DISCOUNTING AND THE TREATMENT OF UNCERTAINTY IN NATURAL RESOURCE DAMAGE ASSESSMENT

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Prepared by the:
Damage Assessment and Restoration Program
Damage Assessment Center, Resource Valuation Branch
National Oceanic and Atmospheric Administration
1305 East-West Highway, SSMC #4
Silver Spring, Maryland 20910
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NOAA would appreciate any suggestions on how this document could be made more practical and useful. Readers are encouraged to send comments and recommendations to:

Brian Julius
Damage Assessment Center
National Oceanic and Atmospheric Administration
1305 East-West Highway, Room 10218
SSMC #4, N/ORCAx1
Silver Spring, Maryland 20910-3281
Phone: (301) 713-3038 ext. 199
Fax: (301) 713-4387
Email: bjulius@exchange.nos.noaa.gov

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GLOSSARY OF TERMS

Baseline

Baseline refers to the condition of natural resources and services that would have existed had the incident not occurred.

Consent Decree

A *consent decree* is a contract between trustees and the settling defendants that defines the defendant's obligations relating to an incident that may have caused injury to natural resources and their services.

Discount Rate

Discount rate refers to the rate at which dollars or other valued items or services being provided in different time periods are converted into current time period equivalents. A discount rate is used to compensate for delayed provision of services. For example, with no inflation and a 3% interest rate, $100 available today could be invested to produce $103 one year from now. Under this scenario, if one wanted to compare dollars to be provided one year from now to dollars being provided today, a discount rate of 3% should be applied ($103 discounted at a 3% annual rate is equivalent to $100 in today's currency).

Injury

Injury means an observable or measurable adverse change in a natural resource or impairment of a natural resource service. Injury may occur directly or indirectly to a natural resource and/or service. Injury incorporates the terms "destruction," "loss," and "loss of use."

Interim Losses

Interim losses refer to the reduction in resources and/or the services they provide, relative to baseline levels, that occur from the onset of an incident until complete recovery of the injured resources.

Liquidated Damages

Liquidated damages, which are written into negotiated settlements, are additional funds collected to compensate the public if a responsible party fails to make timely monetary payments, meet the conditions of restoration, or fulfill other obligations.

Natural Resources and Services

Natural resources means land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the Exclusive Economic Zone), any State or local government or Indian tribe, or any foreign government, as defined in section 1001(20) of OPA (33 U.S.C. 2701(20)). *Services (or natural resource services)* means the functions performed by a natural resource for the benefit of another natural resource and/or the public.

Present Value
Present value is the value of future or past costs and/or benefits in the present time period. The discount rate is used to translate past and future values into present value terms.

Restoration Action
Restoration action includes any of the actions authorized under OPA (restoration, rehabilitation, replacement, or acquisition of the equivalent), or some combination of those actions. Restoration actions by trustees are intended to complement the initial response and cleanup activities of response agencies.

Categories of restoration actions include:

- **Primary Restoration**
  Primary restoration is any action, including natural recovery, that returns injured natural resources and services to baseline. This may include actions to restore, replace, rehabilitate, or acquire the equivalent of injured natural resources or services.

- **Compensatory Restoration**
  Compensatory restoration is any action taken to compensate for interim losses of natural resources and services that occur from the date of the incident until recovery of natural resources and services to baseline. The more quickly the selected primary restoration action expedites recovery of injured natural resources and/or services, the smaller will be the scale of the linked compensatory restoration action required to compensate for interim losses.

Actions to restore, replace, rehabilitate, or acquire the equivalent of injured natural resources or services may be considered in identifying both primary and compensatory restoration actions.

Risk Premium
Risk premium is the difference between the amount of money an individual is willing to pay (or requires) to trade an uncertain outcome for a certain outcome. Whether the risk premium is positive or negative depends on an individual's risk preferences.

Scaling
Scale refers to the size or spatial and temporal extent of restoration actions. *Scaling* refers to the process of determining, for identified restoration actions, the size or scale of the actions that would be required to expedite recovery of injured resources to baseline and compensate the public for interim lost resources and services.

Uncertainty/Risk
Uncertainty and *risk* in economics typically have different meanings, but we use both here to refer to situations in which an individual is uncertain as to which of two or more states of nature will be realized.

U.S. Treasury Securities

Treasury securities are issued by the government to finance public debt. Treasury securities vary in their duration and pay varying interest rates depending on financial markets and the perceived risks of investment. The interest rates on U.S. securities are regarded as low-risk interest rates since the probability that the U.S. Government will default in repaying these loans is very low.

DISCOUNTING AND THE TREATMENT OF UNCERTAINTY IN NATURAL RESOURCE DAMAGE ASSESSMENT

EXECUTIVE SUMMARY

Regulations for natural resource damage assessments under OPA address discounting and uncertainty in the calculation of damage claims. This document provides additional explanation and examples of the approaches outlined in the regulations. The information herein is not regulatory; rather, it is presented to elaborate on the language in the OPA regulations regarding the treatment of discounting and uncertainty in damage assessments. NOAA recommends that this approach also be used for assessments conducted under CERCLA and the National Marine Sanctuaries Act unless the regulations therein specifically require otherwise.

Discounting is a widely used economic procedure that weights past and future benefits or costs such that they are comparable to present benefits and costs. Discounting is necessary for calculating the present value of interim service losses and restoration gains as well as the present value of emergency restoration, restoration, and assessment costs. The discounting discussion in this document focuses on identifying the appropriate discount rates for each of these components of a damage claim. For discounting interim service losses and restoration gains when scaling compensatory restoration, the regulations recommend using the consumer rate of time preference as the rate of discount. Section 4.1 of this document discusses the rationale for this recommendation and concludes that three percent is currently a reasonable proxy of the consumer rate of time preference. For discounting emergency restoration costs, restoration costs, and assessment costs, NOAA recommends that trustees use the rates on U.S. Treasury securities of comparable maturities to the period of analysis, subject to the constraints on the investment instruments available to trustees (Section 5).

Uncertainty affects damage assessment claims because trustees may not know or correctly predict the interim service losses and/or the restoration project gains. (Note that uncertainty in the cost components of the claim is not addressed in detail in this document. However, the typical approach, which is the addition of a flat-rate contingency to monitoring and oversight costs, is discussed in Section 4.2.3.) In other words, the scale of restoration actions and the effectiveness of restoration implementation are both uncertain. This document addresses the treatment of these two types of uncertainty. Uncertainty in the scale of restoration is addressed through two alternative approaches that value the uncertainty. The preferred approach to valuing uncertainty in the scale of restoration is to incorporate uncertainty into the measures of losses and gains (Section 4.2.1). The second approach, to be used when including uncertainty in the losses and gains is not possible, is to incorporate uncertainty into the discount rate (Section 4.2.2).

Uncertainty in the success of restoration actions is addressed through institutional mechanisms (Section 4.2.3). Performance and design standards can reduce uncertainty when the responsible party implements restoration. When trustees implement restoration, uncertainty can be addressed with a contingent claim.

The appendices to this document provide useful reference materials for discounting and the treatment of uncertainty. Appendix A is the discounting and uncertainty sections of the final natural resource damage assessment regulations under the Oil Pollution Act. These sections are the basis of this document. Appendix B includes tables of data on rates of return and inflation

indices, as well as references to the sources of these data. These data provide the key parameters for discounting the treatment of uncertainty. Finally, Appendix C summarizes other agencies' policies on discounting and the treatment of uncertainty.

1.0 INTRODUCTION

The purpose of this paper is to advise natural resource trustees and the affected public on the treatment of discounting and uncertainty in natural resource damage assessments (NRDA) under the Oil Pollution Act (OPA). NOAA recommends that this approach also be used for assessments conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Marine Sanctuaries Act (NMSA) unless the regulations therein specifically require otherwise.

The scope of the paper includes: general principles in the treatment of discounting and uncertainty that would serve as a basis for assessments, and rules of thumb to use for assessments where development of case-specific treatments of uncertainty may not be feasible. The advice in this document should not be rigidly followed, but rather, utilized with the flexibility necessary to resolve the unique problems that confront each case, even in the context of expedited analysis. For this reason, economists and financial experts should be consulted in the selection of the appropriate treatments of uncertainty and discounting in each case.

The discounting discussion identifies the appropriate discount rates for the various components of a damage claim. For discounting interim service losses when scaling compensatory restoration, we recommend using the consumer rate of time preference as the rate of discount. For discounting emergency restoration costs, restoration costs, and assessment costs we recommend that trustees use the rates on U.S. Treasury securities of comparable maturities to the period of analysis, subject to the constraints on the investment instruments available to trustees.

Interim service losses are uncertain and depend on primary restoration success. Mechanisms to incorporate uncertainty about interim losses into the damage claim include valuing uncertainty. We identify two approaches for valuing uncertainty - calculating a sum certain equivalent to the risky outcome, or adjusting the discount rate to reflect uncertainty. Uncertainty also affects restoration implementation. We discuss strategies for reducing this type of uncertainty through performance or design standards when the responsible party implements restoration. When trustees implement restoration, uncertainty can be addressed by designing a contingent claim.

The paper is organized as follows. Section two provides an overview of the elements of natural resource damage claims and the nature of uncertainty and discounting. Sections three and four provide advice on the treatment of discounting and uncertainty in scaling restoration projects. The fifth section provides advice on discounting the cost components of a claim, i.e., restoration costs. Reference information is provided in the Appendices, including the relevant final OPA rule language for NRDA, rate of return and inflation data, and summaries of guidance put forth by other federal agencies.

NOAA's final regulations for natural resource damage assessments under OPA address discounting and uncertainty in the calculation of damage claims. This document provides additional explanation and examples of the approaches outlined in the regulations. The information herein is not regulatory; rather, it is presented to elaborate on the language in the OPA final regulations regarding the treatment of discounting and uncertainty in damage assessments.

2.0 ELEMENTS OF A NATURAL RESOURCE DAMAGE CLAIM

Prior to describing the concepts of discounting and uncertainty as they are used in natural resource damage assessment, it is necessary to describe the elements of a natural resource damage claim. Several federal statutes, including the Oil Pollution Act (OPA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Federal Water Pollution Control Act (Clean Water Act), and the National Marine Sanctuaries Act (NMSA) [1] contain provisions allowing natural resource trustees to recover damages for injuries to natural resources held in public trust. The natural resource liability provisions provide a process for making the public whole for injury to natural resources and/or services. The Oil Pollution Act specifies the following elements of a natural resource damage claim: (1) the cost of restoring the injured natural resources to baseline conditions ("primary restoration"); (2) compensation for the diminution in value of injured natural resources from the time of the injury until full recovery of the resources ("interim losses"); and (3) the reasonable cost of assessing those damages.

The first component reflects the statutory emphasis on restoring injured resources to their baseline. The second component of the claim captures the reduction in resource services pending recovery of the injured resources. Interim losses due to natural resource injury include lost natural resource services, lost consumer surplus, lost government fees, and lost economic rent (that could have been charged by the government for use of a public resource) resulting from injuries caused by the discharge. The third component is the trustees' costs of assessment. The regulations also include emergency restoration costs as an element of natural resource damages.

Under the OPA regulations, there are two measures of interim losses. The preferred measure under the OPA regulations is "resource compensation." The other is the traditional economic measure of "monetary compensation."[2] This document refers to resource compensation measures unless otherwise noted.[3] Under resource compensation, the damage claim for interim losses is the cost of compensatory restoration projects.[4]

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[1] OPA, 33 U.S.C. 2706; CERCLA, 42 U.S.C. 9607(f); Federal Water Pollution Control Act, 33 U.S.C. 1321(f)(4)&(5); NMSA, 16 U.S.C. 1443. The OPA statute delegated to the National Oceanic and Atmospheric Administration (NOAA) the responsibility for writing the natural resource damage assessment regulations to implement OPA.

[2] Monetary compensation is defined as the minimum amount of money necessary to make the individual members of the public as well off as they would have been *but-for* the injury.

[3] For a thorough discussion and comparison of the concepts of monetary and resource compensation, *see* Jones and Pease (1997). Discounting and the treatment of uncertainty is the same for monetary compensation as for resource compensation unless otherwise stated.

[4] The cost of compensatory restoration includes the costs of compensatory restoration projects, as well as monitoring, permitting, and trustee oversight costs.

3.0 DISCOUNTING AND UNCERTAINTY IN NRDA

In most cases, all of the elements of a natural resource damage claim will occur during several time periods and the magnitudes of the damage claim elements will be uncertain because some determinants of damages may be unknown at the time the claim is made (e.g., the duration of injury, time path of recovery of services). Assessments must account for the timing of lost and restored benefits, as well as uncertainty.

Discounting is a widely used economic procedure that weights past and future benefits such that they can be compared. Empirical research has found that individuals weight present consumption more heavily than future consumption (and weight consumption in past time periods more heavily than consumption in the present). (Olson and Bailey 1981) Thus, a unit of benefits (or costs) realized in a future time period is not comparable to a unit of benefits (or costs) realized in the present. Discounting makes past and future benefits or costs comparable; typically, they are converted to a present value equivalent. A discounted benefit (past or future) is known as the present value of that benefit.[5] Discounting allows the trustee(s) to convert series of past and future damages to a single number[6] that is submitted as a damage claim to the responsible party (RP).[7]

The formula used to discount gains or losses is:

$$PV = \sum_{t=t_I}^{T} R_t \times d_t \qquad (1)$$

Where PV is the present value of the stream of gains and losses and t is the time period. t_I is the year of the injury and T is the last time period in the assessment. R_t is a gain or loss realized in time period t. d_t is the weight used to convert to gains and losses realized in different periods such that they are comparable to one another. The formula for d_t is:

$$d_t = (1+r)^{t_0 - t} \qquad (2)$$

where r is the discount rate, and t_0 is the year of the claim.

Section 4.0 concentrates on discounting the *interim loss* portion of the damage claim, as well as discounting the compensation for interim losses. The appropriate discount rate for calculating the present value of past and future natural resource service gains and losses should reflect society's preferences for the timing of natural resource services. This rate is the social rate of time preference.

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[5] Units may be designated by the year in which they are denominated. For example, suppose there is an incident that causes a service loss of 3 acre-years in 2000 (the loss of 1 acre for one year is 1 lost acre-year). The units could be denoted: acre-years (2000). After discounting to the present (i.e., 1998), the units of the service loss could be: acre-years (1998).

[6] OPA requires that the damage claim be presented in the form of a "sum certain."

[7] When the RP implements the restoration, discounting is also used to determine the liquidated damages in the event of noncompliance and the present discounted value of trustee costs.

Section 5.0 focuses on discounting the *cost* components of the claim: assessment costs, emergency restoration costs, and restoration costs. The rationale for discounting these components is slightly different. Each dollar spent on assessment, emergency restoration, or restoration represents a dollar that is not allocated to another use. These costs are discounted at a rate that represents the productivity of alternative uses of these funds in the economy. This rate is the opportunity cost of capital.

The uncertainty[8] associated with any element of the damage claim must be incorporated into the assessment to ensure adequate compensation of the public. Uncertainty may derive from stochastic processes, imprecision in underlying data, or modeling assumptions. The sources and nature of uncertainty should be described as well as possible. The variability in and probabilities of possible outcomes should be incorporated into the damage assessment to ensure compensation of the public. For instance, weather is among the many stochastic factors that influence the success of a restoration action. It is the possible that extreme heat will increase the morbidity of a revegetated marsh area. The resource compensation measure should take such variations in restoration outcomes into account.

Note that this document discusses the treatment of uncertainty only with respect to the interim losses, and not the cost elements of the damage claim. The treatment of uncertainty in both the interim losses and gains from restoration actions are addressed in the section 4.2.

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[8] We use the terms "risk" and "uncertainty" interchangeably.

4.0 THE TREATMENT OF DISCOUNTING AND UNCERTAINTY IN SCALING

Discounting and the treatment of uncertainty are important in scaling compensatory restoration projects because timing and uncertainty affect the level of interim losses and restoration project gains. Since individuals weight present consumption more heavily than future consumption, the values of interim service losses and restoration project gains depend on when they occur. Scaling ensures that the present value of interim service losses is equated with the present value of restoration project gains.

4.1 Discounting

The January 1996 Final Rule on natural resource damage assessment contains a statement of general principles for discounting streams of consumer benefits based on the current economics literature.[9] The regulation states:

> *When scaling a restoration action, ...trustees must take account of the value of time in the scaling calculations by discounting to the present the interim lost services or the value of interim lost services due to the injury, as well as the gain in services or service value from the restoration action. The reference date for the discounting calculation is the date at which the demand is presented* (61 FR No. 4, p. 453).

The rate for discounting interim losses should reflect the social rate of time preference, the rate at which society is willing to substitute between present and future consumption of natural resources with certainty.[10] A large body of economics literature exists concerning which rate(s) best measures the social rate of time preference. Among the rates recommended are the real rate of interest and the government borrowing rate.

Freeman (1993) recommends using the real rate of interest as a measure of the rate of time preference. The underlying argument for this recommendation is that individuals will arrange their time pattern of consumption by borrowing and lending so that at each point in time their rate of time preference is just equal to the after-tax real rate of interest. Estimates of the after-tax real rate of interest range from about 1 percent, if historical real rates of return on U.S. Treasury bills are used, to 6 percent, if the real after-tax return on a portfolio of common stocks is used. (Lind 1982) Because financial markets are now global, world market interest rates may be better measures of the rate of time preference. (Lind 1990) Real short-term interest rates in nine industrialized countries were below 2 percent and did not exceed 6 percent for most of the period between 1959 and 1989. (Barro and Sala-i-Martin 1990) Based on these data, Freeman (1993) asserts that a discount rate of 2 to 3 percent is appropriate in discounting social costs and benefits.[11]

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[9] *See* Lind (1982) and Freeman (1993) for discussions of discounting consumer benefits.

[10] The social rate of time preference is recommended when the goal of social policy is to achieve intertemporal efficiency. Efficient policies are those in which the benefits exceed the losses. (Page 1977)

[11] Freeman (1993) warns that these rates are only appropriate when streams of benefits and costs accrue to people of the same generation.

Others recommend the government borrowing rate as a proxy for the rate of time preference when evaluating government projects. (United States Department of the Interior 1995; Lind 1990) The Department of the Interior uses the 3-month Treasury bill rate to estimate the government borrowing rate because its short time horizon avoids the consideration of investment risk. Over the last 15 years, real 3-month Treasury bill rates averaged about 3 percent. (The Federal Reserve 1998; The Bureau of Economic Analysis 1998)

If an egalitarian distribution of consumption through time is the objective of social policy, Page (1977) shows that this objective can be achieved if the discount rate equals the rate of productivity. The rate of productivity can be measured by the real rate of growth in Gross Domestic Product, which averaged about 3 percent over the last 15 years. (The Bureau of Economic Analysis 1998)

In sum, a 3 percent social rate of time preference has been justified by economists on the basis of several arguments. Regardless of whether the discount rate is the social rate of time preference (measured by either the after-tax real rate of interest or the government borrowing rate) or the rate of productivity, historical evidence shows that 3 percent is within the range of normal variation. Based on these facts, and the discount rate policies and practices of other government agencies summarized in Appendix C, NOAA suggests the use of a 3 percent real discount rate for discounting interim service losses and restoration gains, unless a different proxy for the social rate of time preference is more appropriate.[12]

4.1.1 Example: Discounting Interim Losses

The following example demonstrates the use of the 3 percent social rate of time preference to calculate interim service losses.

Suppose an oil spill occurred in 1997 and injured 50 acres of inter-tidal wetland. Further assume that 100 percent of the wetland services were lost in the initial period, recovery does not begin until 1999, and recovery is linear over a five-year period. If the interim loss calculation is conducted in 1998, the present discounted value of lost acre years of services is 195.80 (see Table 4.1 below).

[12] For instance, a stated preference survey used to measure the economic damage due to an oil spill might be designed to measure the social rate of time preference for losses of the natural resources and services. In this case, the site-specific measure of the social rate of time preference could be more appropriate than the suggested 3 percent rate.

Table 4.1 Discounting Interim Service Losses					
Year	Percent of service losses - start of period	Percent of service losses - end of period	Raw acre years of service losses	Discount Factor (D_t)	Discounted acre years of service losses (R_t)
1997	0.0%	100.0%	50.00	1.03	51.50
1998	100.0%	100.0%	50.00	1.00	50.00
1999	100.0%	80.0%	40.00	0.97	38.83
2000	80.0%	60.0%	30.00	0.94	28.28
2001	60.0%	40.0%	20.00	0.92	18.30
2002	40.0%	20.0%	10.00	0.89	8.88
2003	20.0%	0.0%	0.00	0.86	0.00
2004	0.0%	0.0%	0.00	0.84	0.00
2005	0.0%	0.0%	0.00	0.81	0.00
2006	0.0%	0.0%	0.00	0.79	0.00
2007	0.0%	0.0%	0.00	0.77	0.00
Total Discounted Acre Years of Services Lost					**195.80**

The present discounted value of service losses is the sum, from 1997 to 2004, of the raw acre-years of service loss for a given year multiplied by the discount factor for that year. R_t, the undiscounted losses (see equation 1), are in the fourth column. The discount factor, d_t, is in the fifth column. It is calculated using a social rate of time preference equal to 3 percent. t_0 is the year of the claim, or 1998. In this example, T, the year recovery is complete, is 2004. The values in the rightmost column of Table 4.1 are the present values of the annual losses.

Notice that the discount factor is greater than one for the years before the year of the claim and less than one for the years before the year of the claim. Thus, weighting past service losses by the discount factor for past years increases service losses. Weighting future service losses by the discount factor for future years decreases service losses. These weights reflect the fact that society weights present consumption more heavily than future consumption.

4.2 Uncertainty

Uncertainty must also be considered in determining the scale of compensatory restoration since uncertainty affects interim service losses and the level of restoration project gains. Uncertainties about the value of losses due to the injury and the gains from restoration projects can be categorized as supply-related uncertainties. These uncertainties pertain to the recovery of injured resources and outcomes of restoration projects. Demand-related uncertainties pertain to the values of those outcomes. [13] We focus on supply-side uncertainties here.

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[13] There may be demand-related risks. The values of outcomes are uncertain due to uncertainty regarding individual income and future prices of private goods as well as the supply of substitute resources. The first set of demand-related risks (i.e., future income and prices) is privately borne. The second set of risks (i.e., substitute resources) is by nature public, and could be important in some cases such as injuries to endangered or threatened species.

We first consider supply-side uncertainty associated with the predicted outcomes of primary restoration actions. The extent of uncertainty is related to the period of interim losses, which may range from hours to decades, and will vary substantially across resources and by contaminant and injury type.[14] For shorter term injuries (e.g., restricted beach use), the uncertainties regarding recovery of the resource are likely to be resolved during the period in which the assessment is conducted. For longer term injuries (e.g., injuries to natural resources at waste sites), the characteristics of the resource recovery function are likely to be uncertain at the time the claim is presented, whether the selected primary restoration option is natural recovery or restoration projects.

Analogous issues arise with respect to the uncertainty of outcomes from the compensatory restoration projects. For compensatory restoration projects, uncertain characteristics of the service provision function include the level of maximum function, the timing of maturity, the continuity of function after maturity, and the shape of the maturity function.[15]

The language in the OPA Natural Resource Damage Assessment Rule on accounting for uncertainty in damage claims is:

> *NOAA recommends that, where feasible, the trustees should use risk-adjusted measures of losses and gains, in conjunction with a riskless rate of discount reflecting the social rate of time preference for natural resources... Alternatively, if the streams of losses and gains cannot be adequately adjusted for risks, then NOAA recommends use of a discount rate that incorporates a suitable risk adjustment to the riskless rate* (61 FR No. 4, p. 453-454).

The use of risk-adjusted measures of losses and gains, referred to as Approach 1, is discussed in section 4.2.1. The alternate approach, or Approach 2, involves specifying a stream of discount rates that incorporate uncertainty. Approach 2 is discussed in section 4.2.2.

Approaches 1 and 2 account for uncertainty in the scale of compensatory restoration. Another approach, which is not mentioned in the regulations, is to develop risk-sharing institutions to account for uncertainty in the outcomes of restoration actions. Under this approach, the trustees and responsible parties agree to a contract that defines requirements for restoration and incorporates the uncertainties of restoration. Alternatively, trustees may employ a contingent contract with the RPs. The use of risk-sharing institutions and other mechanisms as a means to account for uncertainty is discussed in section 4.2.3.

4.2.1 Approach 1: Incorporating Uncertainty in Benefits and Costs

Approach 1, in which the streams of uncertain gains or losses are adjusted to reflect the range of possible outcomes, is preferred to Approach 2 by many economists. (Lind 1982; Wilson 1982; Office of Management and Budget 1992) This approach is implemented by characterizing

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[14] For example, contamination of a beach due to an oil spill may last from hours to weeks, but in most cases will be limited to the period of the spill response. The term of injuries to other habitats and to populations of macro-fauna may be short or long, depending upon the contaminant and other factors.

[15] Supply side uncertainty is also relevant when monetary compensation for interim losses is used because the pace of primary restoration determines the duration of interim losses.

the sources and nature of uncertainties as well as possible. Sources of uncertainty in scaling analyses include the duration of injury, the shape of the recovery function, and the shape of maturity functions for restoration projects, among other things. Ideally, probability distributions of uncertain variables, such as interim losses, gains from compensatory restoration, and the scale of restoration projects should be presented. Stochastic simulation methods (e.g., Monte Carlo methods) can be useful for developing insights into these probability distributions. Sensitivity analyses on major assumptions or imprecisely measured variables should be conducted to examine how sensitive outcomes are to alternate sources of uncertainty.

Uncertainty may be incorporated into streams of benefits and costs in several different ways. If variables are characterized by point estimates rather than probability distributions, the expected value measure is appropriate. Expected values are obtained by weighting each possible outcome by its probability of occurring and summing across outcomes.

Another way to incorporate uncertainty is the certainty equivalent approach. This involves measuring the certain benefits that affected individuals would accept in lieu of the uncertain benefits. (Wilson 1982, p.209) The difference between the certain benefit and the uncertain benefits is referred to as the risk premium. In the damage assessment context, risk premia could be added to both the losses and the gains in the resource compensation calculation.[16]

Risk premia may be estimated through the application of stated preference methods to measure the certain benefit that is equivalent to an uncertain stream of benefits. For example, a stated preference study might ask respondents to choose between a certain stream of natural resource services and an uncertain stream of natural resource services. The choices thus elicited would yield information on individual risk premia.

While Lind (1982) advocates the use of risk-adjusted measures of value and riskless discount rates, he recognizes that such analyses are complicated, with extensive requirements for generally unavailable information. Consequently, risk-adjusted measures of value are rarely fully implemented.

4.2.2 Approach 2: Incorporating Uncertainty into the Discount Rate

Approach 2, which is the less preferred approach, involves selecting discount rates that reflect the level of systematic (i.e., non-diversifiable) risk associated with the project. Lind (1982) and Wilson (1982) emphasize that the calculation of a risk premia for discount rates in each period is complex and requires much of the same information required for the calculation of risk premia. Further, a single premium generally is not appropriate for different years during the benefit period. In fact, the only instance in which a single adjustment to a discount rate is conceptually correct is when there is only one future time period.

There is a range of after-tax interest rates that are available for implementation of this approach, and these rates reflect varying levels of risk. The lower end of the range of rates representing a risk-adjusted consumer rate of time preference is the riskless average real after-tax return on U.S. Treasury bills. The upper end of the range is the after-tax return on the market portfolio of stocks. The endpoints of the range of risk-adjusted rates are defined by the historical

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[16] Note that risk premia are included only on the loss side when monetary compensation measures are used.

nominal and real rates of return on private and public instruments. (The historical data discussed in this section are provided in tables in Appendix B.)

Relative to public instruments, corporate stocks and bonds have higher levels of risk and higher rates of return. The arithmetic mean of real total returns on stocks between 1926 and 1997 is 9.7 percent.[17] Assuming a personal tax rate of 30 percent, the after-tax rate of return on stocks is 6.8 percent. In fact, the average real after-tax rate of return on stocks has remained around 7 percent for most of this century. (Table B.1 in Appendix B shows total returns to large company stocks from 1926-1994)

The real rate of return on U.S. Treasury bills with maturities of a year or less is widely regarded as a riskless rate, and is used as the lower bound of our range of possible discount rates. The average real rate on 3-month and 6-month U.S. T-bills from 1962-1996 was 1.55 and 1.70 percent, respectively. Average rates of return on equivalent assets in OECD countries have been around 1 percent as well. (Barro and Sala-i-Martin 1990)

Thus, the risk-adjusted discount rate ranges from a riskless rate of 1 percent to a risk-adjusted rate of about 7 percent.[18] NOAA suggests performing sensitivity analysis over the range of risk-adjusted rates to generate a range of compensation measures.

Like Approach 1, this approach is rarely fully implemented due to the extensive requirements for information.

4.2.3 Institutional Mechanisms and Other Approaches to the Treatment of Uncertainty

The most common method for addressing uncertainty in restoration implementation is through institutional mechanisms. Like Approaches 1 and 2, presented in sections 4.2.1 and 4.2.2, institutional mechanisms address uncertainty in the scale of compensatory restoration. However, institutional mechanisms focus on the uncertainty in the success of restoration actions to the exclusion of uncertainty associated with the injury. Institutional mechanisms include performance standards, design standards, and the creation of contingency funds. These instruments can be applied in negotiated settlements in which the trustees and responsible parties agree to a contract that defines the conditions of restoration and addresses the uncertainties of restoration.

A performance standard is one mechanism for dealing with supply uncertainty. With a performance standard, the responsible party agrees to undertake restoration and is held to a performance standard for the outcomes of primary and compensatory restoration projects. The performance standard shifts the uncertainty associated with restoration to the responsible party

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[17] Data on stock returns are taken from Ibbotson Associates (1998).

[18] NOAA recognizes that the recommended riskless proxy of the social rate of time preference, 3 percent, is greater than the riskless rate of return on U.S. T-bills. While the rate of return on riskless short-term government securities is 1-1.5%, not all relevant individuals are active in this market. The individuals in this market are likely to represent a sub-population that is wealthier, older, and/or more educated than the broader U.S. population. Empirical measurements of the rate of time preference range from negative values to more than 100%. Given this range, the rate of time preference and the average rate of return for the broader U.S. population is likely to be higher than the rate on U.S. T-bills.

(RP); the RP is then responsible for any failure in restoration implementation as it must meet the performance criteria.

Restoration in the Greenhill case[19] demonstrates the performance-based standard. The settlement agreement required the responsible party to create 21.7 acres of wetland, with 80 percent coverage of smooth cordgrass, to compensate for oiled marshes. When the initial planting failed to meet this requirement, the RP had to replant. The second planting also failed and the RP had to plant a third time, after which specified performance standards were met. The performance standard put the uncertainties of restoration on the responsible party and ensured that the restoration was achieved.

A performance standard is also being used for the RP-implemented restoration in the Mobil Mining case.[20] However, the conditions of the performance standard were adjusted since the responsible party wanted certainty with regard to the end of their liability. Should Mobil's wetlands creation project fail to meet the success criteria in the two years following completion of the project, Mobil shall implement actions (recommended by the trustees) to achieve the performance criteria. If the performance criteria are still not met, despite Mobil's best efforts as judged by the trustees, the trustees will certify completion of the restoration project. Thus, Mobil's liability will cease. This is a potential settlement mechanism when responsible parties will not agree to a strict performance standard.

In some circumstances, there may be substantial uncertainty about project outcomes due to factors external to project implementation. In these cases, the RP may not agree to any performance-based standard since performance is, to a large degree, out of its control. Design standards offer a mechanism for sharing uncertainty between the trustees and the RP in this context. With a design standard, the RP (who agrees to implement restoration) is subject to standards on project actions and may incur penalties for noncompliance. The trustees, then, bear the uncertainty of project performance.

The case of Blackbird Mine is an example of a settlement with a design standard and other compliance standards. Copper and other hazardous substance releases from Blackbird Mine eliminated Snake River spring/summer chinook salmon in Panther Creek, Idaho by the early 1960s. The RP is responsible for taking action to restore chinook salmon, which includes implementing a biological restoration and compensation plan. All actions are subject to the approval of the trustees. The defendants are subject to stipulated penalties for each day they fail to complete a deliverable or fail to produce a deliverable of acceptable quality. They also must pay liquidated damages as compensation for interim loss damages in the event of delays in the biological restoration plan. The RP must take additional action, with the approval of trustees and in consultation with EPA, to achieve water quality criteria if standards are not met any time after January 1, 2002. The consent decree includes dispute resolution and force majeure provisions, which are contingency plans for an event arising from causes beyond the control of the settling

[19] In this case, an oil well blowout injured inter-tidal marshes in Timbalier Bay, Louisiana.

[20] Failure in a processing pond at the Mobil Mining and Minerals facility in Pasadena, Texas caused a fish kill in the Houston ship channel. The trustees proposed wetland creation in the Upper Galveston Bay system to compensate for the ecological service losses.

defendants. Once the RP satisfies the trustees' action requirements, the uncertainty of the number of salmon produced for the specified actions falls on the trustees.

For both performance and design standards, the consent decrees can hold the responsible parties to liquidated damages should the RPs fail to meet the quality standards. In addition to motivating the responsible parties to respond in a timely fashion, liquidated damages also provide the trustees with recoveries for additional interim losses resulting from RP inaction. When the RP fails to undertake either primary or compensatory restoration by the agreed upon time, the interim service loss may increase. To fully compensate the public then, the compensatory claim should be expanded. Liquidated damages provide the funds for trustees to increase compensatory restoration.

Supply uncertainty can also be addressed by building funding for contingencies into the claim; contingencies result from unforeseen difficulties in restoration. The settlement in the Mobil Mining case illustrates the use of a contingency fund to address uncertainty in restoration implementation. In that case, where restoration consisted of wetlands creation, Mobil would provide up to a maximum of $100,000 in additional funds to the trustees for use in restoring, rehabilitating, or reestablishing the restoration project site in the event it was injured by hurricanes, high water flows or floods and for general care and maintenance of the site during the three years following the date the restoration project was certified complete. The settlement for the French Limited Superfund site also contained contingency funds for uncertainty in restoration. The responsible parties were to establish a restoration fund of $30,000 to be maintained by the RPs and available for restoration of marsh land if it were injured due to natural events. The balance of the fund would revert to the RPs within five years after completion of the project.

Yet another approach to the treatment of uncertainty can be adapted from the Army Corps of Engineers practices in the treatment of uncertainty. Based on its experience with estimating construction costs, the Army Corps of Engineers has developed contingency factors as a way of incorporating uncertainty in cost estimation. The Corps recognizes the preferred status of Approach 1: valuing the uncertainty in measures of benefits and costs. (The Army Corps of Engineers 1996) When Approach 1 is not possible, the Corps suggests use of a contingency factor as a reasonable guide for valuing uncertainty. The factors are fixed percentages of the expected construction cost. In the reconnaissance/feasibility phase of project development, the Corps recommends adding 25 percent to the construction cost for projects valued at less than $10 million. For projects of more than $10 million, the contingency factor is 20 percent. (The Army Corps of Engineers 1994)

Similar contingency factors might be developed for the NRDA context. One set of contingency factors could cover the gap between predicted and realized service flows. These contingency factors for service losses and restoration gains in scaling calculations could be based on the growing body of case experience in the difference between predicted and realized service losses and gains.

A second set of contingency factors could cover the gap between predicted and realized costs of restoration implementation (conditional on predicted service flows). This approach is at least partially implemented in practice. Cost uncertainties are typically accounted for by calculating a flat rate contingency on monitoring and oversight expenses. Alternatively, escrow accounts may be established with the balance reverting to the RP if it is not needed to fulfill monitoring or oversight requirements.

5.0 DISCOUNTING THE COST COMPONENTS OF A CLAIM

Discounting is used to discount the cost components of a damage claim because the costs of a claim are also incurred over a period of time. The final OPA rule recommends that trustees use the rates on U.S. Treasury securities of comparable maturities to the length of restoration and assessment to discount restoration costs and assessment costs, subject to potential constraints on the investment instruments available for damage awards. The restoration and assessment costs pose public sector capital budgeting problems, for which U.S. Treasury rates are appropriate and recommended by OMB in Circular No. A-94, Appendix C.

Because restoration occurs in the future in most cases, trustees require information on projected Treasury rates and projected price indices for the economic sectors represented in the restoration action (e.g., construction, labor). Several federal agencies, including the OMB and CBO, forecast different rates and indices. However, projected rates may not be available in all cases. In these instances, trustees might employ available, substitute projections or an historical average of the desired rate or index.

The discount rates can be either nominal (i.e., in dollars of the year in which the losses or gains are incurred) or real rates. If the components of the cost claim are denominated in nominal terms, the use of a nominal discount rate is appropriate. Real discount rates are applicable if components of the claim are denominated in real terms with the date of the claim as the base year. To calculate the real rates, trustees should use an appropriate price index to remove inflation expectations from the nominal discount rate.

The rationales for the selection of a discount rate for discounting future restoration cost requirements and past assessment costs are discussed and illustrated with examples in the following sections.[21]

5.1 The Restoration Cost Component of the Claim

Restoration projects generally will be implemented, and related costs incurred, over a period of years. Consequently, in calculating this cost component of the claim, the central issue is one of capital budgeting. In the simplest payment format, the claim will be paid in full when the case is resolved. In this context, the question is: what is the sum certain to be received at the time the case is resolved that will ensure that the Restoration Plan can be implemented?[22] Alternatively, a multi-year schedule for claim payments can be established.[23] In this context, the trustees need to take into account several considerations, including the potential lack of flexibility

[21] While the treatment of uncertainty in the cost components of the claim is not discussed fully in this document, the typical approach is described in section 4.2.3.

[22] The primary and compensatory restoration projects may be implemented by the trustees, or they may be implemented by the RPs subject to performance guarantees and criteria specified by or agreed to by the trustees. If the RPs are to carry out the restoration projects, including the necessary permitting and NEPA compliance activities, the trustee claim for restoration costs will consist primarily of trustee oversight and monitoring costs.

[23] Because of the potential difference in investment opportunities between the RPs and the government, companies may reduce their cost of funding by establishing a fully-funded multi-year payment plan.

in responding to changed circumstances in the amount and timing of payments and expected future financial viability of the RP.

Strictly speaking, to ensure that the calculations of the sum certain to be paid when the case is resolved is sufficient to cover the future expenses of implementing the Restoration Plan, trustees need to identify the amount and timing of restoration expenditures, as well as which investment opportunities are available for recoveries until they are expended. In reality, these aspects of restoration are difficult to predict. After a settlement has been obtained, implementation of a restoration project involves a number of activities with relatively uncertain time requirements including, for example, NEPA public review processes and permitting approvals. Also, future restoration costs are uncertain due to uncertainty concerning future inflation, relative price changes, and the effectiveness of projects. Project effectiveness is unknown due to uncertainties associated with predicted consequences of restoration project designs.

To the extent the trustees can predict the restoration timeline, the regulatory guidance for covering the future expenses of restoration implementation in the final rule is:

> *NOAA recommends that, ...trustees specify future restoration costs in nominal terms (i.e., in terms of dollars of the year in which the costs will be incurred) and then discount the nominal costs using the nominal U.S. Treasury rate for marketable securities of comparable maturity to the period of analysis, when this rate of return is available to the trustees for investment of settlement monies. To specify the future restoration costs in nominal terms, the trustees should employ the indices of projected inflation appropriate to the major components of the restoration costs (e.g., construction price indices for construction costs; the federal employee wage index for trustee monitoring costs). If component-specific inflation indices are unavailable, the Gross Domestic Product price index may be used* (61 FR No. 4, p. 456).

The investment opportunities available to trustees may be limited by one or more of the following: legal constraints on the trustee, predictable yield and payout schedule, low risk, and adequate liquidity. Private instruments, such as corporate bonds and stocks, do not meet the criteria. Some public instruments, such as U.S. Treasury securities and Certificates of Deposit (CDs) potentially meet the criteria, though long-term instruments may impose unacceptable liquidity constraints. If long-term instruments must be sold off before their maturity date, investors face yield uncertainty due to interest rate fluctuations.

5.1.1 Investment Constraints and Opportunities

The final regulations recommend using the interest rate on a U.S. Treasury instrument of maturity comparable to the period of analysis to discount cost streams. The recommendation is subject to availability, because the investment instruments available to trustees may be constrained legally, institutionally, or otherwise. First, we discuss opportunities for investment of trustee funds. Then, we present advice for discounting restoration costs.

Several federal agencies have special accounts to hold damage awards. One of these accounts is the NOAA Damage Assessment and Restoration Revolving Fund (DARRF). Another account is the Department of the Interior's Natural Resource Damage Assessment and Restoration Fund, which is available when DOI is a trustee. This account allows for the investment of recovered damage assessment awards in interest-bearing accounts (the DARRF does not). DOI has the authority to invest in U.S. Treasury instruments of varying maturities to match the expected need of funds.

State trustees may have a wider variety of instruments to consider including money market accounts, or State or Federal Treasury funds.

In some cases, the trustees may choose to request that the federal court retain jurisdiction over some or all of the damage award in a court registry account. When the federal district court retains jurisdiction over the award,[24] the funds are placed in a court registry account. The clerk of each federal court is responsible for the safekeeping and management of court registry funds. The funds may be placed in various interest bearing accounts, including the United States Courts' Court Registry Investment System (CRIS).[25] However, some district courts do not participate in the CRIS.

The CRIS is a court registry fund for the investment of recovered sums that provides for safety of principal, low administrative and transaction costs, near market rate earnings, and detailed and accurate record keeping. The CRIS is a funds management system that pools funds from a number of individual cases from districts enrolled in the system and purchases U.S. Treasury securities with a maturity date of less than 100 days. The investment strategy is to assure safety of principal and to have sufficient liquidity. The pooling allows the clerk's office to minimize transactions costs by making significantly fewer, but larger transactions than would otherwise be possible. Fees for use of the CRIS are a small percentage of the earned income (the percentage decreases the larger the deposits and the longer the investments), allowing the system to provide near market rate earnings. Table 5.1 shows the current CRIS fee structure (which is the same as first reported in the Federal Register on Monday, November 4, 1991; Volume 56 Number 213).

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[24] A benefit of continued court jurisdiction is access to the court in the event of unforeseen events that require legal intervention.

[25] The CRIS is a cash management procedure for handling court registry funds initially developed and tested by the United States District Court for the Southern District of Texas, in Houston.

TABLE 5.1
CRIS charge rates, as a % of income earned

	Length of Investment in CRIS Fund			
Amount of Deposit (millions of dollars)	0-5 Years	5-10 Years	10-15 Years	> 15 Years
Less than 100	10.0	7.5	5.0	2.5
100 to <150	9.0	6.5	4.0	2.0
150 to <200	8.0	5.5	3.0	2.0
200 to <250	7.0	4.5	2.0	2.0
250 to <300	6.0	3.5	2.0	2.0
300 to <350	5.0	2.5	2.0	2.0
350 to <400	4.0	2.0	2.0	2.0
400 to <450	3.0	2.0	2.0	2.0
Over 450	2.0	2.0	2.0	2.0

According to the Administrative Office of the Courts, districts not enrolled in CRIS have other opportunities for placement of the funds; however, they are subject to the same investment restrictions as public funds. The funds must be placed in a federally chartered bank and any amount in excess of $100,000 (the limit of FDIC insurance) deposited in an individual bank must be 100% collateralized. These funds may be invested in a number of financial instruments, including money market accounts, CDs, and Treasury instruments.[26]

The trustees should employ their best estimate of the rate of return for the most likely investment option, net of investment costs, over the period in which expenditures are expected to be incurred. If future rates have not been projected or are unknown, an average of historical returns may be a suitable predictor of rates of return.

We advise calculating the restoration cost estimate in nominal terms and discounting using the nominal rate of return on the instrument available to the trustees for investing the damage award. This requires first inflating the expected value of costs to the year that they are to be incurred. Each cost component should be inflated to nominal terms using an inflation index appropriate for the type of cost. Projections of the Gross Domestic Product Price Index and the Consumer Price Index are found in the Economic and Budget Outlook, which is published by the Congressional Budget Office (CBO). Projections of the Employment Cost Index and the Federal Employment Cost Index are also available from CBO.[27] Alternatively, inflation projections for other categories of costs may be calculated based on an historical average of a relevant cost index. Then, the future time path of nominal restoration costs would be discounted to present value dollars using the nominal rate of return of an instrument of comparable maturity to the period of cost streams.

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[26] For further guidance on placement of funds *see* 28 U.S.C 2041 and 2042 and the Federal Rules of Civil Procedure Rule 67. The Judicial Council of a District may have established additional rules for placement of funds.

[27] *See* Appendix B, Table B.3 for data on price and cost indices and data sources.

5.1.2 Example: Restoration Costs

In the following example, we illustrate discounting of the restoration cost component for a hypothetical compensatory restoration project, wetland creation, designed to compensate for injuries from the oiling of a natural marsh. The three panels of Table 5.2 show (a) restoration costs by category in 1998 dollars, (b) the inflation factors, and finally (c) the annual costs of restoration in nominal terms. The restoration costs include those associated with permitting, land acquisition, site restoration, monitoring, oversight, and maintenance of the compensatory restoration project. Except for monitoring and maintenance, the restoration costs are incurred in the early years of the project. Permitting occurs in 1998 while land acquisition, restoration, and planting of the site will occur in 1999. The site will be monitored and maintained for five years, at which time the site should be stabilized.[28]

All nominal costs are discounted to 1998, which is when the claim is submitted. We assume that CRIS is the only investment option available in this district court and use the average, over the duration of the project, of nominal rates of return on 3 month U.S. Treasury bills (4.9%) as the rate to discount restoration costs to 1998. To simplify the calculations, we assume that all annual costs are incurred at the end of each year.

5.2 Emergency Restoration and Assessment Costs

Emergency restoration costs are those costs incurred by either state or federal trustees immediately after the spill for emergency restoration actions. Assessment costs are those costs incurred in the conduct of the natural resource damage assessment by the trustee(s) or agent(s) of the trustee(s). Emergency restoration and assessment costs are incurred prior to the claim date and are discounted forward to the claim date.[29] The rate of interest employed as the discount rate should reflect the opportunity cost of the government expenditures. Assuming that the government finances expenditures through borrowing, the opportunity cost is equal to the government borrowing rate.[30]

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[28] Assume permitting and oversight costs are incurred by the government, so these costs are inflated by the inflation factor for federal salaries. Assume the remaining labor costs (monitoring and maintenance) are privately borne and should be inflated at the inflation factor in the Employment Cost Index. The inflation factor for restoration is the inflation factor for construction costs.

[29] Note that discounting forward may also be referred to as compounding forward.

[30] *See* Kopp (1994) for a brief discussion of how the opportunity cost would change if the costs were financed by taxes.

Table 5.2 Restoration Costs Example

(a) Costs in 1998 Dollars

Year	Permitting Costs[1]	Land Acquisition[2]	Restoration	Monitoring	Oversight[3]	Maintenance	Total Annual Costs (incurred at end of year)
1996	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0
1998	10,000	0	0	0	1,000	0	11,000
1999	10,000	40,000	40,000	4,000	0	0	94,000
2000	0	0	0	4,000	0	2,000	6,000
2001	0	0	0	4,000	0	2,000	6,000
2002	0	0	0	4,000	0	2,000	6,000
2003	0	0	0	4,000	200	2,000	6,200
2004	0	0	0	0	0	0	0

(b) Inflation Rates and Factors

Year	Annual Inflation Rate in Federal Salaries[4]	Inflation Factor for Federal Salaries	Annual Inflation Rate in Employment Cost Index[5]	Inflation Factor for Non-Federal Labor Costs	Annual Inflation Rate in Construction Costs[6]	Inflation Factor for Construction Costs
1996						
1997						
1998	2.1%	1.00	2.6%	1.00	2.4%	1.00
1999	2.6%	1.03	3.1%	1.03	2.4%	1.02
2000	2.7%	1.05	3.2%	1.07	2.4%	1.05
2001	2.8%	1.09	3.3%	1.10	2.4%	1.08
2002	2.7%	1.11	3.2%	1.13	2.4%	1.10
2003	2.7%	1.14	3.2%	1.17	2.4%	1.13
2004	2.7%	1.17	3.2%	1.21	2.4%	1.16

(c) Costs in Current Dollars

Year	Permitting Costs	Land Acquisition	Restoration	Monitoring	Oversight	Maintenance	Total Annual Costs (incurred at end of year)	Discounted (to 1998) Total Annual Restoration Costs[7]
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1998	10,000	0	0	0	1,000	0	11,000	11,000
1999	10,260	40,000	40,978	4,124	0	0	95,362	90,908
2000	0	0	0	4,260	0	2,130	6,390	5,807
2001	0	0	0	4,409	0	2,205	6,614	5,730
2002	0	0	0	4,537	0	2,269	6,806	5,620
2003	0	0	0	4,682	228	2,341	7,252	5,709
2004	0	0	0	0	0	0	0	0
							133,424	124,774

[1]These include the costs of permitting and performing environmental impact assessments.

[2]The land aquisition costs are in 1999 dollar terms.

[3]The oversight costs include those incurred during restoration and post-restoration.

[4]The inflation rate is the projected annual percentage change in the federal employee cost index, which is 0.5% less than the Employment Cost Index (ECI).

[5]The inflation rate is the projected annual percentage change in the ECI (CBO, 1997).

[6]The inflation rate is the average annual percentage change in the Civil Works Construction Cost Index system 1986-1996 (Army Corps of Engineers, 1997).

[7]The discount rate is 4.9% -- the average of the projected nominal 3-month U.S. T-bill rate from 1998-2003 (CBO, 1998).

The final natural resource damage assessment regulations contain the following rule language on discounting past assessment and emergency restoration costs:

> *To calculate the present value of these costs at the time the demand is presented to the responsible parties, the trustees will compound forward the costs already incurred. ...NOAA recommends that the trustees use the actual U.S. Treasury rate for marketable securities of comparable maturity to the period of analysis for discounting this component of the claim. NOAA acknowledges that, at the discretion of the trustees, a state or tribal borrowing rate may be used to compound the state or tribal component of past costs* (61 FR No. 4, p. 457).

For discounting past emergency restoration and assessment costs, it is straightforward to employ the nominal Treasury rate, or other government borrowing rate, as the discount rate since the nominal interest is observed. Further, past costs are likely to be denominated in nominal terms (rather than real).

The opportunity cost of the use of government funds for emergency restoration and assessment is known at the time the claim is presented. Consequently, the realized U.S. Treasury rates, rather than the projected rates, should be used to discount this component of the claim. The correct procedure is to present the expenditures by the time period they were incurred (e.g., use cumulative annual costs), and to employ the yield on the U.S. Treasury bond **purchased in the year of the expenditure** and maturing in the year the claim is presented. If there is not a bond of the duration of time between the date of the claim and the expenditure, the trustees assume that yields would change linearly between securities of different maturities. Historic yields on Treasury securities can be found on the Federal Reserve Statistical Release web site: http://www.bog.frb.fed.us/releases/H15/data.htm.

5.2.1 Example: Emergency Restoration and Assessment Costs

Table 5.3 shows the emergency restoration and assessment costs in nominal terms, by category. Emergency restoration costs are incurred in 1996 only. In our continuing hypothetical example, emergency restoration activities for the oil spill might include the cleanup of residual oil. Assessment costs are incurred in 1996 and 1997 and represent the costs of determining the injury and developing the restoration plan. The historical nominal rate of return on U.S. Treasury securities issued in 1996 with two-year maturities is used to discount costs incurred in 1996. The analogous rate for securities purchased in 1997 with a one year maturity are used to discount costs incurred in 1997. To simplify the calculation, we assume that the costs (in dollars) are incurred at the end of each period and the date of the claim is at the end of 1998.

Table 5.3 Emergency Restoration and Assessment Costs Example

1	2	3	4	5	6
Year	Emergency Restoration Costs	Assessment Costs	Total Annual Costs (incurred at end of year)	Discount Factor for Discounting[1]	Discounted Total Annual Costs
1996	50,000	10,000	60,000	1.119	67,161.84
1997	0	20,000	20,000	1.056	21,120
				Total Discounted Costs	88,281.84

[1]This discounting scenario uses the historical nominal rate of return on U.S. Treasury securities issued in 1996 with maturities of two years (5.8%) to compound costs incurred in 1996 to 1998.The analogous rate for U.S. Treasury securities issued in 1997 with one year to maturity (5.6%) is used to compound costs incurred in 1997 to 1998.

6.0 SUMMARY

This document provides mechanisms for the treatment of discounting and uncertainty when scaling compensatory restoration projects, as well as mechanisms for discounting capital costs incurred during damage assessment and restoration. NOAA suggests use of a riskless proxy of the social rate of time preference for discounting interim service losses and gains. This proxy is currently approximately 3 percent. NOAA only provides general advice for the treatment of uncertainty in scaling calculations. Section 4 provides general descriptions of techniques to incorporate uncertainty. One mechanism is valuing uncertainty either by calculating a sum certain equivalent to the risky outcome (Approach 1) or adjusting the discount rate to incorporate uncertainty (Approach 2). The former approach is preferred under OPA. Institutional mechanisms used to account for uncertainty include restoration performance and design standards imposed on the responsible party or contingent claim structures.

For discounting the cost components of a claim, as opposed to discounting interim losses and gains, NOAA advises that trustees use the rates on U.S. treasury securities of comparable maturities to the period of analysis to discount emergency restoration, restoration, and assessment costs. Note that the treatment of uncertainty in cost components is not addressed in this document.

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APPENDIX A: 1996 FINAL NATURAL RESOURCE DAMAGE ASSESSMENT REGULATIONS UNDER THE OIL POLLUTION ACT: DISCOUNT RATES AND UNCERTAINTY SUBSECTIONS.

Preamble Language

Subpart E - Restoration Planning Phase

Treatment of Uncertainty and Discounting

When scaling a restoration action, trustees should address the uncertainties associated with the predicted consequences of both the primary and compensatory restoration actions that will affect the level and duration of losses from the injury and gains from the compensatory restoration action. In addition, trustees must take account of the value of time in the scaling calculations by discounting to the present the interim lost services or the value of interim lost services due to the injury, as well as the gain in services or service value from the restoration action. The reference date for the discounting calculation is the date at which the demand is presented.

NOAA suggests that, where feasible, the trustees should use risk- adjusted measures of losses and gains, in conjunction with a riskless rate of discount reflecting the social rate of time preference for natural resources (i.e., the rate society is willing to substitute between present and future consumption of natural resources with certainty). Risk-adjusted measures of losses and gains take account of the fact that people tend to be risk averse, and must be compensated for bearing uncertainty. For example, it may be possible to compensate for uncertainty in outcomes from compensatory restoration actions with a larger scale action. Because of the difficulty in determining the rate of time preference for goods (such as natural resources) that are not generally sold in a market, a real rate of three percent (3%) is recommended as a riskless rate, unless justification is presented for a rate more appropriate for the specific context. Alternatively, if the streams of losses and gains cannot be adequately adjusted for risks, then NOAA suggests use of a discount rate that incorporates a suitable risk adjustment to the riskless rate.

Existing economic literature suggests that three percent (3%) is a reasonable choice for the social rate of time preference, given that it is the middle of the range of values for the subjective rate of time preference implied by long-run growth models of the U.S. economy. Further, 3% is at the lower end of the range of the financial opportunity costs of consumption, which are relatively low for individuals who are net savers, and much higher for individuals who are net borrowers. The long-term average real after tax rate of return on 3-month Treasury bills, a proxy for a riskless savings asset, is around one percent (1%), though more recent rates are substantially higher (around 2% during the 1983-1994 period). Consumer borrowing rates depend upon the source of financing, but may exceed ten percent (10%) in real terms for many credit cards. Because consumers' use of natural resources does not occur primarily through market transactions, consumers do not necessarily adjust their inter-temporal consumption of natural resources in response to the relevant intertemporal financial trade-offs available to them; nonetheless, the financial opportunity costs provide an additional reference point.

The analysis should be conducted in real terms (e.g., in units of services, or in dollars of a specified base year). By definition, an analysis conducted in units of natural resources or services is in real terms. If the analysis is conducted in money value terms, then all money values should be specified in terms of the dollars of a specified base year. To adjust the measures of monetary losses or gains to dollars of the specified base year, the Consumer Price Index is most appropriate when the measure of losses is consumer surplus. Alternatively, for more generalized measures of losses or for future projections of inflation, trustees may use the Gross Domestic Product price index, for which the Administration predicts a time-series of future deflators every year. Sources of information for discounting are identified in the preamble discussion of discounting in the Implementation Phase.

Subpart F - Restoration Implementation Phase

Discounting and Compounding Components of the Claim

Discounting is necessary for the trustees to be able to present a claim for a ``sum certain,'' as required by section 1001(3) of OPA (33 U.S.C. 2701(3)). The reference date for the discounting calculations is the date at which the demand is presented. Trustees must discount future restoration costs back to the present and compound assessment and emergency restoration costs already incurred forward to the present. The use of discounting in scaling restoration actions is discussed separately in subpart E of the rule.

NOAA advises that trustees use the U.S. Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis for both calculations, with some qualifications noted below. Alternatively, for state or tribal claims for past damage assessment and restoration costs, the state or Indian tribe may use the state or tribal borrowing rate on marketable securities. The analysis should be conducted either in terms of nominal values (denominated in dollars of the year in which the losses or gains are incurred) or in constant dollars of a specified base year. For compounding past emergency restoration and assessment costs, trustees should use U.S. Treasury rate as the discount rate and represent the costs in nominal terms, since the nominal interest is observed and past costs are likely to be denominated in nominal terms. Anticipated inflation can be incorporated in estimates of future restoration costs with an appropriate inflation index.

B. Estimated Future Restoration Costs

Most restoration actions will be carried out over a period of years. If funds are insufficient to cover the full costs of restoration, including post-implementation maintenance and monitoring operations, natural resource and service recovery will be incomplete, and the public will be deprived of full compensation for the injuries. NOAA advises that, for discounting future restoration costs, trustees specify future restoration costs in nominal terms (i.e., in terms of dollars of the year in which the costs will be incurred) and then discount the nominal costs using the nominal U.S. Treasury rate for marketable securities of comparable maturity to the period of analysis, when this rate of return is available to the trustees for investment of settlement monies. To specify the future restoration costs in nominal terms, the trustees should employ the indices of projected inflation appropriate to the major components of the restoration costs (e.g., construction price indices for construction costs; the federal employee wage index for trustee monitoring costs). If component-specific inflation indices are unavailable, the Gross Domestic Product price index may be used. If legal and/or institutional constraints prevent investment of settlement monies yielding the U.S. Treasury rate for marketable securities of comparable maturity to the period of analysis, trustees should structure the claim to ensure that sufficient funds will be available to fund the entire selected restoration alternative. One option is to calculate the discounted value of this component of the claim using an alternative discount rate that represents the yield on settlement monies available to the trustees. An alternative option is to structure a multi-year schedule for claim payments to ensure it provides the cash flow for each year required for planned expenditures.

If the settlement is structured so that the responsible parties carry out the restoration actions, the trustee restoration costs to be discounted will be substantially reduced, but they will not be eliminated because trustee monitoring and oversight costs will still be included in the claim.

C. Past Assessment and Emergency Restoration Costs

Past assessment and emergency restoration costs may accrue from the time of the incident to the date of the demand. To calculate the present value of these costs at the time the demand is presented to the responsible parties, the trustees will compound forward the costs already incurred. Because the rate of interest employed as the compound rate for past costs incurred should reflect the opportunity cost of the money spent, NOAA suggests that the trustees use the actual U.S. Treasury rate for marketable securities of comparable maturity to the period of analysis for discounting this component of the claim. NOAA acknowledges that, at the discretion of the trustees, a state or tribal borrowing rate may be used to compound the state or tribal component of past costs. Where the costs are denominated in dollars of the year in which they were incurred (i.e., in nominal terms), the nominal interest rate should be employed.

D. Sources of Data

U.S. Treasury bill and bond rates may be found in the Federal Reserve Bulletin, issued monthly, or the Treasury Bulletin, issued quarterly. The Gross Domestic Product fixed-weighted price index and the Consumer Price Index may be found in the Survey of Current Business, issued monthly, and the Economic Report of the President, issued annually. The Administration prediction for future Gross Domestic Product deflators is updated twice annually at the time the budget is published in January or February and at the time of the Mid- Session Review of the Budget in July. The current Treasury rates and inflation adjustment assumptions, as well as guidance in calculation procedures, are reported in regular updates of Appendix C of Circular No. A-94, available from the OMB Publications Office (202-395-7332).

Rule Language

Section 990.53 Discounting and uncertainty

When scaling a restoration action, trustees must evaluate the uncertainties associated with the projected consequences of the restoration action, and must discount all service quantities and/or values to the date the demand is presented to the responsible parties. Where feasible, trustees should use risk-adjusted measures of losses due to injury and of gains from the restoration action, in conjunction with a riskless discount rate representing the consumer rate of time preference. If the streams of losses and gains cannot be adequately adjusted for risks, then trustees may use a discount rate that incorporates a suitable risk adjustment to the riskless rate.

Sec. 990.63 Discounting and compounding.

(a) Estimated future restoration costs. When determining estimated future costs of implementing a Final Restoration Plan, trustees must discount such future costs back to the date the demand is presented. Trustees may use a discount rate that represents the yield on recoveries available to trustees. The price indices used to project future inflation should reflect the major components of the restoration costs.

(b) Past assessment and emergency restoration costs. When calculating the present value of assessment and emergency restoration costs already incurred, trustees must compound the costs forward to the date the demand is presented. To perform the compounding, trustees may use the actual U.S. Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis. For costs incurred by state or tribal trustees, trustees may compound using parallel state or tribal borrowing rates.

(c) Trustees are referred to Appendices B and C of OMB Circular A-94 for information about U.S. Treasury rates of various maturities and guidance in calculation procedures. Copies of Appendix C, which is regularly updated, and of the Circular are available from the OMB Publications Office (202-395-7332).

APPENDIX B: REFERENCE DATA ON RATES OF RETURN AND INFLATION RATES

Table B.1 Total Returns to Large Company Stocks*			
Year	Total Returns (Nominal Pretax)	Inflation-Adjusted Total Returns (Real Pretax)	Inflation and Tax Adjusted Total Returns (Real, After-tax: 30% tax rate)
1926	11.62%	13.31%	9.32%
1927	37.49%	40.41%	28.29%
1928	43.61%	45.01%	31.51%
1929	-8.42%	-8.59%	-6.01%
1930	-24.90%	-20.08%	-14.06%
1931	-43.34%	-37.37%	-26.16%
1932	-8.19%	2.35%	1.65%
1933	53.99%	53.21%	37.25%
1934	-1.44%	-3.40%	-2.38%
1935	47.67%	43.39%	30.37%
1936	33.92%	32.32%	22.62%
1937	-35.03%	-36.98%	-25.89%
1938	31.12%	34.87%	24.41%
1939	-0.41%	0.07%	0.05%
1940	-9.78%	-10.64%	-7.45%
1941	-11.59%	-19.42%	-13.59%
1942	20.34%	10.11%	7.08%
1943	25.90%	22.04%	15.43%
1944	19.75%	17.28%	12.10%
1945	36.44%	33.43%	23.40%
1946	-8.07%	-22.20%	-15.54%
1947	5.71%	-3.03%	-2.12%
1948	5.50%	2.72%	1.90%
1949	18.79%	20.97%	14.68%
1950	31.71%	24.50%	17.15%
1951	24.02%	17.14%	12.00%
1952	18.37%	17.33%	12.13%
1953	-0.99%	-1.60%	-1.12%
1954	52.62%	53.39%	37.37%
1955	31.56%	31.07%	21.75%
1956	6.56%	3.59%	2.51%
1957	-10.78%	-13.40%	-9.38%
1958	43.36%	40.88%	28.62%
1959	11.96%	10.30%	7.21%
1960	0.47%	-0.99%	-0.69%

Year	Total Returns (Nominal Pretax)	Inflation-Adjusted Total Returns (Real Pretax)	Inflation and Tax Adjusted Total Returns (Real After-tax: 30% tax rate)
1961	26.89%	26.04%	18.23%
1962	-8.73%	-9.83%	-6.88%
1963	22.80%	20.81%	14.57%
1964	16.48%	15.11%	10.58%
1965	12.45%	10.33%	7.23%
1966	-10.06%	-12.98%	-9.09%
1967	23.98%	20.32%	14.22%
1968	11.06%	6.05%	4.24%
1969	-8.50%	-13.77%	-9.64%
1970	4.01%	-1.41%	-0.99%
1971	14.31%	10.60%	7.42%
1972	18.98%	15.05%	10.54%
1973	-14.66%	-21.56%	-15.09%
1974	-26.47%	-34.46%	-24.12%
1975	37.20%	28.21%	19.75%
1976	23.84%	18.16%	12.71%
1977	-7.18%	-13.07%	-9.15%
1978	6.56%	-2.26%	-1.58%
1979	18.44%	4.53%	3.17%
1980	32.42%	17.81%	12.47%
1981	-4.91%	-12.71%	-8.90%
1982	21.41%	16.88%	11.82%
1983	22.51%	18.03%	12.62%
1984	6.27%	2.22%	1.55%
1985	32.16%	27.36%	19.15%
1986	18.47%	17.15%	12.01%
1987	5.23%	0.79%	0.55%
1988	16.81%	11.87%	8.31%
1989	31.49%	25.65%	17.96%
1990	-3.17%	-8.74%	-6.12%
1991	30.55%	26.67%	18.67%
1992	7.67%	4.64%	3.25%
1993	9.99%	7.05%	4.94%
1994	1.31%	-1.33%	-0.93%
1995	37.43%	34.03%	23.82%
1996	23.07%	19.12%	13.38%
1997	33.36%	31.13%	21.79%

*from Ibbotson Associates:
Stocks, Bonds, Bills and Inflation - 1998 Yearbook.

Table B.2 Nominal Treasury Constant Maturity Rates (%), Federal Reserve (*see* website: http://www.bog.frb.fed.us/releases/H15/data.htm)								
Year	**3 month**	**6 month**	**1 year**	**2 year**	**3 year**	**5 year**	**7 year**	**10 year**
1962	2.78	2.91	3.1	**3.57**	3.47	3.7	**3.83**	3.95
1963	3.16	3.25	3.36	**3.2**	3.67	3.83	**3.56**	4
1964	3.55	3.69	3.85	**3.92**	4.03	4.07	**3.98**	4.19
1965	3.95	4.06	4.15	**3.97**	4.22	4.25	**4.13**	4.28
1966	4.88	5.08	5.2	**4.87**	5.23	5.11	**5.04**	4.93
1967	4.32	4.63	4.88	**4.61**	5.03	5.1	**4.78**	5.07
1968	5.34	5.47	5.69	**5.37**	5.68	5.7	**5.57**	5.64
1969	6.68	6.85	7.12	**6.23**	7.02	6.93	7.15	6.67
1970	6.46	6.56	6.9	**8.12**	7.29	7.38	7.38	7.35
1971	4.35	4.51	4.89	**4.59**	5.66	5.99	6.18	6.16
1972	4.07	4.47	4.95	**4.85**	5.72	5.98	6.14	6.21
1973	7.04	7.18	7.32	**6.23**	6.96	6.87	6.86	6.85
1974	7.89	7.93	8.2	**6.79**	7.84	7.82	7.72	7.56
1975	5.84	6.12	6.78	**6.92**	7.5	7.78	7.9	7.99
1976	4.99	5.27	5.88	6.31	6.77	7.18	7.42	7.61
1977	5.27	5.51	6.08	6.45	6.68	6.99	7.23	7.42
1978	7.22	7.57	8.34	8.33	8.29	8.32	8.36	8.41
1979	10.04	10.02	10.65	10.11	9.7	9.51	9.47	9.43
1980	11.51	11.37	12	11.73	11.51	11.45	11.4	11.43
1981	14.03	13.78	14.8	14.57	14.46	14.25	14.07	13.92
1982	11.09	11.86	12.27	12.8	12.93	13.01	13.06	13.01
1983	8.95	9.27	9.58	10.21	10.45	10.79	11.02	11.1
1984	9.92	10.42	10.91	11.67	11.92	12.26	12.42	12.46
1985	7.72	8.06	8.42	9.27	9.64	10.12	10.5	10.62
1986	6.15	6.30	6.45	6.86	7.06	7.3	7.54	7.67
1987	5.96	6.33	6.77	7.42	7.68	7.94	8.23	8.39
1988	6.89	7.27	7.65	8.1	8.26	8.48	8.71	8.85
1989	8.39	8.48	8.53	8.57	8.55	8.5	8.52	8.49
1990	7.75	7.85	7.89	8.16	8.26	8.37	8.52	8.55
1991	5.54	5.69	5.86	6.49	6.82	7.37	7.68	7.86
1992	3.51	3.66	3.89	4.77	5.3	6.19	6.63	7.01
1993	3.07	3.22	3.43	4.05	4.44	5.14	5.54	5.87
1994	4.37	4.83	5.32	5.94	6.27	6.69	6.91	7.09
1995	5.66	5.82	5.94	6.15	6.25	6.38	6.5	6.57
1996	5.15	5.29	5.52	5.84	5.99	6.18	6.34	6.44
1997	5.2	5.39	5.63	5.99	6.1	6.22	6.33	6.35

Rates in bold are from Homer and Sylla (1991).
Rates for 3-month and 6-month securities from 1962-1981 are for new issues.

Table B.3 Price and Cost Indices - Annual Percentage Changes					
Year	**CPI-U[1]**	**GDP[2]**	**ECI[3]**	**FEPCA[4]**	**Civil Works[5]**
1981	10.3%	9.4%	9.9%	9.4%	9.8%
1982	6.2%	6.3%	6.5%	6.0%	7.1%
1983	3.2%	4.3%	5.7%	5.2%	3.1%
1984	4.3%	3.8%	4.9%	4.4%	2.8%
1985	3.6%	3.4%	3.9%	3.4%	1.3%
1986	1.9%	2.6%	3.2%	2.7%	0.5%
1987	3.6%	3.1%	3.3%	2.8%	1.5%
1988	4.1%	3.7%	4.8%	4.3%	3.6%
1989	4.8%	4.2%	4.8%	4.3%	3.8%
1990	5.4%	4.3%	4.6%	4.1%	2.5%
1991	4.2%	4.0%	4.4%	3.9%	2.1%
1992	3.0%	2.8%	3.5%	3.0%	2.1%
1993	3.0%	2.6%	3.6%	3.1%	3.0%
1994	2.6%	2.4%	3.1%	2.6%	2.7%
1995	2.8%	2.5%	2.6%	2.1%	2.9%
1996	3.0%	2.3%	2.9%	2.4%	2.2%
1997	2.3%	2.0%	2.8%	2.3%	2.7%
1998	2.2%	2.0%	2.6%	2.1%	2.8%
1999	2.5%	2.2%	3.1%	2.6%	3.0%
2000	2.7%	2.3%	3.2%	2.7%	3.0%
2001	2.8%	2.4%	3.3%	2.8%	3.0%
2002	2.8%	2.4%	3.2%	2.7%	3.0%
2003	2.8%	2.5%	3.2%	2.7%	3.0%
2004	2.8%	2.5%	3.2%	2.7%	3.0%
2005	2.8%	2.5%	3.2%	2.7%	3.0%
2006	2.8%	2.5%	3.2%	2.7%	3.0%

[1]Consumer Price Index for all urban consumers - Economic Report of the President, 1998 and CBO - The Economic and Budget Outlook: Fiscal Years 1999-2008, 1998.

[2]Gross Domestic Product Implicit Price Deflator - Economic Report of the President, 1998 and CBO - The Economic and Budget Outlook: Fiscal Years 1999 - 2008, 1998.

[3]Employment Cost Index - Economic Report of the President, 1998 and CBO - The Projections Unit - Budget Analysis Division, personal communication.

[4]Federal Employment Cost Index - 0.5% less than the ECI.

[5]Civil Works Construction Cost Index - Army Corps of Engineers, 1997.

APPENDIX C: SUMMARY OF OTHER AGENCIES' POLICIES ON DISCOUNTING AND THE TREATMENT OF UNCERTAINTY

Office of Management and Budget (OMB)

OMB provides "guidance on the discount rates to be used in evaluating activities whose benefits and costs are distributed over time" in Circular No. A-94 (revised October 29, 1992) which applies to all agencies of the Executive Branch of the Federal Government. Exceptions, which are noted in the Circular, include decisions concerning water resource projects, which are to follow guidance put forth in *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*. (Water Resources Council 1983) (*See* summary of Water Resources Council guidance below.) The guidance varies depending upon whether the benefits and costs of an action are provided to the general public or to the government.

Examples of the former are found in public investment and regulatory analyses. In this case, social benefits and their associated investment costs should be discounted using a 7 percent real discount rate in conjunction with constant-dollar benefit-cost analyses. The 7 percent real rate approximates the marginal pretax rate of return on an average investment in the private sector in recent years. Examples of actions that affect the government include lease-purchase decisions, internal government investments, and asset sale decisions. The Federal cost savings and associated investment costs in the analyses of these types of actions should be discounted with a U.S. Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis. This rate is computed in January of each year using the Administration's economic assumptions for the budget and it is published in annual updates of Appendix C of the Circular. These updates are available upon request from OMB.

OMB also provides guidance on the treatment of uncertainty in the Circular. Under ideal conditions, uncertainty would be characterized in analyses by presenting the probability distributions of potential benefits, costs, and net benefits. However, if estimated benefits, costs, and net benefits are characterized by point estimates rather than as probability distributions, the expected value would be an appropriate estimate. Finally, sensitivity analyses should be performed to examine how variations in the major assumptions affect outcomes.

According to OMB, adjusting the discount rate for project-related risks is not the preferred method of adjusting present value for the risks associated with particular projects.

Water Resources Council (WRC)[31]

The Water Resources Council (1983) provided the following guidance on discounting for analyses of water resource and related projects in section 1.4.11 of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*: "Calculate present values using the discount rate established annually for the formulation and economic evaluation of plans for water and related land resources." The discount rate

[31] The Water Resources Council was disbanded, but the guidance is still followed.

referred to is computed in accordance with Section 80(a) of Public Law 93-251. However, the rate shall not change by more than 1/4 of 1 percent per year. This nominal rate was 7.75% in January, 1995, but would have been 7.21% if annual changes were not constrained. [January 1995 memo from Donald Glaser (DOI) to Bureau of Reclamation as per personal communication with Frank Osterhoudt of DOI]

General Accounting Office (GAO)

GAO's most recent discount rate guidance was published in May 1991. (United States General Accounting Office 1991) The GAO is not subject to OMB guidance because it is a legislative branch agency: its guidance applies to GAO staff. However, its guidance is similar to OMB's. GAO recommends using the interest rate for marketable Treasury debt with maturity comparable to the program being evaluated as the base case discount rate. Uncertainty in inflation and interest rates, private sector opportunity costs, intergenerational effects of policies on human life, and other parameters can be addressed through sensitivity analyses.

Congressional Budget Office (CBO)

CBO is a legislative branch agency and is also not subject to OMB guidance. CBO's guidance applies to only to its staff. CBO recommends a 2% real rate as an estimate of the real yield of Treasury debt and a sensitivity analysis of plus or minus 2% to capture the potential variability of real yields (Hartman, 1990). Use of comparable private-sector interest rates is recommended when valuing assets.

U.S. Army Corps of Engineers (ACE)

The Army Corps of Engineer provides guidance on uncertainty in restoration planning. Its guidance is found in the report titled "Introduction to Risk and Uncertainty in the Evaluation of Environmental Investments: An Annotated Bibliography." The report is part of its Evaluation of Environmental Investments Research Program. The Corps does not provide specific guidance for incorporating uncertainty in the evaluation of environmental investments. General guidance is offered because risk and uncertainty protocols for environmental restoration studies and the models and tools to conduct these analyses are not standardly applied.

The Corps suggests a catalog of broad concepts and specific tools for use in risk analysis. Environmental planning risk analysis should consider the following basic concepts (which tend to address information/communication issues): acknowledging uncertainty, education and training, EPA's ecological risk paradigm, full documentation, publicity, risk communication, and software. The specific tools to be applied include: analytical solutions, decision criteria, decision trees and influence diagrams, expert opinion, probability, probability distributions, random sampling, sensitivity analysis, simulations, specialty models, and statistics.

The Corps goes on to identify sources of uncertainty in restoration planning that are both general to all planning and specific to environmental planning. General uncertainty arises in each step of the planning process and can become cumulative if not addressed. The Corps suggests that knowledge of these sources in each step of restoration planning can reduce uncertainty. The four major sources of uncertainty specific to environmental planning include: project performance, extrapolation, models, and habitat evaluation procedures. The Corps then presents an example of risk-based analysis to demonstrate the application of methods for dealing with these sources of uncertainty.

U.S. Department of the Interior (DOI)

The Department of the Interior's recommendation on discounting is presented in an issue paper titled "The appropriate Discount Rate for Social Policy Analysis: Discussion and Estimation" by Bruce Peacock. (USDOI 1995) Interior recommends a 3 percent annual rate as the appropriate discount rate for social policy analysis. This rate is based on both opportunity cost and intertemporal equity considerations.

The economics literature suggests that, based on opportunity cost considerations, the discount rate should be equal to the consumer rate of time preference. Unfortunately, observable market rates of interest may not adequately reflect that rate of time preference. One approach found in the literature suggests using the government loan rate as the discount rate since its use is consistent with the decision criterion of cost/benefit analysis. The literature further suggests using the three-month U.S. Treasury bill rate to discount costs and benefits in social policy analysis since its short time horizon avoids the consideration of investment risk.

With respect to intertemporal equity considerations, the economics literature notes that using the rate of productivity to discount costs and benefits is consistent with an egalitarian distribution of consumption through time. The literature further notes that conservation considerations, which effectively recommend a zero discount rate, are not necessarily inconsistent with the use of a positive discount rate in the analysis of resource allocation decisions.

Interior relied on these considerations to guide its analysis of discounting for social policy analysis. In that analysis, Interior examined the real three-month U.S. Treasury bill rate and the real growth rate in Gross Domestic Product from 1983 to 1994. That time period corresponds generally with relevant economic factors cited in the economics literature, and includes one complete business cycle. The average real three-month U.S. Treasury bill rate is 2.9 percent per year, and the average real rate of growth in Gross Domestic Product is 3.0 percent per year, during that time period. The similarity of these two indicators led Interior to recommend a 3 percent annual rate as the appropriate discount rate for social policy analysis.