rather than many of the fixed budget costs that are more farm specific. In this case benefits are determined by subtracting gross returns without treatment from gross returns with treatment and then adding the reduction in variable production costs. This relative measure of income change is probably more reasonable than absolute measures of levels of income derived from whole budget analysis. Onsite benefits are computed using formula 3–3:

$$OSB = (GR_w - GR_{w/o}) + RVPC \qquad [3\text{–}3]$$

where:
- OSB = onsite benefits
- GR_w = gross returns with treatment
- $GR_{w/o}$ = gross returns without treatment
- RVPC = reduced variable production costs

Because added production input costs are handled as project costs, the RVPC represent the reduction of existing condition variable production costs. This is based on the assumption that farmers will continue to incur their current fixed costs.

(i) Long-term productivity (LP) benefits— These benefits are related to the maintenance of future soil resource base productivity. They are commonly measured in terms of changes in the rate of reduction in soil depth and, therefore, reductions in crop yields. Crop yield increases resulting from technology are not included in the evaluation. Such increases are considered as yield enhancement, not long-term productivity.

Benefits from changes in the crop sequence are associated with modification in the crops grown. An example of such a modification is the conversion from continuous corn to a corn-hay rotation. To simplify the analysis and to ensure that the effects of changes in the cropping sequence do not adversely affect the evaluation of conservation options, it is assumed that the overall mix of crops will not change. Specifically, it is assumed that hay must be already produced on other fields; therefore, the corn and hay are moved around among fields. That is, corn will be used for both the without and with treatment conditions.

In summary, computing long-term productivity benefits where the cropping sequence changes by measuring the change in net income in terms of the original cropping sequence. This ensures that the long-term productivity benefits are based on reduced damage to the resource base, not to budget changes.

Table 3–1 Cost summary

Cost	I	R	O&M	APIC	IP	PA	TA	Avg. ann.	Annual-ized
Project formulation									
EPC	x	x	x	x				x	
MPC				x	x			x	
Net benefit analysis - watershed plan									
EPC	x	x	x	x		x	x	x	x
MPC				x	x	x	x	x	x

- I = Installation cost
- R = Replacement cost
- O&M = Operation and maintenance cost
- APIC = Added production input costs
- IP = Incentive payments
- PA = Project administration costs
- TA = Technical assistance costs
- Avg. ann. = Average annual costs (amortized over project life)
- Annualized = Amortized over the period of analysis
- EPC = Enduring practice cost
- MPC = Management practice cost

(ii) Concurrent damage reduction (CDR) benefits—These benefits are associated with the reduction in year-to-year erosion damages. Concurrent damage reduction benefits include the effects of conservation practices on yields through reduced runoff of applied nutrients, reduced seed and plant washout, and decreased sedimentation of seeds and plants. These effects are sometimes referred to as *now time effects*.

(iii) Yield enhancement (YE)—Yield enhancement may result from removing a limiting problem factor, such as excess water.

(iv) Reduced variable production costs (RVPC) benefits—These benefits are defined as the reduction in without treatment variable input costs associated with a practice. The reduced variable production costs are viewed as benefits.

In a partial budget format, efficiency gains (EG) are the difference between the reduced variable production costs, which include any reductions in management costs, and the added production input costs. This is demonstrated in formula 3–4.

$$EG = RVPC - APIC \qquad [3\text{–}4]$$

Again, the added production input costs are treated as project costs. Therefore, the reduced variable production costs represent efficiency gains in the net benefit evaluation.

(2) Offsite benefits

Offsite benefits are related to water quality, sedimentation, and floodwater. These benefits accrue to individuals who have no control over the source of damage. They generally are derived from reducing the runoff of water, sediment, and associated chemicals. The reduced runoff, in turn, decreases damages or diminishes the resource use impairment.

ECON2 may be used to measure offsite flood reduction, and the LDAMG program may be used to measure sediment, scour, and swamping damage reduction. Impaired use evaluations can be used for any associated chemical damage.

The net benefit analysis is summarized in table 3–2.

(d) Interdependent gully erosion

In evaluation units where significant (i.e., control requires enduring practices) ephemeral or permanent gully erosion is interdependent with sheet and rill erosion, each of the conservation options must treat the gully erosion as well as the sheet and rill erosion problems. When listing conservation options in Stage I, note those options that completely solve the gully erosion problems. By following this instruction, the cost efficiency analysis is based on the cost of gully practices and sheet and rill practices per ton of reduced sheet and rill erosion. Ranking the conservation options by an efficiency measure, such as reduced sheet and rill erosion, does not change the relative position of each conservation option. This is because the effect on ephemeral erosion is constant across conservation options within an evaluation unit.

Table 3–2 Net benefit summary

Item
Average annual benefits ($/Ac)
Damage reduction
LP
CDR
OFF
Subtotal (Dmg Red)
Other
YE
RVPC/EG
Subtotal (other)
Total average annual benefits
Total average annual cost
Net benefits

LP = Long-term productivity
CDR = Concurrent damage reduction
OFF = Offsite damage reduction benefits
YE = Yield Enhancement
RVPC = Reduced variable production costs
EG = Efficiency gains
Dmg Red = Damage reduction (sum of LP, CDR, and OFF)

(e) Threshold considerations

Threshold limitations must be dealt with in many projects. Water quality projects with impairments that affect such things as fisheries (restoration or enhancement) are increasing. For example, some salmon fry cannot survive if the water temperature is above 75 degrees. If the existing temperature is 80 degrees, a practice that will reduce the temperature only 2 degrees is not beneficial. The appropriate technique would be to develop a system that will meet threshold levels as a first increment. Once the threshold levels have been met, then the marginality concept can be used to determine if additional treatment will provide positive effects. Both COP and IAP are well suited to this analysis.

Some threshold levels are admittedly more absolute than others. Sensitivity analysis would be appropriate to demonstrate the cost effectiveness of the threshold level.

(f) Use of other studies

Planners are encouraged to use information from other watershed projects or comparable studies. These studies should be in areas with similar soils, crops, problems, and needs. They should also follow the P&G procedures.

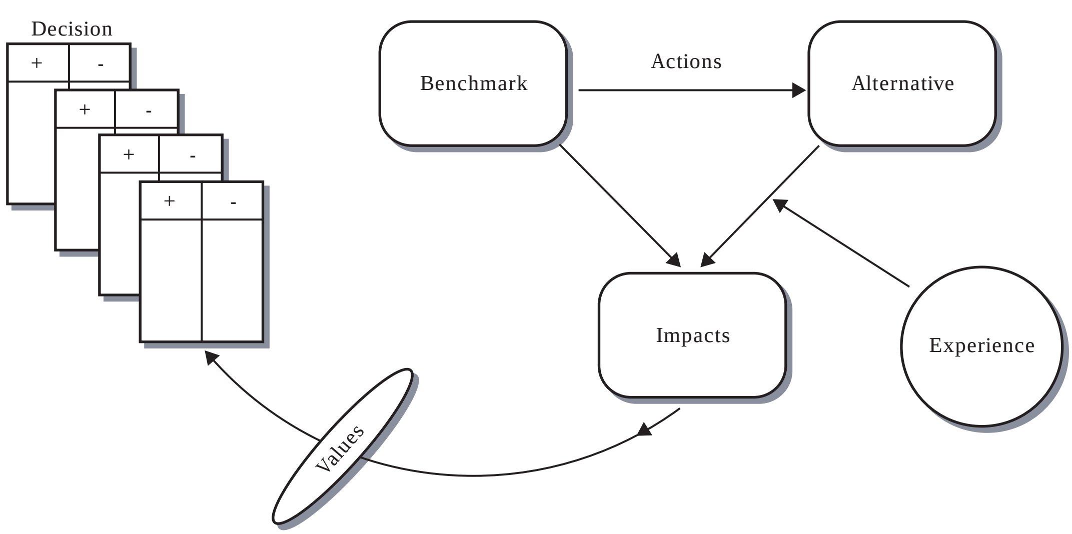
611.0301 Economic evaluation procedures

(a) Conservation effects for decisionmaking and case studies

Conservation effects for decisionmaking (CED) is a process developed by NRCS for evaluation of management practices and should be applicable to the watershed protection planning process. It provides a method and a data source for evaluating a natural resource concern while emphasizing the need for interdisciplinary involvement. The before and after concept is similar to the without and with treatment aspect of watershed protection. CED assists decisionmaking by:

- Providing a method for obtaining and storing effects information.
- Outlining a process for presenting, discussing, and comparing the effects of the present system to any number of proposed treatments.
- Providing a logical method of assisting the decisionmaker in evaluating the conservation alternatives available. A chart of the process is shown in figure 3–1.

Figure 3–1 Conservation effects for decisionmaking



Begin the CED process by examining and documenting the current system and effects, or benchmark. Next, develop conservation alternatives and document the effects (positive or negative). The difference between the effects of the benchmark and alternative are listed as impacts. Decisionmakers use their values to evaluate the impacts and determine the appropriate management practice or system of practices. The CED worksheet (fig. 3–2) lists impacts in a clear and concise format. Experience will also guide actions taken towards making a decision. For more detail see the National Planning Procedures Handbook, part 600.62.

A case study is an effective and cost-efficient method of collecting and storing conservation effects information using the CED process. The resulting case studies are a part of the FOTG, Section V, Conservation Effects. This information is a source of information for the interdisciplinary team of planners.

Typically, actions to implement management practices include changes in inputs and outputs. The case studies measure and quantify these changes. They reflect the farming operations undertaken, type of equipment used, dates of operations, number of operations to complete work, and the kinds and amounts of inputs, such as seed, fertilizer, pesticides, tractor hours, fuel consumption, and labor required. In addition, yields, erosion rates, other observable indicators related to the resources of concern (soil, water, air, plants, and animals), and any significant changes in operational and managerial conditions and decisions during the case study are examined.

The cost and return estimator program (CARE) and the interactive conservation evaluation program (ICE) are tools developed by NRCS to aid in analyzing this information. CARE or another crop budget program is recommended for estimating management or budget changes. Partial budgeting is allowed. Erosion or plant growth models, such as erosion productivity impact calculator (EPIC), and other tools were developed for estimating short-and long-term yield changes.

Figure 3–2 Conservation effects worksheet

U.S. Department of Agriculture
Soil Conservation Service

Conservation Effects Worksheet

Name Joe Decisionmaker	**Address** Lima, Ohio	**OPID No.** JD123456	**Field or Tract No.** 1235

Resource Setting: Morley soils 12–18% slopes	**Resource Problems Before Treatment** Excess sheet, rill and gully erosion, N & P_2O_5 in runoff, pesticides in runoff.	**Description of Treatment Option:** Grassed waterway Conservation Cropping Sequence: (C-Sb-W) Conservation Tillage: (No-till Corn and Soybeans) (Mulch-till Wheat) Nutrient Management, Pest Management
Benchmark (Present management system) Conventional tillage for corn and beans, wheat drilled in lightly disked bean residue. No waterways.		

Actions (Kinds, amounts, and timing)	**Effects** (Effects of continuing the benchmark system)	**Comparison of Effects of Benchmark and Treatment Option** — **Impacts**	**Decisionmaker Evaluation**
CORN: • Apply N, P and K in the fall • Fall plow wheat stubble • Disk • Apply Lariat (Atrex-Lasso) • Field Cultivate to incorporate herbicides • Plant • Rotary hoe • Spray Banvel + 2, 4-D amine as needed • Row cultivate once **Beans:** • Plow in the fall • Disk twice • Plant and spray Turbo • Double back for 15" rows • Rotary hoe **Wheat in bean stubble:** • Disk once • Drill wheat	• P_2O_5 in runoff causing algae bloom in farm pond and contributes to pollution of Lake Erie. • Traces of pesticides in surface water • Nitrates in tile flows in the spring • Soil loss 35 tons/ac. • Three small gullies will enlarge • Soil tilth will decline • Machinery: 125 hp tractor moldboard plow disk field cultivator planter rotary hoe rowcrop cultivator • Chemicals: Corn: Lariat .88 gal./ac. Banvel 1/4 pt./ac. Beans: Turbo 1 qt./ac. Wheat: none • Fertilizer: Corn: N 140 lb./ac P_2O_5 60 lb./ac. K_2O 90 lb./ac. Beans: P_2O_5 40 lb./ac. K_2O 120 lb./ac. Wheat: N 75 lb./ac P_2O_5 45 lb./ac. K_2O 80 lb./ac. • Fuel: Corn 8.3 gal./ac. Beans 7.0 gal./ac. Wheat 5.5 gal./ac. • Labor: Corn 9.8 hrs./ac. Beans 8.8 hrs./ac. Wheat 5.0 hrs./ac. • Yields: (expect to decline over time) Corn 110 bu./ac. Beans 32 bu./ac. Wheat 45 bu./ac.	• Phosphorus runoff reduced but still some in sediment • Less mobile herbicides used • Less leaching of nitrates • Soil Loss reduced 26 tons/ac. • Gully erosion eliminated • Infiltration increased • Power needs reduced 50 hp • Eliminate: Moldboard plow Field cultivator Rotary hoe Row cultivator • Less soil compaction • Slower planting • Need more time for scouting • Chemical use increased • Fertilizer requirements unchanged but timing of application is closer to when crop needs nutrients. • Fuel reduced: C 1.8 gal./ac. B 2.2 gal./ac. W 0.8 gal./ac. • Labor reduced: C 2.4 hrs./ac. B 3.3 hrs./ac. W 0.8 hrs./ac. • Yields will decline over time	(–) Pond will still have some algae problem (–) Poorer weed control (+) Better quality of water (–) Erosion still problem (+) less equipment damage (+) less ponding (+) can sell big tractor (+) less machinery to maintain and fewer trips (+) better root development (-) (-) (-) burn-down herbicide needed (+) Better utilization of nutrients (+) lower input costs (+) (+) (+) can use this time for scouting and more time for (+) livestock (+) (–) Increased fertility needed to offset yield decline

Comments:
NOTE: This sheet is to be completed with the decisionmaker during the planning visit with the decisionmaker's evaluation recorded in the right hand column.

SCS–ANY STATE FEBRUARY 1990

(b) Onsite problems

Evaluation of land treatment involves the relationship of the reduced physical problems, such as erosion, and their effects on crop yields and production inputs. The relationship between crop yield and soil depth must be determined by agronomists and soil scientists for the soils in the problem area. Crop production inputs must be estimated, relate to erosion rates, and estimate the change caused by land treatment practices. These relationships must be developed for sheet and rill erosion, wind erosion, and ephemeral gully erosion.

Damage from sheet and rill erosion builds overtime. Therefore, damage reductions need to be properly discounted. Runoff from high intensity rainfall can wash soil away from seeds, seedlings, and mature plants, reducing plant populations and crop yields. These damages can occur annually without erosion control practices to protect the soil. Effects of erosion on crop yield and production inputs need to be determined to estimate this damage.

Permanent gullies result in the loss of production through voiding and depreciation. The sediment from the gully creates offsite problems. Farming inefficiencies also result. Procedures for analyzing gully damages are described in chapter 2 of this handbook.

Ephemeral gully (concentrated flow) erosion can cause damage to growing crops to some degree each year. Such damage needs to be adjusted to an average annual equivalent if it is established that ephemeral gully development will change over time. A typical cross-section of a field with an ephemeral gully is shown in figure 3–3. The percentage of area in each category varies by field and requires an interdisciplinary effort to determine for each project.

(c) Offsite problems

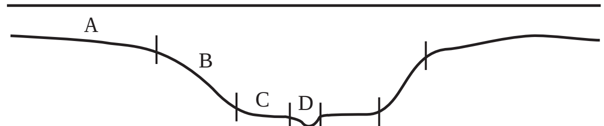
Offsite problems, concerns, and opportunities are an important part of watershed protection evaluations. Sediment can fill road ditches and decrease the life and recreational values of reservoirs. Water runoff carries with it sediment and chemicals that cause offsite damages. It affects the desirability of waterbodies including quantity, quality, and enhancement aspects of recreation, property values, water supplies, power generation, and aesthetic values.

Offsite problems, such as water quality and sedimentation, are analyzed according to procedures explained in other sections of this handbook. Recreation evaluations are in chapter 5 of this part of the handbook, and sedimentation in chapter 2. Also see Part 612, Water Quality.

(d) Conservation options procedure

The conservation options procedure (COP) is comprised of three stages. Stage I is a cost effectiveness analysis of practices and systems of practices (conservation options) that are technically feasible. Stage II is a net monetary benefit analysis performed on the alternative systems of practices identified in Stage I as being cost effective. Stage III adds non-monetary impacts, addresses the tradeoffs among the Stage II alternatives, and documents the rationale for selecting the national economic development (NED), resource protection (RP), and recommended plans. The activities to perform for each stage are shown in table 3–3.

Figure 3–3 Cropland erosion cross-section, percent of field by zone



	Zone	Percent of available cropland
A	Sheet and rill	74
B	Accelerated sheet and rill	13
C	Mechanical ephemeral	10
D	Voided	3
		100

Table 3–3 Conservation options procedure summary

Event	Activity to perform
Stage I	Cost effectiveness analysis
Stage II	Net monetary benefit analysis
Stage III	Identify NED, RP, and other alternative plans and select the recommended plan

The conservation options procedure makes the economic evaluation process more practical. It reduces the time required to analyze an evaluation unit. The procedure incorporates modifications in the handling of production costs and changes in cropping sequence to ensure that the benefits from conservation of soil and water drive the evaluation process. These modifications, the way production costs and changes in cropping sequence are handled, are also applicable to the incremental analysis procedure.

(1) Stage I

This stage is the cost effective analysis of alternatives. It is a 4-step procedure.

Step 1 Specify and identify the nature and scope of the resource problem.

Step 2 Interdisciplinary team must select and list all of the potential alternatives that address the resource problem, that are commonly used in the area, and that are technically feasible. Each alternative will affect the identified problem in varying degrees.

Step 3 Select a common base or common denominator for the cost effectiveness analysis.

Step 4 Eliminate from further consideration the alternatives that are not cost effective.

Once the problem has been identified, an interdisciplinary group of technical specialists should develop a list of technically feasible and socially acceptable systems of practices that address the resource problems. These Stage I systems of practices may be called conservation options. The first option listed represents the existing condition. The second option might be a complete resource management system or a basic conservation system. Other options may represent varying levels of treatment.

Because each conservation option affects the identified problems in varying degrees, a common base must be selected for comparing the options. In all cases the appropriate common denominator depends on the nature of the identified problem. If the primary problem is loss of long-term productivity, then the basis for comparison might be cost per ton of reduced sheet and rill erosion. If the primary problem is offsite sedimentation, then the basis for comparison might be cost per ton of reduced sediment. When other damages are the major resource problem, other common denominators, such as pounds of nutrients or biological oxygen demand levels, may be used.

Stage I requires that watershed planners note only the presence of significant gully erosion in the following cases:

- In evaluation units where ephemeral gully or permanent gully erosion are interdependent with sheet and rill erosion
- Where ephemeral erosion is severe enough to require water disposal systems.
- Where onsite damages are predominant.

Estimates of the amount of gully erosion (tons per acre per year) are needed primarily for the evaluation of sediment problems. As such, when conservation options are developed, include options that completely solve the gully erosion problem. This means that in evaluation units where gully erosion is severe, water disposal systems are the foundation of any conservation options. The cost efficiency analysis, in this case, is based on the cost of gully and sheet and rill practices per ton of reduced sheet and rill erosion.

Onsite gully damages can be computed without estimating the amount (i.e., tons per acre per year) of gully erosion. The only erosion related information needed is an estimate of the dimensions (i.e., length and width) of the voided and the depreciated areas. The computation of onsite and offsite damages is described in the section on Stage II.

Table 3–4 provides a suggested display for an evaluation unit where:

- Ephemeral gully erosion is severe enough to require enduring practices.
- Ephemeral erosion is interdependent with the sheet and rill erosion.
- The major problem is loss of long-term productivity.

The purpose of table 3–4 is to document which conservation options were considered and to systematically screen out conservation options that are not technically feasible.

Conservation options that are not technically feasible, based on the interdisciplinary team's judgment, should be deleted from further consideration. Threshold levels should be considered. This may appear to be redundant if only technically feasible systems of practices were considered to start with. However, technical specialists do not always agree and the initial listing may have overlooked specific area conditions, both physically and socially. The consideration of all five resources (SWAPA) and the human consideration is necessary. This shows the subsequent reviewer that all conservation options were considered.

Finally, a cost effectiveness analysis is performed on the remaining conservation options using the relevant physical effect. In the example shown in table 3–5, the cost effectiveness is shown as tons of soil saved per acre per year. This table is an example of how the cost effectiveness analysis of Stage I might be displayed for an evaluation unit where the primary problem is loss of long-term productivity caused by interdependent sheet and rill and severe ephemeral gully erosion. Conservation options 7 and 8 in table 3–4 were deleted for technical reasons and are not listed in table 3–5.

Sheet and rill erosion should be expressed as tons per acre per year. The erosion reduction is the difference between the existing condition and the conservation option conditions. The first option listed should be the existing condition option. For display purposes, the conservation options in table 3–5 may be ranked by cost per ton of soil saved. Graphing the information will assist in analyzing and displaying the information.

Conservation options that are not cost effective can be deleted from further consideration in the identification of the NED, RP, and recommended plans. Determining which conservation options are efficient and, therefore, to be analyzed as alternative conservation systems in Stage II, is not based on an absolute standard.

Table 3–4 Stage I conservation options, evaluation unit A

Existing condition & conserv. options	Gully 1/ perm (y/n)	Gully 1/ ephem (y/n)	Sheet/rill 2/ eros rate (t/a/y)	Sheet/rill 2/ eros redc (t/a/y)
1. Exist. cond.				
2. RMS/BCS A				
3. RMS/BCS B				
4. RMS/BCS C				
5. RMS/BCS D				
6. RMS/BCS E				
7. RMS/BCS F				
8. RMS/BCS G				

1/ For the Existing condition and conservation options, enter **Yes** or **Y** if ephemeral gully or permanent gully erosion is a significant problem that requires a water disposal system. Enter **No** or **N** if gully erosion is not a problem.
2/ When cost effectiveness is related to other physical problems, use an appropriate parameter, such as tons of sediment.

Table 3–5 Stage I cost efficiency, evaluation unit A

Existing condition & conserv. options	Gully 1/ perm (y/n)	Gully 1/ ephem (y/n)	Sheet/rill 2/ eros rate (t/a/y)	Sheet/rill 2/ eros redc (t/a/y)	Conserv. options cost ($/a/y)	Conserv. options cost ($/a/y)
1. Exist. cond.						
2. RMS/BCS A						
3. RMS/BCS B						
4. RMS/BCS C						
5. RMS/BCS D						
6. RMS/BCS E						

1/ For the Existing condition and conservation options, enter **Yes** or **Y** if ephemeral gully or permanent gully erosion is a significant problem that requires a water disposal system. Enter **No** or **N** if gully erosion is not a problem.

This may be a defined point or a comparison of one alternative with the others. There may be some tough tradeoffs. The interdisciplinary team must use their collective experience to decide which options are efficient.

(2) Stage II

Stage II is a net monetary benefit analysis of the alternative conservation systems identified in Stage I. It is a 2-step procedure.

Step 1 The interdisciplinary team quantifies the physical effects of the conservation options.

Step 2 Once all monetary benefits, including offsite effects, have been valued, the team computes the net benefits for each of the cost effective conservation options identified in Stage I. Table 3–6 displays a recommended format for this information.

Table 3–6 Stage II net benefit analysis, evaluation unit A

Item	RMS/BCS	Conservation alternative 1	Conservation alternative 2
Average annual benefits ($/acre)			
Damage reduction			
LP			
CDR			
OFF			
Subtotal (Dmg Red)			
Other			
YE			
RVPC/EG			
Subtotal (other)			
Total average annual benefits			
Total average annual cost			
Net benefits			

LP = Long-term productivity
CDR = Concurrent damage reduction
OFF = Offsite damage reduction benefits
YE = Yield enhancement
RVPC = Reduced variable production costs
EG = Efficiency gain
Dmg Red = Damage reduction (sum of LP, CDR, and OFF)

(3) Stage III

Stage III is the evaluation of the alternatives and subsequent formulation of the recommended plan (NED and RP plans). In this stage the non-monetary effects are combined with the monetary effects of Stage II. The tradeoffs are evaluated in both monetary and non-monetary terms. In addition, the rationale for selecting the recommended plan is described. The alternative with the greatest net monetary benefit is designated as the NED plan, and the alternative that achieves an acceptable level of resource protection is designated as the RP plan. The interdisciplinary team defines the RP plan criteria. Table 3–7 provides an example display of the Stage III results. When appropriate, items other than those displayed should be used.

In Stage III, technical assistance and project administration costs are to be included in the costs of alternative plans. The total costs (the Stage II costs of management practices and enduring practices, plus technical assistance and project administration) should be amortized for the evaluation period. In the watershed plan, the costs and benefits of the recommended plan need to be annualized for the period of analysis. Cost data shown in the schedule of obligations must be used to compute annualized costs.

(4) Summary

The Conservation Options Procedure assists the resource planner in developing plans for solving offsite land and water resource problems. Economic, environmental, and social concerns are combined into an orderly and systematic display to assist in the planning process. Upon completion of this process, the decisionmaker will have a good understanding of the significant implications of each alternative plan.

One method for analyzing problems that require both structural and nonstructural solutions is to do an incremental analysis of structures to determine size and location. An example is determining the size and location of sediment control basins or dams to control sediment in a downstream lake. Once size and location are determined, the resulting structure(s) can be incorporated into COP as an option along with nonstructural alternatives. Example 3–1 illustrates the conservation options procedure. The sponsoring agency and the stated purpose of the project determine the direction that the interdisciplinary team takes in selecting the recommended plan. The final plan should include both the without project alternative and the recommended alternative.

Table 3–7 Stage III comparison of alternatives

Item	Existing condition	RMS/BCS	Conservation alternative 1	Conservation alternative 2
Erosion rate (tons/ac/yr)				
Erosion reduction (tons/ac/yr)				
Sediment reduction (tons/ac/yr)				
Costs				
Install PL 566				
Install other				
Average annual				
Economic Benefits				
Onsite				
Offsite				
Net economic benefits				
Social effects				
Environmental effects				

Example 3–1 Conservation options procedure

Problem: A resource concern exists where onsite cropland erosion is contributing to sedimentation in a downstream lake. The plan will be formulated to control this sedimentation and the impairments it is having on recreation and water supplies. Alternatives A through G are potential candidates for reducing the sedimentation. The sedimentation is considered to be the primary problem. Other concerns include phosphorus entering the lake and some environmental concerns. The data used here are intended only to show the procedure.

Procedure: COP Stage I—Cost Effective Analysis

Step 1: The concern is an offsite sedimentation problem; therefore, the common denominator used is cost per ton of reduced sediment. Other common denominators might be per pound of phosphorus reduced, per unit of environmental parameter, or per year of extended life of the lake.

Step 2: The alternatives that address the resource problem are displayed in a tabular format. Alternatives could be a conservation option, practice, or conservation management system. The potential alternatives are:

Alternative	- - - Offsite sediment - - -	
	sediment (tons/yr)	reduction (tons/yr)
Existing	48	---
A	33	15
B	31	17
C	25	23
D	23	25
E	45	3
F	38	10
G	43	5

Alternatives that are not technically feasible are eliminated from further analysis. The interdisciplinary team eliminates alternatives E and G for various reasons including their minor reduction of sediment.

Step 3: Perform a cost effective analysis by deriving the cost of the alternatives. The simple division is made using the relevant common denominator. In this example, the cost of each remaining alternative is expressed as cost per ton of sediment reduction.

Example 3–1 Conservation options procedure—Continued

The cost effective analysis is:

Alternative	Offsite sediment (tons/yr)	Offsite sediment reduction (tons/yr)	Total cost avg ann ($)	Cost per ton sediment reduction ($)
Existing	48	---	---	---
A	33	15	98	7
B	31	17	493	29
C	25	23	1,978	86
D	23	25	2,450	98
E (eliminate)	45	3	900	300
F (eliminate)	38	10	1,450	145
G (eliminate)	43	5	1,500	300

Step 4: Eliminate any alternatives that the team feels are not cost effective. In this case, assume alternative F is eliminated because of the high cost per ton of sediment reduction. The time and cost savings of eliminating inefficient alternatives in Stage I become apparent as we proceed to Stage II.

COP Stage II—Net Monetary Benefit Analysis

Step 1: Those alternatives that are the most cost effective and perhaps satisfy other requirements, such as a State standard for a water quality parameter, are displayed in tabular form. The agronomist, sedimentation geologist, resource conservationist, recreation specialist, biologist, soil scientist, and water quality specialist complete their estimates of the physical effects of the project. These effects must be estimated before the monetary values can be determined. Any effects that cannot be converted to monetary values should also be quantified at this time. For comparison purposes, the table in Stage I of this example is used to create the physical effects of alternatives table as follows:

Alternative	Onsite		Offsite			
	sheet eros rate (t/ac/yr)	rill eros redct (t/ac/yr)	phosph in lake (units)	environ. reduct (units)	sediment redct (tons/yr)	cost/ ton ($)
Existing	33	---	---	---	---	---
A	15	18	8	5	15	7
B	14	19	4	3	17	29
C	9	24	5	6	23	86
D	5	28	4	5	25	98
E (eliminated in Stage I)						
F (eliminated in Stage I)						
G (eliminated in Stage I)						

Example 3–1 Conservation options procedure—Continued

Step 2: The team derives both the onsite and offsite monetary benefits for each alternative brought forward from Stage I. The net benefits of each alternative are then computed and displayed as follows:

Alternatives	Onsite benefits avg ann ($)	Offsite benefits avg ann ($)	Total benefits avg ann ($)	Total cost avg ann ($)	Net benefits avg ann ($)
Existing	---	---	---	---	---
A	22	111	133	98	35
B	33	494	527	493	34
C	44	1,932	1,976	1,978	–2
D	55	2,402	2,457	2,450	7
E (eliminated in Stage I)					
F (eliminated in Stage I)					
G (eliminated in Stage I)					

COP Stage III—Evaluation of Alternatives

At this stage in the evaluation, the non-monetary effects, expressed in quantitative and qualitative terms, are combined with the information developed in Stages I and II. The alternative with the highest net monetary benefits becomes the NED plan for a water resources project. For a watershed protection plan, it will be the alternative that achieves an acceptable or desired level of resource protection.

The plans involve evaluating the tradeoffs between the effects displayed in the Stage III tables. Efficiency, social, environmental, and economic tradeoffs define achievability of the plan. The actual criteria for the plan involve a joint effort of the interdisciplinary team and the decisionmakers representing the sponsoring government agencies. The same people may fill both roles. The information derived for the evaluation of the alternatives follows:

Comparison of Alternatives for Plan Selection

Alternative	Onsite		Offsite			Benefits				
	sheet eros rate (t/ac/yr)	rill eros redct (t/ac/yr)	phos in lake (units)	envir (units)	sed redct (tons)	cost avg ann ($)	onsite avg ann ($)	off-site avg ($)	total avg ann ($)	net avg ann ($)
Existing	33	---	---	---	---	---	---	---	---	---
A	15	18	8	5	15	98	22	111	133	35
B	14	19	4	3	17	493	33	494	527	34
C	9	24	5	6	23	1,978	44	1,932	1,976	–2
D	5	28	4	5	25	2,450	55	2,402	2,457	7
E (eliminated in Stage I)										
F (eliminated in Stage I)										
G (eliminated in Stage I)										

(e) Incremental analysis procedures for land treatment

Although incremental analysis is normally equated with water resource projects, it is equally well suited to formulation in watershed protection projects. Incremental analysis for watershed protection projects involves the same conceptual basis as that in water resource project planning.

Incremental analysis is a process of formulating solution alternatives to determine the combination of alternatives that maximizes net benefits. This can be done in one of two ways:

- Plan elements are added to a plan until the added costs exceed the added benefits.
- The elements are deleted from a plan until the reduction in benefits exceeds the reduction in costs.

An accurate analysis results only if the elements are added in decreasing order of efficiency or deleted in increasing order of efficiency. The key is as long as total net benefits continue to increase, additional elements should be added to the system.

(1) Incremental analysis steps

The following steps describe the accepted procedure for incremental analysis of land treatment measures for watershed protection projects.

Step 1 Make a list of all practices that can reduce the identified problem. Determine the costs and benefits of each. Evaluate one practice at a time as the only applied practice.

Step 2 Select as the first increment the practice that gives the highest benefits per dollar of costs from the array analyzed.

Step 3 Evaluate the remaining practices, in combination with the first practice selected, as they alleviate the remaining problem.

Step 4 Select the system of two practices that gives the highest incremental benefits per dollar of costs.

Step 5 Repeat steps 3 and 4 (beginning the evaluation with the selection just made) until all practices have been included that will provide positive net incremental benefits.

Independent increments (practices) should be added systematically in order of the greatest return per dollar of cost and contribution to identified problems. Examples 3–2 and 3–3 illustrate the steps in incremental analysis.

Example 3–2 Incremental analysis using benefit to cost ratio

Given: This incremental analysis uses the benefit to cost ratio as a decision criterion.

Problem:

Step 1 A 160-acre field, typical of the evaluation unit, has a problem of reduced long-term productivity as evidenced by reduced yields associated with an erosion loss of 30 tons per acre per year. Within this field, 15 acres of land sustains damage from small ephemeral gully formation, 5 acres is affected by large ephemeral gullies, and 900 cubic yards of the eroded soil material is being deposited as sediment in boundary line ditches thus reducing their capacity.

The monetary damage associated with sheet and rill erosion is estimated to have a present value of:

- $300 per acre during the evaluation period
- $100 per acre small ephemeral gully damage
- $65 per acre large ephemeral gully damage
- $55 per acre sediment problem

Caution: The monetary damages must be expressed in similar terms and per acre of the evaluation unit. In this example, present value amounts are used for damages, benefits, and costs. The example incremental analysis is shown in table 3–8.

Step 2 All large ephemeral gullies in this example can be treated with land treatment practices; they do not require water control structures to effect control. As a result, the incremental analysis procedure can account for all the costs and benefits that would occur in treating all causes of the identified problems. If large gullies were present, their treatment would be evaluated and their feasibility determined separately using procedures for evaluating voiding and depreciation (see 611.0204(b)).

Solution:

Step 3 The first iteration in table 3–8 shows the incremental effect, both physical and monetary, of each practice separate of other practices. The incremental benefits range from $93 for grass waterways to $353 for the interdependent system of terraces and grassed waterway outlets. The decision criteria for land treatment incremental analysis is return per unit of cost as shown in the column headed **B:C ratio.** The largest return per dollar of expenditure in this iteration is $9.30 for conservation tillage. Conservation tillage as an applied practice then becomes the starting point for iteration 2.

Step 4 The first line of iteration 2 in table 3–8 displays the extent of the problem that would remain following conservation tillage adoption. The remaining entries in this iteration are conservation tillage plus the remaining separate practices. Selection of the second incremental practice is again made on the basis of the B:C ratio column, in this iteration grassed waterways.

Step 5 The iterative process is continued so long as the result is a B:C ratio larger than 1.0.

Example 3–2 Incremental analysis using benefit to cost ratio—Continued

Step 6 The incremental combining of practices based on the optimum per unit of cost from each successive iteration results in the NED plan. In this example, the NED plan is a system that includes conservation tillage, grassed waterways, contour farming, and stripcropping practices. The new NED benefit in present value amount is $265 ($165+52+35+13) per acre of the evaluation unit.

Step 7 A resource protection plan for this evaluation would require terracing in addition to the four practices in the NED plan. The net benefits of this plan would be $211 NED benefits plus the environmental quality or other social effects necessary to offset the $54 ($265-211) of excess NED costs.

Step 8 Table 3–8 should be completed for each evaluation unit in the project.

Table 3–8 Incremental analysis for land treatment for treatment unit 2

Conservation system or practice	Sheet and rill				Small ephemeral gullies				Large ephemeral gullies				Sediment				Inc ben	Inc cost	B:C ratio	Inc net bem
	erosion		damage		erosion		damage		erosion		damage		erosion		damage					
	remain (ton)	reduct (ton)	remain ($)	reduct ($)	remain (ac)	reduct (ac)	remain ($)	reduct ($)	remain (ac)	reduct (ac)	remain ($)	reduct ($)	remain (yd^3)	reduct (yd^3)	remain ($)	reduct ($)	($)	($)		($)
Iteration #1																				
No treatment	30		300		15		100		5		65		900		55					
Cons. till	15	15	150	150	13	2	86	14	5	0	65	0	560	340	34	21	185	20	9.3	165
Contour	22	8	220	80	11	4	73	27	5	0	65	0	675	225	41	14	121	30	4.0	91
Strip crop	18	12	180	120	10	5	66	34	5	0	65	0	610	290	37	18	172	50	3.4	122
Terrace/W	12	18	120	180	3	12	20	80	1	4	13	52	225	675	14	41	353	170	2.1	183
Waterway	30	0	300	0	15	0	100	0	0	5	0	65	450	450	27	28	93	30	3.1	63
Iteration #2 1/																				
CT	15		150		13		86		5		65		560		34					
CT/CF	11	4	110	40	10	3	66	20	5	0	65	0	400	160	24	10	70	30	2.3	40
CT/SC	8	7	80	70	9	4	59	27	5	0	65	0	360	200	22	12	109	50	2.2	59
CT/TERR	7	8	70	80	2	11	13	73	1	4	13	52	140	420	9	23	228	170	1.3	52
CT/W	15	0	150	0	13	0	86	0	0	5	0	65	270	290	17	17	82	30	2.7	52
Iteration #3																				
CT&W	15		150		13		86		0		0		270		17					
CT&W/CT	11	4	110	40	10	3	66	20					200	70	12	5	65	30	2.2	35
CT&W/SC	8	7	80	70	9	4	59	27					180	90	11	6	103	50	2.1	53
CT&W/TERR	7	8	70	80	2	11	13	73					68	202	4	13	166	140	7.2	20
Iteration #4																				
CT&W&CF	11		110		10		66		0		0		200		12					
CT&W&CF/SC	7	4	70	40	7	3	47	19					135	65	8	4	63	50	1.3	13
CT&W&CF/TERR	4	7	40	70	2	8	13	53					50	150	3	9	132	140	.9	-8
Iteration #5																				
CT&W&CF&SC	7		70		7		47		0		0		135		8					
CT&W&CF&SC/TERR	3	4	30	40	1	6	7	40					35	100	2	6	86	140	.6	-54

1/ Abbreviations:

CT	Conservation tillage
CF	Contour farming
SC	Stripcropping
TERR	Terrace with waterways
W	Grassed waterways
Inc	Incremental
ben	Benefit

Example 3–3 Incremental analysis using net benefits per acre

Given: Net benefits per acre is the decision criteria.

Solution: Table 3–9 gives the results of this evaluation.

Table 3–9 Incremental analysis using net benefits per acre as decision criteria

Practice	Present erosion rate (tons/ac)	Remaining erosion w/practice (tons/ac)	Soil savings (tons/ac)	Costs per ac ($)	Benefits per ac ($)	B:C ratio	Net benefits per ac ($)
First increment							
CCS	30	25	5	3	11	3.7	8
CF	30	27	3	2	6	3.0	4
SC	30	20	10	15	22	1.5	7
CT	30	25	5	3	10	3.3	7
NT	30	10	20	35	42	1.2	7
Terr	30	5	25	60	66	1.1	6
Seed out	30	2	28	210	76	0.4	-134
Second increment							
CCS +							
= CF	25	23	2	2	4	2.0	2
= SC	25	15	10	15	21	1.4	6
= CT	25	19	6	3	12	2.4	7
= NT	25	8	27	35	41	1.2	6
= Terr	25	2	23	60	64	1.1	4
Third increment							
CCS + CT +							
= = CF	19	17	2	2	4	2.0	2
= = SC	19	11	8	15	24	1.6	9
= = NT	19	8	21	35	41	1.2	6
= = Terr	19	2	27	60	64	1.1	4
Fourth increment							
CCS + CT + SC =							
= = = CF	11	11	2	2	3	1.5	1
= = = NT	11	4	17	35	32	.9	-3
= = = Terr	11	2	19	60	58	.9	-2

Remaining erosion = 9 tons/acre

abbreviations:

CCS	Contour crop system	CT	Conservation tillage
CF	Contour farming	NT	No till
SC	Strip Crop	Terr	Terraces

(f) Cost effectiveness and least cost analysis

Generally, any conservation practice selected for installation should satisfy the requirement that it not be more costly than any reasonable alternative means of accomplishing the same specified objective. Cost effectiveness and least cost analysis can be used to meet this requirement in watershed protection projects. Cost effectiveness is described in section 611.0301(d).

Least cost analysis is similar to cost effectiveness analysis. However, it involves situations where there is a specific goal and the objective is to find the lowest total cost practice(s) for meeting that goal. An example goal is to reduce sediment entering a lake by 200 tons per year.

(g) Land treatment watershed data needs

Typical data needs for a land treatment economic evaluation of the benefits and costs of conservation measures for erosion and sediment control on cropland are:

- Project discount rate
- Participation rate
- Evaluation period
- Installation schedule
- Period of analysis
- Acceptable conservation measures
- Cost per acre of conservation measures
- Total acres in evaluation unit
- Annual operation, maintenance, and replacement cost
- Acres of erosion types and erosion rates; present, future without, and future with:
  - — Perennial or headcutting gully, voided and depreciated area
  - — Ephemeral gully, voided and depreciated area
  - — Sheet and rill area
- Yield factors for depleted and depreciated acre
- Cost of production for each crop; present, future without, and future with
- Crop yields; present, future without, and future with
- Percent or acreage of each crop in rotation; present, future without, and future with
- Now-time damage

Chapter 4 Urban Flood Damage

Contents:

611.0400	**Introduction**	**4–1**
611.0401	**Planning**	**4–1**
611.0402	**Damage factors**	**4–2**
611.0403	**Income losses and emergency costs**	**4–3**
	(a) Income losses	4–3
	(b) Emergency costs	4–3
611.0404	**Commercial and industrial**	**4–3**
611.0405	**Transportation**	**4–4**
611.0406	**Other damage values**	**4–4**
611.0407	**Benefit evaluation**	**4–5**
611.0408	**Display requirements**	**4–6**
611.0409	**Computer program**	**4–7**
611.0410	**Flood damage schedules**	**4–7**
	Appendix 4A—Blank forms for determining urban flood damage	**4–9**
	Appendix 4B—Flood insurance damage tables	**4–17**

Table	**Table 4–1**	Reach no. 4, Hooper Creek damages resulting from floods of different sizes and frequencies	4–2

Chapter 4 Urban Flood Damage

611.0400 Introduction

Urban flood damage evaluation is another application of the flood damage analysis presented in chapter 2, section 611.0201. The evaluation of urban flood damage involves analysis of the physical damage caused by floodwater and net income effects of modifications of flood plain activities, both existing and introduced. National economic development (NED) benefit evaluation procedures in Principles and Guidelines (P&G) Section IV provide the framework for evaluating urban flood damage.

611.0401 Planning

The evaluation of flood prevention projects involves comparison of without-project and with-project conditions.

The without-project condition is the land use and related condition most likely to occur under existing improvements, laws, and policies. Evaluation of the without-project condition must consider existing and authorized plans. It must also consider possible effects of the Flood Disaster Protection Act and Executive orders on flood plain management and wetlands protection, as well as individual actions of flood plain occupants.

The with-project condition is the most likely condition to occur if a specific project is undertaken. There are as many with-project conditions as there are alternative projects.

The magnitude of urban flood damage is defined in terms of damages to residential, commercial, industrial, and governmental occupants of the flood plain. Urban flood damage includes:

- Physical damage to buildings and their contents
- Losses sustained by infrastructure supporting the urban area
- Income loss by individuals and businesses
- Emergency costs necessitated by the flooding.

Income losses need to be adjusted to account for activities that are postponed or transferred. Emergency costs should exclude normal operations of such organizations as police and fire departments.

611.0402 Damage factors

Damage factors express the relationship between structure damage and the value of the structure or content damage and the value of contents of a structure. Because damage to structure and damage to contents vary with the depth of the flood water, they are stated with reference to specific flood stage above the level at which damage begins.

The extent to which damages to residences varies by type of construction or the style of structure dictates the number of damage factor tables that may be required in an evaluation. For example, where the damage to frame construction differs from damage to brick construction, damage tables must be developed for each of them. Where damages differ among one-story, two-story, and split level residences, damage tables must reflect each style. The multidimensional matrix (depth, type, style) dictates the number of damage factors needed.

While records on historical flooding in the project area may reflect the type and style of houses, they most likely will not represent the various floodwater depth increments. Because of this, standard damage factor tables have been developed by the Corps of Engineers, Flood Insurance Agency (see damage tables in appendix 4B), Stanford Research Institute, and NRCS. Interviews with occupants of the project area are used to confirm or adjust standard tables to the project area. A summary of these interviews should be included in the Investigation and Analysis Report for the project plan. OMB approved forms must be used for data collection (see appendix 4A).

Damage factors must be developed by house type and style because these variables have a large influence on calculated damages. Damage factors are then input to URB1 computer program damage coefficient (CORDAMG) tables for each house type and style by stage. Damage coefficient tables use house type and style, value, flood stage, and damage factors as input.

A picture of the flood plain, and the properties within it, in the form of a water surface profile sheet is helpful to the economist. The sheet should show:

- Stream profile
- Each cross section
- All culverts, bridges and other constrictions
- The 100-year water surface profile
- Each property on the flood plain showing first floor elevation, elevation at which water enters the building, and ground elevation
- Water surface profiles for the various alternatives under consideration.

The horizontal scale should be such that the damage area can be shown on one or two sheets. The vertical scale should be of sufficient magnitude to permit easy reading of water depths above the level at which damage begins for individual buildings.

A stage-damage relationship can now be compiled. Total the damage to all properties at a progressively higher flood stage. Separate relationships should be compiled for residential, commercial, industrial, utility, and transportation categories. An example of a stage-damage curve is shown in chapter 2, figure 2–5. Table 4–1 shows the summation of damage data for various flood depths and related storm frequencies.

Table 4–1 Reach no. 4, Hooper Creek damages resulting from floods of different sizes and frequencies [1/]

Flood stage in relation to flood of 6/15/65 (ft)	Peak damage ($)	Discharge (ft^3/s)	Chance of occurrence [2/] (%)
+ 2	1,000,000	4,200	< 1
+ 1	720,000	3,450	< 1
6/15/65	410,000	2,800	1.4
– 1	110,000	2,000	3.2
– 2	10,000	1,500	6.0
– 3	0	1,200	7.5

1/ The procedures illustrated by this table are useful when two conditions exist:
- Damages to which estimated values apply are normally restored between flood events.
- Such damages are only minimally affected by season in which the flooding occurs.

2/ Change of occurrence may be expressed in several ways, each of which may be converted to the other. The term used here should be interpreted to mean the percent chance of a given peak discharge being equaled or exceeded in any one year.

611.0403 Income losses and emergency costs

(a) Income losses

Income loss cannot be based solely on an estimate of physical damage. Interview data are required to estimate income loss resulting from floodwater damages.

(b) Emergency costs

Emergency costs cannot be based on an estimate of physical damage alone. Interview data are required to estimate emergency costs resulting from floodwater damages.

611.0404 Commercial and industrial

Diversity of activity precludes the use of standard tables for industrial and commercial damages. Industrial and commercial activities on the flood plain require that interviews be conducted to establish damage estimates. In addition to collecting damages from recent flood events, it may be necessary to ask respondents to estimate damages from both greater and lesser flood events. OMB approved forms are to be used (see appendix 4A).

The damage factor estimate table can be used for compiling data by business type. The stage-damage relationship is compiled as described in the residential section. Data are entered into URB1 similar to house data. Data should be collected for each industrial property, utility, and transportation facility on the flood plain. If few properties are involved, the damage-frequency relationship and average annual damages may be established using hand calculations.

611.0405 Transportation

See chapter 2, section 611.0201(c)(3), for details on estimating damages to rural roads and bridges. The evaluation procedure is the same for urban transportation.

611.0406 Other damage values

Other floodwater damage includes losses that result from flooding even though the damaged property was not flooded. Some examples include:

- An electric power plant is flooded, thus power is interrupted and spoilage takes place in freezers and refrigerators.
- A bridge is washed out and traffic is forced to detour a considerable distance. Costs include an estimate of time lost, vehicle costs for commercial and business traffic, and costs for police services and traffic signs to direct traffic.
- Costs for additional spraying of stagnant pools and depressions to control mosquitoes.
- Costs to dispose of flood-damaged household goods. These costs would be in excess of normal public garbage collection services.
- Costs of unnecessary measures taken by people adjacent to a flooded area, who thought they would be flooded, but were not.

In estimating these damages, care must be taken to avoid double counting. For example, if a house is flooded and the family living there loses their clothing, this loss is a damage. The value of substitute clothing supplied by a relief agency would not be an additional damage.

611.0407 Benefit evaluation

Project evaluation requires a comparison of conditions that would exist over the evaluation period without the project and those that can be expected with the project in operation. Existing properties may deteriorate if repairs are not made following floods, and before succeeding floods occur; be maintained essentially in their current condition over the period of analysis; or be improved. These possibilities should be considered in establishing damage values in the absence of a project. In nearly every project the damage value base after project installation is different from the base at the beginning planning period. In an expanding economy the values generally increase; however, adjustments to account for development may involve either increases or decreases in damage values.

In the Frequency Method, the modified (with-project) discharge-frequency curve prepared by the hydrologist enables the economist to prepare a modified damage-frequency curve. The economist can compare this curve and the without-project curve (or original damage-frequency curve) to determine benefits. Modified curves prepared by the economist and hydrologist are necessary for each kind or combination of measure(s) being evaluated.

Flood plain management regulations must be considered when substantial improvements are expected in the future without-project situation. Regulations may require that improvements be protected from a 100-year flood event. In this case future improvements would not be subject to flood damage even without the project.

Damages to existing properties may be significantly affected by land use changes in areas outside the flood plain. For example, urbanization causes urban areas and suburban fringes to encroach upon areas now in agriculture or other low intensity use. This modifies the discharge frequency curve. As a result more severe damages to properties now subject to damage may occur and the number of properties subject to damage during the planning period may increase.

A common approach to the problem of estimating changing damages over time is to estimate the eventual degree of change and the period over which the change will occur, and then assume that the change will take place uniformly over time. This provides an annual increment of change that can be discounted to present worth and used to adjust average future conditions.

Using a simple average of current and eventual values is unsound. When damage values are increasing, the greatest value will be at the end of the period and will receive the heaviest discount. The average annual equivalent values after discounting will be less than the simple average of values. The reverse is true if damage values are declining. Also, changes over time may be neither linear nor constant. For example, it would be erroneous to project floodwater problems according to average hydrologic conditions over a 50-year evaluation period if conditions are changing during the period.

Damages and benefits should be shown by timeframes during the analysis period if it is determined that changing conditions are better represented by a shorter timeframe.

A project alternative that would provide efficient substantial improvement of existing structures is to be credited with benefits equal to the reduced cost of that improvement. Whether floodproofing costs are eliminated or reduced, the benefit to the project alternatives is the difference between the with and without condition. Flood insurance rates probably would be reduced in such a case. However, the reduction in actuarial estimates of flood damage should be accounted for in the reduced damage analysis. Reduced administrative costs may be claimed as a project benefit.

Project measures may achieve economic efficiencies by providing for orderly urban development at a lower cost than would occur without the project. If new development is to take place in the benefited area with the project installed, that development can take place at a reduced cost of floodproofing. The reduced cost of floodproofing is considered a benefit in those areas where development would have taken place in the problem area even without the project. The remaining damages that would have occurred even with the floodproofing are considered as a benefit.

If new development is expected to take place outside the benefited area without the project, cost savings made possible by locating it in the benefited area are a project benefit. The economic advantages of the flood plain location may include available transportation and communication facilities or a close proximity to associated businesses.

If primary features of a plan are included to achieve efficiencies in urban development, the extent of protection provided by the project should be determined in the economic analysis. Structural and nonstructural measures should be equally considered during the planning process. It may be assumed that new areas will be protected from the 100-year event in compliance with Flood Insurance Agency regulations whether the project is installed or not. The problem is to find the proper combination of structural measures and floodproofing or land management measures to provide for an urban development that is least costly, least damaging to the environment, and is compatible with existing law.

Exclude from benefits the beneficial effects of nonstructural measures that would exist without the project and that are not included as project plan measures. However, if nonstructural measures are part of the project, they are evaluated using the same evaluation procedure used to evaluate structural measures; that is, compare the damages with and without the project.

Costs of nonstructural measures for which benefits are claimed should include all foreseeable costs to individual owners and the public. For example, homes or businesses relocated from the flood plain may be too distant from commercial centers. The increased costs of transportation to the commercial centers for employment, shopping, and other activities should be considered. However, these costs should be limited in time to the remaining life of the commercial center. The public service left unused in the old location (schools, streets, utilities) should also be considered.

611.0408 Display requirements

Evaluation procedures, key steps, and rationale should be supported by data presented in displays and reports. Some items that must be displayed are:

- Report procedures for risk and uncertainty, which include remaining flood damages for without and with project damages that are inundated outside the protected area.
- Display summary tables and data used to develop the four accounts (NED, RED, EQ, OSE).

611.0409 Computer program

The evaluation procedures have been computerized for urban floodwater damage determination. The urban floodwater damage economic evaluation (URB1) computer program computes average annual damages to buildings and contents. The program requires data on damage factors, by flood depth, for buildings and contents of representative houses or other types of building.

611.0410 Flood damage schedules

Appendix 4A displays the approved forms for recording information collected during field investigations for residential flood damages (NRCS-ECN-2) and commercial or industrial properties (NRCS-ECN-003). Completed forms are retained in the project file as part of the supporting information for the economic evaluation. The confidential nature of the information collected from respondents in the watershed requires that their identity be protected (5 U.S.C. 522 (b)(4)). The name and location of the respondent are coded on the form. The key to the identity and location code(s) should be kept separate from the completed forms and should not be provided to others outside NRCS.

Appendix 4A Blank Forms for Determining Urban Flood Damage

NRCS-ECN-003 **Flood Damage—Commercial—Industrial** 4–11

NRCS-ECN-2 **Flood Damage—Residential Properties** 4–13

FORM APPROVED
OMB NO. 0578-0007
U. S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NRCS-ECN-003
6-84

FLOOD DAMAGE -- COMMERCIAL -- INDUSTRIAL

This report is authorized by law (PL-83-566). While you are not required to respond, your cooperation is needed to make the results of this survey comprehensive, accurate, and timely.

Watershed ______________________ State ______________ Reach ______________

Interviewer ____ Date ______________

Type of Business ______________ Address ______________ Owner ______________

Structure:

Construction: Frame ☐ Brick ☐ Metal ☐ Other (specify) ______________

Market Value (do not include land) $ ______________

Size: Basement ________ sq. ft. 1st floor ________ sq. ft. No. of floors ________

Value of Contents: (estimated) Basement $ ________ 1st floor $ ________ 2nd floor $ ________

Other $ ________

1st Floor Storage (percent stored in relation to elevation):

0.0 - 1.0 ft. ________% 1.1 - 3.0 ft. ________% 3.1 - 5.0 ft. ________ % 5.1 ft. and over ________%

Number of Employees ________ How Often Do Damaging Floods Occur? ________

Date of Flood ______________ Type of Flood Backwater ☐ Flowing ☐

Depth of Flood: Grounds: ________ ft. Basement: ________ ft. 1st floor: ________ ft. 2nd floor ________ ft.

	Estimated Damages (Dollars)			Remarks
Grounds -- Parking lots, walks, signs	X X X	X X X	$	(Loss prevented by evacuation, emergency preparations, etc.)
Lawns, shrubs	X X X	X X X		
Structure -- Foundation	X X X	X X X		
Walls	X X X	X X X		
Other	X X X	X X X		
Contents -- (Stock)	Basement	1st Floor	Other	
Merchandise	$	$	$	
Equipment				
Records				
Misc. (specify) ________				
Misc. ________				
Other -- Loss of Business	X X X	X X X	$	
Evacuation - Reoccupation	X X X	X X X		
Flood Proofing	X X X	X X X		
Employee Wages Lost	X X X	X X X		
	X X X	X X X		
Totals	$	$	$	

TOTAL LOSS FOR FLOOD $ ________

Estimated Damages at Higher or Lower Stages Than This Flood

Higher 1' S ________ 2' S ________ 3' S ________ 4' S ________ 5' S ________

Lower 1' S ________ 2' S ________ 3' S ________ 4' S ________ 5' S ________

Explanatory Notes

1. Type of Business -- Identify as retail grocery, wholesale drug, lumber yard, music store, toy manufacturing, etc.

2. Market Value of Structure -- This excludes land. Data may be from appraisers, tax records, owners.

3. Value of Contents -- Includes stock, merchandise, equipment, etc. If this varies significantly by season, indicate in Remarks. Prorate by location. Other would include outside or that stored in minor building such as lumber yards.

4. 1st Floor Storage -- Percent of contents stored related to elevation -- This should account for 100% of 1st floor contents by height stored above the 1st floor elevation.

5. Number of Employees -- This includes all full and part-time employees. If part-time, identify as such.

6. Damages - Structure -- if repairs not made, estimate damage. If repairs made other than year of flood, indicate year. Includes repainting, redecoration, etc.

7. Damage - Contents -- Other refers to contents stored outside major buildings. Misc. would include such things as clean-up.

8. Damage - Other -- Evacuation-reoccupation includes moving goods, temporary space leased, etc. Wages lost would be for employee time in which pay was not received.

9. Estimated Damage at Higher or Lower Stages -- This to be completed by interviewer, owner, or both.

10. Remarks -- Use to clarify any data obtained or additional information not specifically covered.

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NRCS-ECN-2
4-94

FORM APPROVED
OMB NO. 0578-0007

FLOOD DAMAGE - RESIDENTIAL PROPERTIES

OMB DISCLOSURE STATEMENT

Public reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Agriculture Clearance Officer, OIRM, AG Box 7630, Washington, D.C. 20250-7630; and to the Office of Management and Budget, Paperwork Reduction Project (OMB NO. 0578-0007), Washington, D.C. 20503.

This report is authorized by law (PL-83-566). While you are not required to respond, your cooperation is needed to make the results of this survey comprehensive, accurate and timely.

Watershed	State	
Reach	Interviewer	Date
Occupant		
Address	Years lived here	
Times residence flooded*	Dates	

Specific Flood Event Information

Date of specific flood event	Hours of advance warning received
Depth of water in basement	

Describe source of floodwater (through windows, walls, basement drains, etc.)

Depth of water on or about first floor

Depth of water on ground or lawn

Depth of water in garage

Depth of water in other buildings

Depth of water in automobiles

Location of automobiles when flooded

Depth below the above flood at which damages begin

* No.-Number of times this house has been flooded since you have lived in it.
Dates-Month, day, and year of all damaging floods mentioned

FLOOD DAMAGE - RESIDENTIAL PROPERTIES - APPRAISAL								
Item 1/ Specific Flood Event	Stages above and below specific flood event							
	Specific Flood Event							
	Extent of Damage 2/ (Dollars - Specify price base if different from flood year)							
Structure - House								
Outbuildings								
Driveways and walks								
Contents - Basement Furniture								
Appliances								
Personal belongings								
First Floor Furniture								
Appliances								
Personal belongings								
Lawn								
Vehicles								
Cleanup (Lawns, driveways, basement, floors, etc.)								
Other (specify)								
Subtotal - Direct Damages								
3/ Indirect Damages Emergency measures of evacuation, etc.								
4/ Loss of income								
5/ Other (specify)								
Subtotal - Indirect Damages								
Total Damages								
6/ Size of residence, square feet:	7/ Market value of residence (do not include lot) $				8/ Replacement value of contents $			

Remarks:

This standard drawing is intended to be used in numerous ways. Any use that can be made of this drawing that serves the enumerator's purpose should be shown. Any penciled modifications, as necessary, should be made.

Class and type of structure (check one)	-	Check the one block which most accurately describes this residence. If the "other" block under "Type" is checked, specify, by footnote, what this "other" refers to.

FLOOD DAMAGE - RESIDENTIAL PROPERTIES - APPRAISAL

Item	Specific Flood Event and Dates of Stages Above and Below							
	Specific Flood Event							
	Extent of Damage (Dollars)(Specify price base if different from flood year)							
Structure - House								
Outbuildings								
Driveways and walks								
Contents - Basement: Furniture								
Appliances								
Personal belongings								
First Floor: Furniture								
Appliances								
Personal belongings								
Lawn								
Vehicles								
Other (specify)								
Cleanup (Lawns, driveways, basement, floors, etc.)								
Subtotal - Direct Damages								
Emergency measures of evacuation, etc.								
Loss of income								
Other (specify)								
Subtotal - Indirect Damages								
Total Damages								

Size of residence ______________________________ sq. ft.

Market value of residence (do not include lot) $ ______________________________

Replacement value of contents $______________________________

Remarks:

Appendix 4B Flood Insurance Damage Tables

(The following tables can be used to identify damages to structures and contents of houses and small businesses. Estimate the value of the building and contents, then multiply the value by the percent damage relative to the depth of water.)

FEDERAL INSURANCE ADMINISTRATION
DECEMBER 1970
Depth Percent Damage Curves
SET III
STRUCTURE-RESIDENTIAL AND SMALL BUSINESS
Damage Begins at 6 Feet Below the First Floor

Depth in feet	Code number 01:12	03:12	05:12	60:12	15:12A*	20:12A*	25:12A*	10:12
	Damage in % of total value							
8								
7								
6				0	0	0	0	
5				30	13	10	11	
4				42	14	12	13	
3				48	15	13	14	
2				50	16	14	14	
1	0	0	0	54	18	15	15	
0 (first floor)	7	5	4	60	20	17	18	0
1	26	12	13		29	20	21	10
2	36	19	24		37	25	26	60
3	42	24	30		44	31	31	85
4	47	29	35		49	36	36	90
5	49	32	37		53	40	38	90
6	53	36	40		55	42	42	90
7	55	38	41		58	46	43	
8	58	41	49		59	48	53	
9	60	47	60		60	53	58	
10	60	50	64		60	55	62	
11		54	66			56	66	
12		56	70			58	68	
13		59	71			59	71	
14		60	72			60	72	
15		60	72			60	72	
16		60	72			60	72	

Classification	**Code no.**
One story, no basement	01:12
Two or more stories, no basement	03:12
Split level, no basement	05:12
All basement	60:12
One story, with basement	15:12A
Two or more stories, with basement	20:12A
Split level, with basement	25:12A
Mobile home on foundation	10:12

* A denotes improved basement

FEDERAL INSURANCE ADMINISTRATION

DECEMBER 1970

Depth Percent Damage Curves

SET III

CONTENTS-RESIDENTIAL

Damage Begins at 6 Feet Below the First Floor

Depth in feet	Code number 27:12	29:12	33:12	31:12	43:12	48:12	53:12	58:12	38:12
	Damage in % of total value								
8									
7									
6					0	0	0		
5					72	10	10	0	
4					82	16	11	10	
3					89	17	14	12	
2					94	18	15	12	
1	0	0	0	0	94	20	16	18	0
0 (first floor)	6	5	2	1	94	25	16	22	4
1	42	19	23	4		48	26	37	36
2	60	34	38	5		70	41	53	67
3	72	44	49	6		84	52	62	86
4	82	52	56	7		91	58	70	94
5	89	56	61	7		94	61	73	94
6	94	59	64	7		94	62	76	94
7	94	60	66	7		94	64	77	
8	94	61	67	8			67	79	
9	94	66	75	12			71	83	
10		70	83	28			77	88	
11		78	90	56			85	91	
12		86	94	77			91	94	
13		94	94	89			94	94	
14		94	94	94			94		
15		94	94	94			94		
16									
17									
18									

Location	**Code no.**
All on first floor	27:12
All on first two or more floors	29:12
All in split level, w/o basement	33:12
All above first floor	31:12
All in basement	43:12
All on first floor and basement	48:12
All on first two or more floors w/basement	53:12
All in split level, w/basement	58:12
Mobile home, on foundation	38:12

FEDERAL INSURANCE ADMINISTRATION

DECEMBER 1970

Depth Percent Damage Curves

Sets I, II, III

CONTENTS-SMALL BUSINESS

All on First Floor and Above

	Code number					
	Set I		Set II		Set III	
	72	73	72:08	73:08	72:12	73:12
Depth in feet	Damage in % of total value					
First 0.0 Floor	0	0	0	Same	0	Same
0.1	1.5	100	1.2	as	1.8	as
0.2	3	100	2.4	Set I	3.6	Set I
0.3	5		4	Code 73	6.0	Code
0.4	6		4.8		7.2	73
0.5	9		7.2		10.8	
0.6	11		8.8		13.2	
0.7	14.5		11.6		17.4	
0.8	16.5		13.2		19.8	
0.9	19		15.2		22.8	
1.0	22		17.6		26.4	
1.1	24.5		19.6		29.4	
1.2	27.5		22		33	
1.3	30.5		24.4		36.6	
1.4	34		27.2		40.8	
1.5	37		29.6		44.4	
1.6	41		32.8		49.2	
1.7	46		36.8		55.2	
1.8	50		40		60	
1.9	54.5		43.6		65.2	
2.0	59		47.2		70.8	
2.1	63		50.4		75.6	
2.2	67.5		54		81	
2.3	72		57.6		85.4	
2.4	76.5		61.2		91.8	
2.5	81		64.8		97.2	
2.6	85		68		100	
2.7	88.9		71.1		100	
2.8	92.5		74			
2.9	96.5		77.2			
3.0	100		80			
3.1			82.1			
3.2			85.3			
3.3			87.8			
3.4			90.2			
3.5			92.5			
3.6			94.7			
3.7			96.8			
3.8			98.8			
3.9			100			
4.0			100			

Location	**Code no.**
All on First Floor and Above - slight susceptibility	72
All on First Floor and Above - slight susceptibility	72:08
All on First Floor and Above - slight susceptibility	72:12
All on First Floor and Above - high susceptibility	73
All on First Floor and Above - high susceptibility	73:08
All on First Floor and Above - high susceptibility	73:12

Chapter 5 Selected Evaluation and Benefits Procedures

Contents:

611.0500	**Recreation benefits**	**5–1**
	(a) Definition of concepts	5–1
	(b) Planning	5–2
	(c) Evaluation methods	5–2
	(d) Recreation evaluation procedures	5–2
	(e) Basic data	5–3
	(f) Unit day value method	5–3
	(g) Incremental analysis	5–5
	(h) Reporting benefits	5–5
611.0501	**Municipal an industrial water supply**	**5–6**
	(a) Evaluation responsibilities	5–6
	(b) Analysis	5–6
611.0502	**Other direct benefits**	**5–8**
	(a) Direct effects	5–8
611.0503	**Employment benefits**	**5–10**
	(a) Background	5–10
	(b) Evaluation procedures	5–10
611.0504	**Regional benefits**	**5–10**
	(a) Income benefits	5–10
	(b) Employment benefits	5–11
	(c) Induced or indirect impacts	5–11
	(d) Relationship between NED and RED effects	5–11
611.0505	**Land, easements, and rights-of-way**	**5–12**
	(a) Landrights	5–12
	(b) Methods of estimating values	5–12
	(c) Economic evaluation	5–13
	Appendix 5A—Blank worksheets and forms	**5–15**

Figure

Figure 5–1 Consumer surplus for a recreation trip by a typical consumer 5–1

Example

Example 5–1 Other direct benefits 5–9

Chapter 5 — Selected Evaluation and Benefits Procedures

611.0500 Recreation benefits

Guidelines are presented for selecting an appropriate technique for valuing recreation benefits. However, the evaluator must carefully consider the implications of methodological assumptions, potential sources of bias, and such factors as site quality, location, and availability on these estimates. The evaluator should compare value estimates obtained from studies using each of the techniques to check for reliability and consistency.

Absence of a standard approach to the estimation of the economic value of recreation poses problems for a recreation benefit analysis. The three methods described in Principles and Guidelines (P&G) Section 2.8.1 may be used to determine an economic value for recreation activities and resources. They are the travel cost method (TCM), contingent valuation method (CVM), and unit day value method (UDV). Any one of the three may be used; however, because of the complexity and data requirements of the TCM and CVM, the UDV method is recommended for Natural Resources Conservation Service (NRCS) projects. This method is summarized in this chapter.

The recreation value estimates obtained using the following techniques must be qualified as being constrained by income of users, availability of leisure and other variables, and pertain only to the in situ value of these opportunities. Significant psychological values associated with the preservation of recreation resources and the ecological value of preserving natural resources are not accounted for in these estimates.

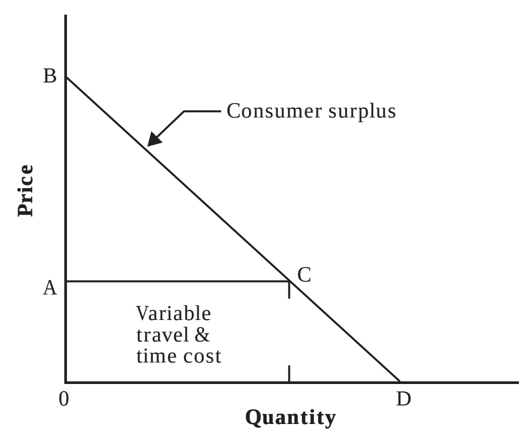
(a) Definition of concepts

Consumer surplus—That value above and beyond what the consumer is willing to pay (fig. 5–1).

Willingness to pay as a measure of benefits—P&G specifies that the value of increased output of goods and services is to be measured in terms of willingness of users to pay for each increment of output provided rather than go without it. Willingness to pay includes entry and use fees actually paid plus an estimate of the additional amount, in excess of these charges, that users could be willing to pay (consumers surplus) rather than forego the opportunity to recreate. Payments for costs associated with recreation, such as equipment, food, travel, or lodging that may be made in conjunction with the recreation experience, are not appropriate to include because these payments are not specifically for use of the site.

Consideration of recreation gains and recreation losses—Evaluation procedures must account for recreation gains and also for recreation losses that may occur as a result of the project. For example, recreation gains obtained as an increase in water recreation at a reservoir may be at the expense of stream-based recreation occurring before the construction and recreation use displaced from existing recreation facilities. Net recreation benefits are the difference between the value of the recreation opportunities gained and the value of the recreation opportunities displaced. The net value may be positive or negative.

Figure 5–1 Consumer surplus for a recreation trip by a typical consumer 1/



1/ The area ACD0 is the amount that the consumer is willing to pay. The area ABC is defined as the area of the demand curve that consumers are not willing to pay.

(b) Planning

(1) With and without-project concept

Changes in recreation use and value associated with alternative plans should be determined by analyzing the with- and without-project conditions. The with-project condition is the pattern of recreation activity expected throughout the period of analysis with a recreation plan or project. The without-project condition provides the basis for benefit determination of the with-project condition. The without-project condition includes existing water and related land recreation resources, and recreation resources being developed or most likely to be developed during this period in the absence of the project.

(2) Criteria for recreation valuation procedures

To provide for the efficient allocation of resources, procedures for estimating the contribution of recreation to national economic development should meet the following criteria:

- The evaluation should be based on an empirical, objective, and reproducible estimate of demand applicable to the particular project.
- Estimates of value should be consistent with, and have a level of precision similar to, the estimates of value derived for other goods and services produced by the project.
- Procedures should be readily applicable to evaluating proposed changes in specific recreation opportunities affected by the project being analyzed. This includes opportunities most likely to be created or eliminated by alternative plans.
- Estimates of recreation demand should reflect socioeconomic characteristics of market populations, qualitative characteristics of resources under study, and characteristics of existing alternative recreation opportunities.
- Value estimates for existing recreation opportunities are useful if the analysis is used to value a proposed change in the availability of similar opportunities. Valuation procedures should be readily applicable to proposed alternatives involving recreation of differing qualities for which there may be a range of available substitutes and potential users.
- Individuals who have access to a range of highly desirable recreation alternatives presumably are less willing to pay for use than individuals with fewer and less desirable alternatives. Consequently, the values derived should reflect the availability of a number of alternatives.
- The underlying determinant of recreation value should be willingness to pay projected over time.

(c) Evaluation methods

P&G identifies three evaluation methods: Travel Cost Method, Unit Day Value Method, and Contingent Valuation Method. To determine the appropriate method, see pages 68 and 69 of the P&G.

The Unit Day Value Method is used for most NRCS projects unless:

- An available regional recreation model may be applicable to the project.
- Specialized recreation activities are involved.
- Estimated annual use exceeds 750,000 visitors.
- Annual Federal recreation costs exceed $1,000,000.

The Travel Cost or Contingent Valuation Methods can be used where they are possible, suitable, and cost effective in the planning process.

(d) Recreation evaluation procedures

The evaluation procedures provide the basis for estimating recreation use and value and for computation and display of recreation benefits. The P&G outlines four approaches for estimating recreation use for with-project and without-project conditions. They are regional use of estimating models, site-specific use estimating models, application of information from a similar project, and capacity method of determining use. Use of any other method should conform to characteristics listed in P&G section 2.8.2(b). Estimates of use should include the following information:

- Delineation of the market area from which most users will originate
- Estimates of the socioeconomic characteristics of the market, including the area's population and per capita participation rates
- Evaluation of the quality (attractiveness) of the proposed site in comparison to the quantity and quality of similar recreational alternatives available to the population of potential users

- Estimates of changes in use at existing recreation sites
- Projected population growth to support benefit estimates that include a buildup over time

(e) Basic data

(1) Sources of data

Several different methods are available to estimate recreation use. State staffs may use, for example, the Statewide Comprehensive Outdoor Recreation Plan (SCORP), which frequently provides useful information on visitations, participation rates, population, inventory of sites and facilities, and projected demand. Useful contacts for information are the state or local agency responsible for recreation planning, state university extension specialists or professors who specialize in resource economics, and cooperating agencies, such as the Forest Service, Fish and Wildlife Service, Corps of Engineers, National Park Service, or Bureau of Reclamation. In addition, the U.S. Census Bureau has population data that can be arrayed by origin areas with respect to any given point, such as comparable recreation sites.

(2) Problems in estimating recreation use

The common pitfalls to avoid in estimating recreation use are double counting activities, failure to consider the availability of substitute sites, and assuming that recreation use will automatically equal capacity of physical facilities.

When total use estimates are aggregated from specific activity data, double counting should be avoided because many users engage in more than one activity. One way to avoid double counting is to estimate the total recreation use and then disaggregate to specific activities. Another way is to sum estimates of use by activity and then divide by an empirically based factor of multiple daily activities.

Lack of consideration of possible shifts from existing facilities is a common problem in recreation evaluation. If recreation use at a proposed reservoir results in less use of existing reservoirs, the loss in value at existing reservoirs must be subtracted from the value of use at the proposed site to derive the net increase in national income benefits. This is only necessary if the method chosen to estimate use does not account for substitute sites. Regional use estimator models generally include this adjustment. Planners making estimates of use at the proposed site must address this problem and evaluate what is most likely to happen at existing sites considering the determinants of future net recreation demand for the proposed site; i.e., number and quality of sites, distance, and population. The same process is to be used for projects without reservoirs.

The third problem arises where the planner assumes that physical facilities always generate recreation demand. This problem can be avoided by making a sound analysis of recreation demand in the market area and documenting all cases where excess demand is found to exist. Otherwise, recreation use should be developed using a site specific or similar project use estimating model, as described in the P&G.

The NRCS recreation policy in the General Manual gives additional details and guidance for estimating recreation use.

(f) Unit day value method

(1) Advantages

(i) Size of benefits and nature of activities**—**Of the three methods P&G recognized for estimating recreation value, the Unit Day Value (UDV) procedure has been most commonly used in NRCS. This is because of the typical size of recreation benefits created or displaced and the nature of activities affected by NRCS assisted projects. It is the recommended method for NRCS activities. (P&G Section 2.8.2 should be consulted to determine if other methods may be used.)

(ii) Easiest to use**—**The UDV method is considered to be the easiest to construct of the three available methods. This method relies on expert judgment to approximate the average willingness to pay (WTP) for recreation activities. The estimates are theoretically consistent to the maximum WTP per day for the current number of annual days of recreation at the site as estimated using the contingent valuation methodology. The UDV values also correspond to consumer surplus values defined as the area under an ordinary demand curve and above the price line.

(2) Disadvantages

The more common criticisms of UDV are:

- Ranges of values per user day for generalized and specialized recreational experience have no empirical basis.
- Separate use estimates associated with UDV often fail to account for the determinants of recreation demand, such as substitute sites and cost of participation.
- Even though the UDV method is easy to use and does not require extensive primary data like the other methods, the P&G values for generalized and specialized recreational activities in this method were initially based on a survey of entrance fees at private recreation areas in 1962 and may not adequately reflect current WTP estimates. To compensate for this, you must make appropriate use of studies for preferences, user satisfaction, and willingness to pay for different characteristics influencing the recreation experience. When studies are used, particular efforts should be made to use estimates derived elsewhere from applications of the TCM and CVM techniques to support the value selected. Also, where data or use-estimating models are available, the travel cost method should be considered, particularly for larger recreation developments and where recreationists could be expected to come from more distant locations.

(3) Unit day value range

The ranges of unit day values for fiscal year 1982 published in the P&G are:

- General recreation $1.60 – $4.80
- Specialized recreation $6.50 – $19.80

General recreation refers to a recreation day involving primarily those activities that are attractive to the majority of outdoor users and that generally require the development and maintenance of convenient access and adequate facilities. Examples include swimming, picnicking, and fishing.

Specialized recreation refers to a recreation day involving activities where opportunities in general are limited, intensity of use is low, and a high degree of skill, knowledge, and appreciation of the activity by the users may often be involved. Whitewater boating and inland salmon fishing are examples.

The values given in the P&G are to be updated annually in proportion to the change in the consumer price index from the July 1982 base value.

Selecting a specific unit value from the unit day values range may be difficult. One means of solving the problem is to use the point assignment matrix in the P&G (pages 85-86) where specific criteria and standards are applied to the proposed project.

(4) Point rating system

The UDV point rating system systematically evaluates the proposed project in terms of generally accepted criteria and judgment factors that reflect relative values, thus serving as a proxy for willingness to pay by recreationists. The criteria and their relative weights as included in the P&G are:

- Recreation experience 30
- Availability of opportunity 18
- Carrying capacity 14
- Accessibility 18
- Environmental quality 20

Recreation experience means the number and quality of the activities available at the site. The *availability of opportunity* measures the substitutes at various travel time distances that may be available to the recreationist. More alternate opportunities would generally mean less willingness to pay for the site being evaluated. *Carrying capacity* refers to facilities available at the site. *Accessibility* means the extent of roads and access to the site and within the site. *Environmental quality* criteria are used to measure the esthetic factors, such as water, vegetation, geology, and topography.

Specialized recreation uses the same criteria and similar judgment factors. However, the recreation experience criterion places a premium on the absence of crowding and interference by others.

Proper application of the point assignment method requires a clear specification of the development being evaluated. Independent reviewers must apply the method using common information about the site, the market area, and other factors. Narrative statements by each reviewer to support judgments would be helpful documentation. The public may be involved in the value determination process, particularly where local interest is high and where unique resources are involved. The Benefit Evaluation Worksheet in appendix 5A is useful for recording individual and summary valuations.

The point assignment matrix, criteria, judgment factors, and point distribution are consistent among the major Federal water and resource agencies. Therefore, when this method is used, changes to the matrix should not be made unless approval is received. Once points have been tallied, they may be converted into dollar values using a conversion table as shown in the P&G, table VIII-3-1. The dollar values shown in the conversion table are to be updated to reflect changes in the consumer price index over time.

(g) Incremental analysis

Incremental analysis of recreation is a six-step procedure:

Step 1—Estimate recreation use for the indicated mix of recreation activities.

Step 2—Apply the point rating system recursively for each general and specialized activity. Include activities technically suitable for the site, even ones other than the local sponsors' interests. For example, camping should be considered even though local sponsors may be interested only in fishing, swimming, and picnicking.

Step 3—Estimate the costs attributable to each activity. Use standard procedures for estimating separable costs. Express costs on an annual equivalent basis comparable to the benefits being estimated.

Step 4—Convert the point rating to a dollar value and apply to the estimated recreation visitor days for each activity. Rank activities in order of highest benefit-to-cost ratio. Select the activity with the highest benefit-to-cost ratio as the first increment.

Step 5—Apply the point rating system to each of the other activities as they might each be paired with the first increment. Convert to a dollar basis and apply to estimated recreation visitor days for the paired activities. Again rank in order to the highest benefit-to-cost ratio. Select the highest as the second increment.

Step 6—Apply the point rating system for each of the remaining activities, and so on until the mix of activities is exhausted. Each iteration adds another activity to the mix as benefits are found to exceed costs.

While this 6-step procedure uses activities as increments, some economies or diseconomies of scale effects may also be evident as a result of overbuilding or underbuilding an activity.

(h) Reporting benefits

Determination of recreation benefits reported in the plan report requires careful consideration of three additional issues:

- Displaced recreation use and diminished value of current activities at the proposed site that may result from the project
- Use levels below capacity on existing waterbodies
- Discounting and annualization of recreation benefits

When recreation is a project purpose, the analyst should project the diminished recreation use resulting from physical displacement of existing recreation values. Examples include inundation by reservoirs and loss of land/water recreation through channel modification. The same procedures used in forecasting recreation use should be used to estimate possible displacement. The value of diminished use is to be determined using the method used to value the recreation experience.

The P&G states that if excess capacity for any recreation activity exists in the study area, benefits must be limited to user costs savings plus the value of any qualitative differences in recreation. Table 2.8.14-1 in the P&G should be used to reveal excess capacity.

Project benefits must be annualized using normal discounting procedures. However, recreation facilities frequently are installed well into the construction phase, so some lag in accrual of benefits is probable. Also, a typical year of recreation use and value is most likely to occur only after a buildup period.

NED benefits are the average annual value of recreation less the average annual value of adjustments for diminished use and excess capacity.

611.0501 Municipal and industrial water supply

Although the NRCS does not participate in cost sharing for municipal and industrial (M&I) water supply projects, evaluations by organizations sponsoring M&I water supply purposes are reviewed as a part of a project plan. Comprehensive evaluation procedures for M&I water supply projects are described in P&G, Section 2.2.1-14.

(a) Evaluation responsibilities

If a project provides for municipal or industrial water supply, then the sponsors must furnish an estimate of the benefits to be derived from this segment of the project. They must provide data that define the most likely condition expected in the future in the absence of the proposed water supply plan and known changes in laws and public policies.

Specific elements included in the without project conditions are:
- Existing water supplies with aging facilities and changes environmental requirements.
- Institutional arrangements that include future water systems, water management contracts, and operating criteria.
- Additional water supplies that are under construction or authorized and likely to be constructed.
- Evaluation of water quality for potential water supplies.
- Evaluation of repairs and altering demand for water.
- Modifying management of existing water development. Increase watershed management of ground and surface water.

The structural and nonstructural elements that are most likely to exist without the development of the Federal water plan must be considered in determining the future condition.

Sponsors customarily hire consulting engineers who study the water supply needs and supply alternatives (considering the yield and quality of water supply), estimate costs, evaluate expected benefits, and recommend a solution to the water supply problem.

NRCS personnel do not estimate the need for, or the benefits to be obtained from, inclusion of water supply for municipal or industrial use in a project. However, they are responsible for checking estimates provided by local organizations to ensure that benefits are realistic.

(b) Analysis

(1) Data requirements

(i) Data furnished by sponsors—Sponsoring organizations are responsible for furnishing most of the data necessary to evaluate the need for municipal and industrial water supply. This includes hydrologic, geologic, and economic information. The sponsor is responsible for estimating future demands based on population and industrial expansion and determining water use projections. The projections of water requirements should be provided in a timeframe analysis (see P&G tables 2.2.14-1, 2, and 3).

The adequacy of the sponsor's alternative plan to meet M&I water supply needs can be determined after consideration of water yield, evaporation, and seepage losses at the site of the improvement. Ordinarily, the sponsor's consulting hydrologist prepares a water budget for a critical period to make this determination.

Sources of water supply should be examined by the sponsor to determine the least costly alternative to a federally assisted plan that provides an equivalent water supply, both in quantity and quality, to a common delivery point. Normally, one of the alternatives available would be storage at the sites being considered for the federally assisted plan. The alternative cost is generally greater than M&I components of the multipurpose structure being considered.

Smaller sponsoring communities may not be able to afford development of cost estimates for alternative water supply systems. In those communities sponsors may analyze the updated cost of water supply systems in municipalities of similar size in the region and estimate alternative costs or willingness to pay using the average of those costs.

***(ii) Data accumulated by NRCS*—**NRCS must have sufficient data to fulfill its responsibility for checking estimates made by the sponsoring organizations. Determination of water yield at the site should be sufficiently accurate to provide reasonable estimates of the supply, particularly during critical periods.

Information on water supply needs and the costs and benefits from water supply developments in comparable areas provides a convenient benchmark for NRCS appraisal of estimates submitted by the sponsoring organizations.

(2) Benefit determination

Municipal and industrial water supply is considered to be economically justified if it supplies water at no greater cost than the most likely alternative source that would be used in the absence of the project. If an alternative source is not available or it is not economically feasible, benefits may be estimated by using the average cost of raw water from water supply projects planned or recently constructed in the general area or region. Therefore, the value of water is not necessarily what it costs in that specific community. If the cost becomes too high, further development is handicapped. The cost may become so excessive that it causes migration to an area where costs are lower. This is especially true of water for industrial use. Information on costs of water in similar situations is helpful in estimating the upper limit of justifiable water costs.

The sponsoring organization's estimate of benefits may include only the benefits from the multiple-purpose development. On the other hand, it may include the benefits from the entire water supply system, including facilities for storage, purification, and distribution. In all cases NRCS must ascertain what is included before it can judge the validity of the estimate. If benefits are dependent upon features other than the project facilities, the cost of providing, operating, and maintaining the additional features must also be included as associated costs.

For communities with a population of 10,000 or less, the alternative cost of providing a water supply may be extremely expensive on a per capita basis. This is mainly because smaller communities lack the efficiencies of large-scale development. Since these communities may not be able to afford an alternative water supply comparable to the Federal plan (see P&G Section 2.2.12), that alternative should not be used as the basis for evaluating the benefits of the Federal water supply plan. In this case the benefit may be considered equal to the cost of the separable M&I facilities plus an appropriate share of the remaining joint cost of the project (see Chapter 6, Costs and Cost Allocation). This option may require that project cost be allocated using the separable cost-use of facilities method.

(3) Deferred use of M&I water supply

A watershed project may provide for construction of facilities to meet future municipal or industrial water needs, with repayment deferred for 10 years or until use of the water begins. Under this repayment plan, costs are incurred during project installation, but water supply benefits are deferred. Consequently, benefits must be discounted for their lag in accrual.

611.0502 Other direct benefits

Other direct benefits in the National Economic Development (NED) benefit evaluation of water resource projects are the incidental direct effects that increase economic efficiency, but are not otherwise accounted for in the evaluation. These direct effects are incidental to the purpose for which the water resources project is being formulated. They include increases in output of goods and services and reductions in production costs.

(a) Direct effects

(1) Planning

Standard evaluation procedures involve comparison of with-project conditions to the without-project conditions. In considering other direct benefits, define the boundaries of the plan as they relate to the purposes for which the project is being formulated.

(2) Evaluation procedure

When applicable, compute other direct benefits according to procedures for measuring benefits in this handbook. Incidental irrigation is to be evaluated by procedures in chapter 2, section 611.0203, and incidental recreation is to be evaluated by procedures described earlier in this chapter. Some benefits, such as reduced costs for water supply treatment, can be computed on the basis of reduced costs.

(3) Limitations on use

Other direct benefits are incidental to the purposes for which the project is being formulated; therefore, they are not used in plan formulation, nor are they included as beneficial effects in incremental analysis.

(4) Problems in application

A significant problem encountered in estimating other direct NED benefits is identifying businesses and consumers who will be affected by these incidental benefits and costs. Tracing all incidental benefits is not practicable. Determining the relevant context or system within which other direct benefits might occur is a useful first step in delineating measurable incidental impacts.

(5) Reporting procedure

Other direct benefits should be identified individually and compiled as part of the benefit-cost analysis. Methods used to value benefits should be presented and a tabular breakdown provided for all other direct benefits claimed for the project. Example 5–1 shows how an NRCS planning team determines other direct benefits of a flood protection project.

Example 5–1 Other direct benefits

Background: An NRCS planning team completed an evaluation of the Logan Creek Watershed in Any State, United States. The purpose of the evaluation was to provide flood protection to a rural community and its highly productive agriculture land.

Results: The study showed that a small floodwater control dam just above the flood prone community would result in the most viable alternative, and is the NED alternative.

Direct benefits of this proposed project include flood protection of the homes in the disadvantaged community, protection of the productive farmland, and the reduction in road maintenance and repair.

In addition to the direct benefits, other direct benefits will accrue as a result of the project. One of the other benefits, or incidental benefits, resulting from this proposed project would be the improved ability of some growers to access 2,000 acres of highly productive agriculture land above and adjacent to the proposed dam site. Currently, growers must bring equipment in and out of the property at a point 6 miles out of their way. With the installation of the flood control dam, growers would have direct access in and out of the property, which would reduce their equipment transportation cost. Therefore, the other direct benefit that would result from this proposed project is reduced transportation cost.

611.0503 Employment benefits

This section describes evaluation of employment benefits that may be expected from the construction or installation of watershed protection or flood prevention projects.

(a) Background

The use of otherwise unemployed or underemployed resources for the installation of project measures should be treated as an adjustment to costs. The resource has no real opportunity costs to society because it would be used without the project. It is a "free" good to society. However, because this approach leads to difficulties in cost allocation and cost-share calculation, the P&G permits effects from the use of these resources to be treated as an addition to NED benefits resulting from the project.

P&G limits the use of employment benefits to the employment of otherwise unemployed or underemployed labor used for project construction or installation located in an eligible area. Only those people employed onsite in the construction or installation of a project or a nonstructural measure should be counted.

NED benefits for employment of unemployed labor can only be claimed in areas where substantial and persistent unemployment exists at the time the plan is submitted for authorization. Areas of substantial and persistent unemployment are defined in P&G Section 2.11.1.

(b) Evaluation procedures

Specific evaluation procedures are detailed in a 5-step process in the P&G (see section 2.11.4). When project measures are wholly or partly located in eligible areas, those procedures are used for the NED benefit evaluation of employment benefits.

611.0504 Regional benefits

This section describes the general effects that an alternative project plan may have on a region significantly affected by a water or related natural resource project. The two measures of effects generally assessed are regional income and regional employment. Regional Economic Development (RED) benefits are reported for only the significantly affected region and the rest of the Nation. Effects outside the significantly affected region should be recorded in the "rest of the Nation" category. See P&G Section 1.7.4 for additional information on RED benefits.

(a) Income benefits

(1) Positive effects
The positive effects of a project on a region's income are equal to the sum of NED benefits that accrue to that region plus transfer of income from outside the region. The region is defined for the RED account so that all or almost all of the NED benefits for the plan accrue to that region.

Income transfers to a region as a result of a project include income from implementation outlays, transfers of basic economic activity, and indirect and induced effects. In each case income transfers refer to new income within the region rather than to increases in total expenditures.

(2) Negative effects
The negative effects of a project on a region’s income are equal to the sum of NED costs borne by the region plus transfers of income from the region to the rest of the Nation.

The NED costs of the project borne by the region should be organized in the same categories used in the cost section of the NED account. Information from the cost allocation and cost sharing sections of the project plan are needed to estimate regional costs.

Income transfers from the region include net income losses from project-induced shifts of economic activity from the region to the rest of the Nation and losses of existing transfer payments.

(b) Employment benefits

(1) Positive effects

Positive effects of the project on regional employment are parallel to the regional income effects; therefore, the analysis should be similar. Note the composition of increased employment by service, trade and industrial sector, and by skill or wage classification.

(2) Negative effects

Negative effects on regional employment should be organized the same as regional cost effects. Include any decrease in the numbers and types of jobs resulting from development.

(c) Induced or indirect impacts

In addition to the direct benefits caused to the regional economy, additional economic impacts stem from the primary or direct project benefits. These benefits result from the recirculation of dollars in the local economy. These project-induced effects include:

- Changes in employment
- Various types of income
- Total business sales
- Other economic parameters not directly attributable to the project action

Several computer simulation models are used to measure regional economic impacts. The models produce regional multipliers based on the project expenditure in the designated study area. Many state universities maintain input/output or other regional models that may provide more detailed state data than some of the larger regional models. Two of the more popular systems are the Economic Impact Forecast System (EIFS) and Impact Analysis for Planning (IMPLAN).

EIFS is a collection of computer based models that can calculate the regional multipliers for sales, employment, and income. These models were developed by the U.S. Army Corps of Engineers and reside on a mainframe computer at the University of Illinois.

Additional information on EIFS is available from the Department of Urban and Regional Planning, Planning Information Program, University of Illinois, Urbana-Champaign.

IMPLAN is available in a personal computer version. It was developed by the U.S. Forest Service Land Management Planning Unit at Ft. Collins, Colorado, with assistance from the University of Minnesota. It is currently maintained by the Minnesota IMPLAN Group, Inc. NRCS economists in each region support this model for water resources and program usage.

(d) Relationship between NED and RED effects

The relationship between affected regional economies and the national economy should be recognized. To compare federally funded projects, multiplier effects should be shown only in the RED account. Since the NED account registers all effects on the national economy, any differences between regional and national economic effects of the project take the form of transfers from or to the rest of the Nation. Multiplier effects should not be shown in the NED account because they represent inter-regional transfers of regional economic activity, not increases in the national economy.

Information in the RED account should be organized in the same categories as those in the NED account. Values displayed in the RED account can include changes in dollars of sales, dollars of employment, number of jobs, tax changes, population changes, and demand for housing.

611.0505 Land, easements, and rights-of-way

Responsibility for estimating the value of land, easements, and rights-of-way rests with the local sponsoring organization. The Natural Resources Conservation Service only tests the reasonableness of the estimate to ensure that all economic costs of land, whether purchased or donated, are included in the project cost.

(a) Landrights

(1) Fee title

Fee title is an absolute ownership of property. Landrights, which may be conveyed to the local sponsoring organization by fee title, are often difficult to evaluate on a fair market basis. The reasons for this are the change in demand and supply of land for sale in project areas, varying land use, the effect of landrights on surrounding land, and other variables. Federal and state laws have established that no private property may be taken for public purpose without payment or just compensation. The courts have held that just compensation means the fair market value of the property rights taken, plus damages, if any, to the remaining property. The courts have also said that the landowner should be in the “same pecuniary position” before and after the taking.

Land obtained in fee title for public purposes may be secured either through negotiation or condemnation proceedings.

(i) Negotiation—Land may be secured through private negotiation between the sponsors and the landowner. Such proceedings normally involve a willing buyer and seller.

(ii) Condemnation proceedings—The right of eminent domain is a power of government to take private property for public use without consent of the owner. When unable to obtain landrights by negotiation, many local governments have the authority to institute condemnation proceedings. Procedures for condemnation of land depend upon applicable statutes, with methods of determining values varying somewhat from one legal jurisdiction to another. The determination of just compensation is generally made by a jury or by the court. Through the years, court decisions have established the meaning of just compensation as being the fair market value. Fair market value is the amount that would be paid by a willing buyer, not compelled to buy, and accepted by a willing seller, not compelled to sell.

(2) Easements

Easements are distinguished from fee title because they do not transfer property ownership. An easement is any of several rights to which one may have the right of use. Put another way, an easement is any of several rights that one may have to use another person’s property.

Easements are fractional property rights and involve the transfer of something less than all of the rights inherent in absolute fee ownership. Because some residual value remains with the owner, the value of an easement is some amount less than the market value of the property.

(b) Methods of estimating values

Three basic approaches may be used to determine the fair market value of land and land improvements. They are:

- Market data approach
- Capitalized value of net income
- Cost approach

(1) Market data approach

The market data approach is most often applied to determine fair market value of farm land. This method involves comparisons of market values for similar land at current prices. Considered in this method are those factors that affect land prices, such as speculative interest, land zoning regulations, special easements or tax evaluations, and accessibility to farm commodity markets, roads, schools, and related cultural facilities.

Qualified land appraisers, real estate agents, and local loan agency officials are prime sources of assistance in estimating fair market values.

(2) Capitalized value of net income

The income capitalization method is based on productive capacity of the land and involves an estimate of net income accruing to the land and the choice of a capitalization rate. Where cash rental or leasing is common, this determination is relatively simple. The capitalized rate should be the average interest rate for real estate mortgage loans and for land sales contracts in a fairly wide area. Caution should be exercised in placing too much emphasis on the capitalized value of land since many uncertainties are involved in its computation.

(3) Cost approach

The cost approach is a partial analysis where price is determined through the cost of separate components of land. When farm improvements are of such a nature that no sales or income data are available, they may need to be evaluated separately from the land by using the replacement cost less depreciation.

Cost estimates of onfarm improvements, such as buildings, public utilities, oil or gas pipelines, highways, bridges, and railroads, generally can be prepared on the basis of relocation in kind, modification, or salvage costs. Additional factors must be considered where land values are determined by potential use of urban-industrial, commercial, or residential use. In the absence of known sales of similar land, values set above those reflecting present land use must be based on the early likelihood of changed use and the location and desirability of the property. The economist may also interview several owners of the land to assess its asking price or consult local real estate appraisers.

(c) Economic evaluation

Land, easement, or rights-of-way costs should reflect values of the landrights acquired without adjustment for offsetting benefits. Included would be landrights values based on either market values or income losses, time and travel expense associated with the acquisition of landrights, legal fees, recording fees, and other incidental expenses (see Principles and Guidelines Section 2.12.5(b)).

Landrights to be evaluated for reservoirs should be limited to the area used by the dam, emergency spillway, storage area, borrow area, and, under special circumstances, areas of siltation above the pool elevation. Where recreational or fish and wildlife development is included as one of the project purposes, additional landrights are required to ensure public access and enjoyment of associated facilities.

Flowage easements may be needed if release rates from structure or channel improvement causes prolonged submergence or temporary high peaks that induce damage.

In projects formulated for rehabilitation of an existing system, a landrights cost is estimated on that land area now serving the purpose for which the project is formulated. Additional lands beyond those used for the facility or to service the facility will be valued at fair market value. These additional lands may be needed for disposition of spoil, as construction easements, or for enlargement of the existing facility.

Appendix 5A Worksheets and Forms

Benefit Evaluation Worksheet 5–17

Benefit Evaluation Worksheet

Unit Value Day Method

Site No. ____________________

Watershed ____________________

County/state
recreation ____________________

Check one

________ General recreation

________ Specialized

Criteria

Criteria	Point value assigned	Basis for point value
Recreation experience		
Availability of opportunity		
Carrying capacity		
Accessibility		
Environmental quality		
Total point value assigned		

Remarks

____

____

____

____

____

Rater

Name ______________________________

Agency ______________________________

Unit Value Day Method

Point assigned by rates (3 or more)[1]

Criteria	Unit values[2] 1		2		3		4		Avg.	
	G	S	G	S	G	S	G	S	G	S
Recreation experience 30 points										
Availability of opportunity 18 points										
Carrying capacity 14 points										
Accessibility 18 points										
Environmental quality 20 points										
Total										

Rater (name)

1 ______________________ **3** ______________________

2 ______________________ **4** ______________________

[1] Representatives of NRCS, USFWS, sponsors, local agencies.
[2] G - General recreation - picnicking, camping, biking, riding, cycling, fishing, hunting, etc.
S - Specialized recreation - activities that are not common to the region and/or nation as well as those that are usually of high quality.

Chapter 6 Costs and Cost Allocation

Contents:

611.0600 Costs **6–1**
(a) Project costs 6–1
(b) Associated costs 6–2

611.0601 Cost allocation **6–2**
(a) Definition of terms 6–2
(b) Cost allocation methods 6–3

Appendix 6A—Cost Summary Sheet for Cost Allocation **6–9**

Tables

Table 6–1	Separable cost - remaining benefit cost allocation	6–4
Table 6–2	Separable cost - use of facilities cost allocation	6–5
Table 6–3	Separable cost - remaining benefits cost allocation using constituent	6–7

Examples

Example 6–1	Separable cost - remaining benefit method	6–4
Example 6–2	Separable cost - use of facilities method	6–5

611.0600 Costs

Economic analysis involves the comparison of costs of a project with the benefits that it produces. This may be done by capitalization of period benefits and costs to place them in the same terms as capital outlays. Alternatively, the comparison may be made by converting capital sums to their annual equivalent through amortization.

Costs may be divided into two main groups: project costs and associated costs. See National Watershed Manual and Principles and Guidelines.

(a) Project costs

Project costs include all costs incurred in project installation, operation, and maintenance. They are in three groups: installation costs, operation and maintenance costs, and other direct costs.

(1) Installation costs
All costs of construction are included in project installation costs. These costs include design, engineering, inspection, and an allowance for contingencies. Also included are the value of lands, easements, rights-of-way, and the cost of relocating facilities that must be moved because of the installation.

At times, sites may be purchased. In such cases funds expended are a measure of costs. In other cases the value estimated by the local organization, with the concurrence of the NRCS, is used for determining the value of the site. Even when sites are donated, there generally is a cost to someone, although it may be offset in whole or part by incidental benefits from the new use of the site. Some of the considerations inherent in site cost evaluation are described in section 611.0505, Land, easements, and rights-of-way.

Installation costs are capital expenditures incurred during project installation. Current price levels should be used to maintain the necessary relationship with prices used for the computation of benefits. For purposes of comparison with project benefits, installation costs are amortized over the period of analysis. Although salvage values generally are not applicable to flood prevention projects, they are appropriate deductions from the installation cost.

In some cases project installation may induce damage to fish and wildlife or archeological resources. The costs for improvements to mitigate these damages are generally incorporated into the project analysis.

(2) Operation and maintenance costs
The cost of maintaining improvements so they deliver the full benefit for which they were designed is another cost component. Maintenance costs vary from year to year. In economic appraisal, however, the best estimate that can be made of average costs over the period of analysis should be used. Normally, the longer the project life, the greater the allowance for project maintenance. Sometimes a project has facilities designed to be replaced during the life of the project. The original cost of these facilities is included in the project installation cost and amortized over the project life. Provision for replacement is made by including sufficient funds for this purpose in the maintenance cost of the project.

Another item of annual cost is operation of the works of improvement. Drop inlets for floodwater retarding structures that operate automatically may have minimal operating costs. However, when manually operated gates and similar types of equipment are involved, the operating costs can be considerable.

(3) Other direct costs
Other direct costs include all uncompensated adverse effects in goods and services associated with the construction or operation of a project. A typical example is the loss in production on lands taken for project purposes that is in excess of the payment or estimated easement value. Thus if the estimated amortized easement value is $5,000, but the loss in agricultural production is $6,000 annually, the difference, $1,000 annually, is an other direct cost and should be included with project costs.

If channel improvement or other similar waterflow-control measures are terminated so that they cause floodwater, sediment, or erosion damages downstream, such damages should be considered as induced by the project. Sometimes flowage easements provide a financial measure of these costs. If such costs are not adequate, the excess is a form of other economic costs of the project.

(b) Associated costs

Associated costs are the value of inputs, over and above project costs, that are required to realize output levels claimed for the project. In the accounting process the value of these inputs is generally accounted for by deductions from benefits.

In agricultural water resource projects, associated costs normally are onfarm measures that allow the use of land and water resources at or near their potential. For example, in irrigation projects where the main feature is to install a distribution pipeline, the onfarm sprinkler that is necessary to achieve the benefits of irrigation is a cost that could be treated as an associated cost if the installation of the sprinkler was not part of the project.

Where municipal water supply is a project purpose, the cost of water treatment facilities needed to filter and purify project water would be an associated cost.

611.0601 Cost allocation

This section describes the procedures for cost allocation in connection with the development of water resource projects. Public Law 83-566, as amended, authorizes the Secretary "to make allocations of costs to the various purposes, and to show the basis of such allocations and to determine whether benefits exceed costs." NRCS national policy directs that in allocating total project financial costs among the purposes served by the project or plan, "separable costs will be assigned to their respective purposes, and all joint costs will be allocated to purposes for which the project was formulated."

The distinction between cost allocation and cost sharing must be recognized. Cost allocation pertains to works of improvement serving more than one purpose. It is the process of dividing costs of the structure equitably among the purposes served, with each purpose receiving its fair share of the advantage resulting from multiple purpose installation. Cost sharing is the division of the cost allocated to each purpose by the financing agencies or groups involved. In NRCS water resource projects, costs of the works of improvement are shared between Federal and local funds.

The need for allocation stems from cost-share rates that vary among purposes. Although either annual equivalents or capital costs can be used in allocations, NRCS policy is to use capital costs.

(a) Definition of terms

Financial costs—Implementation outlays, transfer payments (assistance payments for replacement housing), and the market value of contribution in kind.

Separable cost—The difference between the cost of a multiple-purpose project and the cost of the project with that purpose omitted. In calculating separable cost, each purpose should be treated as if it were the last addition of the multiple-purpose project. This calculation shows the added cost of increasing project size, changes in design, or other factors that would be necessary to add to the purpose to the project.

Joint cost—The difference between the cost of the multiple-purpose project and the sum of the separable costs for each purpose.

Alternative cost—The least cost method of achieving, by use of a single purpose project, the same or equivalent benefits that accrue to that purpose in the multiple-purpose project. The alternative single-purpose project should be realistically devised; e.g., it should be one that could be built and one that could provide equivalent benefits. However, the physical project may be entirely different from the multipurpose project.

(b) Cost allocation methods

(1) Separable cost - remaining benefit method

The separable cost - remaining benefit (SCRB) method provides for assigning to each purpose its separable cost and a share of the joint cost in proportion to the remaining benefits. This method allows for an equitable sharing among the various purposes including any savings that may result from multiple-purpose development.

SCRB allocates costs to the purposes so that each purpose is economically feasible as long as the following requirements of project formulation are met:

- The overall benefit-to-cost ratio is favorable.
- The separable cost of any purpose does not exceed the benefits of that purpose.
- The sum of the lesser of the benefits or the alternate cost is equal to or greater than the project cost.

SCRB also requires that the following be determined:

- Authorized purposes intentionally served by the project
- Financial cost to be allocated
- Separable cost for each purpose
- NED benefit for each purpose
- Alternative financial cost for each purpose
- Joint cost, which is the financial cost less the sum of the separable costs

Example 6–1 shows how the separable cost-remaining benefit method is used.

(2) Separable cost - use of facilities method

The separable cost - use of facilities method apportions the total joint costs among purposes by substituting the use each purpose makes of the multiple purpose reservoir(s) for remaining benefits. Caution: While the SCRB method allocates cost to each purpose so that each purpose is economically feasible, the same is not automatically true of the separable cost - use of facilities method.

The separable cost - use of facilities method requires that the following be determined:

- Authorized purposes intentionally served by the project.
- Financial cost to be allocated.
- Separable cost for each purpose.
- The NED benefit for each purpose.
- Alternative financial cost for each purpose.
- The joint cost, which is the financial cost less the sum of separable costs.
- For step 5, the use each purpose makes of the multiple purpose facility. (When two purposes make joint use of the same reservoir capacity, that capacity is equally divided among the purposes.)

Example 6–2 illustrates the separable cost - use of facilities method of cost allocation.

Example 6–1 Separable cost - remaining benefit method

Table 6–1 Separable cost - remaining benefit cost allocation

Step	Item	Purposes: flood prevention	Purposes: irrigation	Purposes: recreation	Total
		------ (Dollars unless otherwise noted) ------			
1	Benefits	10,000	8,000	4,000	22,000
2	Alternative cost	8,000	8,000	10,000	26,000
3	Lesser of step 1&2	8,000	8,000	4,000	20,000
4	Separable cost	1,000	6,000	3,000	10,000
5	Remaining benefits	7,000	2,000	1,000	10,000
5a	Percentage of remaining benefits	70%	20%	10%	100%
6	Allocated joint cost	5,600	1,600	800	8,000
7	Total allocated cost	6,600	7,600	3,800	18,000

Step 1 Report the benefits for each purpose for which the plan was formulated. Benefits are shown in present value terms.

Step 2 The alternative cost is the financial cost of achieving the same or equivalent benefits by a single-purpose project.

Step 3 Record the lesser of the benefits or the alternative cost, by purpose.

Step 4 Separable cost is the cost of adding each purpose to the multiple purpose project. This figure indicates the minimum cost that will be allocated to the purpose. If the separable cost for a purpose exceeds the amount shown in step 3, the project contains an infeasible purpose.

Step 5 Remaining benefits are equal to the difference between the amount in step 3 and the separable cost (step 4).

Step 5a Calculate the remaining benefits for a purpose as a percentage of the total remaining benefits.

Step 6 The allocated joint cost in the total column is the difference between project financial cost and the sum of the separable costs for all of the purposes. The total allocated joint cost is distributed to each purpose by the percentage shown for that purpose in step 5a.

Step 7 Total allocated cost for each purpose is the sum of the separable cost and allocated joint cost for the purpose.

Example 6–2 Separable cost - use of facilities method

Table 6–2 Separable cost - use of facilities cost allocation

Step	Item	Purposes: flood prevention	Purposes: irrigation	Purposes: recreation	Total
		(Dollars unless otherwise noted)			
1	Benefits	8,000	8,000	15,000	31,000
2	Alternative cost	12,000	8,000	10,000	30,000
3	Lesser of step 1 or 2	8,000	8,000	10,000	26,000
4	Separable cost	2,000	5,000	5,000	12,000
5	Use of facility (ac ft)	2,000	1,000	2,000	5,000
5a	Percentage use of facility	40%	20%	40%	100%
6	Allocated joint cost	4,800	2,400	4,800	12,000
7	Total allocated cost	6,800	7,400	9,800	24,000
8	Net benefits	1,200	600	200	2,000

Steps 1 through 7 There steps are comparable to the same steps in the SCRB method except for step 5. Step 5 is the use each purpose makes of the multiple purpose facility in acre feet. When two purposes make joint use of the same reservoir capacity, that capacity is equally divided among the purposes.

Step 8 Net benefits are the difference between the amounts in step 3 and step 7. Because purpose feasibility is not automatic in this method, step 8 is added.

(3) Cost allocation with constituent costs

So far, the information in this chapter has been limited to the allocation of project installation costs. As mentioned earlier, the need for cost allocation stems from cost-sharing policies that differ among project purposes. Frequently, cost-sharing policies are directed toward variations in the cost-share rate for construction or landrights cost, depending on the purpose served, or of differences in the rates for structural as compared to nonstructural measures. Hence, that part of the construction cost, or some other cost constituent, incurred for each specific purpose generally must be identified.

Cost allocation of constituent costs requires the following be determined:

- Authorized purposes intentionally served by the plan
- Constituent components of the financial cost to be allocated
- NED benefit for each purpose
- Constituent components of the alternative financial cost for each purpose
- Joint cost (the financial cost less the sum of the separable costs, as calculated by constituent components)

Table 6–3 shows an example of cost allocation using constituent costs

(4) Specific cost - remaining benefits method

The specific cost - remaining benefits method differs from the separable cost - remaining benefit method only to the extent that specific costs are used rather than separable costs. Costs allocated to each purpose are equal to specific costs plus allocated joint cost.

Specific costs for each project purpose consist of the cost of facilities that exclusively serve only one project purpose. Irrigation outlet works, irrigation water delivery systems, and basic recreation facilities are examples of project facilities that serve a specific purpose.

(5) Use of facilities method

This method differs from the separable cost - use of facilities method in that the cost of individual multiple purpose facilities are allocated proportionate to the use each purpose makes of the facility. In practice, joint costs normally are allocated by use of facilities. Total allocated cost for a purpose is the sum of the allocated joint cost and the specific cost.

The cost summary sheet shown in appendix 6A can help organize information for cost allocation.

Table 6–3 Separable cost - remaining benefits cost allocation using constituent

Step	Item	Purposes: flood prevention	Purposes: irrigation	Purposes: recreation	Total
		(Dollars unless otherwise noted)			
1	Benefits	15,000	8,000	12,000	35,000
2	Alternative cost				
	Construction	11,000	8,000	8,000	27,000
	Land rights	1,000	1,000	3,000	5,000
	All other	2,000	1,000	1,000	4,000
3	Lesser of Step 1 or 2				
	Construction	11,000	6,400 1/	8,000	25,400
	Land rights	1,000	800 1/	3,000	4,800
	All other	2,000	800 1/	1,000	3,800
4	Separable cost				
	Construction	2,000	3,000	3,000	8,000
	Land rights	0	0	2,000	2,000
	All other	0	0	0	0
5	Remaining benefits				
	Construction	9,000	3,400	5,000	17,400
	Land rights	1,000	800	1,000	2,800
	All other	2,000	800	1,000	3,800
5a	Percentage of remaining benefits				
	Construction	51.72%	19.54%	28.74%	100%
	Land rights	35.71%	28.57%	35.71%	100%
	All other	52.63%	21.05%	26.32%	100%
6	Allocated joint cost				
	Construction	8,792	3,322	4,886	17,000
	Land rights	714	572	714	2,000
	All other	526	211	263	1,000
7	Total allocated cost				
	Construction	10,792	6,322	7,886	25,000
	Land rights	714	572	2,714	4,000
	All other	526	211	263	1,000
	Total	**12,032**	**7,105**	**9,863**	**30,000**

1/ In this case, where benefits are less than the total purpose cost, the benefits must be in proportion to the cost constituents. The cost distribution of the alternative cost is used.

Appendix 6A Cost Summary Sheet for Cost Allocation

Purpose	MPS [1/] cost	MPS w/o purpose	Separable cost	Alternate cost
1. _______________ Purpose				
Construction				
Engineering services				
Project administration				
Landrights				
OM&R (capital equivalents)				
2. _______________ Purpose				
Construction				
Engineering services				
Project administration				
Landrights				
OM&R (capital equivalents)				
3. _______________ Purpose				
Construction				
Engineering services				
Project administration				
Landrights				
OM&R (capital equivalents)				

1/ MPS - Multipurpose structure.

Chapter 7 Addendum, Supplements, Rehabilitation

Contents:

611.0700	**Introduction**	**7–1**
611.0701	**Policy**	**7–1**
611.0702	**Economic analysis**	**7–2**
	(a) Benefit and cost	7–2
	(b) Price and cost index	7–2

Figure	**Figure 7–1** Benefits to rehabilitation of a practice	7–2

Chapter 7 Addendum, Supplements, Rehabilitation

611.0700 Introduction

The purpose of chapter 7 is to provide guidance for the economic analysis required for addenda, supplements, and rehabilitation activities.

611.0701 Policy

The National Watersheds Manual (NWSM) provides guidance via the following subparts (Note: Changes or updates to the NWSM after this handbook was printed may not be reflected):

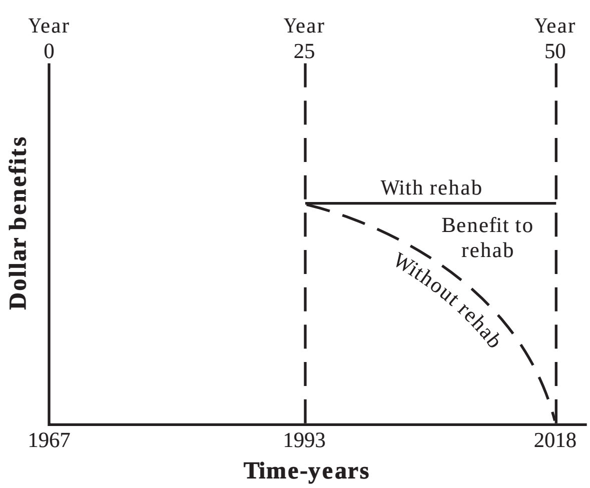
- Addendum (504.32(d))—An addendum is used in a final project plan only when an update to the document is necessary because of a change in the discount rate, price base, or both. New average annual project costs and benefits and the benefit-to-cost ratio must be derived and referenced in the addendum.

- Supplements (subpart 506B)—A supplement plan is a document that changes part of an existing plan. The amount of economic analysis required depends on the nature of the modifications and their effect on the overall project. The following guidelines are used:
  - All works of improvement should be evaluated using procedures in effect at the time of the modification.
  - The current interest rate will be used to evaluate proposed changes in projects that meet the criteria in effect. The interest rate used to evaluate the original plan will be used for installed works of improvement and approved works of improvement not significantly impacted by the proposed changes (NWSM 506.10(b)). For modifications that require preparation of an environmental impact statement (EIS), the remaining works of improvement are evaluated using both interest rates. The definitions of changes to approved water resource plans that require reevaluation and reformulation are listed in NWSM 506.11.
  - Current cost estimates for works of improvement remaining are to be used. As-built costs should be used for measures already installed and contract cost for those measures under construction. These values are to be indexed to current dollar values or the remaining works are to be evaluated as a separate remaining increment. The as-built cost is indexed to current values.

- Rehabilitation Work (508D)—Rehabilitation work is defined as all work in excess of the operation and maintenance required to repair, restore, or improve a practice to a condition appropriate for its current or intended purpose(s). The without-project scenario must be correctly identified. The current time period becomes the point from which the rehabilitation analysis begins (fig. 7–1).

Economic analysis is required to analyze the average annual project costs and benefits, including the benefit-to-cost ratio for the rehabilitation project. In figure 7–1, it is assumed that rehabilitation will begin in year 25 of the 50-year project life. The down sloping (without rehabilitation) curve indicates the decline in benefits because of the need for rehabilitation. If the damages to practice are repaired, the horizontal line (with rehabilitation) indicates the level of benefits maintained at the 25-year level. The benefit then is the area marked **Benefit to rehabilitation.**

Figure 7–1 Benefits to rehabilitation of a practice



611.0702 Economic analysis

Economic analysis involves the same economic analysis that is done for initial evaluations. However, the detail may be less and the time for analysis shorter.

(a) Benefit and cost

The economic analysis varies within and among the three types of modifications. The benefits and costs must have the same price base and discount rate. When a final project plan is approved, it must reflect the current discount rate and a current price base.

(b) Price and cost index

The correct index to use varies with the benefit or cost category being updated. The definition of each index should be known before using it. The commonly used indices and applications are:

Index	Application
Consumer Price Index	All benefits other than agriculture including recreation
Prices received by farmers	Agriculture benefits
Prices paid by farmers	Agriculture costs
Composite construction cost	Structural costs
Construction cost	Structural costs
Engineering News Record	Structural costs

Chapter 8 Wetland Economics

Contents:

611.0800	Introduction	8–1
611.0801	Evaluation	8–1

Table — Table 8–1 Standard economic methodologies 8–1

Chapter 8 Wetland Economics

611.0800 Introduction

Wetlands provide many goods and serve many functions. Standard economic methodologies can be used for an economic evaluation of some of the monetary goods and functions. For other goods and functions, the economist must work with the appropriate technical specialist to devise a good economic methodology.

611.0801 Evaluation

Wetland valuations can be hampered by lack of economic evaluation methodologies, lack of methodologies to relate wetland characteristics to functions or outputs, and lack of widespread acceptance of monetary and non-monetary cost-to-benefits estimates. Any of these problems can be a barrier to adequate economic evaluation of wetlands.

Existence of a wetland in and of itself does not imply economic value. There must be a demand for the good or function. The function of the wetland should directly contribute to the prevention of a damage. A wetland may store excess runoff, but if this does not contribute to prevention of flood damages to an agriculture or urban area, then there is not an economic benefit related to these two potential flood damages. Principles and Guidelines procedures should be followed as needed.

Some standard economic methodologies can be used if there is a directly observable damage prevention. Some examples are given in table 8–1.

Table 8–1 Standard economic methodologies

Function/output	Economic tool
Flood prevention	ECON2, URB1
Recreation	P&G unit day values
Water supply & storage	P&G least cost alternative
Ground water recharge	P&G least cost alternative
Natural resources	Value of timber, peat, fur
Pollution assimilation	P&G least cost alternative
Waste removal	Treatment costs
Erosion prevention	Damage costs
Scenic value	Non-monetary
Spiritual value	Non-monetary
Education	Non-monetary
Food chain	Non-monetary

Appendixes

Contents:

Appendix A—Miscellaneous Techniques	**A–1**
Appendix B—Investigation and Analysis Report	**B–1**

Flood Damage Benefits from Reducing National Flood Insurance Costs

Purpose

Guidance for estimating benefits related to changes in the administrative costs of the national flood insurance program in Public Law 566 watershed projects.

Background

Principles and Guidelines (P&G) considers reductions in flood insurance administrative costs a claimable flood damage reduction benefit. See P&G section 2.4.12.

The Federal Insurance Administration's 1991-1992 national average costs per policy for servicing flood insurance policies were:

Loss adjustment cost	$140 per policy
Agent commission	72 per policy
Other operating expenses	14 per policy
Total	**$226 per policy**

These costs are representative of all types of flood insurance policies that are available to flood plain occupants. These values should be used for evaluations made during this fiscal year.

Where it is determined that land use in the flood plain is the same with and without the project, the reduction in insurance overhead becomes a claimable flood reduction benefit. Natural Resources Conservation Service projects will not likely eliminate a large number of flood insurance policies, hence the administrative overhead costs (other operating expenses) will not be significantly reduced. Therefore, $14 per policy is considered a fixed cost.

To estimate flood insurance cost reduction benefits, interview flood plain residents to determine the number of policies in effect. Use the inventory to estimate the number of policies most likely to remain in effect under each of the alternatives presented in the plan. In the analysis, claim benefits only for those policies that would most likely be terminated. Close attention must be given to changes in flood plain limits and stage-damage relations under the various alternative conditions.

The example below illustrates an evaluation using average annual dollars.

Evaluation of flood insurance cost reduction benefits

Items	Number of policies	Cost per policy	Total cost
Without project	100 (in force)	$226	$22,600
Subtotal			22,600
With alternative	30 (terminated)	14	420
	70 (remaining in force)	226	15,820
Subtotal			16,240
Benefits (difference with and without)			**$6,360**

Plan–EIS Problems and Opportunities

Purpose

Example writeup for the problem and opportunities section of watershed plan-Environmental Impact Statement (EIS).

Background

Many plan–EIS's do not contain an adequate description of the problems and opportunities found in the project area. This section of the plan–EIS is used to show cause for Natural Resource Conservation Service involvement in the watershed project. A complete description of each problem and opportunity must be included with as much quantification as possible.

The following example will assist in preparing Plan EIS's. This writeup was prepared by Clint Russell, NRCS economist, in 1983. It is only a guide, and only those sections that apply should be used. The extent of the information presented should be commensurate with the magnitude of the project.

Problems and Opportunities

The major problems in the watershed are reduced farm income resulting from erosion and sediment damage to ______ acres of upland, reduced farm and business income, and increased government service costs caused by floodwater, erosion, and sediment damage on ______ acres of flood plain along _______________ Creek and its tributaries. The magnitude of these damages are estimated to be $__________ annually, including $__________ increased government costs. The problems are summarized as follows:

Agriculture	$ ____________
Urban	
Residential	$ ____________
Business	$ ____________
Government service costs	$ ____________

Upland—The income problem in the upland area of the watershed can be traced to erosion, specifically sheet and rill erosion, concentrated flow erosion, and voiding and depreciation. Erosion causes a loss of organic matter, natural fertility, and commercial fertilizers, and a depletion of long-term productivity. It also causes a reduction in the effectiveness of herbicides and pesticides. This results in reduced yields and increased production costs and thus reduces net farm income. The principal crops affects are ____________________, ____________________, ____________________, ____________________, and ____________________. Reduced income from sheet and rill erosion on cropland for selected erosion rates and selected capability classes are shown in table 1.

Table 1 Reduced income from sheet and rill erosion

Land use	Acres	Erosion rate 1/	Reduced income per acre: Present	1990	2000	2010	2020	Evaluation period 2/
Cropland								
Class IIe	9,100	8	$________	$________	$________	$________	$________	$________
Class IIIe	12,400	17	$________	$________	$________	$________	$________	$________
Class IVe	16,900	22	$________	$________	$________	$________	$________	$________
Class VIe	2,600	31	$________	$________	$________	$________	$________	$________
Weighted average			$________	$________	$________	$________	$________	$________

1/ Tons per acre per year.
2/ End of evaluation period.
Note: Other categories, such is SRG's and other time periods could be used if desired.

In areas where erosion occurs from concentrated flow, damage occurs to an estimated ______ acres of cropland annually. This erosion generally manifests itself as large rills or small gullies. It not only destroys crop production, but decreases efficiency. It also causes extensive repair costs and often requires reshaping to permit continued farm operation. Reduced income from concentrated flow erosion is estimated to be $__________ annually. (Note: Include the area affected by sediment in the figure.)

Erosion damage resulting from gullies causes some areas to become voided and other areas to become depreciated. Gullies cause a total loss of the land resource in the areas actually voided and a depreciated use of the land resource immediately adjacent to the voided areas. Presently, an estimated ______ acres have been voided and ______ acres have been depreciated. Since the gullying process is continuing, it was determined that ______ acres will become voided and ______ acres will be depreciated by the end of the evaluation period. Reduced income from gully erosion is summarized in table 2.

Table 2 Reduced income from gully erosion

Erosion	Present	1990	2000	2010	2020	Evaluation period 1/
Voiding	$________	$________	$________	$________	$________	$________
Depreciation	$________	$________	$________	$________	$________	$________
Weighted average	$________	$________	$________	$________	$________	$________

1/ End of evaluation period.
Note: Other time periods may be used if desired.

A summary of the damages resulting from erosion in the upland areas of the watershed is as follows:

Erosion	**Average annual damage**
Sheet and rill	$________
Concentrated flow	$________
Gully	$________
Total	**$________**

Flood plain—The area subject to flooding is ______ acres, including ______ acres of agricultural land and ______ acres of urban land. Major floods (those inundating more than half of the total flood plain) occurred in ______ (year), ______ (year), ______ (year), and ______ (year). The most damaging flood occurred in ______ (month), ______ (year), when ______ acres were flooded. This flood, which has a recurrence interval of ______, caused an estimated $________ damage.

Land use in the flood plain consists of ______ acres of cropland, ______ acres of pastureland, ______ acres of forest land, ______ acres of urban land. Current cropland includes ______ acres of corn, ______ acres of soybeans, ______ acres of alfalfa, and ______ acres of idle land. Crop and pasture damage is estimated to be $__________ annually. Crop damages begin with the ______ year of flood. Data regarding estimates for crop and pasture damages are shown in table 3.

Table 3 Crop and pasture damage

Evaluation reach 1/	Flood plain (acres)	Production flood free	Production flooded	Damage total	Damage per acre acre	Damage % of flood free
1	_________	$_________	$_________	$_________	$_________	_________
2	_________	$_________	$_________	$_________	$_________	_________
3	_________	$_________	$_________	$_________	$_________	_________
4	_________	$_________	$_________	$_________	$_________	_________
5	_________	$_________	$_________	$_________	$_________	_________
etc.	_________	$_________	$_________	$_________	$_________	_________

1/ Evaluation reaches are shown on the project map.

Other agricultural property located in the flood plain includes ______ farmsteads, and estimated ______ miles of private farm roads, ______ miles of fences, ______ miles of farm levees, and ______ irrigation systems. The flood plain includes ______ acres of irrigated land. Total average annual damage to other agricultural property is $_________. Damages for each of the evaluation reaches are as follows:

Evaluation reach	**Estimated damages**
1	$_________
2	$_________
3	$_________
4	$_________
etc.	$_________
Total	**$_________**

Nonagricultural property subject to damage consists of ______ miles of federal and state roads and ______ miles of county and township roads. ______ road crossings are subject to damage. In addition, ______ miles of railroads, ______ miles of natural gas pipelines, and ______ miles of utility lines are in the flood plain. Damages to roads and railroads include the replacement of surface materials and the cost of sediment and debris cleanout. Cost associated with traffic delays and rerouting traffic, such as school buses, mail delivery, and the delivery of farm products during flood periods when major road repairs are required, are extensive. Damages are estimated to be $_________ annually.

Urban flooding within the town of ____________________ causes floodwater damages to the __________ properties and creates a threat of loss of life to __________ people in the 100-year flood plain. The flood plain within the urban area contains ______ acres and includes __________ residential units, __________ commercial properties, __________ schools, __________ hospitals, __________ public buildings (courthouse, public library, fire station), and __________ undeveloped lots that are damaged by floodwater. The town's water main crosses the creek along ____________________Street. There are __________ miles of city streets of which __________ miles are subject to flooding and can cause disruption of travel that affects accessibility in cases of emergency. Floodwater gets ______ feet above floor level in ______ of the residential units and ______ feet deep in the businesses during the 100-year flood. ______ of the residential units flooded are owned by minorities, of which ______ are owned by people 62 years of age or older. The total number of minorities living in the flood plain is ______. Caucasians own ______ of the residences flooded, of which ______ are owned by people 62 years of age of older. The total number of Caucasians in the urban flood plain is ______. Urban flood damages are summarized in table 4. (**Note:** The sentence in parenthesis should probably be deleted except in those watersheds where it would be significant.)

Table 4 Flood damages by evaluation reach (damages are in average annual dollars)

Evaluation reach 1/	Flood plain acres	Crop & pasture	Other agric.	Urban	Road & bridge	Sediment	Scour	Swamping	Total
1	5,275	126,200	2,000		9,480	15,620	14,070	- - -	167,370
2	6,356	498,320	4,210		23,430	19,820	12,460	- - -	558,240
3	1,030	37,650	2,250		11,980	1,880	1,130	- - -	54,890
4	2,065	92,060	1,910	98,000	6,430	4,950	4,470	1,800	209,620
5	2,223	168,730	2,110		7,340	12,550	8,770	- - -	199,500
6	918	28,620	1,960		500	1,510	1,000	- - -	33,590
7	985	64,820	2,300		3,370	3,100	2,680	- - -	76,270
8	476	30,760	1,200		1,100	1,480	1,060	- - -	35,600
9	752	21,900	610		1,660	1,850	1,580	- - -	27,600
10	1,227	79,860	740		3,450	3,950	1,050	- - -	89,050
11	572	11,310	200		20	- - -	- - -	- - -	11,530
12	748	21,490	1,410		120	380	160	160	23,720
13	765	46,110	4,890		2,970	6,870	3,460	- - -	64,300
14	208	20,065	1,140		30	- - -	- - -	- - -	21,235
Total	**23,600**	**1,247,895**	**26,930**	**98,000**	**71,880**	**73,960**	**51,890**	**1,960**	**1,572,515**

1/ See project map.

Sediment damage (overbank deposition) on the flood plain causes a deteriorations of productivity on an estimated ______ acres of the agricultural flood plain. Table 5 shows the areas affected by sediment and the accompanying loss of productivity.

Table 5 Physical damage of composite acre caused by sediment

Acres damaged	- Loss of net income - (%)	($)
22	10	$__________
18	15	$__________
11	20	$__________
Total		**$__________**

Sediment deposits have interrupted the flow of water from the flood plain. This has resulted in swamping damages on ______ acres of cropland. Table 6 shows areas damaged by swamping and the associated loss in productivity.

Table 6 Physical damage of composite acre caused by swamping

Acres damaged	- Loss of net income - (%)	($)
15	10	$__________
9	20	$__________
5	30	$__________
Total		**$__________**

Erosion (scouring) causes damage on an estimated ______ acres of flood plain land. Scouring generally removes soil material to the plow sole depth and results in substantial crop loss depending on the velocity of the flood flow. Damages for the area affected are shown in table 7.

Table 7 Physical damage of composite acre caused by scouring

Acres damaged	- Loss of net income - (%)	($)
210	10	$__________
180	20	$__________
60	30	$__________
Total		**$__________**

All damages occurring on the flood plain are summarized by evaluation reach in tables 4 and 8.

Table 8 Urban flood damages, average annual

	Residential property					Commercial property			Other urban	Total
reach	no. of yards / lawns	damage ($)	no. houses	damages contents ($)	damages structures ($)	no.	damages contents ($)	damages structures ($)	damages ($)	damages ($)
1	34	4,200	29	16,000	4,000	0	0	0	$2,000	26,200
2	21	2,900	16	8,500	2,000	2	12,000	3,000	3,000	31,400
3	9	1,100	6	2,900	400	6	41,000	10,000	8,000	63,400
Total	**64**	**8,200**	**51**	**27,400**	**6,400**	**8**	**53,000**	**13,000**	**13,000**	**121,000**

Note: Urban evaluation reaches are shown on the urban flood plain map.

Plan–EIS Problems and Opportunities—Continued

Management of water provides opportunities for the development of facilities for water-based recreation activities. Currently, recreation activities are limited to the city park(s) in ____________________ and ____________________ and a minimum amount of stream fishing along ____________________ Creek. At present the unmet recreation demand is estimated as _______ visitor days. According to SCORP, additional picnicking sites, camping sites, swimming beaches, and boating facilities are needed (table 9).

Table 9 Recreation needs

Activity	Units	Available	Demand	Remaining need

An opportunity for water storage to meet present and future needs for municipal and industrial uses exists. The growth in population and the recent expansion in industry (specify where expansion is occurring) makes present supplies inadequate. According to a study prepared by (specify the engineering firm), the present supply will be inadequate by ______ (year). Table 10 shows the expected municipal and industrial water needs. Additional supply will alleviate the problems of rationing and the loss of industrial production that causes unemployment. An additional water supply will also provide for increased fire protection and lower insurance costs. (Data on reduced insurance costs can be attained from the State Insurance Rating Board.)

Table 10 Municipal and industrial water needs

Year	Projected population	- - - - - - Present use - - - - - -		Amount available	- - - - Projected needs - - - -	
		residential	industrial		residential	industrial
Present						
(10 yr)						
(25 yr)						
(50 yr)						

Appendix B Investigation and Analysis Report

Appendix B includes segments from completed plan reports and is intended to serve as an example only. These reports were published before October 20, 1994, when the Soil Conservation Service (SCS) became the Natural Resources Conservation Service (NRCS), so the Agency name throughout this appendix is shown as Soil Conservation Service. The completed plan reports are:

East-West-Dry Maple Creeks Watershed Plan-EA

Recreation Values - Acton Lake

Economics Documentation

Investigation and Analysis Report for East-West-Dry Maple Creeks Watershed

Colfax, Cuming, Dodge, Platte, and Stanton Counties, Nebraska

Abstract

The East-West-Dry Maple Creeks Watershed Plan-Environmental Assessment (EA) describes a project of accelerated land treatment to reduce erosion, sedimentation, and agricultural flooding problems. Alternatives considered during planning included no action and accelerated land treatment measures. The recommended plan consists of accelerated land treatment measures, which include conservation tillage, contour farming, terraces with grassed waterway or outlets, and terraces and/or water and sediment control basins with underground outlets. Economic benefits exceed costs of the proposed plan. The Sponsor and land users will pay 30 percent of the $7,661,400 total installation costs. Other favorable effects include improved fish and wildlife habitat, improved water quality, and improved economic conditions.

The Watershed Plan-EA is intended to fulfill requirements of the National Environmental Policy Act and to be considered for authorization of Public Law 566 funding. It is prepared under the Authority of the Watershed Protection and Flood Prevention Act, Public Law 83-566 as amended (16 U.S.C.-1001-1008) and in accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969, Public Law 91-1010, as amended (42 U.S.C. 4321 *et seq*).

Prepared by: Lower Elkhorn Natural Resources District
U.S. Department of Agriculture, Soil Conservation Service

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Contents

Abstract B–1
List of tables B–2
List of figures B–2
Introduction B–3
Rationale fof Formulation B–3
  Determining without project conditions B–3
  Formulation of accelerated land treatment alternatives B–4
Problems and Opportunities B–14
  Erosion B–14
  Sediment delivery B–15
  Floodwater B–15
Development of National Economic Development Account B–16
  Costs B–16
  Benefits B–16
  Average annual equivalents B–17
Development of Environmental Quality Account B–17
Cost Sharing B–17
  General B–17
  Policies and procedures B–17
Exhibits B–21
  Exhibit A—Recreation Values – Acton Lake Four Mile Creek Watershed Project
  Exhibit B—Belfield Plan – EIS Economics

Tables

1 East-West-Dry Maple Creeks Watershed soil erosion groups by map unit B–5
2 East-West-Dry Maple Creeks Watershed average annual erosion rates B–6
3 East-West-Dry Maple Creeks Watershed present non-irrigated crop yields B–7
4 East-West-Dry Maple Creeks Watershed current erosion areas and changes in damages as affected by conservation practices B–7
5 East-West-Dry Maple Creeks Watershed floodwater damage reduction B–10
6 Incremental analysis of land treatment B–13
7 East-West-Dry Maple Creeks Watershed total erosion with and without project B–14
8 East-West-Dry Maple Creeks Watershed estimated average annual net income per acre with and without project B–14
9 East-West-Dry Maple Creeks Watershed annual sediment delivery with and without project B–15
10 East-West-Dry Maple Creeks Watershed estimated average annual flood damages (without project) B–15
11 East-West-Dry Maple Creeks Watershed land treatment benefits B–16
12 East-West-Dry Maple Creeks Watershed average annual equivalents of costs and benefits of land treatment of SEG 2 for a 40-year period of analysis and 8 5/8 percent interest rate B–18
13 Environmental quality effects—Alternative 2 – NED plan B–19
14 Cost sharing B–19

Figures

1 East-West-Dry Maple Creeks Watershed soil erosion group areas B–5
2 East-West-Dry Naple Creeks Watershed crop yields SEG 1 (without moisture) B–8
3 East-West-Dry Naple Creeks Watershed crop yields SEG 2 (without moisture) B–9
4 East-West-Dry Maple Creeks Watershed economic-incremental analysis of land treatment B–12

Introduction

The principal motivations for the Lower Elkhorn Natural Resource District (herein referred to as Sponsor) request for developing the Watershed Plan-Environmental Assessment for the East-West-Dry Maple Creeks Watershed are: 1) loss of short-term crop production and long-term crop productivity of upland soils as a result of soil erosion; and 2) damages to crops, pastures, roads, and bridges as a result of flooding sedimentation, and scouring. The plan for this project has been formulated to protect the resource base by installing watershed protection measures. The document describes plan formulation; displays expected economic, environmental, and social impacts; and provides the basis for authorizing Federal assistance for implementation. The sponsoring local organization that developed the plan is the Lower Elkhorn Natural Resources District. The U.S. Department of Agriculture's Soil Conservation Service provided assistance to the Sponsor in the development of the plan. Additional financial assistance for plan development was provided by the Nebraska Natural Resources Commission. Other Federal, State, and local agencies provided input into the planning process.

The plan was prepared under the authority of the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended (16 USC 1001-1008) and in accordance with Section 102(2)(C) of the National Environmental Policy Act of 1969, Public Law 91-190, as amended (42 USC 4321 et seq). Responsibility for compliance with the National Environmental Policy Act rests with the Soil Conservation Service.

The purpose of this Investigation and Analysis Report is to provide the reviewer of the Plan and Environmental Assessment Report with brief statements on the methodology and procedures used.

All information and data, except as otherwise noted, were collected during the watershed planning investigation by the SCS, USDA.

Rationale for Formulation

Determining with and without project conditions

Future without-project conditions were forecasted using present conditions as a base and considering trends indicated by existing records, statistical reports, environmental assessment studies, and the Elkhorn River Basin Report. Land treatment was evaluated for long-term resource base deterioration using a soil erosion-crop productivity procedure. Ephemeral annual crop damage was evaluated using procedures developed by the Water Resources Planning Staff and the Resource Conservation Staff (see appendixes A and B). Floodwater damages were analyzed using the ECON 2 computer program for assessment of crop and pasture damages with and without the project. Road and bridge data were collected by the water resources planning staff and analyzed using the Road/Bridge option of ECON 2.

The Soil Conservation Service (SCS) Water Resources Planning Staff worked with other Federal, State, and local agencies, individual watershed residents, private professional services consultants, the Sponsors, and SCS state staff specialists throughout the planning process. Interdisciplinary teams were utilized in the assessment and evaluation of present, future without project, and future with project conditions.

This coordinated planning effort produced a forecasted without-project condition that permitted the consideration of several alternatives. This led to selection of a cost-effective alternative that was socially, politically, and economically acceptable.

Formulation of accelerated land treatment alternatives

The development and analysis of data for this formulation are organized according to the problems, opportunities and the complementary effects as listed in the left hand column of figure 4. The Sponsors and SCS field and state office personnel provided the basic data. A land treatment inventory was developed to determine the amounts, kinds, and costs of land treatment measures. The data included soil survey information, construction costs, technical assistance requirements, land use data, crop yield data, and ongoing program assistance.

Sheet and rill erosion-long term

This section explains development of data for the sheet and rill erosion long-term problem. However, the majority of the data developed also are the basis for the other problems and complementary effects.

All soils in the watershed were inventoried to determine the type and amount of each soil. The critically eroding non-irrigated cropland soils were determined to be composed of fourteen different soil types in two land capability classes.

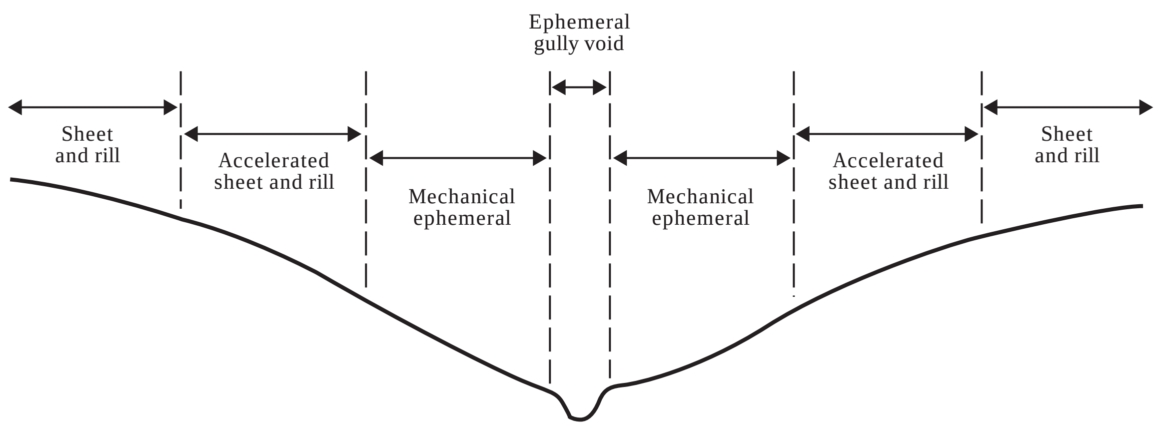
These soils were assigned to Soil Erosion Groups (SEGs) by the Water Resources Planning Staff with technical guidance from the state soil scientist and state resource conservationist. SEGs are defined according to erosion rates and those soil characteristics that are similar to each soil type. The SEGs are displayed in table 1.

Table 1 East-West-Dry Maple Creeks Watershed soil erosion groups by map unit

Map unit	Soil name	Slope	Land cap. class	Estimated acres
	SEG No. 1			
CrC2	Crofton SIL, eroded	2-6	IIIe8	
MoC2	Moody SICL, eroded	2-6	IIIe8	
NoC2	Nora SICL, eroded	2-6	IIIe8	
SEG Total				4,100
	SEG No. 2			
NoD	Nora SICL	6-11	IIIel	
MoD	Moody SICL	6-11	IIIel	
NoD2	Nora SICL, eroded	6-11	IIIe8	
MoD2	Moody SICL, eroded	6-11	IIIe8	
NpD2	Nora-Crofton, eroded	6-11	IIIe8	
CrD2	Crofton, SIL, eroded	6-11	IVe8	
TmD2	Thurman-Moody, eroded	6-11	Ive5	
CrE2	Crofton SIL, eroded	11-15	IVe8	
NpE2	Nora-Crofton, eroded	11-15	IVe8	
NoE2	Nora SICL, eroded	11-15	IVe8	
NoE	Nora SICL	11-15	IVe1	
SEG Total				37,200
Total				**41,300**

These SEGs were divided into four areas: sheet and rill area (74%), accelerated sheet and rill area (13%), mechanical ephemeral area (10%), and voided area (3%). These areas were defined within each SEG based on interrelationships between sheet and rill erosion, ephemeral erosion, and crop yields. Delineation of these four areas within the SEGs was done to provide more detail and accuracy to the economic analysis. Although each area has been named for the dominant erosion process in it other processes can also occur. For instance, the ephemeral void area is subject to sheet and rill erosion that has been superseded by the ephemeral voiding. In the mechanical ephemeral area there is also accelerated sheet and rill erosion since this area is usually at the bottom of convex slope profiles. A cross section is shown in figure 1.

Figure 1 East-West-Dry Maple Creeks Watershed soil erosion group areas



Sheet and rill erosion rate determinations were made for the individual soils in both SEGs using the Universal Soil Loss Equation (USLE). Actual R and K values were taken from SCS technical guides. An average L/S factor for each soil and erosion area were determined in consultation with the local district conservationist and the water resource planning staff. P factors were dependent on the type of treatment specified for each alternative. C factors, also dependent on the alternative, were computed for each crop with a weighed average developed according to the percent of crop distribution in the watershed.

Ephemeral gully erosion has only recently been identified as a separate contributing erosion source, and quantifying procedures are still under development. In the interim, a method using the erosion/sediment-yield subroutine of CREAMS has provided acceptable ephemeral, gully erosion values.

Six alternatives of practices and practice combinations were used throughout the analysis. They are:

Alt. 1 No Treatment - Clean till, up & down hill.
Alt. 2 Conservation Tillage - 30% cover.
Alt. 3 Grassed Waterway or Outlets - 7% of untreated area.
Alt. 4 Combination of Alt. 2 and Alt. 3.
Alt. 5 Terraces, Water and Sediment Control Basins, Underground Outlets, Grassed Waterway or Outlets, Contour Farming.
SEG 1 - Terraces: 100%. Conventional, Contour Farming Grassed Waterway or Outlets - 5% of untreated area
SEG 2 - Terraces and/or Water and Sediment Control Basins, Underground Outlets, Contour Farming.
Alt. 6 Conservation Tillage (40% cover) added to 5 above for each SEG.

Contour farming alone is not considered to be an acceptable practice due to length of slopes in the area. Also, steep slopes prevent the use of grassed waterways or outlets on SEG 2.

For each treatment alternative, erosion rates were calculated for the four erosion areas within each SEG. A weighted average was computed using the actual number of acres of that particular soil. Table 2 shows the average annual rates used for each alternative in its respective SEG.

Table 2 East-West-Dry Maple Creeks Watershed average annual erosion rates

SEG/erosion area	- - - - - - - - - - - - - Conservation practice alternatives - - - - - - - - - - - - -					
	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5	Alt.6
SEG #1						
Sheet and rill	10	5	10	5	3	1
Accelerated sheet & rill	22	11	22	11	5	2
Mechanical ephemeral	114	99	62	57	24	11
Ephemeral gully void	764	683	392	387	153	76
Weighted average	45	36	28	22	7	4
SEG#2						
Sheet and rill	29	16				
Accelerated sheet & rill	45	25	NA	NA	5	2
Mechanical ephemeral	153	128	NA	NA	30	3
Ephemeral gully void	909	823	NA	NA	182	14
Weighted average	70	53	NA	NA	13	6

NA - not applicable

Yield evaluations were completed in an attempt to determine the effects of erosion on crop production for each SEG. The present yield determinations were made by an interdisciplinary team consisting of the water resource planning staff leader, resource conservationist, state conservation agronomist, and state soil scientist. Yield values were based on: actual sample data for each erosion area, previous East-West-Dry Maple crop yield data, soil survey data, and Nebraska Ag Statistics crop yield data for Colfax and Stanton Counties. These yields are shown on the table 3.

Soil erosion-crop yield evaluations were completed on the SEG 1 and 2 non-irrigated cropland soils to determine the effects of erosion on crop production. The Nebraska Estimated Future Yield Procedure described in exhibit A is used to compute the crop yields for the 25-year planning period. Crop yields are displayed in figures 2 and 3.

Table 3 East-West-Dry Maple Creeks Watershed present non-irrigated crop yields

SEG/erosion area	S [1] inch	Corn R [2] (bu)	Corn Present yield (bu)	Soybeans R [2] (bu)	Soybeans Present yield (bu)	Oats R [2] (bu)	Oats Present yield (bu)	Alfalfa R [2] (bu)	Alfalfa Present yield (bu)
SEG #1									
Sheet and rill	9	10	88	7	38	10	70	0.8	3.6
Accelerated sheet and rill	6	10	68	7	28	12	56	1.0	3.1
Mechanical ephemeral	3	10	51	7	28	14	43		2.8
Base or cut off [3]			40		15		30		1.8
SEG #2									
Sheet and rill	6	12	80	7	30	10	65	0.8	3.4
Accelerated sheet & rill	3	12	64	7	24	12	52	0.8	2.9
Mechanical ephemeral	3	12	48	7	24	14	39	1.0	2.4
Base or cut off [3]		12	40		15		30		1.8

1/ S = inches of soil (3 inches for eroded phase; 6 to 9 inches for noneroded phase).
2/ R = yield change in bushels or tons (loss of yield where soil erodes S inches).
3/ Minimum attainable yield where all topsoil is depleted down to the topsoil.

Ephemeral-annual crop damage

The procedure for determining the extent of annual crop damage is explained in exhibit B. The annual crop damage lies within three of the four erosion areas described in this report. Table 4 describes the effects of conservation practices on the size of the annual crop damage areas. The no treatment line indicates the current situation. The annual crop damage is assumed to be a loss of the total crop and thus the total net income on those voided acres.

Table 4 East-West-Dry Maple Creeks Watershed current erosion areas and changes in damages as affected by conservation practices [1]

Conservation practice(s) [2]	Sheet and rill 74% [3] long-term	Accelerated sheet and rill 13% [3] long-term	Accelerated sheet and rill 13% [3] annual crop	Mechanical 10% [3] long-term	Mechanical 10% [3] annual crop	Ephemeral channel 3% [3] no damage	Ephemeral channel 3% [3] damage	Annual crop damage [4]
	Percent							
No treatment (NT)	74	12	1	7	3	0	3	7.0
Cons. tillage (CT)	74	13	0	7.7	2.3	0	3	5.3
Grassed waterway or outlets (GWO)	74	12.5	.5	6.5	1.5	1.5	1.5	3.5
Terraces (GWO)	74	13	0	10	0	2.5	.5	.5
Terraces (UO)	74	13	0	10	0	2.5	.5	.5
Cons. till, grassed waterway or outlets (CT, GWO)	74	13	0	8.5	1.5	1.5	1.5	3.0
Terraces (GWO), CT	74	13	0	10	0	2.5	.5	.5
Terraces (UO), CT	74	13	0	10	0	2.5	.5	.5

1/ Same percentages apply to both SEGs
2/ Abbreviations: NT—no treatment; GWO—grassed waterway or outlets; CT—conservation tillage; Terraces (GWO)—terraces, contour farming & grassed waterway or outlets; Terraces (UO)—terraces, contour farming and underground outlets.
3/ Percentage of field.
4/ Source: Nebraska Ephemeral Crop Damage Procedure.

Figure 2 East-West-Dry Naple Creeks Watershed crop yields SEG 1 (without moisture)

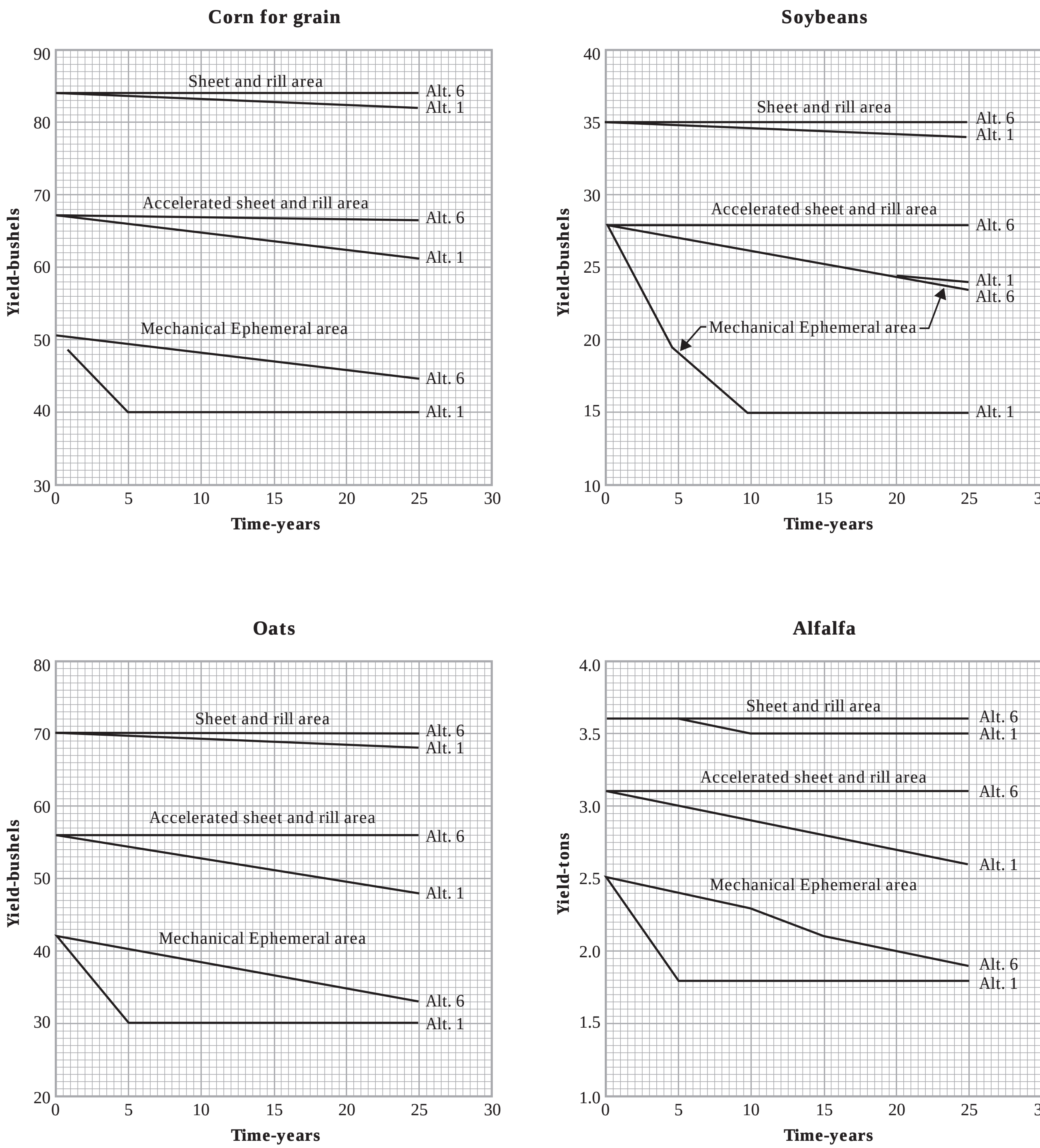
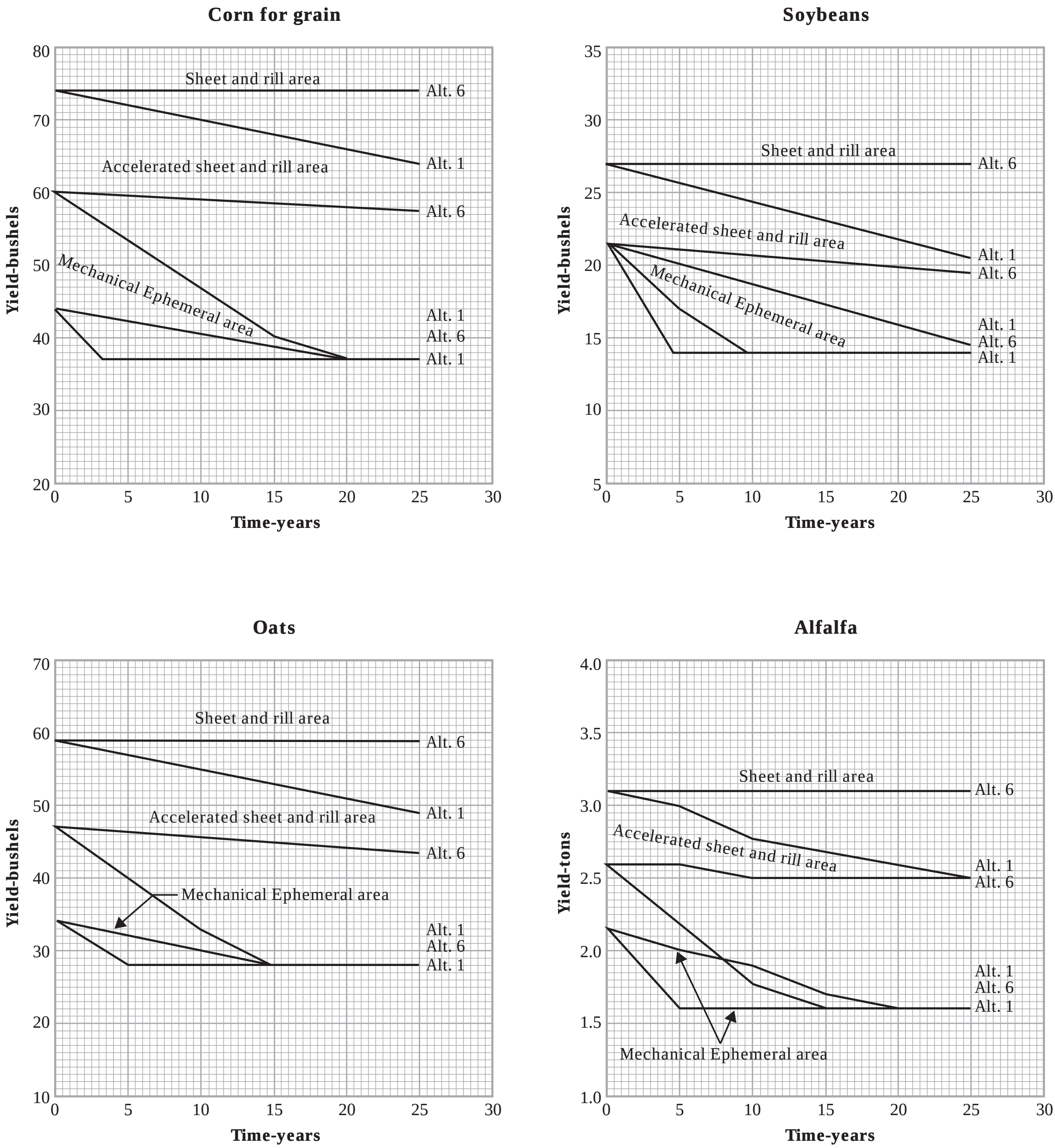


Figure 3 East-West-Dry Naple Creeks Watershed crop yields SEG 2 (without moisture)



Ephemeral deposition

Ephemeral deposition areas occur on Land Capability Class I and II cropland lying below the untreated SEG 1 and 2 cropland, but above the 100-year flood plain. Damages are reduced crop yields resulting from sediment and swamping. In this watershed, 53 40-acre fields were sampled. These samples indicated that for each acre of SEG 1 and 2 upland cropland, there is 0.34 acre (34 percent) of ephemeral deposition area on adjacent Class I and II bottomland cropland. In this watershed, 14,040 acres of ephemeral sediment deposition area are subject to damage from 41,300 acres of SEG 1 and 2 cropland. Crop yield reductions, based on yield samples obtained in October 1985 in eastern Nebraska (including East-West-Dry Maple Creeks Watershed) are 46 percent for corn grain and 40 percent for soybeans. Conservation practices applied to the upland SEG 1 and 2 cropland reduce the damage to Class I and II cropland lying below. These damage reductions are directly related to the respective reduction in total erosion rates as conservation practices are applied to the untreated SEG 1 and 2 cropland.

Roadside sediment

Sediment from various sources accumulates on roadways and in roadside ditches. Sources of the roadside sediment include: agricultural land, roadsides, streambanks, urban areas, and other miscellaneous sources. Colfax and Stanton County officials provided an estimate of average annual expenditures of $140,000 for repair costs to roads and for cleaning sediment from ditches in the watershed. Erosion on untreated SEG 1 and 2 cropland caused about 69 percent of the sediment. This percentage is based on 84 percent of the sediment coming from agricultural land and 82 percent of this coming from untreated SEG 1 and 2 cropland. Conservation practices applied to the upland SEG 1 and 2 cropland reduce the damage to roadways and roadside ditches lying below. The damage reductions are directly related to the respective reduction in total erosion rates as conservation practices are applied to the untreated SEG 1 and 2 cropland.

Floodwater damage

Floodwater damage reduction can, at best, minimally be contributed to land treatment practices. Land treatment measures without detention storage, such as gradient terraces, contouring, and conservation tillage, can reduce the speed in which rainfall contributes to the runoff volume. Land treatment measures with detention storage have more of an effect in the actual reduction of runoff volume. These practices include terraces or water and sediment control basins with underground outlets. Floodwater damage reductions corresponding to the conservation practices have been analyzed, and the results are listed in table 5.

Table 5 East-West-Dry Maple Creeks Watershed floodwater damage reduction

Practices	SEG 1	SEG 2	
	Cropland & pasture	Cropland & pasture	Roads & bridges
	Percent (NA = not applicable)		
No treatment	0	0	0
Conservation tillage	0.5	0.5	0
Grassed waterway or outlets	0	NA	NA
Grassed waterway or outlets, conservation tillage	0.5	NA	NA
Terraces, grassed waterway or outlets, contour farming	0.2	NA	NA
Terraces and/or water and sediment control basins, underground outlets, contour farming	NA	3.5	1.5
Conservation tillage, terraces, grassed waterway or outlets, contour farming	0.2	NA	NA
Conservation tillage, terraces, water & sediment control basins, underground outlets, contour farming	NA	3.7	1.5

Complementary effects

Several effects are associated with the installation of conservation practices. A positive harvestable acre change occurs as ephemeral cropland gullies are eliminated. Harvestable acres are reduced as grassed waterway or outlets are installed. Underground outlets result in a harvestable acre gain. Elimination of the need to mechanically fill ephemeral cropland gullies lowers production cost. Conservation tillage has a lower cost of production. Finally, since soil erosion includes a loss of moisture, conservation practices improve the moisture retention capacity of the soil and subsequently result in increased crop yields.

Crop production costs, prices and interest rates

Crop production costs are calculated using the annually updated University of Nebraska Estimated Crop and Livestock Production Costs with modifications made as necessary using SCS and other sources of data. Current normalized prices (1985) are used for the commodities. The prices are:

- Corn for grain - $2.56 per bushel
- Soybeans - $4.89 per bushel
- Oats - $1.70 per bushel
- Alfalfa hay - $46.63 per ton
- Grazing - $11.64 per AUM

Average annual net income is based on an 8 5/8 percent interest rate.

Incremental analysis

Incremental analysis was used to determine the combination of land treatment practices that provide the highest incremental benefit-to-cost (B:C) ratio. The general flow of the incremental analysis of land treatment is diagrammed in figure 4. The problems and opportunities and the complementary effects are associated with economic damages or benefits (dollars per acre). Alternate solutions to the erosion and income reduction problems are then evaluated by analyzing each individual practice. Subsequent iterations incrementally apply practices to the practice selected in the first iteration. The reduction in erosion rate and the B:C ratio are evaluated in each iteration until the combination of practices is obtained that has the highest B:C ratio and reduces erosion to acceptable levels.

The detailed incremental analysis is shown in table 6. The analysis proceeds as follows for SEG 1. The individual (including some interdependent) practices are evaluated in iteration 1. Conservation tillage has the highest B:C ratio, but the sheet and rill erosion is still 15 tons per acre per year. Since conservation tillage has the highest incremental B:C ratio, it is selected as the base practice for iteration 2.

The other practices in iteration 1 are combined with conservation tillage. The practice combination - conservation tillage and grassed waterway or outlets - has the highest incremental B:C ratio in iteration 2. The remaining sheet and rill erosion is 11 tons per acre per year and ephemeral-annual crop damage is at 124 acres. Because the conservation tillage and grassed waterway or outlets combination has the highest incremental B:C ratio, it is selected as the base practice for iteration 3.

The other practices in iteration 2 are then combined with conservation tillage and grassed waterway or outlets. The practice combination (conservation tillage, terraces with grassed waterway or outlets, and contour farming) has the highest incremental B:C ratio in iteration 3. The remaining sheet and rill erosion is less than 5 tons per acre per year, and ephemeral-annual crop damage is at 21 acres. These rates are acceptable, and the NED combination of practices has been selected.

Figure 4 East-West-Dry Maple Creeks Watershed economic-incremental analysis of land treatment

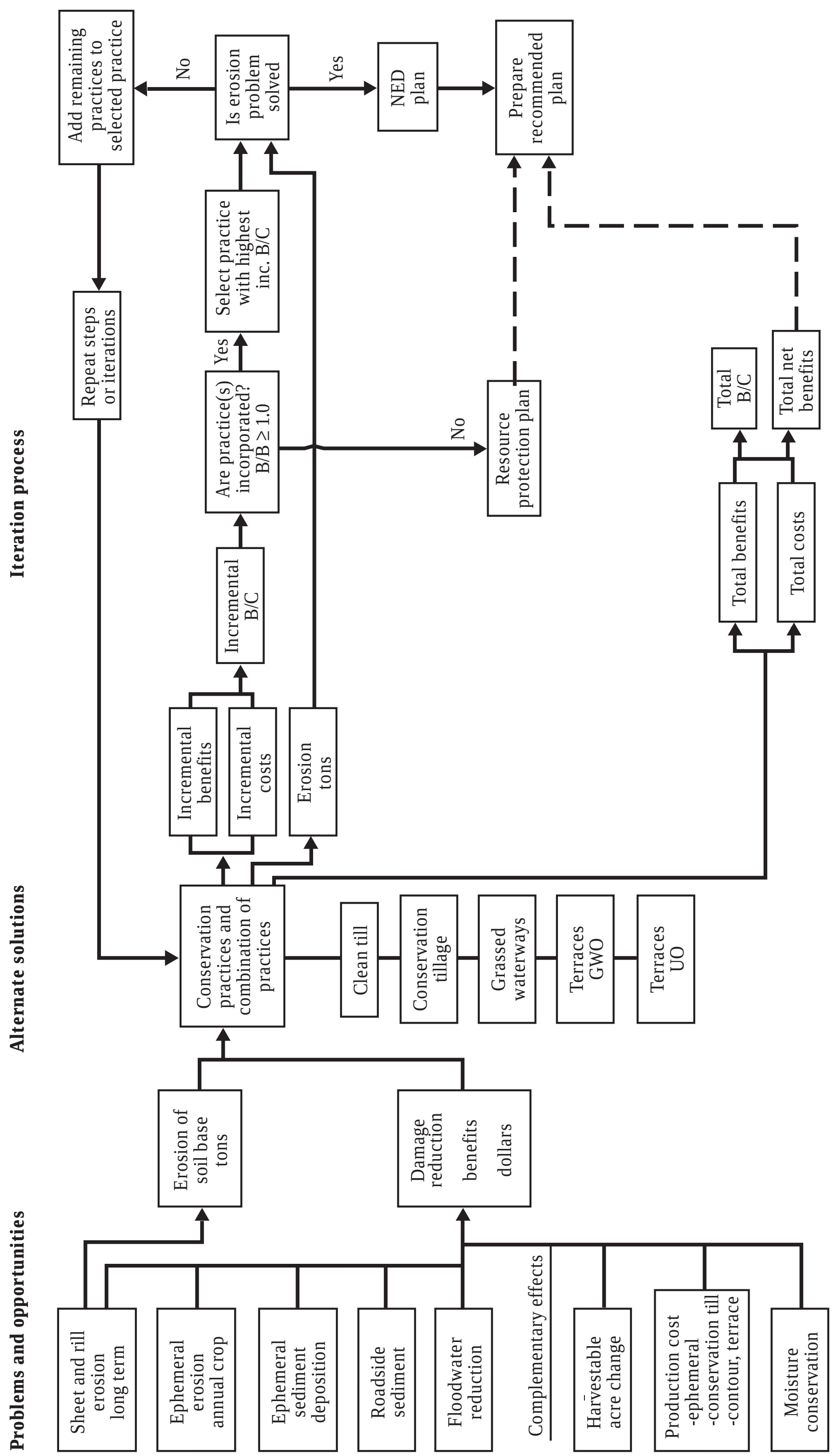


Table 6 Incremental analysis of land treatment

Seg 1

Conservation practice 1/	Resource base-long term Eros rem	Eros red	Dam rem	Dam red	Ephemeral-annual crop damage Eros rem	Eros red	Dam rem	Dam red	Moist. consv. incre.	Prod. actv. chg.	Sediment eph. deposition Dam rem	Dam red	Roadside sediment Dam rem	Dam red	Downstream floodwater Dam red	Dam incre	Incremental Ben	Cost	B/C	Totals Ben	Cost	Net ben	B/C
3/	-----Tons -----		-------- $ --------		----- Acres ------		----------$ ----------		-----------$								----------$ ---------			------------------$ ------------------			
Iter #1																							
NT	22	--	3.42	--	287	--	6.14	--	--	0	20.99	--	2.34	--	0	--	0	0	--	0	0	0	--
CT	15	7	2.59	.83	217	70	5.60	.54	.70	5.00	16.77	4.28	1.86	.48	.16	.16	11.99	0	99.99 2/	11.99	0	11.99	99.99 2/
GW	16	6	3.10	.32	144	143	2.43	3.71	0	.16	13.33	7.66	1.49	.85	0	0	12.90	6.76	1.91	12.90	6.76	6.14	1.91
Ter(GWO)	5	17	2.41	1.01	21	266	.73	5.41	1.95	-11.68	3.19	17.80	.36	1.98	.63	.63	17.10	12.51	1.37	17.10	12.51	4.59	1.37
Iter #2																							
CT	15	--	2.59	--	217	--	5.60	--	--	5.00	16.71	--	1.86	--	.16	--	11.99	0	--	11.99	0	11.99	--
CT, GW	11	4	2.20	.39	124	93	2.37	3.23	.27	5.36	10.54	6.17	1.17	.69	.16	0	16.11	6.76	2.38	28.10	6.76	21.34	4.16
CT, Ter(GWO)	5	10	.45	2.14	21	196	.73	4.87	2.38	-6.60	2.00	14.63	.23	1.63	.63	.47	19.52	12.51	1.56	31.51	12.51	19.00	2.52
Iter #3																							
CT, GW	11	--	2.20	--	124	--	2.37	--	--	5.36	10.54	--	1.17	--	.16	--	16.11	6.76	--	28.10	6.76	21.34	--
CT, Ter(GWO)	5	6	.45	1.75	21	103	.73	1.64	2.11	-6.60	2.08	8.46	.23	.94	.63	.47	8.77	5.75	1.53	36.87	12.51	24.36	2.95

Seg 2

Conservation practice 1/	Resource base-long term Eros rem	Eros red	Dam rem	Dam red	Ephemeral-annual crop damage Eros rem	Eros red	Dam rem	Dam red	Moist. consv. incre.	Prod. actv. chg.	Sediment eph. deposition Dam rem	Dam red	Roadside sediment Dam rem	Dam red	Downstream floodwater Dam red	Dam incre	Incremental Ben	Cost	B/C	Totals Ben	Cost	Net ben	B/C
3/	-----Tons -----		-------- $ --------		----- Acres ------		----------$ ----------		-----------$								----------$ ---------			------------------$ ------------------			
Iter #1																							
NT	43	--	7.93	--	2604	--	4.94	--	0	0	20.99	--	2.34	--	0	--	0	0	--	0	0	0	--
CT	28	15	5.13	2.80	1972	632	4.62	.32	.61	5.00	15.74	5.25	1.76	.58	.16	.16	14.72	0	99.99 2/	14.72	0	14.72	99.99 2/
Ter(UO)	8	35	2.01	5.92	186	2418	.59	4.35	5.64	-10.88	3.93	17.06	.44	1.90	1.28	1.28	25.27	23.99	1.05	25.27	23.99	1.28	1.05
Iter. #2																							
CT	28	--	5.13	--	1972	--	4.62	--	--	5.00	15.74	--	1.76	--	.16	--	14.72	0	--	14.72	0	14.72	--
CT, Ter(UO)	5	23	.63	4.50	186	1786	.59	4.03	4.77	- .49	1.81	13.93	.20	1.56	1.35	1.19	29.49	23.99	1.23	44.21	23.99	20.22	1.84

1/ Abbreviations: NT - no treatment; GW - grassed waterway; CT - conservation tillage; Ter(GWO) - terraces, contour farming and grassed waterway or outlets; Ter(UO) - terraces, contour farming and underground outlets; Eros - erosion; Red - reduction; Dam - damage; Ben - benefit; Rem - remaining; Incre - increment; Iter - iteration.

2/ The benefit divided by 0 is represented as 99.99.

3/ All benefits and costs calculated on a per acre equivalent basis.

Problems and Opportunities

Erosion

Total erosion without the project is 4,877,200 tons per year. The project will reduce total erosion by 20 percent to 3,897,800 tons per year. It will reduce annual sheet and rill erosion by 479,400 tons (23%) and annual ephemeral gully erosion by 473,700 tons (20%) Table 7 shows the reductions with and without project. Within the project area itself, this tonnage indicates much greater reductions equal 81 percent for sheet and rill erosion and 80 percent for ephemeral gully erosion. From an average annual net income perspective, not controlling sheet and rill and ephemeral gully erosion will reduce net income $10.88 per acre of untreated cropland as compared to the with project alternative.

Table 7 East-West-Dry Maple Creeks Watershed total erosion with and without project

Erosion source	Without project	With project	Reduction	
	- - - - - - Tons per year	- - - - - -	- - - - - -	%
Sheet and rill	2,087,600	1,608,200	479,400	23
Ephemeral gully	2,367,500	1,893,800	473,700	20
Gully	5,600	5,100	500	9
Streambank	397,000	373,000	24,000	6
Flood plain scour	19,500	17,700	1,800	9
Total erosion	**4,877,200**	**3,897,800**	**979,400**	**20**

Agricultural income would be improved from increased production on SEG 1 and 2 cropland. Estimated income increases associated with erosion control ranged between 13 percent for SEG 1 and 32 percent for SEG 2 (table 8).

Table 8 East-West-Dry Maple Creeks Watershed estimated average annual net income per acre with and without project

SEG	Acres to be treated	Without project	With project	Net benefit	Percent increase
		- - - - - - Dollars	- - - - - -	- - - - - -	
1	2,800	62.41	70.27	7.86	13
2	25,400	35.31	46.52	11.21	32

Sediment delivery

Without the project annual sediment delivery to the mouth of the watershed equals 2,685,100 tons per year. With the project this amount will be reduced by 23 percent to 2,061,100 tons per year (table 9).

Table 9 East-West-Dry Maple Creeks Watershed annual sediment delivery with and without project

Erosion source	Without project	With project	Reduction	
	----------------- Tons per year		----------------	%
Sheet and rill	648,400	464,000	184,400	28
Ephemeral gully	1,671,300	1,253,400	417,900	25
Gully	4,000	3,700	300	8
Streambank	351,600	331,100	20,500	6
Scour	9,800	8,900	900	9
Total sediment	**2,685,100**	**2,061,100**	**624,000**	**23**

Floodwater

Flooding from a 100-year storm occurs on 24,300 acres of flood plain land. Storms of a 10-year frequency or less are responsible for the majority of the flood damages. Average annual floodwater damages are estimated to be $999,100. A 15-year flood inundates about 18,800 acres, or about 77 percent of the 100-year flood plain. Some flooding occurs every year.

Land use on the flood plain consists of 21,700 acres of cropland, 2,100 acres of grassland, 300 acres of forest land, and 200 acres of other land. Current flood plain cropland includes 10,800 acres of corn, 8,700 acres of soybeans, and 2,200 acres of alfalfa. Average annual floodwater damages are summarized in the table 10.

Table 10 East-West-Dry Maple Creeks Watershed estimated average annual flood damages (without project)

Damages	Dollars 1/
Crop and Pasture	880,800
Road & Bridges	118,300
Total	**999,100**

1/ Price base 1985

Development of National Economic Development Account

The NED plan consists of accelerated land treatment measures. The following is some background in how the National Economic Development account was developed.

Costs

Construction costs are direct costs, such as earthwork, excavation, and seeding. The unit costs used in the engineer's estimate were based primarily on costs of previous watershed protection projects and county average costs in Nebraska. The water resources planning staff maintains a cost summary based on recent unit prices.

Technical assistance costs were based on actual costs that the SCS has experienced on installation of land treatment practices. It is calculated as a cost to apply an amount of each practice.

Cost of operation, maintenance, and replacement (OM&R) of the measures was based on experience from similar practices and adjusted to meet local conditions.

Benefits

Benefits from land treatment were computed using the various procedures in the section on Formulation of Accelerated Land Treatment Alternatives. The incremental analysis of erosion rates, annual crop damage acres, and net income changes for each SEG gives the combination oil practices for the NED plan. The land treatment measures selected produce land treatment benefits of $43.46 per acre (table 11).

Table 11 East-West-Dry Maple Creeks Watershed land treatment benefits

SEG	Acres to be treated	Percent	NED benefits per acre ($)
1	2,800	10	36.87
2	25,400	90	44.21
Total	**28,200**	**100**	**43.48**

Benefits for flood damage reduction were computed using table 5. The benefits are as follows:

Without project	999,100
With project	963,000
Reduction benefit	36,100
Percent reduction	4

Average annual equivalents

The method used for this plan includes converting all benefits and costs to an average annual equivalent over the 40-year period of analysis. The period of analysis includes the 15-year installation period plus the 25-year evaluation period. All the benefits and costs were discounted from the year that they were planned to incur to the beginning of the 40-year period of analysis by converting them to present value equivalents. When the present values were determined, they were amortized over the 40-year period of analysis to establish average annual equivalents. To provide an example, the values for SEG 2 of the land treatment measures (table 12) are described in the following text.

The present value of the $7,315,200 capital expenditure for land treatment measures is $4,449,619 resulting in an average annual equivalent of $398,336. The present values of the annual increments of OM&R costs and total benefits accrued over the 40-year period are $280,772 and $6,975,442, respectively. The average annual equivalents are $25,135 and $624,451, respectively. These values result in a benefit-to-cost ratio of 1.47 for SEG 2 (table 12).

Development of environmental quality account

An assessment was made of the environmental quality (EQ) effects of the National Economic Development (NED) plan (Alt. 2). No permanent negative EQ effects were identified for the candidate plan. Table 13 lists significant EQ effects of the candidate plan.

Cost sharing

General

Construction costs were allocated 65 percent and 35 percent between SCS and the sponsor, respectively (see table 14).

Policies and procedures

The Watershed Plan-EA details the policies and procedures of cost sharing. Land treatment measures will be installed by means of long-term contracts between the land users and the SCS. Land users have indicated a willingness to participate in the program at public meetings conducted by the Sponsors.

The Sponsors, by resolution at official board meetings, have committed their administrative and capital resources to provide funds for installation of the project structural measures.

Table 12 East-West-Dry Maple Creeks Watershed average annual equivalents of costs and benefits of land treatment of SEG 2 for a 40-year period of analysis and 8 5/8 percent interest rate

Years	Present value factor	Capital costs	Present value costs	OM&R costs	Present value	Benefits	Present value benefits
1	0.92060	365760	336718	0	0	0	0
2	0.84750	512064	433975	2260	1915	56147	47585
3	0.78021	694944	542201	5650	4408	140367	109516
4	0.71826	731520	525421	10170	7305	252660	181475
5	0.66123	914400	604627	14690	9713	364953	241317
6	0.60873	731520	445295	20340	12381	505320	307601
7	0.56039	731520	409938	24860	13931	617614	346106
8	0.51590	548640	283041	29380	15157	729907	376556
9	0.47493	548640	260567	32770	15564	814127	386655
10	0.43722	548640	239878	36160	15810	898347	392777
11	0.40251	365760	247221	39550	15919	982567	395489
12	0.37055	365760	135531	41810	15493	1038714	384892
13	0.34112	197510	67375	44070	15033	1094860	373483
14	0.31404	36576	11486	45200	14195	1122934	352645
15	0.28910	21946	6345	45200	13067	1122934	324644
16	0.26615	0	0	45200	12030	1122934	298867
17	0.24502	0	0	45200	11075	1122934	275136
18	0.22556	0	0	45200	10195	1122934	253290
19	0.20765	0	0	45200	9386	1122934	233178
20	0.19116	0	0	45200	8641	1122934	214664
21	0.17598	0	0	45200	7954	1122934	197619
22	0.16201	0	0	45200	7323	1122934	181928
23	0.14915	0	0	45200	6741	1122934	167482
24	0.13730	0	0	45200	6206	1122934	154184
25	0.12640	0	0	45200	5713	1122934	141942
26	0.11637	0	0	45200	5260	1122934	130671
27	0.10713	0	0	42940	4600	1066787	114281
28	0.09862	0	0	39550	3900	982567	96901
29	0.09079	0	0	35030	3180	870274	79012
30	0.08356	0	0	30510	2550	757981	63353
31	0.07694	0	0	24860	1913	617614	47522
32	0.07083	0	0	20340	1441	505320	35794
33	0.06521	0	0	15820	1032	393027	25629
34	0.06003	0	0	12430	746	308807	18538
35	0.05527	0	0	9040	500	224567	12412
36	0.05088	0	0	5650	287	140367	7143
37	0.04664	0	0	3390	159	84220	3945
38	0.04312	0	0	1130	49	28074	1211
39	0.03970	0	0	0	0	0	0
40	0.03654	0	0	0	0	0	0
Total		**7,315,200**	**4,449,619**		**280,772**		**6,975,442**
Avg ann equivalents		**398,336**			**25,135**		**624,451**
Benefit-to-cost ratio		**1.47**					

Table 13 Environmental quality effects—Alternative 2 – NED plan

Significant resources	Effects on EQ attributes: ecological	cultural	aesthetic
Soil	Beneficial—Stabilize soil resource base for food and fiber production	No Effect	Beneficial—Improved conservation ethic image of residents
Water	Beneficial—Improve water quality	No effect	Beneficial—Improved clarity of water and beauty of landscape
Prime farmland	Beneficial—Protect prime farmland	No effect	No effect
Wetlands	No effect	No effect	No effect
Streams	Beneficial—Reduced sediment	No effect	Beneficial—Improved beauty of landscape
Fish habitat	Beneficial—Improve existing warm water fishery potential	No effect	Beneficial—Provide less sediment laden water
Wildlife habitat	Beneficial—Increase habitat and habitat edge on 28,200 acres of cropland	No effect	Beneficial—Increase habitat and habitat edge for landscape beauty enhancement

Table 14 Cost sharing

Works of improvement/item	Sponsor/ land user (%)	NRCS (%)	Estimated total project costs 1/ ($)
Land treatment measures			
Construction costs	35	65	6,013,200
Technical assistance	10	90	1,650,200
OM&R	100	0	29,800 2/

1/ Price base 1985
2/ Average annual equivalent

Exhibit A
Recreation Values - Acton Lake
Four Mile Creek Watershed Project

Background

User days at Hueston Woods State Park range from 1.7 to 2.5 million annually. For 1986, strictly water-based recreation use was 65,593 visits for fishing, 167,293 visits for boating, and 167,085 visits for swimming. This total of 397,971 visits for water-based recreation represents approximately 16 percent of the 1986 total of 2,424,526 user days.

This project will have no impact on providing now recreational facilities or displacing existing recreational opportunities within the watershed. The value of water-based recreation at Hueston Woods State Park will not be changed through increased acreage of water or improved accessibility. However, the project should increase the value to the user by reversing the trend of declining water quality in Acton Lake.

The primary water quality problem for recreation in Acton Lake is the large amounts of sediment entering the lake and the resultant high turbidity. Although total phosphorus levels in the lake are relatively high also, excessive plant growth has not resulted. Algae are probably kept in check through intense predation by fish, and zooplankton macrophytes are probably affected by the reduced light penetration due to turbidity. The cause of occasional elevated bacterial counts is uncertain at this time.

Method used

The Unit Day Value (UDV) method was selected to estimate recreation benefits from the application of land treatment measures. Since no applicable regional model exists, specialized recreational activities are not involved, annual visits are less than 750,000, and no recreation costs are part of the project. Neither the Travel Cost method nor the Contingent Valuation method was considered feasible or justified.

Using the methods described in Principles and Guidelines, point values for the UDV were assigned by Romy Myszka, recreation specialist, and Jan Whitcomb, economist. These values were later reviewed and revised by Mark DeBrock, recreation specialist. Staff from Hueston Woods State Park, ODNR-Division of Wildlife and professors at Miami University familiar with Acton Lake were all consulted in the process of assigning these values.

Values selected

The values shown in this section were selected using the judgment-factors and range of values in table VIII-3-2 of Principles and Guidelines.

Without project
Criteria A, Recreation Experience—Several general activities, one high quality value activity (11-16) = 16. This was rated at the high end of the range due to the existence of the raptor rehabilitation program. These birds are open to viewing by the public, and an explanatory talk is given by park personnel at various times. Only a few of these facilities are in the United State, so this provides an unusual opportunity for park visitors.

Criteria B, Availability of Opportunity—Several within 1 hour, none within 30 minutes travel time (4-6) = 4. One large lake is located just over 30 minutes away; therefore, the low end of the range was selected.

Criteria C, Carrying Capacity—Optimum facilities to conduct activity at site potential (9-11) = 10. Park facilities include a marina, lodge, cabins, golf courses, outdoor amphitheater, and nature trails.

***Criteria D, Accessibility*—**Good access, high standard road to site; good access within site (15-18) = 15. Interstate 70 is about 20 miles away with state highways to the park. Roads within park boundaries are paved. Lower end of range selected due to distance from interstate highway.

***Criteria E, Environmental Quality*—**Average esthetic quality; factors exist that lower quality to a minor degree (3-6) = 3. Water quality is impaired due to suspended sediment resulting in occasional closing of swimming beach and marina and perception of poor fishing quality. Low end of range selected since problem is on the verge of significantly impacting quality of site.

With project

***Criteria A, Recreation Experience*—**No change.

***Criteria B, Availability of Opportunity*—**No change.

***Criteria C, Carrying Capacity*—**No change.

***Criteria D, Accessibility*—**No change.

***Criteria E, Environmental Quality*—**Above average esthetic quality; any limiting factor can be reasonably rectified (7-10) = 8. Some suspended sediment will still remain, but it should be less than similar sites in the area. The need for dredging, closures, fish stocking, and artificial fish habitat manipulation will be minimized. (Next section provides more information on rationale for change.)

Four Mile Creek Recreation User Day Points

Criteria	Without project	With project
Recreation experience	16	16
Availability of opportunity	4	4
Carrying capacity	10	10
Accessibility	15	15
Environmental quality	3	8
Total	**48**	**53**

Rationale for chance

Turbidity and sedimentation affect the quality of water for recreation in a variety of ways. Highly turbid water may be so aesthetically unpleasant as to cause people to abandon use of them for boating, fishing, water skiing, and swimming. Even where turbidity is not bad enough to discourage use, certainly turbid water is less pleasant for use than clearer water. Even activities not directly related to water, such as hiking or picnicking, may be made less pleasant by reduced water quality.

Safety and ease of swimming and boating can be negatively affected by turbidity and sedimentation. Swimmers and boaters are unable to see obstacles or dangers in turbid water, and rescue of accident or drowning victims is difficult. Shallow depth due to sedimentation reduces the accessibility of areas for boaters and swimmers. In Acton Lake, boaters complain about the loss of access to areas in the upper end of the lake due to sedimentation. Boaters may also be concerned about fouling or staining of boats and equipment.

Recreational fishing may be affected by turbidity and sedimentation in two ways. Changes in water quality and habitat due to turbidity and sedimentation influence the type and size of fish that will inhabit a lake. The effects are well known and include loss of spawning areas, reduced light penetration, increased anaerobic conditions, smothering of eggs, reduction of plant growth important to fish and decrease in invertebrate food sources. The relationship between predator and prey fishes is also altered with changes in turbidity. All these often lead to a situation where less desirable fish species or smaller fish predominate the population. Although Acton Lake still maintains good populations of desirable game fish, such as largemouth bass, crappie, sunfish and catfish, there is concern that the stage is set for a decline in desirable fish species due to deteriorating habitat quality. Actions that have been taken (stocking tiger muskellunge, artificial habitat improvement by local angler clubs) can only offset some of the changes due to declining habitat quality.

The second effect of turbidity and sedimentation on recreational fishing is a decrease in the quality of the fishing experience. As with swimming and general boating, people enjoy fishing in a turbid lake less than a clearer lake. Accessibility to sites and reduction of area available results from increased sedimentation. Fishers may also be concerned about fouling of fishing gear and boats or the undesirability of handling or eating fish from turbid water. Angler success is also decreased in turbid water due to the decreased distance at which fish can see and respond to lures or baits.

The actual impact of turbidity on use for recreation may be less than an individual's perception of that impact. Some people will continue to use turbid water for recreation even at elevated levels of turbidity. However, if people perceive that Acton Lake's desirability for water-based recreation is decreased through turbidity and sedimentation, this can result in lessened use or lessened enjoyment of times they do use the lake.

Since there is very little information directly relating certain levels of turbidity or sedimentation to changes in use of bodies of water for recreation, the change in points is based on professional judgment rather than the application of any formula or quantitative analysis. There is no way to directly relate sediment input reduction to an exact change in water clarity (whether measured by Secchi disc readings, suspended solids concentrations, or turbidimeter readings). However a noticeable improvement in water quality can be reasonably expected with the 70 percent reduction of sediment input that will be accomplished with project. It can be reasonably assumed that a correction of the major problem affecting recreational usage of Acton Lake (i.e., sedimentation and turbidity) would result in improved quality of the lake for recreation. The qualitative nature of this evaluation is sufficient to justify the modest change in UDV points for this site.

Since the high turbidity may be having a dampening affect on the growth of algae or macrophytes, there is concern that reducing the sediment-caused turbidity levels in Acton Lake will result in plant growth to nuisance levels. This could have a negative impact on recreational values. This problem is likely to be minimal, however, due to a variety of reasons.

Although phosphorus levels (both in sediment and dissolved in lake water) are relatively high, there are factors weighing against massive plant growth in response to excess nutrients. Large, deep, turbid reservoirs that have moderate to fast flushing rates (such as Acton Lake) are less responsive to phosphorus inputs than smaller, shallower lakes with longer residence time. Although turbidity will be reduced, some will continue, which restricts plant growth to a lesser degree. Dredging that may continue (although on a less frequent basis) will remove some of the phosphorus stored in sediment that would be a problem even with greatly reduced phosphorus inputs from the watershed. Fish predation on phytoplankton will continue and possibly increase with improved water quality.

Increased macrophyte growth is likely in some areas of the lake due to increased light penetration. This has a positive impact on fishery habitat and the removal of even more suspended solids; however, it negatively impacts recreational use if the growth is excessive in swimming or boating areas. Again the response may be dampened by decreased phosphorus availability from current levels. Weed removal may be necessary in certain areas, such as near the marina or in swimming areas. Weed removal is much less costly than dredging sediment, however, and would be less of an impediment to recreational use of Acton Lake.

Prepared by: Mark DeBrock, May 1991

Exhibit B
Belfield Plan—EIS
Economics

Flood damages were estimated to residential and commercial properties located in the flood plain of the Heart River and its unnamed tributary in the city of Belfield. There are 281 structures, residential and commercial, within the 100-year flood plain. The evaluation of damages was limited to existing properties. Of the 281 structures, 53 are commercial. These commercial structures are located mostly along Main Street and Second Avenue. The rest of the structures are housing units or garages and storage structures related to the housing units.

Evaluation reaches were determined by the SCS engineer and economist to evaluate the damages to residential and commercial properties. The determinations were based on natural breaks, such as bridges and the confluence of the Heart River and its tributary.

The Urban Floodwater Damage Evaluation (URB1) computer program was used to analyze the urban flood damages. Data needed for this analysis were obtained from interviews with homeowners, business people, and town officials. These data were compared to the U.S. Army Corps of Engineers (COE) publication, *Inventory of Structures Within the Flood Plain/Floodway of the Heart River, Belfield, North Dakota,* prepared for the North Dakota State Water Commission (SWC), September 1987. The data collected consisted of house values and business values (structure and contents of each).

Flood damages were estimated for residential and commercial properties based on an inventory of the structures. The inventory included information on property and content values, business or house type, structure type, valley stationing, flood elevation, and elevation to first floor. URB1 used the data to calculate damages by flood frequencies and average annual damages. Flood frequencies used in calculating damages were the 2-, 5-, 10-, 25-, 50-, and 100-year flood frequency storms. In a separate run, the 500-year frequency was also evaluated.

The average annual damages to city streets, bridges, and utilities were calculated by using a historical method of analysis. The city provided data on previous flooding events and the damages incurred by these events. The North Dakota State Water Commission also provided some input on these damages.

For the alternative chosen, URB1 was used to evaluate the current conditions only, since this alternative will reduce damages to zero.

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Glossary

Acceptability The workability and viability of the alternative plan with respect to acceptance by state and local entities and the public, and to compatibility with existing laws, regulations, and public policies.

Acres per hour Speed (mph) times width (ft) times efficiency (%) divided by 8.25.

Agricultural benefits The adjustment in land use with structural and nonstructural measures designed to reduce or prevent damages from surface water caused by floodwater. Water quality improvement is reflected in the reduction of chemicals, nutrients, and agricultural waste.

Alternative cost Expenditures for achieving a goal or objective similar to one previously evaluated.

Alternative plan A system of structures and/or nonstructural measures, strategies, or programs formulated to alleviate specific problems or take advantage of specific opportunities associated with water and related land resources in the planning area.

Amortization Converting capital or initial cost to annual cost by determining the size of annual payments needed to pay off a debt over a given time at a given interest rate.

$$\frac{i(1+i)^n}{(1+i)^n - 1}$$

where: i = interest rate and n = number of periods

Amount of an annuity of $1 per year How much an annuity invested each year will grow over a period of years. (i = interest rate, n = number of time periods)

$$\frac{(1+i)^n - 1}{i}$$

where: i = interest rate and n = number of periods

Annuity A series of payments made over time. An annuity may be a benefit or a cost.

Assessed value The estimated worth of property for general property tax purposes.

Average annual benefits All the quantifiable benefits for the evaluation period described in average annual terms.

Average annual cost Initial cost of capital amortized to an annual cost plus the necessary operation, maintenance, and replacement costs.

Average annual equivalent (annualized)
: The present value (at a given interest rate) of benefits and costs that occur at subsequent intervals over the period of analysis. Present values are then annualized by amortizing over the period of analysis at the given interest rate. Intervals are identified by the schedule of obligations.

Average product
: The ratio of total output (a total product) to the quantity of input used to produce that amount.

Base period
: A point in time with which other index numbers are compared; for example, the year 1967 = the base index 100.

Basic crops
: Crops grown throughout the United States in quantities such that no water resource project would affect the price and thus cause transfers of crop production from one area to another.

Benchmark
: The resource setting from which options are evaluated. A benchmark is commonly thought of as representing the current resource setting.

Benefit-to-cost ratio
: A mathematical computation where benefits accruing from some action are divided by the cost of the action.

Breakeven point
: The point where the proceeds from total output of an alternative plan equal the costs of all inputs associated with that alternative.

Capital
: One of the four traditional factors of production used to produce goods and services. Capital is normally defined to include such items as machinery, livestock, buildings, and/or cash that can be used to purchase or trade for other resources. Capital does not include land and labor contributed toward the production of goods and services.

Capital investment
: Monetary expenditures necessary for initial installation of a practice or system.

Capital recovery period
: The length of time an individual or group may chose to retire (pay off) a debt (see Evaluation period).

Cash outlay
: Direct cash expenditures for purchase items, such as farm supplies, hired labor, and services.

Competitive enterprise
: A business entity that increases its own production to capture a greater share of the market, thus causing other competing entities to decrease their production.

Complementarity
: Where an increase in the production of one good or service causes an increase in production of another.

Completeness
: The extent to which a given alternative provides an account for all necessary investment or other action to ensure the realization of the planned effects.

Composite acre
: A weighted unit showing the percentage or proportion that each crop is of the total cropland acreage.

Compound interest — Interest that is earned for one period and immediately added to the principal, thus resulting in a larger principal on which interest is computed for the following period.

$$(1+i)^n$$

where: i = interest rate, n = number of periods

Compound interest and annuity tables — A collection of factors used to express the functions of interest rate and time.

Contingent value method — The valuation of a recreation experience is based on what users say they are willing to pay.

Cost effectiveness analysis — An appraisal technique especially useful where benefits cannot be reasonably measured in money terms. On a present value basis, the least expensive alternative combination of tangible costs that will realize essentially the same benefits should be identified. The combination is often referred to as *least cost* or *cost effectiveness*. Once it is determined that the least expensive alternative has been identified and its costs valued, then the subjective question "is it worth it?" can be more readily addressed.

Cost and return estimator (CARE) — An interactive software program designed for use on a microcomputer to create or adjust cost and return estimates (crop budgets).

Crop budget — A systematic listing of resources used, their cost for specified yield levels, and the value of the output by individual crops or enterprises.

Crop budget system — A computerized system designed to create and adjust cost and return estimates.

Cropping pattern — The crops that are currently grown in the evaluation area. Project the most probable cropping patterns expected to exist with and without project.

Current normalized prices — The weighted average of prices received for a commodity over the preceding 3- to 5-year period.

Custom rate — The usual fee for farm services rendered; generally for machine hire.

Damage factors — Data from actual or projected damages used to calculate or estimate with and without project conditions and to estimate the impacts of developed alternatives.

Demand — The quantity of goods (or services) that consumers will purchase at a certain price.

Deposition — Soil movement (erosion) from one location to another resulting in the covering of fertile soil sediment, which results in a less productive soil.

Depreciation — A decrease in the value of property through wear, deterioration, or obsolescence.

Diminishing returns	A condition where each successive unit of input adds less to total output than the previous unit.
ECON2	An economic evaluation computer program for floodwater damages that computes average annual damages to crops and pasture, other agricultural damages, and damages to roads and bridges.
Economic analysis	An analysis done using economic values. In general, economic analysis omits payments, such as credit transactions, and values all items at their value-in-use or their opportunity cost to the society.
Economics	The science of allocating limited resources among competing ends so as to maximize some desired quality or benefit.
Economies of scale	Ability of business firms to spread their fixed costs over larger quantities of output.
Effective economic life	The point where the present worth of expenditures for extending the life of a facility exceeds the present worth of its benefits.
Effectiveness	The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.
Efficiency	The extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specific opportunities, consistent with protecting the Nation's environment. Considered a measuring stick for evaluating choices based on the ratio of output to input.
Environmental quality account (E.Q.)	Displayed in appropriate numeric units or non-numeric terms and measures ecological, cultural, and aesthetic attributes of significant natural and cultural resources.
Evaluation period	The period beginning at the end of the installation. Based on the expected useful economic life.
Evaluation unit	Areas that may be grouped based on like physical characteristics, like treatment requirements, or both.
Factors of production	Resources, either human (labor) or nonhuman (capital), used for producing goods or services that in turn satisfy wants. The four factors of production commonly identified are land, labor, capital, and management.
Fair market value	The price at which an informed owner of an asset would sell that asset to an informed and willing buyer.
Family labor	Nonhired labor inputs from an individual or from their household.
Financial analysis	Analysis done to determine effects of a particular action or plan on the liquidity, cash flow, or profitability of a business or enterprise.
Fixed cost	Expenditures an enterprise would incur even if no output were produced.

Flood plain An area defined by such characteristics as depth, velocity, and storm frequencies including the 100-year and 500-year storms for urban projects.

Flood plain scour Temporary damage to crop productivity resulting from soil removal from a specific location.

Future with project The future conditions that will exist, actual or estimated, for each alternative and the approved plan of action.

Future without project The future conditions, actual or estimated, most likely to exist in the absence of the proposed plan or project.

Gross returns Total production in units multiplied by the price per unit.

Hydrologic unit A drainage basin or watershed that collects and discharges its surface streamflow through one outlet or mouth, typically implying a topographic divide.

Installation period The number of years required to install the measures of the planned alternative.

Intensification benefits The calculated changes in net income and land values for with and without project measures.

Interactive conservation evaluation (ICE) Software program designed for use on a microcomputer to make economic analyses of the costs and benefits of conservation.

Interdependent measures Practices that are dependent upon another practice(s) to realize its full potential impact of reducing or preventing damages to a resource.

Interest The earning power of money or the price for the use of money.

Interest rate The cost of using borrowed capital or the value placed on using owned capital, either determined by demand, time, or risk.

Internal rate of return The interest rate money will earn as the total investment is repaid by its revenues.

Lagged A value that takes place sometime in the future.

Least costly alternative The lowest expenditure for installing, operating, and maintaining a system or systems of conservation measures to achieve a specified objective.

Limited resource farmer Farmers who, when compared to other farmers and farming operations in a given geographic area (state, county, or project area), have distinct disadvantages in obtaining United States Department of Agricultural program assistance.

Management A decisionmaking process of determining how land, labor, and capital will be combined into an enterprise or organization for the purpose of obtaining one's objective.

Marginal analysis Determining the level of production where marginal costs are equal to marginal benefits and net benefits are maximized.

Marginal benefits The additional benefit of producing one more unit of output.

Marginal costs The additional cost of producing one more unit of output.

Marginal rate of substitution The amount of one commodity or product a consumer is just willing to give up in order to get an additional unit of another commodity or product.

Maximum net benefit The level of development where the value of total output minus the value of total required input is the greatest.

Mean Mathematical average obtained by dividing the sum of two or more quantities by the number of these quantities.

Median Designating the middle number or the middle between two numbers in a long series of ordered numbers or values.

Mode Mathematical most frequent value of a set of data, or the value that maximizes a probability function.

National economic development (NED) account The only required account that measures increases in the economic value of the national output of goods and services from the plan and is displayed in monetary terms.

Net returns The residual value of production after total costs of production are subtracted from the gross returns.

Nonagricultural benefits Benefits that are damage reductions to transportation facilities, such as road, bridges, and railroads. Also included are damages to residential, commercial, and industrial properties, utilities, and other publicly owned properties.

Number of years (or periods) hence Number of years (or periods) into the future for which the calculations are being made.

Objective Qualified goals or achievements to answer or solve projected needs as expressed by a person or group of persons.

Operating cost Expenditures for machine operation that generally include lubrication, repairs, and fuel (not applicable to all machines).

Operation, maintenance, and replacement (1) Actual expenditures and donated services to ensure proper functioning of the facility or measure throughout its intended life. (2) Capital outlay required to maintain the benefit stream and planned mitigation measures.

Opportunity costs The earning capabilities of money for use in alternative investments having similar risks and timeframes.

Other agricultural benefits The reduction of onfarm damages other than crop production. Urban and community impacts and effects on life, health, and safety that may be displayed in monetary or non-monetary terms.

Overhead costs Expenditures associated with the farm organization, not generally influenced by levels of production or kinds of crops grown. Examples include most utilities, machine shop and related shop tools, and accountant or management fees.

Overland flow Flood water that has no defined course and may damage various areas with each flood event within the flood plain.

Ownership costs Costs unrelated to rate of annual use, such as expenditures for depreciation, taxes, interest on investment, insurance, and housing.

P & G *The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* provides for an orderly development and use of water and related land resources studies with a consistent set of economic standards and criteria.

Partial budgeting A technique where only the relevant changes in income and production costs are identified, listed, and used in the analysis.

Perennial crops Those having a life cycle of more than 2 years.

Performance rate Rate of accomplishment based on machine width, tractor speed, and the percent efficiency.

Period of analysis This includes the installation and evaluation periods. It must be the same for each alternative plan and includes time for significant or adverse effects not to exceed 100 years. Appropriate consideration must be included for environmental factors.

Perpetuity An indefinite or extremely long period.

Planning horizon The period within which a businessowner, farmer, or rancher formulates goals for the operation or business.

Present value (present worth) Future costs or benefits discounted or lagged to show their current value.

Present value of a decreasing annuity Today's value of an annuity that is not constant, but decreases uniformly over time.

Present value of an annuity of 1 per year The discounted or lagged value of a series of equal payments to be covered over a period of years.

Present value of an increasing annuity Today's value of an annuity that is not constant, but increases uniformly over time.

Present value of 1	The amount that must be invested now at compound interest to have a value of 1 in a given length of time or what $1 due in the future is worth today. Also known as the discount factor or the reciprocal of the compound interest factor.
Price	The exchange value for commodities generally determined through the market system.
Price base	A common level of prices generally adjusted using price indexes.
Principal	The initial investment exclusive of interest.
Prior appropriation (water rights)	Water rights that have been allocated by legal entitlements associated with landownership.
Production costs	Expenditures, both fixed and variable, for all items required for specified levels of crop or livestock production.
Projections	Best estimates of future development, based upon historical trends, analysis of current relationships, and an evaluation of foreseeable conditions.
Public participation	An integral part of planning with local people and units of government that provides opportunities for the public to be involved in an exchange of data and decisionmaking.
Quality differential	Changes achieved through resource improvement in quality of harvested crop that affects per unit prices received.
Recurrence of flooding adjustment	The time interval of flooding where damages exist from a previous flood event and the current flooding event.
Regional economic development (RED) account	This account shows the changes in the distribution of regional economic activity that result from each alternative plan. The effects may be displayed in monetary terms, non-monetary terms, or both.
Rent (pure economic)	The price paid for the use of land and other natural resources that are completely fixed in total supply.
Riparian (water rights)	A right (as access to or use of water) of one owning riparian land that is defined as relating to or living or located on the band of a natural watercourse or lake.
Salvage value	The monetary value of an investment at the end of its economic life, usually the trade-in value as new equipment is purchased.
Sediment damages	The movement of soil to where deposits result in lost production or cost is incurred to remove it.
Simple interest	Money earned on the principal only and not on accumulated interest.

Sinking fund A program for capital accumulation over a period of years. The factor indicates how much needs to be invested annually to accumulate a given amount over a given number of years at a specified compound interest rate (reciprocal of the amount of an annuity of 1 per year).

Streambank erosion The removal of soil from the streambank by water movement. This is considered a permanent resource damage.

Substitution of capital The continuing application of new technological innovations to improve production efficiencies over what could previously be provided.

Supplementary enterprise Production from one enterprise is increased without increasing or decreasing production of another enterprise.

Supply The quantity of a good or service a firm is willing to produce to sell at a given price.

Travel cost method Participation at a recreation site decreases as out-of-pocket and time cost of travel to the site increases.

Unit cost Monetary value or charge per unit; e.g., cost per cubic yard of concrete, cost per acre of owning an 18-foot self-propelled combine.

Unit value day The value is based on expert or informed opinion and judgment to estimate the willingness of the public to pay for a recreational experience.

URB1 A flood water damage economic evaluation computer program that computes average annual damages to buildings, their contents, and other properties located within the urban area flood plain.

Value added The increase in value resulting from doing something to or with the product.

Variable costs Costs relevant to production or those occurring only as production takes place.

Watershed protection project Federally or locally funded projects that have land treatment measures only and address the resource problems without the requirement to comply with P&G.

Water resource project Projects including structural measures that could include land treatment in the planned alternatives. It must comply with P&G if Federal funds are used.

With condition The anticipated situation projected to occur in the future if the proposed conservation measures are installed.

Without condition The anticipated situation projected to occur in the future if the proposed conservation measures are not installed.