NATIONAL ECONOMIC DEVELOPMENT

US Army Corps of Engineers®

IWR INSTITUTE FOR WATER RESOURCES

NATIONAL ECONOMIC DEVELOPMENT PROCEDURES MANUAL

OVERVIEW

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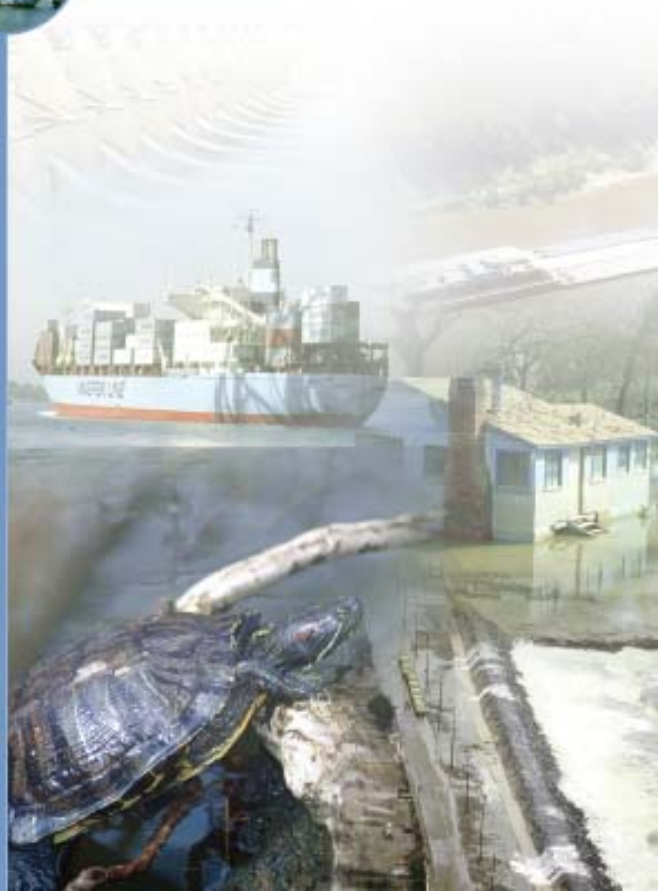

U.S. Army Institute for Water Resources

The Institute for Water Resources (IWR) is a Corps of Engineers Field Operating Activity located within the Washington DC National Capital Region (NCR), in Alexandria, Virginia and with satellite centers in New Orleans, LA and Davis, CA. IWR was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional, and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of strategies and tools for planning and executing the Corps water resources planning and water management programs.

IWR strives to improve the performance of the Corps water resources program by examining water resources problems and offering practical solutions through a wide variety of technology transfer mechanisms. In addition to hosting and leading Corps participation in national forums, these include the production of white papers, reports, workshops, training courses, guidance and manuals of practice; the development of new planning, socio-economic, and risk-based decision-support methodologies, improved hydrologic engineering methods and software tools; and the management of national waterborne commerce statistics and other Civil Works information systems. IWR serves as the Corps expertise center for integrated water resources planning and management; hydrologic engineering; collaborative planning and environmental conflict resolution; and waterborne commerce data and marine transportation systems.

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Foreword

"*The Corps of Engineers Planning Excellence Program is designed to build planning capability now and for the future. Economics is a vital component of the planning process and updating the National Economic Development manual series is a key element of the Planning Excellence Program. I appreciate the efforts of the interdisciplinary team from across the Corps that contributed to this manual. I am pleased to endorse this manual for use throughout the Planning Community of Practice.*"

-Harry Kitch
U.S. Army Corps of Engineers, Headquarters
Chief of the Planning Community of Practice

This manual provides an overview of basic economic concepts and measures underlying the use of National Economic Development (NED) analysis in civil works planning studies. It was developed to complement the series of separate Procedures Manuals that provide detailed procedural guidance on computing NED benefits for different NED purposes.

This document was prepared by Paul Scodari of the Corps of Engineers (Corps) Institute for Water Resources (IWR), under the guidance of Dr. David Moser (IWR), who is the U.S. Army Corps of Engineers' Chief Economist, and Dr. Leonard Shabman, who at the time of manual development was the Arthur Maass-Gilbert White Visiting Scholar at IWR. Drs. Moser and Shabman also served as expert reviewers for various drafts of the manual. Erin Wilson and Susan Durden were the project managers. The penultimate manual draft was also reviewed by Lillian Almodovar (IWR), Susan Durden (IWR), Erin Wilson (IWR), John Burns (former employee of the US Army Corps of Engineers (USACE) Headquarters Office), and Harry E. Kitch (Chief of Planning Community of Practice, USACE). This document was prepared under the IWR Program in support of the Corps Planning Community of Practice.

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1. Introduction

1.1 Background

The Civil Works Program of the U.S. Army Corps of Engineers (Corps) includes a variety of program areas that involve different activities concerned with the management of water and related land resources to serve the nation's needs. Corps decision-making within these program areas necessarily confronts choices among possible alternative courses of action that involve tradeoffs in economic and other opportunities. The Corps uses economic analyses for the evaluation of economic tradeoffs in order to reach decisions that promote the efficient allocation of scarce societal resources. For example, the Corps uses economic analysis to support planning and decision-making for new or modified civil works projects; for decisions relating to the operation of existing water civil works infrastructure, such as dam regulation and the dredging of harbors and inland navigation channels; and for decisions relating to the decommissioning and rehabilitation of aging water infrastructure. The Corps has also sometimes relied on economic analysis to support permit decisions within the Clean Water Act Section 404 permit program involving proposed public water supply projects.

The primary guidance document that sets out principles and procedures for the formulation, evaluation, and selection of civil works project plans to recommend for federal involvement is the *Principles and Guidelines* (P&G).[1] Another guidance document, the *Planning Guidance Notebook* (PGN), provides Corps policy guidance for implementing the P&G and other Corps policies.[2] The P&G states, "The Federal objective of water and related and land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment…" It further explains, "Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units…" With regards to plan selection, the P&G states, "A plan recommending Federal action is to be the alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (the NED plan)…" The P&G thus directs the Corps to formulate, evaluate, and select alternative project plans based on their estimated net economic benefits (plan benefits less and plan costs) expressed in dollars. The Corps refers to such economic analysis as "NED analysis."

In the civil works project planning context, NED analysis can be generally defined as economic benefit-cost analysis for plan formulation, evaluation, and selection that is used to evaluate the federal interest in pursuing a prospective project plan. The P&G analytical framework for the use of NED analysis relates specifically to civil works

[1] U.S. Water Resources Council. 1983. *Economic and Environmental Principles and Guidelines for Water and Related Implementation Studies*. It is important to note that Congress, in the Water Resources Development Act of 2007, directed the Secretary of the Army to revise this guidance document to conform with a number of planning concepts, considerations, and tools enumerated in the act. At the time of this writing, Corps Headquarters had published in the *Federal Register* (on September 12, 2008) proposed revisions to the "principles" part of the guidance document for public review and comment.
[2] ER 1105-2-100 (22 April 2000).

project planning; nevertheless, all Civil Works Program Areas rely to some extent on NED analysis to support decision-making.

1.2 Purpose and Scope

The purpose of this manual is to provide readers with a basic conceptual and practical understanding of the use of NED analysis in civil works planning. Towards that end, this manual:

- Reviews the conceptual foundation of the basic benefit-cost framework and economic standard of value defined by economic theory and presented in Corps planning guidance, and

- Relates this conceptual basis to the specific economic benefit measures defined by guidance (the P&G and the PGN) for different categories of goods and services. The set of goods and services for which NED benefit measures are explicitly addressed in guidance and that are considered in this manual include: flood damage reduction, hurricane and storm damage reduction, transportation (inland and deep draft navigation), agriculture, commercial fishing, municipal & industrial water supply, hydropower, and recreation.

This manual uses the civil works project planning context to illustrate the conceptual foundation of NED analysis and to relate that foundation to the specific economic measures of NED benefits and costs for the different goods and services considered in planning guidance. However, as noted above, the economic concepts and measures considered in this manual are broadly applicable to informed decision-making for all civil works activities.

1.3 Intended Audience

The primary audience for this manual includes Corps economists and planners who conduct or rely on NED analysis for civil works planning and decision-making. As the primary practitioners and users of NED analysis, these Corps personnel require a basic conceptual understanding of the economic benefit-cost framework and standard of value outlined in planning guidance, as well as the strengths and limits of the economic measures defined by guidance for evaluating the economic benefits and costs of alternative plans. Such an understanding can help Corps economists and planners to 1) identify and apply potential adjustments or alternatives to the benefit measures defined by guidance that may be practical and warranted in particular planning contexts, and 2) anticipate and respond to potential questions about NED analyses in planning studies.

A secondary audience for this manual includes non-federal sponsors of civil works projects and other project stakeholders who need to understand the general focus of and specific economic measures used by the Corps for NED analysis. That audience can benefit from an improved understanding of what NED analysis measures and considers for decision-making, and why. As one example, this manual reviews the distinctions

between NED benefits and other types of project effects that non-federal sponsors and project stakeholders often care about, and why those distinctions matter for evaluating the federal interest in civil works involvement.

1.4 Organization

The manual is organized as follows. Chapter 2 provides background on the relationships between economic theory and the civil works planning framework defined by Corps planning guidance. It reviews the economic rationale for federal involvement in civil works, and the role played by the NED objective and NED analysis in civil works planning and decision-making.

Chapter 3 provides an overview of the conceptual foundation underlying the use of NED analysis in civil works project planning. It first defines and reviews the conceptual basis and economic measures of NED benefits and costs. It then considers various types of potential project effects that are not recognized by guidance as NED effects, and discusses the conceptual and empirical differences between those effects and NED effects.

Chapter 4 reviews the measures of NED benefits and costs set out in planning guidance. It first reviews the specific NED measures for evaluating project benefits for different categories of goods and services, and then comments on the potential correspondence between these benefit measures and the economic standard of value defined by guidance. Chapter 4 also outlines economic measures for representing NED costs, noting the distinction between measures of NED benefits foregone by project plans and the financial costs of project plans.

Appendix A provides a more detailed explanation of the concept of economic value that is the basis for NED analysis, and Appendix B discusses the rationale and procedure for accounting for the timing of estimated plan benefits and costs for NED analysis.

2. Background: Economics and Civil Works Planning

2.1 Introduction

This chapter provides an overview of the relationship between certain economic concepts and civil works planning that underlie the National Economic Development (NED) objective to increase the net economic value of the national output of goods and services. It outlines the economic rationale for federal involvement in civil works projects, the NED objective for civil works planning, and the role played by economic analysis in the planning process.

2.2 Public Goods and the Market Failure Rationale for Civil Works

In our decentralized economy, most goods and services are supplied through markets via price signals. The price mechanism organizes economic activity by coordinating the decisions of millions of economic actors—including consumers, producers, and owners of productive resources—toward the mutual fulfillment of each other's wants. Price signals determine what goods are produced and in what quantity, the most efficient mode of production, and how goods are distributed to consumers according to their preferences. In well-functioning, competitive markets, the price mechanism is presumed to ensure the efficient production and consumption of goods and services.

Not all desired goods and services can be efficiently supplied by commercial markets via price signals, however. For example, so-called public (or collective) goods represent a case of such "market failure." The most important characteristic of pure public goods that precludes their commercial supply is non-excludability. An excludable good is one that can be withheld by suppliers from potential consumers who do not pay for it; that is, excludable goods are characterized by well-defined, exclusive property rights. If consumer demand for an excludable good is sufficiently high, entrepreneurs will have an economic incentive to produce the good for commercial sale. With a pure public good, by contrast, once produced it is freely available to all potential consumers. Since pure public goods can not be withheld from potential consumers who do not pay for them, they can not be profitably supplied by the private sector. Pure public goods thus can not be efficiently supplied through markets via the price mechanism, and provide an example of market failure that might warrant government intervention.[3]

While examples of pure public goods are exceedingly rare, a wide variety of desired goods and services—including many water resource services—are characterized by some degree of "publicness" that may require government actions to ensure their efficient supply. From an economic efficiency perspective, whether or not the production of such goods warrants government involvement turns on the costs of excluding potential non-

[3] Another type of market failure that might warrant government intervention relates to situations in which people have incomplete information on goods and services. For example, to the extent that people do not have full information on the flood risks associated with land uses, this represents a form of market failure that might warrant government action. Determining what that action should be, however, is a separate issue.

paying beneficiaries, since, in principle, exclusion generally is not impossible. That is, for services characterized by some degree of publicness, it would be possible for suppliers to prevent consumers who do not pay for them from reaping their benefits, but only at some cost to the supplier. As long as the costs of excluding non-paying consumers from enjoying the benefits of some service are minimal, then the private sector might be able to recoup all production and exclusion costs and profitably supply the service in the commercial marketplace. In that event, the economic case for government intervention breaks down, and service supply should be left entirely to the private sector. But as the costs of exclusion rise, then it becomes increasingly less possible for the private sector to recover production and exclusion costs through commercial sale. Thus, the economic case for government investment in the supply of water resource services rests on whether the costs of excluding non-paying users are high enough to preclude efficient market supply.

A few examples can help illustrate situations in which the market failure justification for government involvement in the provision of water and related land resource services might and might not hold. Consider a proposal to build a navigation channel that could possibly serve only one specific private company. Since there are no other potential beneficiaries, the benefiting company faces no exclusion costs, and thus there is no market failure rationale for government investment in the channel. That same conclusion might extend to a case in which the proposed channel would benefit several, clearly-defined private companies. Any one of those companies would not be expected to build the channel at its own expense if it were excessively costly for that company to prevent the others from using the channel. Nevertheless, it might be possible for the several firms to form a consortium for the purpose of pooling resources to finance and build the channel for their collective use under rules that ensure that each member realizes a net economic benefit from the venture. In this second case, as in the first, there would be no market failure rationale for government investment in the channel. In both cases, a private entity (a single company or consortium of several companies) should be left to build the channel at its own expense according to its own evaluation of private benefits and costs. As the number of possible channel beneficiaries increases beyond several well-defined companies; however, the costs involved in establishing a private consortium to build the channel, or the costs of preventing others outside the consortium from using the channel once it is built, could become prohibitive, thus precluding the possibility of private sector supply. In that case, the channel would not be built in the absence of government involvement.

Another relevant issue involves what particular level(s) of government should bear the responsibility for providing water resource services that could not otherwise be efficiently supplied in the marketplace. Consider a city that seeks to secure flood damage reduction infrastructure for the protection of city residences and businesses. To the extent that this infrastructure would provide flood damage reduction benefits only for properties that lie within municipal city limits, then it might be argued that the city should pay the full costs of the project under the presumption that those people who benefit from

a project should pay for it.[4] But if project benefits would be realized by the owners of widely-dispersed properties extending well beyond city boundaries, then an economic case could be made for sharing project costs with higher levels of government.

The above discussion provides some insight into the market failure (i.e., economic efficiency) basis for federal involvement in water resource development. Establishing the market failure justification for federal involvement in civil works is seldom clear cut. However, the one example of when federal civil works involvement is never appropriate involves situations in which water or land resource enhancements would benefit only a single, clearly-identifiable landowner or private company. Beyond that obvious example lie mostly grey areas. The important point is that the wider the geographic or other scope of water resource problems, the greater is the economic rationale for government participation in general, and federal participation in particular, in addressing those problems.

The market failure rationale provides the general economic case for why the Corps Civil Works Program is needed. But it is Congress that ultimately determines when and where the Corps shall participate in civil works planning, by conferring to the Corps general programmatic and specific study authorities. And Congress is the final decision-maker for the authorization and federal funding of recommended plans for specific projects. These congressional decisions appropriately consider political factors, such equity and ability-to-pay considerations.

2.3 Civil Works Planning for National Economic Development

A Corps project planning study to address specific water and related land resource problems in some area involves translation of the basic problem into area-specific planning objectives, the formulation of alternative plans to address them, plan evaluation and comparison, and the possible selection of a plan to recommend for federal funding. The prominent role played by National Economic Development (NED) analysis in this planning process is briefly reviewed below.

2.3.1 Federal Objective and Plan Selection Criterion

Corps planning guidance defines the federal objective and plan selection criterion for civil works project planning as follows:

> The Federal Objective
>
> *(a) The Federal objective of water and related land resource project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.*

[4] In this case, an economic rationale for at least government regulation of the project might still hold if the project had the potential to impose external costs on others residing outside the city (e.g., external costs associated with increased downstream flooding).

(b) *Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed.*

(c) *The Federal Objective for the relevant planning setting should be stated in terms of an expressed desire to alleviate problems and realize opportunities related to the output of goods and services or to increased economic efficiency.* (P&G, Chapter I, Section II)

Plan Selection

(a) *The alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (the NED plan) is to be selected unless the Secretary of a department or head of an independent agency grants an exception when there is some overriding reasons for selecting another plan, based on other Federal, State, local and international concerns.* (P&G, Chapter I, Section X)

Together, the federal objective and plan selection criterion for civil works projects indicate that, at the individual project level, planners should formulate, evaluate, and select plans to recommend for federal involvement that provide the greatest net economic benefits to the nation as a whole, subject to an environmental protection constraint.[5] This direction is based on the presumption that federal civil works investments should be considered only for project plans that maximize net economic benefits—measured in terms of a single index of monetary value—realized by the nation as a whole. That is, the federal objective and plan selection rule impose a "national economic efficiency" standard for federal participation in a civil works project without regards to the distributional consequences for affected individuals (i.e., who gains and who loses). Planners are directed to formulate plans for relevant project purposes (e.g., inland navigation) that contribute to the NED objective, and to recommend for federal implementation the plan that maximizes the difference between money measures of aggregate benefits and costs, as calculated by summing measured economic gains and losses (including the financial costs required to implement projects) realized by affected individuals.[6]

[5] The P&G states, "Protection of the Nation's environment is to be provided by mitigation of the adverse effects of each alternative plan" [P&G, Chapter 1, Section VI, 1.6.1(g)]. In particular, mitigation measures are presumed to satisfy the environmental protection constraint, and the costs of these measures are included in the calculation of net economic benefits of alternative plans.

[6] The policy assertion that civil works planning should identify and recommend for federal involvement project plans that maximize the difference between aggregate economic benefits and costs to all affected individuals considered together is based on the so-called "potential compensation principle" (or "Kaldor-Hicks criterion"). This normative decision rule presumes that if those individuals who would gain from a project could, *in principle*, fully compensate those individuals who would lose from the project, and after

2.3.2 NED Analysis and the Planning Process

Following the federal objective and plan selection criteria, **NED analysis** in the civil works project planning context can be generally defined as economic benefit-cost analysis for plan formulation, evaluation, and selection that is used to determine the federal interest in pursuing a prospective project plan.

The P&G establishes a six-step process for civil works project planning:

1. Specification of water and related land resources problems and opportunities (relevant to the planning setting) associated with the federal objective and specific state and local concerns.
2. Inventory, forecast, and analysis of water and related land resource conditions within the planning area relevant to the identified problems and opportunities.
3. Formulation of alternative plans.
4. Evaluation of the effects of alternative plans.
5. Comparison of alternative plans.
6. Selection of a recommended plan based upon the comparison of alternative plans.

These planning steps are part of an incremental and iterative planning process that is dynamic and involves feedback effects across the various steps that may sharpen the planning focus or change its emphasis as new information is generated. NED analysis, as defined above, is also an incremental process that plays a role within each step and iteration of the planning process. It relies on the **marginal analysis** of benefits and costs for the formulation, evaluation, and selection of alternative plans that provide incremental changes in the net value of desired goods and services.

NED analysis is perhaps most obviously associated with steps 2, 4 and 5 of the planning process involving the estimation, aggregation, and then comparison of economic values for goods and services affected by alternative project plans. In step 2, determination of the economic conditions expected to prevail over time if any project plan were not implemented is a critical component of NED analysis for civil works planning. This **without-project condition** establishes the common baseline from which the incremental NED benefits and costs of project plans are evaluated. Only when both the with- and without-project conditions over a consistent time-period have been established can the cause-and-effect relationship between project plans and NED benefits and costs be estimated and compared in steps 4 and 5.

In practice, NED analysis is not limited simply to the evaluation and comparison of economic costs and benefits for alternative plans that are formulated separately from the process of NED analysis. For example, information on the economic conditions associated with resource problems and opportunities, and the potential incremental

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Continued from previous page. providing this compensation the gainers would still be better off, then the project would increase overall national economic well-being.

economic benefits and costs of alternative management actions, is needed to identify specific planning problems and opportunities in step 1, and for formulating initial plans to address them in step 3. And as more complete information on incremental economic costs and benefits of alternative plans are generated in subsequent planning iterations, that information may cause planners to step back and redesign plans or formulate new plans.

In sum, NED analysis in the civil works project planning context represents economic benefit-cost analysis that is used to evaluate the federal interest in pursuing a prospective project plan. NED analysis is used to formulate, evaluate, and compare alternative plans by measuring and aggregating economic values for the goods and services affected by the alternatives, as measured against a common without-project condition. The NED analyst measures the economic benefits associated with changes in the quantity, quality, or costs of using the affected goods and services with versus without each plan under consideration. These estimates for some plan are then summed to calculate total NED benefits for that plan. NED analysis is also used to estimate the total NED costs for each plan, which includes any economic opportunities foregone (e.g., reduced recreation benefits) as a result of some plan, as well as the financial costs of implementing the plan. The sum of the estimated NED costs for some plan are then netted from the plan's estimated total NED benefits to calculate net NED benefits for that plan. In civil works planning for traditional NED purposes, such as urban flood damage reduction and inland navigation, the alternative plan with the greatest net NED benefits is defined as the NED Plan, which is interpreted to be the economically-optimal project plan. The next chapter reviews the conceptual foundation of NED analysis.

3. Conceptual Foundation of NED Analysis

3.1 Introduction

This chapter provides an overview of the conceptual foundation underlying the use of NED analysis in civil works project planning. It first defines and reviews the conceptual basis and economic measures of NED benefits and costs. It then considers various types of potential project effects that are recognized by Corps planning guidance as something other than NED effects, and discusses the conceptual differences and potential overlap between these effects and NED effects.

3.2 Definition and Conceptual Basis of NED Value

Corps planning guidance recognizes that the choice of alternative project plans to recommend for federal involvement necessarily involves tradeoffs, and directs the use of **economic value** as the basis for measuring their "worth." The P&G describe the appropriate measure of economic value as follows:

> *The general measurement standard of the value of goods and services is defined as the willingness of users to pay for each increment of output from a plan. Such value would be obtained if the "seller" of the output were able to apply a variable unit price and charge each user an individual price to capture the full value of the output to the user.* [P&G, Section 1.7.2(b)]

In any project context, alternative plans will be formulated that would produce different effects on desired goods and services as compared to a common "without-project" baseline. Economic value, as measured by users' aggregate willingness-to-pay for plan effects on goods and services, is defined as the measure to be used to assign economic worth to these tradeoffs.

Conceptually, the **willingness-to-pay (WTP)** measure of economic value represents tradeoff rates between two different situations. This suggests that economic value is relative—it can only be defined and measured with reference to a choice that necessitates tradeoffs. In the civil works project planning context, **NED benefits** is a measure of the monetary equivalent of goods and services that society would be willing to give up in order to obtain plan outputs, and **NED costs** is a measure of the monetary equivalent of goods and services that the resources required or displaced to achieve plan outputs could buy. (A more detailed explanation of the concept of economic value that is the basis for defining NED benefits and costs is presented in Appendix A)

3.2.1 Consumer Sovereignty and Revealed Preference

The concept of economic value based on the tradeoffs that people make in pursuit of their own well-being follows from the economic principle of **consumer sovereignty**. That principle conveys the notion that people, in their roles as consumers of goods and services, know what is in their individual best interests. Accordingly, the consumption

decisions of people ultimately determine how resources are allocated to the production of goods and services that serve their wants or "preferences." In the civil works planning context, recognition of consumer sovereignty suggests that the specific preferences used to evaluate the prospective choice of alternative plans should be the preferences held by the citizens that would be affected by those plans.

The concept of economic value thus follows from the premise that each person is the relevant judge of what is best for that person based on the degree to which his or her personal preferences are satisfied. Economic theory presumes that each person has well-defined and stable preferences for alternative bundles of goods and services that include goods that are exchanged in the marketplace (marketed goods) as well as goods that are not (non-marketed goods), and that each person possess full information on the characteristics of goods and services. Another important presumption is that each person has broad scope for the substitution among goods in the pursuit of individual preference satisfaction. In other words, the effect of a decrease in the consumption of some good on a person's level of preference satisfaction can be offset through an increase in the consumption of other goods. This substitution possibility lies at the heart of the WTP basis for valuing plan benefits (and benefits foregone) in civil works planning.

In sum, the concept of economic value that corresponds to the definition of NED value rests on the premise that the economic well-being of people derives from individual preference satisfaction. Further presumptions are that people know their preferences before being confronted with a choice; that people have full information on the objects of choice before a choice is made; that people are willing to make tradeoffs to satisfy their preferences; and that whatever a person chooses is in the best interest of that person.

Acceptance of these premises implies that the tradeoffs that a person makes as he or she chooses less of one good in favor on more of another good reveals the person's preferences for this tradeoff. This economic principle, known as **revealed preference**, implies that the measurement of economic values for alternative project plans should be based on the actual choices of people that are observed in the marketplace, since in market exchange money is given up (a price is paid) to secure goods and services.[7]

3.2.2 Channels of Economic Value

There are two roles through which people can gain (or lose) economic value as a result of civil works investments. First, people can realize value in their roles as consumers of goods and services; thus, a project plan that changes the quantity or quality of, or the cost of using some service could affect benefits received by the people who use that service. For example, a project plan that would enhance recreational services in some area would result in economic benefits for the users of those services. Similarly, a project plan that would reduce the costs of barge transportation along certain inland navigation routes

[7] As one example, land price differentials for comparable residential properties located in areas with different levels of flood risk can, in principle, reveal residents' WTP for lower flood risks based on their subjective understanding of those risks, provided that the myriad of other factors affecting the choice of residential location (e.g., quality of schools, environmental amenities) can be effectively controlled for.

could result in economic benefits to the shippers who use that service and their customers.

Second, people can realize value in their roles as owners of scarce factors of production that can not be readily substituted for with other factors. Examples include land, broadly defined to include all natural resources, and specialized labor skills. A project plan that changes the productivity of such factors would affect the net incomes of factor owners. For example, a project plan that would increase the productivity of agricultural lands would result in economic benefits to the owners of those lands.

3.3 Market Price Measures of Value

As explained above, the WTP concept of economic value follows from the principle of consumer sovereignty, which suggests that the ways in which society allocates resources through market exchange reflects the preferences of citizens. The corollary to consumer sovereignty is the principle of revealed preference, which suggests that by observing the choices that people make in market exchange, the relative value that people place on different goods and services can be inferred. Since people's preferences are presumed to be revealed in the choices that they make in the marketplace, the analysis of market prices provides the conceptual foundation and empirical data for measuring economic values.

Within well-functioning, competitive markets, sellers and buyers exchange money for goods and services, where the market price of some good reflects the amount of money that must be exchanged for each unit of a good bought and sold. Buyers of a marketed good are willing to pay money for the good if they value it more highly than other goods and services that may be purchased for the same amount of money. Sellers of a marketed good are willing to produce and sell the good at some money price if they value the other goods and services that the same amount of money could buy more highly than the good they offer for sale. The price at which a good is voluntarily exchanged thus provides the basis for measuring the economic value of the good, since market prices reflect the "revealed" value of marketed goods to buyers and sellers.

Prices for marketed goods are determined by the interaction of market demand and supply, as illustrated in Figure 3-1. The market demand function for a marketed good shows the collective willingness of buyers to purchase incremental units of the good at alternative prices for the good, assuming all other factors that can affect demand for the good (e.g., income, prices of other goods, number of consumers) remain constant. It represents a marginal value (WTP) function that reflects the incremental value of consuming each unit of the good. The demand function for a marketed good is typically downward sloping, because as the price of the good falls, the good becomes cheaper relative to other goods, inducing consumers to buy more of that good and less of other goods.

The supply function for a marketed good shows the willingness of sellers to incur costs to produce for sale incremental units of the good at alternative prices, assuming all other

factors that can affect supply of the good (e.g., prices of the inputs used to produce the good, technology, number of producers) remain constant. It represents a marginal cost function[8] that reflects the incremental **opportunity cost** of the resources used to supply each unit of the good—that is, the value of the alternatives which are foregone as a result of devoting resources to production of the good.

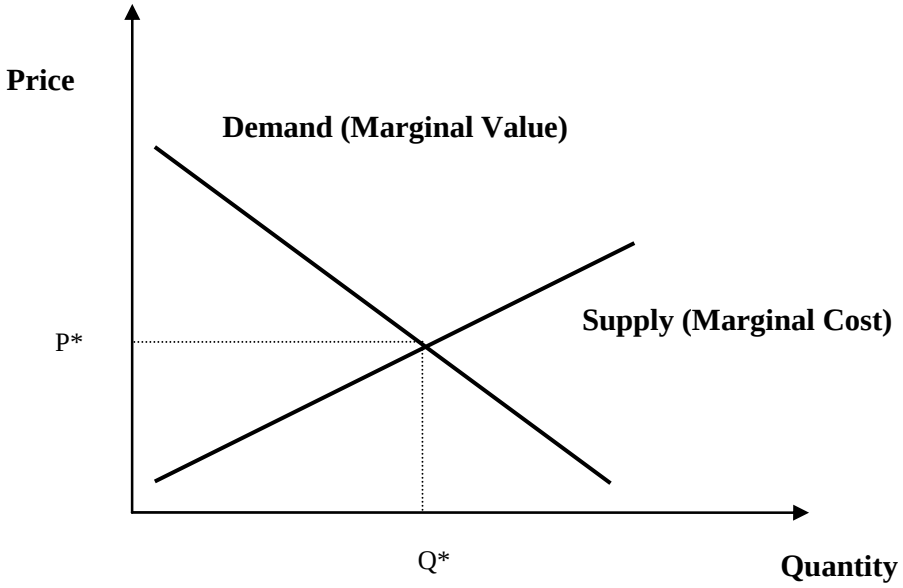

Figure 3-1: Market Exchange for Some Good

The shape of the industry supply function for a marketed good depends in part on the time horizon under study, since the timeframe affects the alternatives available to suppliers. In the short-run, some factors of production (inputs), such as capital stock (production technology), are essentially fixed, while others are variable. A **short-run supply function** is typically upward sloping, because at some level of output, larger amounts of variable production inputs are required to produce each additional unit of the good using fixed production technology. In the long-run, however, all factors of production are variable and suppliers can enter and exit the industry. A **long-run supply function** that is horizontal (no slope) indicates that the marginal costs of production are constant with respect to output. Under such conditions of long-run constant marginal costs, technology and input prices ultimately determine the market price of the relevant good, not the level of good output in the market. The long-run supply function for some good can also be upward (or downward) sloping over some range of output, if an increase

[8] If there is only one seller in a market, the market supply function reflects that seller's marginal costs of producing additional units of the good. If there are numerous sellers, the supply function reflects the sum of marginal costs for all sellers.

in the output of the good caused suppliers' cost functions to change.[9] Given the long planning horizons for civil works projects, the long-run supply function is the relevant supply function for the analysis of the NED benefits and costs of project plans.

In the market for some good, sellers will continue to produce and buyers will continue to purchase the good until the marginal cost to sellers equals the marginal value to buyers. This is illustrated in Figure 3-1 by the point at which the market demand and supply functions for a good intersect. This market-clearing, equilibrium point determines the market price for the good (P*) and the amount of it that will be bought and sold (Q*). At this market equilibrium, the market price of the good exactly equals the marginal value to buyers and the marginal cost of production to sellers for the last unit of the good bought and sold. Thus, the **market price** of a good that is exchanged in a well-functioning market reflects the **marginal value** and **marginal (opportunity) cost** of the last unit of that good exchanged.

Since the market price for some good reflects the marginal value (to consumers) and the marginal cost (to producers) of the last unit of that good bought and sold, market price is an appropriate measure of value (cost) for a prospective change in a good's output that is small relative to the total output of the good. That is, for a change in a good's output that is too small to affect the market price of the good, then the current price is a good measure of the value for the change in output. In that case, market price provides an appropriate measure of the value for a unit increase (or decrease) in the output of a good.[10]

However, it is important to recognize that the prices for goods and services determined through market exchange cannot be the basis for establishing value if the exchange process is absent or flawed. As outlined in Chapter 2, property rights for some goods and services may not be well-defined or may be costly to enforce, which can preclude private entrepreneurs from profitably producing the good for commercial sale. Examples of such non-marketed goods and services include in-stream recreation activities. When market prices are absent or do not reflect full measures of value, then "shadow prices" for the goods can sometimes be estimated that reflect the prices that would emerge if these goods were exchanged in well-functioning markets. Thus, for non-marketed goods affected by project plans, unobserved shadow prices rather than observed market prices provide the foundation for value measurement.

In other cases, market prices are observed for goods supplied in the marketplace, but those prices are distorted by exogenous factors and therefore may not accurately reflect marginal values and opportunity costs. As one example, federal price supports for agricultural crops can artificially increase market prices for the affected crops. In that

[9] For example, the long-run industry supply function for some good could be upward sloping if increased output of the good, and thus increased supplier demand for some essential production input, led to a rise in the price of that input paid by suppliers.

[10] Similarly, if the use of materials, labor, and other resources to construct, operate, and maintain the project would not alter the market prices for these inputs, then their market prices provide appropriate measures of the NED financial costs of the project. NED costs area the subject of Section 4.3.

case, crop prices would need to be adjusted to strip out the subsidy before they could be used to accurately measure the value of a unit change in crop output resulting from a project plan.[11]

In sum, market prices for the goods and services that are affected by a civil works project provide an appropriate measure of NED benefits when these prices accurately reflect marginal values and opportunity costs, and any change in the output of the goods or services resulting from a project are too small to alter those prices. However, observed market prices, even if they accurately reflect marginal values and opportunity costs, can not provide a good measure of value for a non-marginal change in the output of some good that is driven by structural changes in the good's demand or supply. This is because non-marginal changes in the good's supply or demand will cause the market price for the good to change. In that case, simply multiplying the current (pre-change) price by the expected additional quantity of output would not provide a valid measure of economic value for the output change. As will be discussed further below, when a project plan involves a non-marginal change in the supply or quality of some good that can be expected to result in a change in its price, then measuring the economic value of the change requires more information on the demand and supply functions for the good in question.

3.4 Economic Surplus Measures of Value

As noted earlier, there are two basic channels through which people can realize economic value. First, people can realize value in their roles as consumers of final and intermediate goods and services. For example, an inland navigation (barge transportation) service along some route provides economic benefits for the shippers who use that service (e.g., grain elevators that purchase barge services to transport farm commodities to domestic buyers or to ports for export). Such benefits can be represented by consumer surplus in the market for barge transportation services along that route. Recall that the market price for some good exactly equals the value to buyers of the last unit of the good bought. For all other (infra-marginal) units of the good bought, however, the economic value to consumers is greater than price. **Consumer surplus** is a measure of this premium of value over market price; that is, consumer surplus for some good is a measure of consumers' WTP for the good beyond what they actually do pay for it.

Second, people can realize value in their roles as owners of scarce factors of production (inputs) that have no ready substitutes. For example, consider a landowner who owns a plot of farmland that, by virtue of some special characteristics, yields higher levels of output for some specialty agricultural product, per unit of input, than other lands devoted to production of that product. Such benefits can be represented by economic rent in the market for that factor. The relatively higher productivity of the land plot in producing the agricultural product will be reflected in a higher land value (market price) for that plot

[11] Determining the existence or importance of such market distortions is not always straightforward or uncontroversial, however. In the absence of compelling evidence to the contrary, the general presumption is that the observed prices for marketed goods and services accurately reflect their marginal values and opportunity costs.

relative to other lands used to produce the same product. That higher land value reflects that if the landowner chose to rent out the land to some farmer for production of the product, the landowner could charge the farmer a relatively higher rental amount because of the land's relatively higher productivity. **Economic rent** is a measure of the benefits to the landowner associated with this premium in land productivity; that is, economic rent is a measure of what a factor owner earns by employing the factor in some use, above the amount of return that the landowner would require to keep the factor in that use.

In sum, consumer surplus and economic rent are economic measures that can be used to estimate the economic value of changes in goods and factors of production, respectively. The estimation of these measures of economic value is based on information on the demand and supply functions for the affected goods and factors, as outlined below.

3.4.1 Consumer Surplus

In the civil works project planning context, consumer surplus can be interpreted as the beneficiaries' WTP for the changes in the supply or quality of final and intermediate goods resulting from the project. To illustrate project benefits using consumer surplus, consider the market for barge transportation along some route, as depicted in Figure 3-2. The downward sloping line labeled D represents shippers' derived demand[12] (marginal value) function for incremental units of barge transportation, while holding constant the prices of alternative modes of transport and all other factors that can affect the demand for barge transportation services. The horizontal line marked S represents the supply (cost) of barge transportation. The point at which these curves intersect determines the market price of barge transportation faced by shippers, denoted by P*, and total use of barge transportation, denoted by Q*. The triangular area labeled A above the price line and below the demand function represents the consumer surplus realized by shippers. That is, it represents shippers' WTP for barge transportation beyond what they actually do pay to use those services.

Now consider a project plan to improve the waterway that will reduce the costs of providing barge transportation. This is represented in Figure 3-2 by a downward shift in the supply curve from S to S1. The reduction in transport costs causes the market price for barge transportation paid by shippers to decrease from P* to P*1, and the total quantity of barge transportation used by shippers to increase from Q* to Q*1. The rectangular area labeled B plus the triangular area labeled C represents the change in shippers' consumer surplus in the with-project condition. That is, the sum of these areas represents shippers' WTP for the improvement of the waterway.

[12] Shippers' demand for barge transportation services is derived from the demand for their commodities that barge carriers transport to buyers.

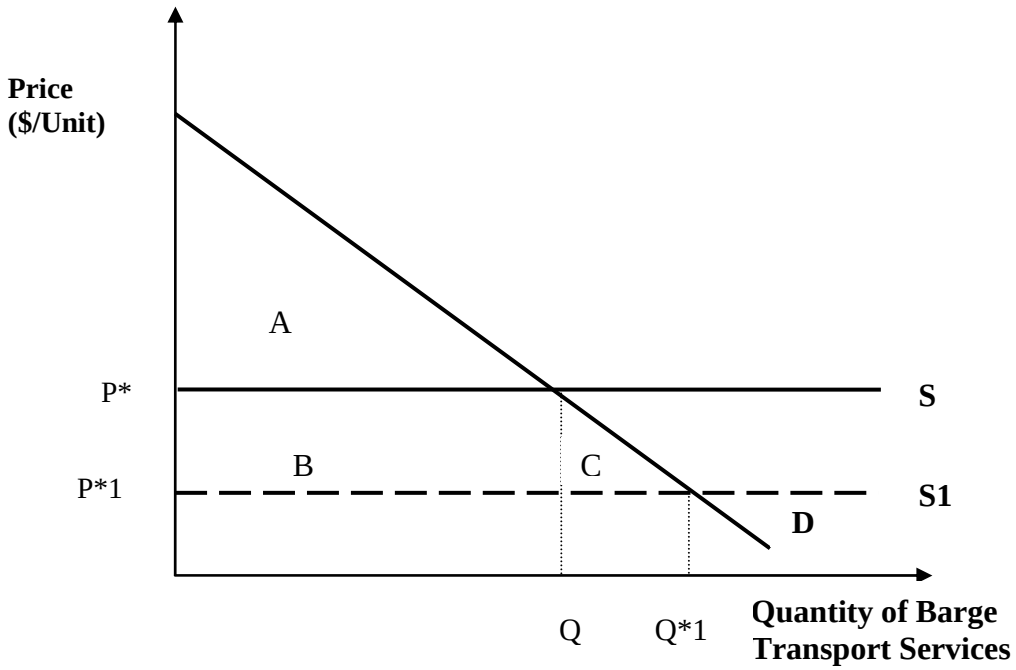

Figure 3-2 Change in Consumer Surplus for Shippers Using Barge Transportation

3.4.2 Economic Rent

In the civil works project planning context, economic rent can be interpreted as the WTP of the affected factor owners for an increase in factor productivity resulting from a project. To illustrate project benefits using economic rent, consider the market demand for some factor owner's lands for producing some specialty crop, as depicted in Figure 3-3. The downward-sloping line represents the (derived) demand for the factor owners' lands for crop production—that is, it indicates the market value of devoting incremental acres of the factor owner's lands to producing the specialty crop.[13] The solid, upward-sloping line represents the marginal cost of bringing additional acres of the factor owner's lands into crop production. The intersection of the factor demand and marginal cost functions determines the quantity of the factor owner's lands devoted to producing the crop, as denoted by Q*. The triangular area labeled A that is bounded by the demand and marginal cost functions represents the economic rent realized by the factor owner by devoting Q* acres of his lands to producing the specialty crop.

Now consider an irrigation project that would decrease the costs of bringing the factor owner's lands into crop production. This productivity improvement causes the factor owners marginal cost function for bringing lands into crop production to shift downward from MC to MC1. The reduction in production costs results in an increase in the quantity

[13] A factor (input) demand function is derived from the demand for the good that it is used to produce. It represents the "value of marginal product" (VMP), or the marginal physical contributions of incremental factor units in producing the output of that good, multiplied by the unit price of the good (which in this example is the price of the specialty crop that is exogenously determined in the market for that crop).

of the factor owner's lands devoted to crop production from Q* to Q*1. The area labeled B plus the triangular area labeled C represents the increase in economic rent realized by the factor owner in the with-project condition. That is, the sum of these areas represents the factor owner's WTP for the irrigation project improvement.

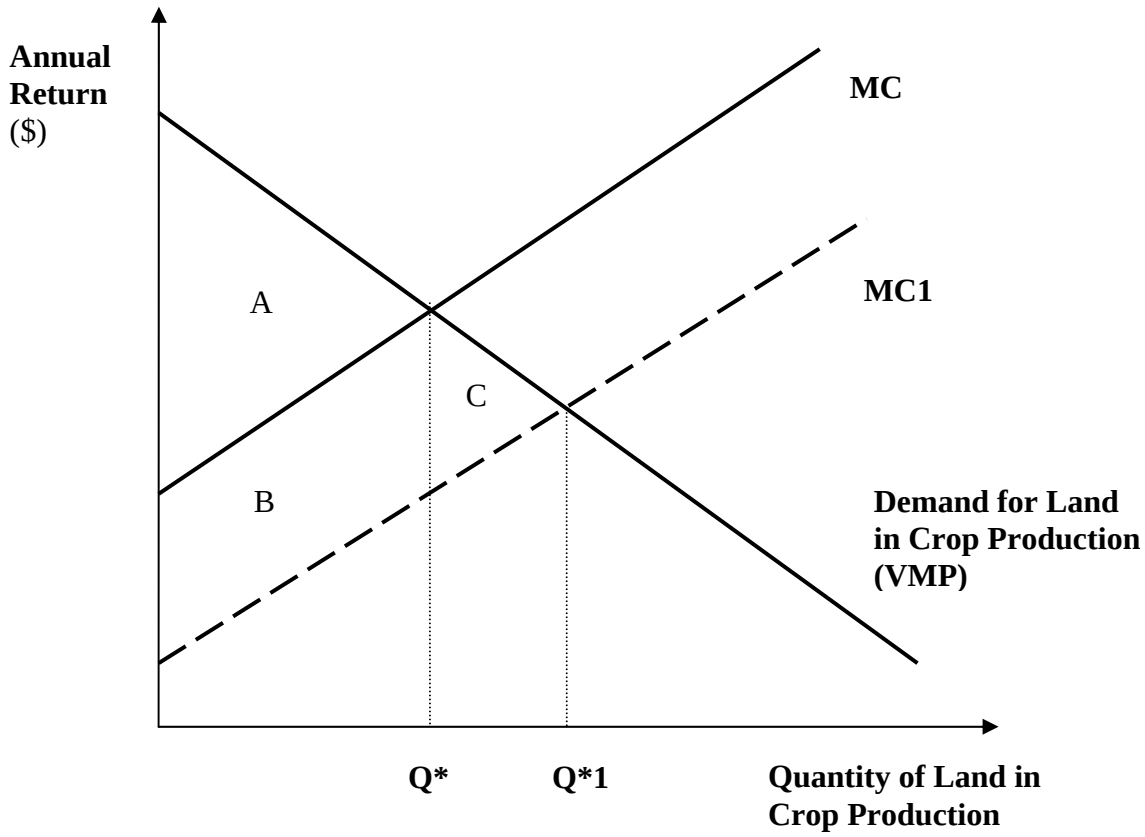

Figure 3-3: Change in Economic Rent from Lands Used in Crop Production

The increase in economic rent resulting from the project could be estimated in the factor market for the owner's lands, since in principle it would be reflected in a change in the market prices of those lands. This result would be expected because, in land markets characterized by full information, the market price of land reflects the capitalized (present discounted value) of the annual streams of economic rent that the land is expected to yield. Thus, if planners could compute the expected differences in the prices of affected lands with and without the project, the differentials in those prices would provide a measure of the increase in economic rents resulting from the project.

Alternatively, project-induced changes in economic rent could be approximated in the market for the specialty crop rather than in the factor (land) market. In that case, the change in **producer surplus**, reflecting the change in expected profits from producing

the specialty crop in the with-project condition, could be calculated and used as a measure of project benefits.[14] The concept of producer surplus is illustrated in the next section.

3.5 Economic Surplus, Transfers, and Market Expenditures

As outlined above, the net change in economic surpluses resulting from some project plan represents the NED benefits of that plan. It is important to distinguish between the net change in economic surpluses, which reflects NED benefits, and market expenditures and economic transfers, which do not. These distinctions are made below with reference to Figure 3-4, which illustrates the effect of some project plan in the market for strawberries.

The downward sloping function in Figure 3-4 labeled "Demand" represents the market demand for strawberries, reflecting strawberry buyers' marginal WTP for incremental units of the good. The upward sloping function labeled "Supply $_{w/o}$" represents the market supply of strawberries in the without-project condition, reflecting sellers' marginal costs of producing incremental units of strawberries in the absence of the project. The marginal costs of producing additional units of a good include the opportunity costs of all production inputs, including purchased and already-owned inputs. In strawberry production, purchased inputs might include seeds, fertilizer, equipment rental and fuel, for example, while owned inputs might include farmlands and farmers' own labor.

At market equilibrium in the without-project condition, $Q_{w/o}$ units of strawberries are produced and sold at a market price of $P_{w/o}$. This market equilibrium is established by the intersection of the market demand function and the without-project market supply function (Supply $_{w/o}$). In the without-project condition, strawberry buyers realize consumer surplus as represented by the triangular area labeled A bounded by the demand function and the price line at $P_{w/o,}$ and strawberry sellers realize producer surplus as represented by the sum of the areas labeled B and C bounded by the without-project supply function and the price line at $P_{w/o.}$. As noted in the previous section, producer surplus realized in the output market for some good is often used to approximate economic rent realized by the owners of the scarce factor used to produce that good.

[14] Producer surplus and economic rent are different concepts that nevertheless converge under certain conditions. Economic rent is the economic value generated by an owned production input (e.g., farmland) as measured in the market for that factor. Producer surplus, on the other hand, represents the returns earned by suppliers of a good that is produced by combining several production inputs, as measured in the market for that good. But under certain circumstances, the producer surplus yielded by the production of some good can be properly interpreted as a measure of economic rent realized by the owners of the scarce factor input used in the production of that good. For example, if all non-land inputs in crop production are available in any amount at constant prices, and these inputs are applied in fixed proportions to a given quantity of farmland, then the crop supply function is upward sloping only because the best farmland is in limited supply, and as the crop price rises with an expanding demand, it becomes worthwhile to bring inferior lands into production. Under those conditions, producer surplus measured in the market for the good (as reflected in the area above the crop supply function in Figure 3-4) provides an exact measure of economic rent accruing to the owners of farmland used to grow the crop as a result of the productivity of that farmland—the scarce production input in limited supply.

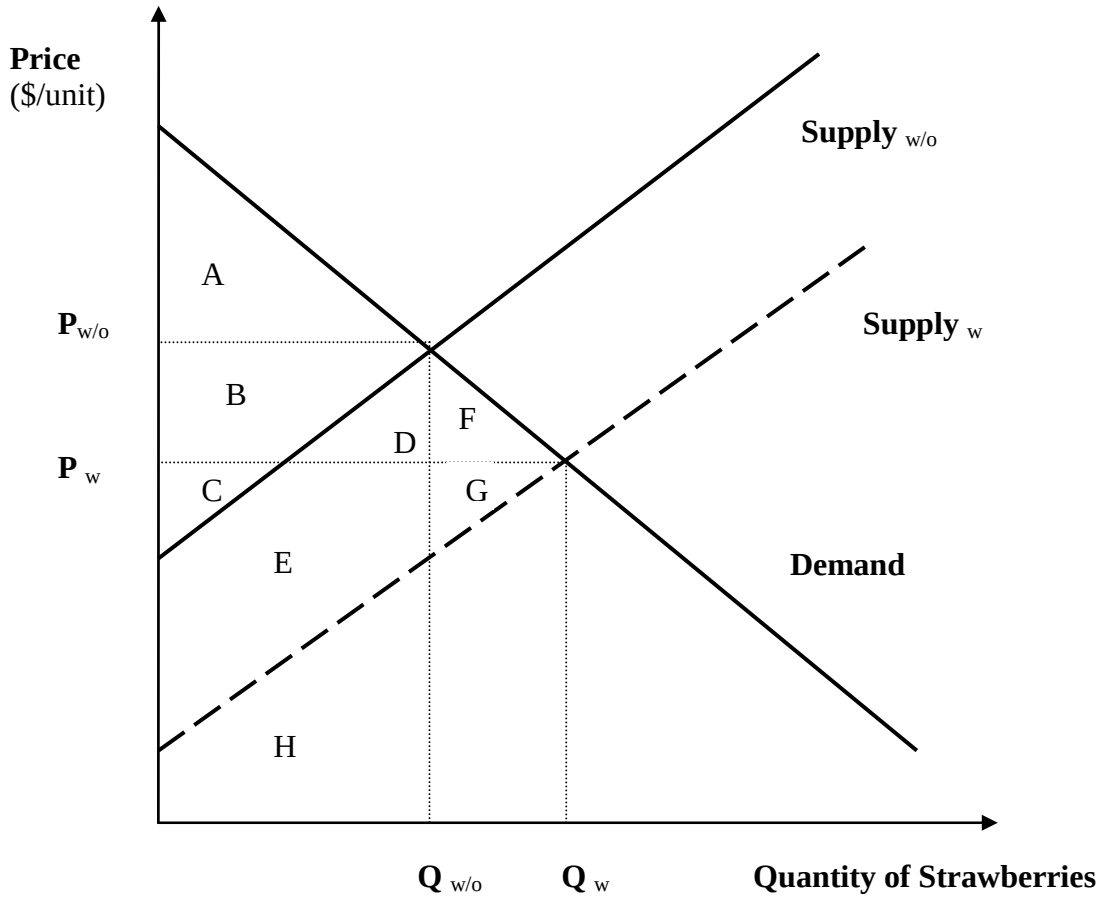

Figure 3-4. Benefits of an Increase in Agricultural Land Productivity

Note that in the without-project condition, total market expenditures on strawberries (price multiplied by quantity sold) is not equivalent to the economic value realized by strawberry buyers and sellers. In Figure 3-4, the without-project market expenditures on strawberries is represented by the sum of areas B,C, D, E and H, while net economic benefits are represented by the sum of areas A, B and C. This highlights that **market expenditures** on some good provide a measure of economic activity that does not directly indicate economic benefits yielded by the production and consumption of the good.

In the with-project condition, the increase in productivity for the affected farmlands would cause the marginal cost of producing any level of strawberries to fall, as indicated by the downward shift of the supply function to Supply $_{w.}$ This decrease in production costs would in turn cause the market output of strawberries to rise to Q_w and the market price of strawberries to fall to P_w. Again, since market expenditures do not represent economic value, the change in market expenditures for strawberries in the with-project condition provides no direct indication of the change in NED benefits resulting from the

project. Rather, the NED benefits of the project are measured by the change in consumer surplus and producer surplus (where the latter serves as an approximation of economic rent accruing to owners of the affected agricultural lands) between the with- and without-project conditions.

The net effect of the project on consumer and producer surpluses can be illustrated using the areas labeled D-G in Figure 3-4. With the project, consumer surplus accruing to strawberry buyers increases in an amount equivalent to the sum of areas B, D and F. With the project, producer surplus to strawberry sellers is increased by the sum of areas E and G, but reduced by area B.

Area B indicates that the bulk of the producer surplus enjoyed by sellers in the without-project condition becomes part of the consumer surplus accruing to consumers in the with-project condition. That is, area B represents of a **transfer of economic value** from strawberry sellers to strawberry buyers as a result of the project. Such a redistribution of economic value between sellers and buyers provides no net economic gain, and therefore is not part of the NED benefits of the project. Thus, in the project example shown in Figure 3-4, the aggregate net benefits of the project accruing to strawberry buyers and sellers is given by the sum of areas D, E, F, and G.

The above example illustrates the complexity of measuring project NED benefits when a project is expected to alter the prices for affected outputs or inputs. However, such cases are the exception rather than the rule. Thus, NED analysis typically focuses on marginal valuations of project costs and benefits, for which market prices are applicable when project inputs and outputs involve marketed goods. Nevertheless, NED analysis of water resource projects sometimes might need to confront the valuation of non-marginal changes in the supply or demand for goods, as in the example in Figure 3-4. In that example, the without-project market price of strawberries is not applicable for valuing project benefits, since the expected non-marginal change in strawberry output in the with-project condition will be accompanied by a change in market price. In that case, accurate measurement of changes in consumer and producer surpluses resulting from the change in strawberry price and output would require more complete information about strawberry demand as a function of price and income. However, since good demand information is not always available, NED analyses often must rely on proxy measures of benefits for the valuation of project outputs.

The various measures of NED benefits set out in Corps planning guidance for different categories of goods and services are reviewed and evaluated in the next chapter. But before turning attention to those NED measures, the distinctions between NED effects and various non-NED effects that may result from project plans is reviewed below.

3.6 NED and Other Project Effects

As outlined in Chapter 2, planning guidance instructs planners to formulate and recommend for selection project plans that maximize net NED benefits—that is, maximize net increases in economic value realized by the nation as a whole—consistent with environmental protection. However, guidance also recognizes other types of potential project effects that stakeholders may view as important for civil works planning. Accordingly, the P&G establish four "accounts" to represent different categories of plan effects, which the PGN [Section 2-3d.(3)] describes as follows:[15]

1. *The national economic development (NED) account displays changes in the economic value of the national output of goods and services.*

2. *The environmental quality (EQ) account displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and negative aspects of ecosystem restoration plans.*

3. *The regional economic development (RED) account displays changes in the distribution of regional economic activity (e.g., income and employment).*

4. *The other social effects (OSE) account displays plan effects on social aspects such a community impacts, health and safety, displacement, energy conservation and others.*

While guidance provides scope for the consideration of virtually any type of project effect, its directive to planners to maximize net NED benefits may be a source of confusion and frustration for non-federal sponsors of civil works projects. This can happen when certain anticipated project effects that are desired by non-federal sponsors do not represent NED benefits as defined by guidance, and thus are not given primary weight in project planning and justification.[16] Indeed, non-federal sponsors may not understand the distinction between NED benefits and other types of project effects, or readily accept why these distinctions should matter for determining the federal interest in pursuing civil works projects. Conceptual differences and potential overlap between project effects included in the NED account and project effects included in the other three accounts are briefly reviewed below.

3.6.1 Regional Economic Development Effects

The Regional Economic Development (RED) account considers project effects on the regional economy where a project is to be implemented. This might include changes in

[15] According to the PGN, the evaluation and display of NED and EQ effects is a requirement for project planning, while consideration of RED and OSE effects is discretionary.

[16] Frustration can also arise when local sponsors learn that the project effects desired by them, although included in the NED account, are not accorded federal budgetary priority (e.g. recreation benefits). So even if a project is eventually recommended based on a calculation of estimated net NED benefits that includes net benefits associated with non-priority outputs, it might be given low funding priority within the President's budget.

regional income and employment that are of primary concern to citizens of the region and their elected officials. The distinctions between these types of effects and NED effects are often lost on non-economists, in part because both represent project effects that are characterized and viewed as "economic."

Although there can be some overlap between RED and NED effects,[17] these two categories of economic effects differ in two fundamental ways. First, RED effects are always manifested in the marketplace, while this is not always true for NED effects. RED effects on regional employment, business income, and local tax revenues, for example, are all reflected in cash transactions within the regional economy. Although some measures of NED value may show up in market transactions (e.g., as changes in net income), other NED measures may not. For example, consider a project that would enhance recreation services in some area, for which the appropriate measure of NED benefits is represented by the affected recreation users' change in WTP for the improved recreation services. To the extent that this WTP exceeds what users actually do pay for use of the recreation area (e.g., as admission and/or user fees), then this measure of value would not be fully represented in cash transactions within the regional economy. This is because the increase in NED value (i.e., preference satisfaction) that would be realized by affected recreation users would not be "spent" in the marketplace.

The second important distinction between RED and NED effects, and the one that explains why the former generally are not considered for the justification of project plans, relates to their different accounting stances in project planning. Consider a project to improve a harbor in one region that competes for maritime traffic with another harbor in a different region. To the extent that the project would cause some traffic to be diverted from the competing harbor to the improved harbor, then any shipper costs savings resulting from that diversion would be counted as a project NED benefit. The traffic diversion might also cause certain commercial enterprises that service cargo ships (e.g., stevedore companies) to relocate from the competing harbor to the improved harbor, thus transferring jobs and income from one region to the other. From the accounting perspective of the region to which these businesses relocate, the additional jobs and income they bring clearly represent economic benefits. But from a national perspective—the appropriate accounting stance for NED analysis—the jobs and income gained by this region are offset by the loss of jobs and income in the other region. That is, the RED benefits accruing to the one region are presumed to be no greater than the RED benefits lost in the other region as a result of the transfer of jobs and income. Therefore, such transfers of regional economic activity are counted as RED rather than NED effects in civil works planning.[18]

[17] For example, the incidence (distribution) of NED benefits to people in some region that are manifested in cash transactions (e.g., increases in regional net income) represents part of the RED benefits for that region.
[18] In an economy characterized by full employment and labor mobility, project effects on jobs and income are presumed to represent transfers of economic activity from one place to another, and thus are not considered in NED analysis. The one exception recognized by Corps guidance concerns the use of structurally underemployed and immobile labor resources in project construction, which is discussed in Section 4.3.1.

3.6.2 Environmental Quality and Other Social Effects

The Environmental Quality (EQ) account considers project effects on significant natural, aesthetic, and cultural resources, while the Other Social Effects (OSE) account considers social and community effects. In both accounts, effects are to be measured and recorded in non-monetary terms. Thus, project effects on wildlife habitat might be evaluated in biophysical metrics (such as "habitat units") and recorded in the EQ account, while project effects on human safety risks might be evaluated in terms of changes in populations at risk and recorded in the OSE account.

At the time that the P&G was written, these types of project effects were viewed as "intangibles" that could not be evaluated in economic terms. However, in the last several decades economists have increasingly conceptualized and applied the economic valuation paradigm to changes in "environmental services"[19] and human health and safety risks. Indeed, environmental and human health risk valuation represents an extensive research program within economics, and its participants often argue that the techniques they have developed provide a preferred way to measure people's WTP for environmental services and reductions in health risks for public policy analysis. Given this, and the longstanding tradition of benefit-cost analysis in civil works planning, some commentators argue that the Corps should move towards representing more fully the range of expected project effects in monetary terms. These commentators often point to efforts by other federal agencies to monetize public policy effects on environmental services and human health and safety risks.[20]

The recommendation to pursue broader monetization of project effects raises questions of whether this would be technically possible, practical, and acceptable in civil works planning. But questions facing the Corps go beyond whether and how to monetize environmental services and human health risks for civil works planning. They also include the question of how to use monetary as well as non-monetary estimates of changes in environmental services and health risks in project planning. Monetization of a broader range of possible project effects would provide the means to more comprehensively evaluate project plans in terms of the single NED federal objective, which focuses on maximizing the satisfaction of individual economic preferences. But would broader monetization of projects effects obviate the usefulness of also recording project environmental and social effects in non-monetary terms? The answer might be yes, if only the "utilitarian" implications of projects were deemed relevant for decision-making, implying that the only relevant standard of value for project decision making is

[19] NED analysis of traditional civil works purposes can be viewed as an exercise in the valuation of "environmental services," but ones that are closely connected to marketed goods and services (e.g., barge transport services). The types of environmental services that that are now the focus of environmental valuation research, on other hand, include those that directly affect the quality of human life (e.g., recreational opportunities) as well as those that contribute to, but may be far removed from, the end product of market value (e.g., habitat and nursery grounds for commercial fish species).

[20] For example, the U.S. Environmental Protection Agency has increasingly tried in its regulatory impact analyses to provide monetary estimates for regulatory effects on human morbidity and mortality risks and, to a much lesser extent, for environmental services.

economic (NED) value. But to the extent that other, non-economic value stances[21] are also relevant for decision-making, then the EQ and OSE accounts would remain relevant and useful, even if these project effects were also estimated in monetary terms.

For example, consider a floodplain evacuation plan that, in addition to providing off-site flood damage reduction benefits that are recorded in the NED account, would enhance breeding habitat for an endangered bird species on the evacuated lands. In principle, any expected increase in bird populations could be valued in monetary terms in project NED analysis. Such valuation might focus on the WTP of birders for enhanced bird-watching opportunities and/or individuals' WTP for the mere knowledge that bird populations will increase. Such NED benefits estimates would represent the economic value of changes in endangered bird populations to affected people who think about this environmental outcome in terms of their own economic self-interest. Other people, however, may not conceptualize endangered species as a "commodity" that can be traded-off for other things, but who nevertheless view enhancing endangered species as an important public policy objective. In other words, some people may hold non-economic values for endangered species. To the extent that project stakeholders include both types of people, then project effects on the endangered bird could usefully be included in both the NED and EQ accounts. Their representation in the NED account would provide a monetary indication of individual preferences for this environmental outcome. Their representation in non-monetary terms in the EQ account would provide information that would allow those project stakeholders who hold non-economic values for this environmental outcome to weigh the merits of alternative plans in terms of that alternative value stance.

3.6.3 Initiatives to Consider Non-NED Objectives and Effects

It is important to note that in recent years the Corps has taken steps to broaden the focus and scope of civil works project planning to consider non-NED objectives and effects in plan formulation, evaluation, and selection. For example, a non-economic objective and standard of value has been established for formulating, evaluating, and justifying project plans pursuant to the Corps' "National Ecosystem Restoration" (NER) mission. In the latest update of the PGN, the Corps issued guidance that formally adopted NER as a federal mission with the objective to increase the quantity and quality of "desired ecosystem resources," as measured in biophysical rather than monetary terms. Guidance further specifies that decision-making for the final selection of an NER plan will be informed by cost-effectiveness and incremental cost analyses (rather than benefit-cost analysis) that relate non-monetary NER outputs against NED costs. The philosophy of the NER mission thus represents a significant departure from NED primacy in civil works planning.

[21] For example, some commentators have argued that people hold different types of preferences that are each relevant for public policy. One type is "consumer" preferences reflecting personal economic self-interest. Another type, which has been variously labeled as "community" and "ideal-regarding" preferences, reflect what people believe to be good for the community as a whole. Only the former type of preferences is represented by the concept of economic value.

Moreover, Corps headquarters has signaled the agency's intention to consider non-NED objectives and effects in all civil works planning. In 2005, the Corps issued an Engineering Circular entitled, "Planning in a Collaborative Environment" (EC 1105-2-409; 31 May 2005), that broadens the scope of objectives and effects that planners can consider in "collaborative" civil works planning. In the words of the EC:

> *Collaborative planning with other Federal agencies and Tribes requires the Corps to move beyond the Corps interest and embrace solutions that reflect the full range of the national Federal interest (the collection of all responsibilities assigned to Federal agencies.).*

Accordingly, the EC specifies that all Corps planning studies should evaluate and compare alternative project plans in terms of their full effects across all four planning accounts. It states:

> *For example, evaluation of inland navigation improvements should not only address effects on transportation savings but also security, safety, and environmental advantages or disadvantages with respect to other models of transport . . . Any alternative plan may be selected and recommended for implementation if it has, on balance, net beneficial effects after considering all plan effects, beneficial and adverse, in the four Principles and Guidelines evaluation accounts.*

Further, the experience of Hurricane Katrina in 2005 has focused attention on the need to evaluate and consider project effects on human health and safety. Moving forward, project analyses, particularly for flood, hurricane, and storm damage reduction projects, will be expected to estimate the public safety impacts of project plans, including residual risks to human life and safety after plan implementation, in addition to plan NED benefits and costs.

4. Measures of NED Benefits and Costs

4.1 Introduction

This chapter reviews the NED (value) measures set out in the P&G for evaluating project benefits (and benefits foregone) for different categories of goods and services. It also comments on the potential correspondence between the P&G benefit measures and the WTP standard of value reviewed in Chapter 3. This commentary is intended to provide Corps planners with a basic understanding of the strengths and limits of the measures set out in the P&G for evaluating NED gains and losses for different goods and services. Such an understanding can help planners to 1) identify and apply potential adjustments or alternatives to P&G benefits measures that may be possible and warranted in particular planning contexts, and 2) anticipate and respond to potential questions about NED evaluations in planning studies.

The categories of goods services for which NED benefits measures are explicitly addressed in the P&G and the PGN and considered herein include flood damage reduction, hurricane and storm damage reduction, transportation (inland and deep draft navigation), agriculture, commercial fishing, municipal & industrial water supply, hydropower, and recreation. The P&G measures of NED benefits for these different goods are services are addressed in this chapter. As such, this chapter considers NED measures for a much broader set of goods and services than those that are presently accorded budgetary priority in civil works planning. This broad focus is warranted since project plans formulated for one or more priority outputs may also affect non-priority goods and services that should be considered in the NED evaluations of plan benefits and costs. For example, it seems likely that accounting for negative impacts on currently-provided goods and services will be increasingly important in the context of civil works planning for ecosystem restoration (a priority output). To the extent that project plans formulated for ecosystem restoration reintroduce greater hydrologic variability in watersheds, they may sometimes result in increased flood damages, reduced hydropower production, and adverse impacts on other existing watershed goods and services. This potential illustrates that project NED evaluations must sometimes need to address a wide range of affected goods and services.

4.2 Measures of NED Benefits

As outlined in Chapter 3, the P&G defines the measurement standard for evaluating NED benefits as the beneficiaries' aggregate WTP for project effects on goods and services. Conceptually, the WTP measure of benefits is reflected in net changes in consumer surplus and/or economic rent in the markets for the affected goods. However, the P&G recognizes that that estimation of the demand functions for the goods and services affected by project plans is generally impractical for most planning studies. Accordingly, the P&G allows planners to use proxy measures of NED benefits that can be estimated using methods that do not rely on the relevant demand functions for project outputs. The P&G explains the need for these proxy measures and characterizes them as follows:

Since it is not possible in most instances for the planner to measure the actual demand situation, four alternative techniques can be used to obtain an estimate of the total value of the output of a plan: Willingness to pay based on actual or simulated market price; change in net income; cost of the most likely alternative; and administratively established values.

***Actual or simulated market price**. If the additional output from a plan is too small to have a significant effect on price, actual or simulated market price will closely approximate the total value of the output and may be used to estimate willingness to pay. If the additional output is expected to have a significant effect on market price and if the price cannot be estimated for each increment of the change in output, a price midway between the price expected with and without the plan may be used to estimate the total value.*

***Change in net income**. The value of the change in output of intermediate goods and services from a plan is measured by their total value as inputs to producers. The total value of intermediate goods and services to producers is properly measured as the net income received by producers with a plan compared to the net income received without a plan. Net income is defined as the market value of producers' outputs less the market value of producers' inputs exclusive of the cost of the intermediate goods and services from a plan. Increased net income from reduced cost of maintaining a given level of output is considered a benefit since released resources will be available for production of other goods and services.*

***Cost of most likely alternative**. The cost of the most likely alternative may be used to estimate NED benefits for a particular output if non-Federal entities are likely to provide a similar output in the absence of any of the alternative plans under consideration and if NED benefits cannot be estimated from market price or changes in net income. This assumes, of course, that society would in fact undertake the alternative means. Estimates of benefit should be based on the cost of the most likely alternative only if there is evidence that the alternative would be implemented. In determining the most likely alternative, the planner should give adequate consideration to nonstructural and demand management measures as well as structural measures.*

***Administratively established values**. Administratively established values are proxy values for specific goods and services cooperatively established by the water resource agencies. An example of administratively established values is the range of unit-day values for recreation.* [P&G, Section 1.7.2(b)]

The techniques outlined above reflect that civil works projects typically produce economic benefits in two main ways—by reducing the costs of supplying the expected without-project levels of goods and services, or by increasing the quantity (or quality) of goods and services supplied beyond their expected without-project levels. The specific proxy measures of NED benefits for the various goods and services discussed in the P&G and the PGN are identified in Table 4-1.

Table 4-1: Primary NED Benefit Measures for Specific Goods and Services

Goods & Services	Primary Benefit Measure
Flood Damage Reduction	Reduced property damages
Hurricane and Storm Damage Reduction	Reduced property damages
Transportation – Inland & Deep Draft Navigation	Reduced transport costs
Municipal & Industrial Water Supply	Market value of output, or alternative cost of providing equivalent output when market price does not reflect marginal costs
Hydropower	Market value of output, or alternative cost of providing equivalent output when market price does not reflect marginal costs
Agriculture	Net income from increased crop yields and/or decreased production costs
Commercial Fishing	Net income from increased catch and/or decreased production cost
Recreation	Actual or simulated (shadow) prices, or administratively established values for site services

The goods-specific benefit measures summarized in Table 4-1 are reviewed and commented on in the remainder of the section. Before proceeding to that review, it is important to note that the possible range of NED benefits associated with-project plans are not necessarily limited to the specific goods and services addressed in Corps guidance. As one example, it has been noted that inland navigation projects might produce NED benefits beyond those accruing directly to the users of barge transportation. This recognizes the potential for such projects to result in reduced highway transport and associated auto emissions and traffic accidents, for example, thus providing environmental and human health, and safety benefits. The P&G defines such effects as "other direct benefits [that] are incidental to the primary purpose of water resource projects," and encourages planners to estimate and consider such benefits in planning studies when technically possible and practical. The important point is that the NED effects of project plans are not limited to the goods and services specifically addressed in guidance or that are the primary plan formulation focus for civil works projects.

4.2.1 Flood, Hurricane, and Storm Damage Reduction Benefits

The P&G defines the benefit measurement standard for flood damage reduction as "the reduction in actual or potential damages associated with land use. The PGN defines the same benefits measure for hurricane and storm reduction projects designed to reduce wind-generated and tide-generated waves and currents along the nation's shores. The remainder of this section reviews this measure and its estimation in the context of urban

flood damage reduction projects that are designed primarily to reduce the impacts of flooding from the nation's rivers and streams.

The P&G outlines two methods for estimating project-induced reductions in damages to land uses: avoided costs and changes in land prices. The implicit presumption by the P&G that avoided costs and land price changes are adequate proxies for beneficiaries' WTP for urban flood damage reduction is explored below.[22]

The P&G measurement standard for flood damage reduction—reduced damages to land uses, is further divided into three sub-categories for evaluation purposes:

1) Inundation reduction benefits,
2) Intensification benefits, and
3) Location benefits.

Inundation reduction benefits are applicable when floodplain uses are assumed to be the same with and without the project. Intensification benefits are applicable when land use is expected to remain unchanged with the project, but that use will be modified. For example, an affected homeowner may add a garage or finish a basement if the flood threat is reduced. Location benefits are applicable when the land use is expected to be altered because of the flood damage reduction project.[23] Both intensification and location benefits depend upon projections by planners of likely land use modifications and changes, respectively, with versus without the project.

For each of these sub-categories of benefits, three types of prevented flood damages are listed in the P&G:

1) Property damages avoided (PDA),
2) Avoided income losses to businesses, and
3) Reduced emergency costs.

In a typical case, the primary benefit is avoided damages to residential and commercial properties. The PDA method for estimating inundation reduction benefits to property owners computes the expected reduction in average annual damages to physical property (buildings, contents and vehicles) located in the floodplain based on planners' calculations of expected flood risks and monetary damages avoided.[24] Thus, the cost of

[22] The discussion that follows is closely adapted from (with the author's permission): Leonard Shabman. 1988. *Non property flood control benefits analysis using the principles and guidelines for water and related land resource planning*. Report submitted by the Greely Polhemus Group to the U.S. Army Corps of Engineers, Institute for Water Resources. (December 12, 1988)

[23] The magnitude of location benefits that can be claimed in planning studies is limited by Corps policy, however. [see: PGN, Section 3-3, c.(1)]

[24] Procedurally, the PDA method estimates the costs of repairing and restoring buildings and associated property and belongings for floods of different magnitudes. Then the expected damages are calculated by weighting these individual repair and restoration costs by the probability of occurrence of each separate flood event. These probability-weighted damages are summed over all possible flood events and affected properties to attain a total benefit estimate for a given year. The analysis is repeated each year of the project planning horizon, for the conditions with and without the project, to compute the reduction in expected property damages. The present value of the expected annual damage reduction is computed at

restoring flood-damaged properties to pre-flood conditions is the measure of flood reduction benefits produced by the PDA method.

The P&G assumes that PDA measures of benefits approximate beneficiaries' WTP for flood damage reduction. But measures of PDA as calculated by project planners will reflect beneficiaries' WTP for flood damage reduction only if several conditions hold. Some of these conditions relate to the correspondence between planners calculations of PDA and beneficiaries' subjective assessments of expected property damages. For example, use of the PDA as a proxy for WTP implicitly assumes that floodplain occupants would compute property damage reduction benefits in exactly the same manner as planners. That assumes, for example, that floodplain occupants possess the same knowledge and understanding of the probability and consequences of flood events as planners, and that they use the same time horizon and discount rate as planners do when determining their WTP for reductions in flood risks. To the extent that any of these assumptions do not hold, then PDA measures of benefits would diverge from beneficiaries' WTP for the *property* effects of flood damage reduction.

Further, the PDA measure of benefits provides a proxy for only the property dimension of beneficiaries' WTP, but neglects potential non-property dimensions of WTP for flood reduction. In principle, floodplain occupants' WTP for reductions in flood risk would reflect their subjective assessments of the value of plans in terms of both property and non-property benefits of concern to them. Non-property benefits of flood risk reduction represent the reduced impairment of the *human* resource, which can be manifested as a reduced feeling of general well-being and as reduced worker productivity. The primary potential sources of human benefits associated with flood risk management include reductions in pre-flood anxiety, and post-flood trauma relating to flood-induced loss and displacement, for example.

Because property damages avoided are based on **expected damages**, the implicit assumption is that all affected individuals are **risk neutral**. However, to the extent that some affected people are risk averse, they would be willing to pay more than less risk-averse individuals for the same level of flood risk reduction. One potential source of risk aversion in the flood risk context relates to personal anxiety associated with the potential for flooding; thus, affected individuals who are risk averse may be willing to pay a premium over expected property damages to avoid the anxiety of living with a flood threat. Affected individuals might also be willing to pay to avoid personal trauma (emotional or physical pain and suffering) that they might experience during and after a flood event, and community members may also be willing to pay to avoid post-flood trauma to others in the community and general community disruption. These potential human dimensions of beneficiaries' WTP for flood protection are not captured by PDA measures of flood reduction benefits.

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some selected project discount rate, and then annualized over the project life to yield an estimate of average annual expected benefits.

Although the P&G does not specifically mention potential human benefits of flood reduction, it recognizes the relevancy of what it terms "intangible" benefits. The P&G says that analysis of expected land price changes can be used to estimate such intangible benefits:

> *If the market value of existing structures and land is lower because of the flood hazard, restoration of market value represents a quantification of otherwise intangible benefits. In such cases, the benefit is the difference between increased market value and that portion of increased market value attributable to reductions in flood damages.* [P&G, Section 2.4.13(d)].

The P&G thus allows planners to claim a "restored land value" benefit reflecting the non-property benefits of flood risk reduction. In essence, this provision envisions that planners might compute an increase in land prices that could occur if the full amount of damage reduction to *property* were reflected in land market prices. If this computed increase could be shown to be less than the expected price increase in the actual land market, the difference between the computed with-project price and the projected with-project land market price could be included as benefit for the "intangible" or non-property effects of flood risk reduction. That benefit would then be combined with estimates of property damages avoided and other avoided costs to calculate total inundation reduction benefits from flood reduction.

This guidance is misleading, however, because if land price analysis were used to calculate flood reduction benefits there would be no need to do a separate analysis of PDA. To the extent that land market values reflect the subjective assessments of land traders of their discounted present value of the future stream of utility or income that the lands provide, then estimated changes in land market prices resulting from flood protection would, in principle, capture both property damages avoided as well as any non-property benefits. In effect, if the restored land value benefit were claimed, then the total benefit measurement for inundation reduction collapses into a comparison of with- and without-project prices of affected lands, where land prices increases are expected to capture both property damages avoided and human benefits.

The P&G also stipulates that land price analysis is the appropriate approach for measuring "intensification" and "location" benefits associated with expected changes in land uses resulting from flood risk reduction. For the measurement of these benefits, planners are instructed to forecast land use patterns in the project area with versus without the project. Then, using market sales data and following approved procedures, the difference in prices for protected versus unprotected lands for each land use is computed.[25] The resulting price increment represents the present value of the land traders' subjective assessment of the flood risk reduction benefit stream, discounted by an interest rate deemed appropriate by land market traders. Summing over all land parcels

[25] Procedurally, land price analysis is accomplished by using multiple regression techniques to separate the influence of flood risk from other factors, such as structural characteristics and environmental amenities, that determine property values

yields a measure of benefits of the project for the intensification and location benefit categories.

In summary, the primary benefit measure for urban flood damage reduction articulated in the P&G is property damages avoided. Nevertheless, the P&G does make an explicit provision for measurement of "intangible" benefits, which can be viewed as representing the non-property or human values of flood protection at existing properties, through use of comparative land price analysis. Implicitly, these non-property factors are also included in the benefit estimate procedures for intensification and location benefits that depend upon projections of changes in land uses and land prices.

Of the two flood risk reduction benefit measures articulated by the P&G—property damages avoided and land price changes—the latter best approximates the WTP standard of value since, in principle, land price differentials capture both property and non-property benefits of flood risk reduction as subjectively assessed by affected land market traders. And with land price analysis, there is no need (or ability) to separate property from non-property benefits, because land price bids will be a composite of the two concerns. Thus, if land price differential is used as the benefit measure, there is no need to use any alternative measurement technique, given the WTP rationale as a benefit standard. However, application of the land price approach for the evaluation of flood reduction benefits is technically challenging, and few attempts have been reported in the literature. Largely for these reasons, PDA continues to be the primary benefit measure used to evaluate the NED benefits of urban flood damage reduction.[26]

4.2.1.1 Permanent Evacuation Benefits

While the P&G establishes PDA as the primary measure of inundation reduction benefits resulting from structural flood management alternatives (e.g., channels, levees and floodwalls), it disallows use of PDA as a measure of benefits for floodplain properties that would be permanently evacuated under a project plan. For the measurement of inundation reduction benefits associated with evacuated lands, the P&G states:

> *To the extent that [there will be] a difference in land use for an evacuation plan, the benefit is the reduction in externalized costs of floodplain occupancy that are typically borne by taxpayers or firms providing services to floodplain activities. Examples of such costs are subsidized insurance; casualty tax deductions; flood emergency costs; and flood damages to utility, transportation, and communication systems. Reduction of costs not borne by floodplain activities may be a major benefit of projects to evacuate or relocate floodplain activities. Reduction of flood damages borne by floodplain activities should not be claimed as a benefit of evacuation or relocation because they are already accounted for in the fair market value of floodplain properties.* [P&G, Section 2.4.14(a)]

[26] Indeed, current Corps policy overrides the P&G allowance for claiming flood risk reduction benefits based on restored market value. It states, "Valid estimates of restored market value are difficult and costly to make in typical flood control project evaluations. Therefore, no resources should be used in efforts to quantify restoration of market values for flood control projects (EP 1165-2-1; 30 July 1999).

The first part of this passage indicates that, to the extent that the evacuation of floodplain properties would result in the avoidance of costs that are not borne by floodplain occupants in the without-project condition, these avoided costs can be counted as a benefit of evacuation plans. But the last sentence in the passage prohibits claiming additional benefits for evacuation plans using PDA for the specific properties to be evacuated, based on the presumption that the market prices of properties to be evacuated are fully discounted for flood hazards (i.e., market values for floodplain properties are lower than for comparable properties with lower flood risk). Under that presumption, the buyout costs for floodplain properties would already incorporate the value of expected property damages avoided from evacuation. In other words, if flood risks were fully discounted in the market prices for the lands and structures to be evacuated, then the owners of these properties would receive no net economic benefit from a project buyout of their properties at those prices. This logic implies that adding estimated properties damages avoided for evacuated properties to buyout costs would represent double counting of benefits.

This guidance is underpinned by several explicit and implicit assumptions, including that land buyers and sellers have **full information** regarding flood risks for affected properties. Critics of this guidance stance question whether real estate prices fully reflect potential flood hazards, and argue that property damages avoided should be included as part of a standardized framework and methods for NED evaluation of any management alternative. But to the extent that the guidance assumptions hold in reality, then the separate methods established for evaluating NED benefits of structural versus evacuation alternatives for flood damage reduction are fully consistent in conceptual foundation. That is, if real estate prices accurately reflect flood risks, then the logic underlying the P&G guidance for NED evaluation of evacuation plans is identical to that for NED evaluation of structural management alternatives.

Thus, under the full information assumption included in the P&G, the NED benefits for flood reduction *at the site of evacuated properties* are limited to any avoided insurance subsidies and other such "externalized costs," and the NED value that arises from any new uses of the evacuated properties. The last item might include, for example, flood damage reduction and open space benefits to owners of adjacent properties, as well as any recreation and environmental benefits provided by the evacuated lands.

If the full information assumption does not hold in reality, however, then the NED benefits at the site of evacuated properties, as measured following the P&G guidance, would provide a lower bound estimate for the true on-site benefits of permanent evacuation. A PDA measure of on-site benefits, on the other hand, which implicitly assumes that land markets traders are completely ignorant of flood risks at the site, would provide an upper bound estimate of flood reduction benefits arising from permanent evacuation.

However, Corps policy for the NED evaluation of permanent evacuation was changed in 2001 in order to comply with the Water Resources Development Act (WRDA) of 1999.

Section 219 of that act directed the Secretary of the Army to calculate the NED benefits for nonstructural flood damage reduction projects using methods similar to those used in calculating the NED benefits for structural projects, while avoiding the double-counting of benefits. To comply with this directive, current Corps policy says that PDA for the properties to be evacuated can now be claimed as an NED benefit of evacuation plans. However, for the NED evaluation of the net benefits of such plans, planners are to use a measure of plan costs that reflects the market value of flood-free properties that are comparable to the properties to be evacuated. That is, for evacuation plans, the measure of NED cost should reflect the market vale of comparable properties that lie outside the floodplain, rather than the appraised value of the evacuated properties.[27]

This new policy guidance would be directly comparable to the P&G approach for using PDA in the case of structural flood damage reduction plans in cases where the market value of the properties to be evacuated equals the market value of comparable flood-free properties used in the NED evaluation. Any equivalence between the market value of the floodplain properties to be evacuated and comparable flood-free properties would imply that market traders have complete ignorance (i.e., the opposite of complete information) regarding the flood risks for the floodplain properties. But if the market value of the floodplain properties were less than the market value of comparable flood-free properties, then the new guidance would employ measures of NED costs (market value of flood-free properties) and NED benefits (PDA for floodplain properties to be evacuated) that overstate actual economic costs and benefits. The implicit assumption within the new guidance is that these inflated measures of NED benefits and costs will serve to cancel each other out, and thus satisfy the WRDA directive to use PDA measures of benefits in the case of nonstructural evacuation plans, without double-counting benefits.

4.2.2 Transportation: Inland and Deep Draft Navigation Benefits

The P&G defines the primary economic benefit of inland and deep draft navigation projects as the reduction in the value of resources required to transport commodities. The specific categories of benefits set out in the P&G for inland navigation include:

1) Cost reduction benefits,
2) Shift in mode benefits,
3) Shift of origin-destination benefits, and
4) New movement benefits.[28]

Cost reduction benefits are the principal benefit category; the other benefit categories reflect the different ways that cost reduction can give rise to non-marginal changes in the use of inland navigation.

Figure 4-1 uses a hypothetical project example to illustrate benefits estimation corresponding to three of these categories of inland navigation benefits. It depicts the

[27] The policy guidance states, "Note that this adjustment in costs is intended for use in the economic evaluation only and should not otherwise affect the financial cost associated with evacuation of the floodplain."
[28] The P&G lists similar benefit categories for deep draft navigation planning.

calculation of benefits to shippers[29] from expanding locks along a specific origin-destination route as a means to alleviate barge traffic congestion and associated passage delays at the locks. The vertical axis represents the unit prices (rates) for transport, and the horizontal axis shows the total quantity of commodity units transported in response to different rates.

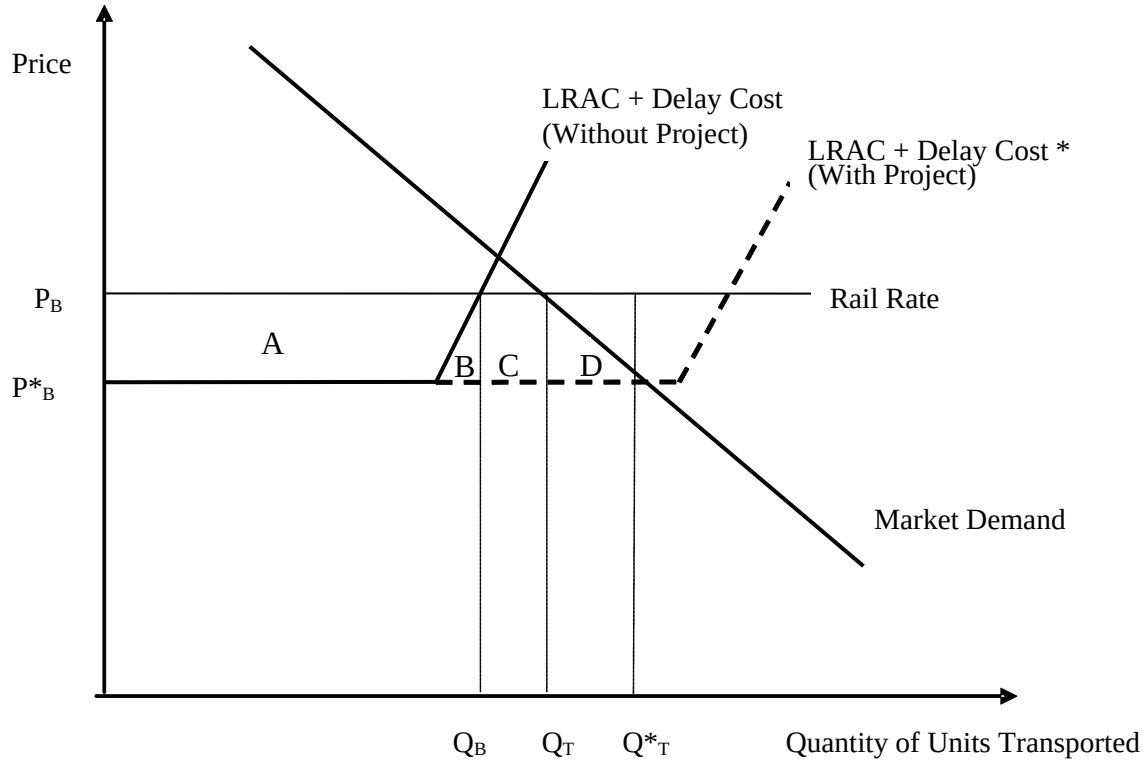

Figure 4-1 Benefits to Shippers from Lock Expansion

The downward sloping line shows shippers' total market (derived) demand function for transporting a specific commodity from a given origin to a given destination. The slope of the demand function, or Market Demand for all available transportation methods, represents the response of the quantity of the commodity transported to changes in transportation rates. For simplicity, it is assumed that this market is served by only two transport modes--waterway barge and railroad, and there is no qualitative difference between the services they provide.

In the Figure 4-1 example, it is assumed that, because of the open access nature of the barge industry, competition forces barge rates to the level of the long-term average costs

[29] Shippers include grain elevators and other entities that purchase barge services to transport commodities to buyers.

(LRAC) of providing barge transportation. Further, the example assumes that the long-run average cost function for barge transportation is horizontal over some initial range of shipments, reflecting constant marginal costs of moving that range of shipments by barge. However, the example also assumes that as the level of barge shipments increases beyond a certain point, increased barge traffic results in congestion and queuing delays at the locks on the system. The increasing waiting times for passage through the locks reflects diseconomies for barge transportation due to increasing factor input costs, which is represented in Figure 4-1 by the portion of the barge long-run average cost function that suddenly veers upwards and to the right. The difference between the horizontal and upward sloping sections of this function is the delay (congestion) cost.

In the without-project situation, the total quantity of units shipped is Q_T. Of this total, Q_B is shipped by barge at price P_B that approaches but remains slightly below the prevailing rail rate. Since barge rates are set equal to barge long-run average costs, the barge price for Q_B includes a lock delay cost that is imposed on all barge shippers. The remaining quantity transported ($Q_T - Q_B$) is carried by rail, since the prevailing rail rate is below the rate that barges would need to charge shippers to accommodate the increased delay cost if total barge shipments were to increase beyond Q_B.

Expansion of the locks would increase total potential barge shipments to Q^*_T by eliminating delay costs for this level of shipment. This is illustrated by the horizontal section of the without-project average cost function and the extending dashed line. This represents the new long-run average cost function for barge shipment with lock expansion. The new average cost function eventually turns upward, reflecting that even with lock expansion, delay costs would reappear if barge shipments increased much beyond Q^*_T.

Estimation of the benefits of lock expansion begins with a prediction by planners of the amount of barge shipments that would result if the new lock capacity were fully utilized, which in this example is Q^*_T. At this new level of barge shipment, project benefits would be the sum of 1) *cost reduction benefits* for the level of barge shipments that existed in the without-project condition, 2) *shift of mode benefits* associated with the level of without-project shipments that were carried by rail, but with the project will now switch to barge, and 3) *new movement benefits* associated with any increase in total market shipments beyond the without-project level.

Cost reduction benefits are equal to the sum of areas A and B in Figure 4-1 and are calculated by multiplying existing barge shipments (Q_B) by the difference between the without-project barge rate (P_B) and the estimated with-project barge rate (P^*_B). Shift of mode benefits are equal to area C, and are calculated by multiplying the quantity previously carried by rail ($Q_T - Q_B$) by the difference between the prevailing rail rate and the with-project barge rate. Finally, new movement benefits are equal to area D.

Economists have long noted that several factors can cause the measures of navigation benefits outlined above to diverge from shippers' WTP for navigation improvements. First, it has been noted that prevailing rail rates do not necessarily reflect rail companies'

long-term marginal costs of providing rail transport, and thus may provide a dubious basis for estimating shipper cost savings with a navigation improvement. This argument was typically made prior to the 1980s when rail was a highly concentrated (and regulated) industry, ranging from one seller (monopoly) to several sellers (oligopoly) over different service routes. Given the lack of competition in those markets, rail companies were presumed to have the ability and incentive to charge rail rates that exceeded their long-term marginal costs. To the extent that benefits estimation for a navigation project—particularly one that provided a new rather than improved waterway—used prevailing rail rates that were actually higher than actual rail long-run marginal costs, then estimates of avoided alternative costs would overstate actual benefits. Further, since estimates of future traffic on the waterway are based on prevailing rail rates, such estimates would overstate estimated shift of mode benefits if the rail rate exceeded true long-term marginal costs. This is because rail companies would be expected to respond to a new or improved waterway by reducing rail rates towards their marginal costs in order to limit the loss of traffic to barge transportation whenever possible.[30]

In the present day, however, the potential problems noted above that were argued to attend navigation benefits analysis in a previous era may no longer be as significant. Two main factors lead to this conclusion. First, the Civil Works Program now rarely constructs new navigation channels; contemporary navigation projects primarily involve the improvement of existing waterways. Thus, rail companies presently face competition in the markets served by established waterways and have already been forced toward more competitive rate-setting in these markets to attract and retain traffic. Second, rail is now a deregulated industry, which has fostered intra-mode (rail-rail) competition and forced rail rates downwards. These factors suggest that rail rates may now be a reasonably good proxy for the long-run marginal costs of rail transport, and thus provide an adequate basis for estimating benefits from cost reduction and shift of mode resulting from navigation improvements.

Another reason that P&G measures of navigation project benefits might not reflect shippers' true WTP for navigation improvements relates to the significant potential for the predictions of traffic levels that would use the improved waterway, which in the example in Figure 4-1 is $Q^*_{T,}$ to diverge significantly from the traffic levels that are actually realized with the project in place. Indeed, navigation benefits estimates are extremely sensitive to such projections, and inaccurate predictions of future use can

[30] If prevailing rail rates in the without-project condition accurately reflect the long-term marginal costs of rail transport, then rail companies would not be able to respond to a waterway improvement by reducing rail rates in an effort to retain market share. If that situation applied to the navigation example in Figure 4-1, then actual shift of mode benefits would be equal to area C, and all market traffic would move by waterway with lock expansion. However, if the initial rail rate were above rail long-term marginal costs, then rail companies would have scope to reduce rail rates to retain some share of their without-project traffic, and actual shift of mode benefits would be less than area C. In that event, the reduced (or "water-compelled") rail rate paid by those shippers who continued to use rail transportation after the waterway improvement would represent a transfer of value from rail companies to rail shippers, or RED effects rather than a NED benefit of the navigation project.

easily swamp other potential problems associated with the measures used to evaluate the NED benefits of navigation improvements.

Indeed, forecasting long-term commodity movements on a navigation systems is complicated by uncertainties regarding future domestic demand and supply functions for the different commodities shipped on the system; the costs, capacities, and other characteristics of alternative transport modes; and in the case of grain moved on the system for export, world-market conditions (demands, supplies, prices, and transport costs) that affect international commodity movements.

Another overarching issue that complicates navigation benefits analysis relates to the fact that navigation infrastructure is part of an overall transportation system that involves various alternative and interconnected transport modes. The interconnected nature of transportation infrastructure, and the many commodity flows and final goods markets it serves, means that a comprehensive systems approach is needed to estimate the system-wide impacts of navigation improvements.

As one example of this need, accurate benefits analysis for deep draft navigation planning must account for the potential effects that improving one harbor may have on other regional harbors that may lose traffic to the improved harbor. The potential problem is that, in the absence of a multi-port planning and analytical framework, uncoordinated project-by-project planning could lead to a series of harbor improvement projects that individually appear economically worthwhile, but that cumulatively result in the over-supply of harbor capacity relative to total demand.

The Corps is currently undertaking a major research and development program, known as Navigation Economic Technologies (NETS), to address the problems and complications for navigation benefits analysis noted above. The program goal is to develop a standardized and defensible knowledge base and suite of economic tools for navigation benefits analysis in a systems context. The NETS program promises to provide a much-improved analytical basis for evaluating the NED benefits of potential waterway improvements.[31]

A final issue worth noting concerns the incidence (distribution) of the benefits of navigation improvements. The benefits measures illustrated by Figure 4-1 and reviewed above imply that all of the benefits of inland navigation improvements will initially accrue to the shippers who purchase barge services along the affected routes. However, various different entities could reap at least some share of navigation project benefits, depending on the shapes (elasticities) of the demand and supply functions in their relevant markets. These entities include the producers of the shipped commodities (e.g.,

[31] The NETS program has two key focus areas. First, it is developing a standardized knowledge base for assessing global market conditions, including international competition and commodity flows needed for predicting potential future waterway use. Second, NETS it is developing new and improved economic tools for benefits assessment that are capable of analyzing shipper behavior and responses to waterway improvements and exogenous events, particularly shipper decisions to switch to alternative transport modes.

farmers), shippers (e.g., grain elevators), barge carriers, and the buyers and ultimate consumers of the shipped commodities. Since Corps project planning is concerned with total national benefits of project plans, planning guidance does not speak to the incidence of navigation benefits. The implicit presumption within guidance is that the total national benefits of an inland navigation project plan, however those benefits are eventually distributed, will equal the reduced costs to shippers as calculated using the assumptions represented in Figure 4-1. However, some commentators have noted that international trade may result in some share of inland navigation benefits to accrue outside the national economy. For example, depending on conditions in the relevant markets, some share of inland navigation benefits associated with shipping grain to ports for export to overseas markets may flow through to the foreign buyers and consumers of the shipped grain.[32] Corps guidance, however, does not address the potential for such international transfers of some share of the estimated NED benefits of navigation projects.

4.2.3 Hydroelectric Power and Municipal & Industrial Water Supply Benefits

The P&G says that the NED benefits for project effects on hydroelectric power (hydropower), and municipal and industrial (M&I) water supply outputs may be measured using market prices if the prices accurately reflect the marginal costs of producing these goods. It goes on to say that, if market prices can not be presumed to approximate the marginal costs of producing hydropower and water supply outputs, then planners may use the cost of the most likely alternative means of providing those outputs as a proxy for project beneficiaries' WTP for project outputs.

At the time that the P&G was written, both hydropower and M&I water were supplied through regulated rather than competitive markets. Since the market prices that emerge from regulated markets generally cannot be assumed to reflect true marginal costs of production, benefits estimation for hydropower and M&I water in an earlier era typically relied on the alternative cost measure of benefits. For example, in the absence of a Corps project that would provide hydropower for some community, that community might alternatively construct a coal- or gas-fired power plant. Similarly, in the absence of Corps project to provide municipal water supply for some community, that community might alternatively construct well fields to tap available groundwater. In these cases, the costs avoided by having the same goods provided instead by a Corps project provides a measure of beneficiaries' WTP for project output of the goods.

Economists have long noted that the circumstances under which the alternative cost valuation method can provide an accurate measure of beneficiaries' WTP are severely limited, given the method's focus on service supply rather than demand. Specifically, alternative cost can accurately approximate WTP for some good only if three conditions hold:

[32] Similar arguments have been made for deep-draft navigation projects. For example, it has been noted that some share of the benefits of domestic port-deepening projects may be retained by foreign-owned shippers and carriers.

1) The alternative supply means would provide a good of equivalent quality and quantity as the Corps project,

2) The alternative supply means is the least-costly alternative way to provide the good in the absence of the Corps project, and;

3) Evidence suggests that community investment in the alternative means of providing the good would actually be undertaken if the Corps project were not implemented.

The last item relates to the important issue of what specific output level for the good that users would actually pay to secure if they were forced to absorb the full cost. In the community water supply context, for example, residents might be willing to pay for a system that provides a water supply capable of reliably serving all desired uses, all the time. Alternatively, residents might opt for a lower-cost system that might not necessarily ensure a water supply that could meet all desired water uses under all situations, thus possibly necessitating water-use restrictions at certain times. This example highlights that use of alternative cost as a benefit measure requires identification of the specific output level for which the cost estimate is developed. In the water supply example outlined above, the determination of the output level would appropriately consider not only projected future community water use, but also the willingness of residents to accept potential restrictions on water use. Thus, although the alternative cost method provides a means for estimating the benefits from increased output of a good in the absence of an empirically estimated demand function for the good in question, its use can best approximate WTP for project output when at least some information on demand for the good is available to guide its application.

In the case of project effects on hydropower, Corps project planners no longer need to revert to alternative cost as the default valuation method. Wholesale electricity can now be purchased directly from the "grid," and increased competition in wholesale electricity markets resulting from evolving industry deregulation and restructuring have forced electricity providers towards marginal-cost-pricing. The result is that market prices for wholesale electricity now better reflect marginal costs and provide an appropriate measure of users' marginal WTP for electricity. Thus, project effects on hydropower output generally can be approximated by changes in net revenues to hydropower producers associated with the estimated change in hydropower output. [33]

However, there are multiple market prices for hydropower, reflecting, for example, prices for base demand versus peak demand, and determining how to apply these different prices for valuing hydropower benefits is not necessarily straightforward. Another challenge for valuing hydropower benefits relates to characterizing for decision-makers

[33] The assumption here is that project effects on output can be readily estimated and, together with market prices for hydropower inputs and output, provide the appropriate basis for estimating hydropower benefits to producers and consumers. However, hydropower producers need to be concerned not only with how much they can produce but also *when* that production can occur. That is, producers focus on their operational ability to meet unpredictable spikes in demand in real-time. Thus, hydropower producers and consumers may be more concerned about project effects on operational flexibility in production (e.g. minimum output allowed at any time) than about total allowable production over some timeframe.

alternative scenarios relating to the possible future direction of electricity prices over the project life, and their attendant uncertainty. This is particularly important given that the prediction of future energy prices beyond a few years is fraught with uncertainty, since the factors that determine energy prices—including future fuel prices, technological change, pollution control requirements, and electricity demand—can not be reliably predicted over extended timeframes.[34]

4.2.4 Agriculture Benefits

For project outputs involving agriculture, the P&G says that benefits can be estimated as the increased net income to producers (market value less production costs) resulting from any decreased production costs and increased harvest levels. This benefits measure, and the potential for this measure to diverge from beneficiaries' WTP for changes in agricultural outputs, is outlined below.

Corps projects can increase the productivity and use of agricultural lands by providing irrigation for lands that otherwise would have inadequate precipitation or water supply, by the drainage of excess water, or from the reduction of flood hazards and erosion. The same benefit measures are used for the evaluation of these different types of project effects. Specifically, the P&G identifies two benefit categories for agriculture—damage reduction benefits and intensification benefits.

Damage reduction benefits are those that accrue to agricultural lands when there is no change in cropping pattern in the with-project condition, while intensification benefits are those that accrue to lands where a change in cropping patterns is expected to result with the project. The P&G states that both types of benefits can be measured as increased net income to farmers resulting from increased crop yields and decreased production costs, as calculated using "farm budget analysis." Farm budget analysis combines agricultural crop price information, prices for production inputs, and expected yields to calculate the with-project increase in farmers' future stream of net income over the project life, which is then discounted back to present values.

The extent to which the net income measure of agricultural benefits provides a good approximation of NED benefits for increased output depends largely on the credibility of estimates of current and projected future yields, production costs, and output prices used in farm budget analysis. It also turns on whether or not the crop prices used to estimate benefits reflect real exchange values (that is, true opportunity costs). If the crop prices

[34] The International Lake Ontario-St. Lawrence River Study provides a contemporary example of how the challenges that attend the use of market prices for valuing hydropower have been addressed in practice. That study evaluated alternatives to the criteria currently used for regulating water levels on Lake Ontario and in the St. Lawrence River. Some of the alternatives under consideration would lower hydropower output from that now supplied in the base case. Following a recommendation by an economic advisory committee, the study team used a representative set of current seasonal market prices for electricity to measure hydropower benefits foregone. The study also used long-term forecasts of electricity prices for hydroelectric generation from various sources to evaluate the sensitivity of the hydropower benefits estimates to alternative scenarios reflecting varying possible trends in prices over extended timeframes.

accurately reflect opportunity costs, then the price received by farmers represents consumers' WTP for the agricultural output. But if the crop prices used in the calculation of net income include the value of any federal agricultural subsidies, then the estimated increase in net income will overstate actual benefits.

Federal subsidies represent economic transfers (shifts of value from one group of people to another) rather than NED benefits. Accordingly, the P&G directs planners to use prices in benefits evaluations that represent "real exchange values," and it specifies that for agricultural outputs "normalized prices prepared by the U.S. Department of Agriculture (USDA) should be used." While the P&G does not specifically define normalized prices, its intent was to require planning studies to use prices for agricultural commodities that reflect real exchange values—that is, output prices that are undistorted by federal price supports. At present, however, the normalized prices reported by the USDA are not adjusted to strip-out the effects of any federal agricultural subsidies.[35]

In the case of intensification benefits, the P&G says that planners may alternatively use land price changes to value project outputs. To the extent that land price changes reflect land market traders' subjective assessment of the present value of expected future increases in agricultural net returns resulting from project plan, then the estimated changes in the market price for farmland resulting from a project provides a WTP measure of the agricultural benefits of the project. As with the net income approach, however, benefit estimates based on land price changes would overstate WTP to the extent that land price changes reflect farmers' expectations for an increase in federal agricultural subsidies in the with-project condition.

As noted earlier in this chapter, land price analysis is technically challenging and has generally not been used for NED evaluations in the civil works context. Nevertheless, in some cases, a simple comparison of land price data in the project area can serve as a useful check on NED evaluations of net income to farmers that have been calculated using farm budget analysis. For example, in areas dominated by farming and where alternative land development opportunities are severely limited, land market prices should reflect the capitalized value of the expected future stream of net returns to agricultural use, as affected by land traders' expectations about crop insurance subsidies and other federal farm program benefits. In that case, observed differentials in land prices across the area would indicate differing agricultural productivity of these lands.

This suggests that data on varying land prices in such areas might usefully serve as a check on estimates of the capitalized (present) value of the estimated future stream of net income to farmers, since these two measures would be expected to converge as long as the effects of any agricultural subsidies are consistently included or not included in both

[35] For a time prior to 1993, the USDA employed methods for estimating normalized prices that removed the effects of federal subsidies. However, the USDA in 1993 abandoned methods for estimating subsidy-free normalized prices, arguing that farm legislation enacted in 1985 and 1990 reduced the influence of government support prices for most agricultural commodities. But subsequent farm legislation has increased transfer payments and thus the likelihood that federal support programs now directly or indirectly buttress present-day prices for some commodities.

measures. That is, the estimated capitalized net returns to farmlands affected by a project plan could be compared to the market prices of other farmlands in the area with similar levels of agricultural productivity. If such a test revealed that the two measures differed significantly, this might signal potential problems in the farm budget analysis relating to the prediction of current or future agricultural yields, production costs, and/or output prices.

4.2.5 Commercial Fishing Benefits

The P&G says that commercial fishing benefits may result from project effects that reduce harvesting costs or that increase fish harvests, which may be measured as the increased net returns to commercial fish harvesters. But the extent to which this benefit measure can provide a good approximation of project-induced changes in some commercial fishery depends largely on how that fishery is managed. This is because the long-term economic value of a commercial fishery is influenced not only by market conditions, but also by potential regulatory policies that determine resource access and rate of utilization.

At the extremes, fishery management regimes include "open access" with no regulation of fishing effort and catch, and "common property" with regulation of effort and catch in order to sustain the resource and fishery benefits over time. In an open access regime, harvesters' access to and utilization of the fishery are unconstrained; that is, no potential harvester is denied access to the resource nor limited in fish catch. This system produces incentives for harvesters to catch as much fish as they can, as quickly as they can, since the harvestable resource is limited and subject to depletion by other harvesters. The result is over-capitalization of fishing fleets and over-exploitation of the resource as more and more fishing effort chases short-term returns from the limited resource. This eventually raises harvesting costs and eliminates any economic rents (economic benefits to harvesters) as the resource is depleted. That is, under conditions of open access with no regulation of fishing effort and catch, competition among harvesters drives economic rents to zero.[36]

In a fishery managed as a common property regime with "optimal" regulation, property rights (fishery access and use rights) are reserved for a limited group of harvesters, and catch rates are regulated in an attempt to mimic outcomes that would result in a perfectively competitive market for a private good. For example, an "Individual Transferable Quota" (ITQ) system represents such an optimal management regime. In an ITQ system, an annual total allowable harvest quota is established and divided among a set of ITQ permits that allow their holders to harvest up to a certain percent of the quota for a given fish stock. The ITQ permits are initially allocated to harvesters in some

[36] The P&G states, "Unless entry is restricted, excessive quantities of capital and labor may enter a fishery; that is, entry may continue until the economic rent from the living stock is dissipated. This excess entry will result in economic inefficiency in the utilization of the fishery resources because value of the resulting extra output will be less than the social opportunity cost of the entry. Some economic benefits may be realized but the total benefits will not be as large as they might be if entry were restricted." [P&G, Section 2.9.9 (b)]

manner, and subsequently can be freely traded (bought and sold) among harvesters.[37] The ITQ system eliminates the potential for over-capitalization, since property rights to the fishery are limited and fixed. The result is that ITQ holders earn economic rents from their property rights to the fishery, and the long-term economic health of the fishery is sustained.

Since the management regime for a fishery determines whether economic rents can be realized in the long-term, the potential for P&G measures of commercial fishing benefits to approximate project-induced economic benefits likewise turns on how the affected fishery is managed. Consider first the P&G measures of commercial fishing benefits from project effects on a fishery that is optimally managed using the ITQ system outlined above. If the project is expected to reduce harvester costs (by improving access, for example), benefits are measured as the reduced costs of securing existing harvest levels. When the allowable fish catch is expected to increase with the project (through an increase in the total harvest quota), but the change is too small to affect the market prices of fish harvested, then planners are instructed to calculate increased total revenues received by harvesters from the additional catch using seasonally-weighted averages of recent ex-vessel fish prices. In this case, commercial fishing benefits are calculated as the change in total revenue due to the increased catch less the change in total harvesting cost associated with the increased catch. In both cases outlined above, the P&G benefit measures provide reasonably good approximations of the change in economic rents to harvesters, which are realized due to the access and use restrictions imposed by the ITQ system.

Now consider the case in which estimated project-induced increases in fish harvest are expected to result in a fall in the market price for fish in an optimally managed fishery.[38] For benefits estimation in that case, the P&G says that the change in net income associated with the additional catch can be measured using an estimate of increased revenue calculated by using a price midway between the expected with- and without-project prices. But it is unclear how well this measure of net benefits would approximate actual net benefits, which depend on how the project affects both economic rents to harvesters and consumer surplus to buyers. For example, if the demand for an affected commercial fish species is fairly inelastic (implying that price will fall with an increase in supply over the relevant range of output), then accurate benefits estimation for a change in harvest levels ideally requires sorting through the change in benefits accruing to both harvesters and buyers.

However, the reality is that, in the present day, commercial fisheries continue to be dominated by open-access regimes. When a project is projected to affect harvester costs and/or harvest levels in an open access fishery, long-term benefits to harvesters are

[37] ITQ holders could include harvesters or fish processors.

[38] In general, civil works projects would not be expected to change fish harvests on a scale sufficient to affect fish prices, although it is possible. For example, large-scale programs for restoring and protecting Louisiana coastal marshes are now being studied, and if eventually implemented, could potentially significantly alter harvest levels in fisheries involving species that depend on wetlands for nursery and feeding grounds.

unlikely, since any short-term benefits would attract greater fishing effort and thus be short-lived. Nevertheless, it is possible for project effects to result in long-term benefits in an open access fishery under certain conditions, although that determination would likely require more information and analysis than that required to estimate the benefit measures set out in the P&G.[39] The important point is that when the specific fisheries affected by a project are known to be open-access with no regulation of access and utilization, then the P&G measures of commercial fishing benefits may substantially overstate project benefits.

4.2.6 Recreation Benefits

The P&G says that the benefits of enhanced recreation opportunities resulting from a project plan are measured as beneficiaries' WTP for those enhancements. Benefits for an increase in the quantity of recreation services are measured as the WTP for each new increment of supply, while benefits for a change in the quality of recreation are measured as the difference between WTP in the with- and without-project conditions. Recognizing that water-based recreation opportunities largely are non-marketed services, the P&G outlines a set of methods for estimating recreation use and "simulated market prices" (or shadow prices) that, in principle, represent the prices that would emerge for recreation services if they were exchanged in competitive markets.

The specific methods discussed in the P&G include the Travel Cost Method (TCM), the Contingent Valuation Method (CVM), and Unit Day Value (UDV) Method. The TCM is a "revealed preference" valuation approach that exploits the fact that the people who use recreation services at some site travel from various locations to visit the site, and thus bear different travel costs to use the same service. The TCM estimates the demand for site recreation services by modeling the relationship between visits to a site and travel costs. The CVM is a "stated preference" valuation approach that relies on the use of sophisticated public surveys that describe a potential improvement in services, and solicit information on respondents' WTP to obtain the improvement. The UDV Method relies on administratively-established unit values for various recreation activities (such as a day of fishing or hunting) for the estimation of recreation benefits.

The P&G establishes a procedure for guiding the selection of valuation approach that gives first priority to regional (TCM or CVM) demand models when applicable models are already available. Such regional demand models are generally needed to account for how recreation users will respond to a change in the quality of recreation services at one site, or the introduction of new sites or the elimination of existing sites, within a regional area that includes a set of quality-differentiated recreation sites. The P&G also says that benefits estimation for recreation site improvements that reach a certain cost threshold or that affect a certain level of annual visitation should develop a regional model or conduct a site-specific study.

[39] For example, if a project were expected to result in declining fish prices, then fish consumers would realize an increase in consumer surplus. Measurement of such benefits would require evaluation of both the demand and supply conditions in the affected fisheries.

Several decades ago, the Corps experimented with the development and use of regional as well as site-specific recreation demand models for estimating recreation benefits at Corps reservoir projects that provided significant slack-water[40] recreation opportunities. However, regional demand modeling is data intensive, costly, and requires specialized expertise. Moreover, accounting for variations in site quality within multi-site demand models often involves simplifications that limit the ability of these models to accurately characterize recreation demand. And while site-specific recreation demand modeling is less data intensive and costly, such models are even more problematic for characterizing and estimating the effects of changes in site quality on recreation demand.[41] Largely because of these difficulties and costs, and the fact that the Corps now only rarely constructs reservoir projects providing significant recreation opportunities, the UDV method has become the default approach for estimating recreation benefits yielded by Corps projects.

In current economics terminology, the UDV method represents a "benefits transfer" valuation approach. Benefits transfer refers to the process of using valuation results for one or more sites derived in original demand studies (the study sites) to calculate benefits estimates at another site (the project site). The UDV method represents the simplest type of benefits transfer in which average values for units of various recreation activities (e.g., average value for a day of general fishing) are combined with estimates of the number of recreation units (fishing days) provided by a project to estimate recreation benefits. The P&G provides "look-up" tables providing administratively-determined unit-day values for various general and specialized recreation activities that were developed using expert judgment.[42] The UDV method is thus an inexpensive and expedient alternative to original analysis of recreation demand at project sites.

However, the practical advantages of the UDV method come at the expense of potentially significant inaccuracy in recreation benefits estimation. Several factors suggest that, in general, the UDV method can provide only gross proxies for beneficiaries' WTP for recreation improvement at Corps projects. First, the economic value of some change in output is user-specific and context-specific. Thus, economic valuation should seek to identify the WTP of affected individuals for a well-defined change in output in the context of the specific local and regional economic and environmental settings in which the change occurs. But the use of standard, average unit values for the estimation of recreation benefits essentially presumes that differences among projects in terms of the specific changes in recreation services, affected users, and other aspects of the specific change contexts that determine economic benefits are unimportant for benefits

[40] Slack-water is a stretch of water with no appreciable current or movement.

[41] With site-specific demand modeling, there is typically little in the way of historical data indicating differences in site quality over time that can provide the basis for modeling the effects of site quality change on recreation demand. And characterizing and estimating the effects of the "prices" and qualities of substitute sites on site recreation demand within site-specific models is also problematic. For these and other reasons, site-specific models have been largely displaced by regional models in contemporary recreation demand analysis.

[42] The unit day values are periodically updated for inflation and reported in Corps Economic Guidance Memoranda. The FY 2008 unit day values range from roughly $4-10 for general recreation, and $14-40 for specialized recreation.

estimation.[43] Second, the unit day values used by the Corps were first developed in 1962, and they are significantly lower (in real terms) than unit values for comparable recreation activities estimated in contemporary recreation demand studies. Third, application of the UDV method requires a separate estimation of how a project will affect recreation use at the project site, which typically must rely on various ad hoc estimation approaches (such as "per capita use curves"). But such methods for estimating use generally cannot adequately account for potential transfers of use from existing recreation areas to the project site. And importantly, the UDV method is generally poorly-suited for estimating benefits associated with an increase in the quality (rather than supply) of recreation services.[44]

4.3 Measures of NED Costs

The P&G defines NED costs as the opportunity costs of the resources required or displaced to achieve plan purposes (hereafter referred to as "plan resources"). For the measurement of NED costs, planners are instructed to use market prices for plan resources under the presumption that such prices reflect real exchange values (true opportunity costs). In the case of plan resources for which evidence suggests that there is an important degree of "market failure," planners are instructed to use "surrogate values" that adjust or replace market prices to approximate opportunity costs.

The P&G identifies three categories of NED costs—implementation outlays, associated costs, and other direct costs. **Implementation outlays** include all out-of-pocket (cash) costs to construct and then operate and maintain project plans, including any required expenditures to minimize and mitigate losses of fish and wildlife habitat. **Associated costs** are the out-of-pocket costs of additional measures, over and above plan components, that would be needed to achieve benefits claimed for some plan. For example, associated costs might include expenditures for boat ramps necessary to fully realize claimed recreation benefits. Market prices are used for the estimation of both implementation outlays and associated costs.

Other direct costs include the costs of resources required for a project plan but for which no implementation outlays are made. For example, if a non-federal project sponsor supplies for a project lands that it already owns, then no out-of-pocket costs are incurred to secure project lands. Nevertheless, there is still an economic (opportunity) cost of using the land for project purposes that must be accounted for in the evaluation of NED costs, reflecting the net benefits foregone by not using the land in its best alternative use.

Other direct costs also include the value of any uncompensated losses in goods and services resulting from project plans. That is, other direct costs include any NED benefits foregone due to negative project impacts on the supply or quality of currently-provided goods and services. Examples cited in the P&G include increased downstream flood

[43] The UDV method does provide some limited scope for adjusting unit day values to reflect quality considerations at project sites as well as relative scarcity, ease of access, and aesthetic features.
[44] Benefits associated with an increase in the quality of recreation services will be a composite of increases in both unit values for the service and total use.

damages that are caused by channel modifications, increased water supply treatment costs that are caused by irrigation return flows, and loss of recreation values from reduced in-stream flows due to use of water for agriculture.

It seems likely that accounting for NED benefits foregone in project evaluations in future civil works planning will assume more importance, given the new emphasis on projects formulated for ecosystem restoration. To the extent that such projects reintroduce greater hydrologic variability in watersheds, for example, they may sometimes result in increased flood damages, reduced hydropower production, and adverse impacts on other existing watershed goods and services. The measurement of such NED benefits foregone is accomplished using the same value measures and estimation methods outlined in Section 4.2 for the evaluation of NED benefits.

4.3.1 Use of Underemployed Labor for Project Construction

As mentioned above, implementation outlays include all financial costs to construct and operate a project plan, including labor costs. In a full employment[45] economy, the use of labor resources for project construction precludes application of those resources in other productive uses; thus, the wages paid to workers for project construction normally are counted as an NED (opportunity) cost of the project. However, the P&G recognizes that some areas of the country may be characterized by "substantial and persistent" unemployment or underemployment. In such areas, the use of labor resources for project construction would not entail an opportunity cost equivalent to the market wages paid to those workers for project construction. Rather, the opportunity cost of employing otherwise underemployed people for project construction equals their without-project earnings, which, because of their underemployment, are less than their market cost for project construction. The P&G outlines procedures for estimating opportunity costs associated with the use of underemployed labor in project construction, and discusses the various complications attending such calculations. It also provides the following instruction for how those estimates should be recorded in the NED account:

> *The most straightforward way to reflect the effects of employing unemployed or underemployed resources for would be to reduce the by the appropriate amount the project construction costs in the NED account, but this method would cause accounting difficulties in appropriations, cost allocation, and cost sharing. Therefore, these effects are treated as a project benefit in the NED account.* [P&G, Section 2.11.2(a)]

[45] The term "full employment" does not imply that there are no people who want a job but are without one. Rather, the meaning of this term assumes some small level of "structural" unemployment (roughly 4-6% of the workforce) representing people who are only temporarily unemployed because of their present circumstances, such as people who are newly entering the workforce (e.g., recent college graduates) or those who are in the process of changing jobs.

4.3.2 Economic Versus Financial Costs

The above discussion alluded to an important distinction between the financial costs and economic costs of project plans. **Financial costs** represent the out-of-pocket costs of undertaking a project plan, including all implementation outlays (including mitigation expenses) and associated costs. **Economic costs**, on the other hand, represent all opportunity costs of project plans, and thus include not only the financial costs of plans, but also any net NED benefits foregone that would result from plan implementation.

NED cost evaluations consider economic costs rather than simply financial costs since the purpose of NED analysis is to evaluate the national economic efficiency implications of alternative plans. Thus, all economic gains and loses should be considered in NED analysis, whether or not any of these effects are realized as financial impacts.

At the same time, however, it is necessary to isolate the financial costs of project plans for federal capital budgeting and other purposes (as noted above in the P&G excerpt on accounting for the use of underemployed labor for project construction). That is, when the Administration and the Congress consider which among the portfolio of recommended projects to fund in any federal appropriations cycle, they require information on how much federal money will be needed to implement a project. This is one reason that feasibility studies are required to calculate and report for all projects plans—along with net NED benefit estimates—benefit-cost ratios in which the cost side of the ratio records financial costs only.[46] Therefore, if the estimated NED costs for some plan include net uncompensated losses of goods and services, these non-financial opportunity costs are shown on the benefits side rather than the cost side of the benefit-cost ratio (BCR). In other words, any estimated NED benefits foregone resulting from a project plan, and for which no plan compensation will be provided to the affected people, are netted from estimated NED benefits yielded by that plan for purposes of reporting the plan's BCR.

The above conclusion is applicable only when estimated net benefits foregone represent uncompensated losses. But if the people who would realize these opportunity costs must be compensated in some way for a project plan to move forward, and that compensation involves cash outlays, then those costs represent an additional financial cost of the plan. As noted above, the ecosystem restoration mission in particular may often result in the formulation of project plans that impose opportunity costs on users of existing watershed services. As a condition for their acceptance of such project plans, the people who would bear these costs may increasingly demand financial compensation or "economic mitigation," where the latter involves additional plan measures that could reduce or eliminate the economic loss.[47] Thus, to the extent that project plans involve direct

[46] Another purpose of reporting a project benefit-cost ratio is to indicate the amount of project benefits received per dollar of project financial cost. That is, benefit-cost ratios provide information on the financial rate of return of prospective federal investment in alternative projects.

[47] As an example of economic mitigation, levees might be added to a restoration project plan in order to protect a specific residential area that, in the absence of the levees, would be exposed to greater flood risk with the plan. The financial cost of such measures can be viewed as the dual to expenditures for fish and wildlife mitigation measures that also are recorded as part of the financial costs of plans.

financial compensation or economic mitigation measures that involve cash outlays, these costs would appropriately be recorded on the cost side of the BCR.

Note that it is entirely possible that when cash outlays for financial compensation or economic mitigation measures are part of the financial costs for some plan, the cash amount could be more or less than the estimated economic loss (opportunity cost) for which it is provided. That is, the financial costs to be paid as financial compensation or economic mitigation as part of a project plan may not equal the economic costs of the foregone opportunities resulting from the plan. This should not change the basic conclusions reached above, however. In all cases, estimates of the net NED benefits foregone are included in the estimation of net NED benefits used for economic efficiency analysis and for selection of the NED plan. But in the reporting of the BCR for some plan, the financial costs of providing compensation are included in the cost side of the ratio.

Appendix A: Economic Basis for Valuing NED Effects

The economic basis for valuing plan NED benefits and benefits foregone can be understood as the amount of monetary compensation that affected individuals would require to maintain their levels of personal "well-being" with the plan as without the plan. In the case of plan benefits, this compensation measure is negative; in the case of plan benefits foregone, this compensation measure is positive.

Consider a project plan to remove a dam along a river in order to restore the river's natural flow regime. An affected person who is a kayaking enthusiast might be expected to realize an increase in personal well-being if the plan were implemented.[48] In that event, this person would require negative compensation in order to maintain the same level of personal well-being experienced in the absence of that opportunity. This is represented by the person's maximum willingness to pay for the opportunity to kayak on the free-flowing river.

Now consider another affected person who is not a kayaking enthusiast but who instead enjoys slack-water fishing in the dam impoundment. This person might be expected to experience a decrease in personal well-being if the dam were removed. In that event, this person would require positive compensation in order to maintain the same level of personal well being experienced in the absence of dam removal. This is represented by the minimum amount of money the person would willingly accept to forego fishing opportunities in the dam impoundment.

The above example suggests that a **"willingness-to-pay" (WTP)** measure of compensation represents the appropriate basis for valuing benefits yielded by a project plan, while a **"willingness-to-accept" (WTA)** measure of compensation is the appropriate basis for valuing benefits foregone as a result of a plan. This conclusion presumes that the status quo (without-project) situation is the appropriate point of reference for determining required compensation, which in turn implies that affected individuals have an implicit property right to the status quo situation. But, if it were instead presumed that the appropriate reference point for determining required compensation is the with-project situation (implying that affected individuals have an implicit property right to the with-project situation rather than the status quo), then the conclusion would be reversed. In that case, the affected individuals' WTA compensation would be the appropriate measure for valuing project benefits, and affected individuals' WTP compensation would be the appropriate measure for valuing benefits foregone as a result of the project. If the latter presumption were applied to the dam removal example, then project benefits would be defined as the minimum amount of compensation that affected individuals would be willing to accept for not receiving the opportunity to kayak on the free-flowing river, and project benefits foregone would be defined as the maximum amount that affected individuals would be willing to pay in order to continue to have the opportunity to fish in the dam impoundment.

[48] Although that result would depend on the supply and quality of other nearby free-flowing rivers as well as other circumstances specific to the individual and the choice context.

The above discussion highlights that there are different, theoretically-valid measures that could be used to represent the economic value of some choice to affected individuals. While these measures represent the same concept of value, they follow from different presumptions about implied property access and use rights. This raises the question of whether it matters which of these measures of economic value are used in public policy analysis. It has been demonstrated that WTP and WTA compensation are comparable measures of policy benefits (or benefits foregone) under certain conditions, while under other conditions they can differ substantially.[49] And importantly, WTP measures of compensation are more readily estimated than WTA measures.

For these and other reasons, the WTP measure is the standard typically used for valuing policy effects in public policy analysis, and the P&G endorses the WTP standard as the appropriate basis for valuing NED benefits and benefits foregone in civil works planning. For both benefits yielded and foregone by project plans, the same economic measures are applicable; the only difference is that a positive sign is attached to the measure representing benefits yielded, while a negative sign is attached to the measure representing benefits foregone.

[49] The main reason that WTA and WTP measures for some tradeoff can differ is that is that an affected person's maximum WTP for some change is necessarily limited by the person's income level, while an affected person's minimum WTA compensation for some tradeoff is unconstrained.

Appendix B: Accounting for the Timing of NED Effects

The estimated NED costs and benefits for some project plan typically would be realized in different time periods, and often in varying amounts, throughout the project time horizon. For example, construction costs for some plan might be realized in several (constant or varying) increments over the initial years following commencement of the project, while plan operation and maintenance costs and plan benefits might not begin until project construction was completed, at which point they might be realized as (constant or varying) annual flows throughout the project useful life. When plan benefits and costs are separated in time from each other, it would be incorrect for the calculation of plan net NED benefits to simply sum all of the estimated NED benefits and costs without taking account of when they are expected to occur. In order to accurately calculate plan net NED benefits, the annual time streams of estimated benefits and costs must be translated into total values at a common point in time.

The reason that the annual streams of estimated plan NED benefits and costs must be translated into total values at a common point in time is the recognition that people value a given level of consumption today more highly than they value the same amount of consumption at some future point in time. The procedure by which plan NED benefits and costs that occur in future time periods are translated into comparable total values is called "discounting." In essence, discounting is an added valuation procedure that measures the "time value" of plan benefits and costs that occur in future time periods.

The discounting procedure employs a formula that includes an interest (discount) rate reflecting the rate at which people are assumed to be willing to trade-off future consumption for current consumption. The interest rate used for civil works studies is calculated annually by the U.S. Treasury using a prescribed formula, and is published each year by Corps Headquarters as an Economic Guidance Memorandum.

Corps guidance requires that the period of analysis for converting NED benefits and costs into comparable values should be the same for each alternative plan, and include the time required for plan implementation plus the time period over which any alternative would have significant beneficial or adverse effects. In studies for which alternative plans have different implementation periods, Corps guidance says that a common "base year" should be established for calculating total NED benefits and costs, reflecting the year when the project is expected to be "operational." The estimated annual streams of NED benefits and costs expected to occur in time periods following the base year are to be discounted back to the base year using the prescribed interest rate. And since the implementation period for some plan may begin prior to the base year, any estimated NED benefits and costs for that plan expected to be realized before the base year are to be "compounded" forward to the base year. That is, for plan benefits and costs expected to be realized before the base year, the discounting procedure is applied in reverse, so that the interest rate serves to compound rather than discount those effects to the base year. The same prescribed interest rate is to be used for both compounding benefit and cost streams that occur prior to the base year, and for discounting benefit and costs streams that occur after the base year.