Potential Indirect Economic Impacts and Benefits Associated with Guidance Clarifying the Scope of Clean Water Act Jurisdiction

U.S. Environmental Protection Agency

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I. Introduction

This preliminary economic analysis is intended to provide an estimate of the possible range of indirect impacts associated with implementing the proposed Guidance on Identifying Waters Protected by the Clean Water Act.[1] The proposed guidance itself is not binding: existing statutory and regulatory programs and requirements, such as the 402 and 404 permitting programs, impose costs and provide benefits. In addition, neither field staff nor courts are required to follow the guidance -- it is only to the extent that the non-binding guidance is followed that these indirect costs and benefits accrue. While this proposed guidance represents a reasonable interpretation of these requirements in light of the recent Supreme Court decisions, it may not apply to a particular situation depending on the circumstances. Nevertheless, the U.S. Environmental Protection Agency (EPA) has attempted to estimate these possible indirect costs and benefits associated with implementing the proposed guidance when compared to implementation of existing guidance.[2]

Among its many provisions, the Clean Water Act (CWA) establishes oil spill prevention programs (section 311); requires permits for pollutant discharges (section 402); requires permits for filling in wetlands or streams (section 404); calls for states to set standards for meeting water quality goals and develop plans to restore polluted waters (section 303); establishes state roles in approving federal permits (section 401); and allows the federal government, states, and communities to enforce the law. Any water found not to be a “water of the U.S.” generally is not protected by the Clean Water Act’s programs and strategies.

In January 2001, the U.S. Supreme Court in *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers (SWANCC)* held that intrastate, non-navigable, isolated waters could not be protected as “waters of the US” under the CWA based solely on the presence of migratory birds. Since *SWANCC*, no isolated waters have been declared jurisdictional by a federal agency. In June 2006, a split Supreme Court vacated and remanded judgments of the Sixth Circuit Court of Appeals in *Rapanos v. United States.* The pivotal opinions are those by the plurality (indicating that jurisdictional waters include “relatively permanent waters” and wetlands with a continuous surface connection to such waters) and by Justice Kennedy (indicating that waters are jurisdictional where they have a “significant nexus” to a traditional navigable water). The government position since *Rapanos* has been that a water is jurisdictional under the CWA when it meets <u>either</u> the plurality or Kennedy standard.

The effect of the *SWANCC* decision is primarily on so-called “isolated” waters. These waters include vernal pools, prairie potholes and playa lakes—waters that lie entirely within a

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[1] The proposed guidance clarifies and interprets requirements of the CWA and the agencies' implementing regulations in light of *SWANCC* and *Rapanos* and provides guidance on waters protected by the CWA. The CWA provisions and supporting regulations contain legally binding requirements. The guidance does not substitute for those provisions or regulations and is not itself a regulation. It does not impose legally binding requirements on EPA, the Corps, or the regulated community, and may not apply to a particular situation depending on the circumstances. Any decisions regarding a particular water will be based on the applicable statutes, regulations, and case law. The proposed guidance does represent a change in practice from existing guidance which did not make full use of the authority provided by the CWA to include waters within the scope of the Act, as interpreted by the Court. The agencies expect, based on relevant science and recent field experience, that the extent of waters over which the agencies will assert jurisdiction will increase compared to the extent of waters over which jurisdiction has been asserted under existing guidance, though not to the full extent that it was typically asserted prior to the Supreme Court's decisions. This economic analysis was developed to provide rough estimates of the range of possible indirect effects from a change in practice, but it is the statute, regulations and caselaw which determine the scope of CWA jurisdiction.

[2] This particular baseline was deemed most useful for the purpose of comparing the potential outcome of proposed guidance.

single state and lack a direct, surface water connection to the river network. The effect of the *Rapanos* decision has been primarily on some small streams, rivers that flow for part of the year, and nearby wetlands.

Current practice may be under-representing Clean Water Act jurisdiction. EPA and the Army Corps of Engineers (Corps) have prepared joint proposed guidance to clarify the regulatory definition of “waters of the United States” affecting all CWA programs. The proposed guidance would replace existing guidance documents on CWA jurisdiction. Any impacts examined that are associated with this proposed guidance are both indirect (because any impact would be as a result of actions of the CWA implementing programs) and contingent on parties following the guidance. To the extent that additional indirect costs are incurred, additional mitigation costs associated with CWA Section 404 are expected to be the largest category of such costs.

EPA does not believe that much reduction in 402 permits has occurred as a result of *SWANCC* and *Rapanos*, and thus both costs and benefits of increased 402 permits are expected to be minimal. There are several potential explanations for this. The first is that EPA has delegated operation of the 402 permit program to most (46) states, and states apply jurisdiction to “waters of the state” which must be as inclusive as “waters of the U.S” but may be more inclusive. In contrast, only two states have assumed the 404 program (to the extent it can be assumed for “non-navigable” waters). It is also possible that a permitted discharger may have the effect of creating a permanent water where there once was an intermittent or ephemeral water because of continuous discharge (i.e., an “effluent dependent” or “effluent dominated” water). In these cases, jurisdiction may not come under question. Additionally, facilities may have invested the capital in treatment and simply be willing to continue operating under their permit and see no need to challenge jurisdiction.

II. Assessing Potential Indirect Costs

Economic analyses examine the differences between a baseline, the "world without the action taken", and the "world with the result of the action taken" (i.e., assuming the guidance would be followed in regulatory decisions). Analyses of costs are applied to the incremental change between the baseline and the effect of the action. EPA typically conducts such an economic assessment in conjunction with proposed rules, and is providing a general assessment of potential indirect economic impacts of the proposed guidance to help inform decision-makers and the public. This analysis is based on the 2009-2010 period of time, after issuance of the most recent guidance interpreting the *SWANCC* and *Rapanos* Supreme Court decisions.

To the extent costs would be incurred, the majority of such costs would result from permitting costs and mitigation expenses incurred by entities seeking CWA 404 permits. These indirect costs may include wetlands mitigation, stream mitigation, and project re-design and relocation expenses. In addition, to the extent the guidance is followed, there would be program management, training, and associated environmental compliance costs to government associated with administering the CWA. For example, the Corps would process permit requests, conduct jurisdictional determinations (JDs) if needed, manage data, coordinate with federal and state resource agencies, and determine compensatory mitigation needs. There would be costs associated with these additional actions. This rough estimate is intended to identify the potential order of magnitude of potential indirect cost impacts to the regulated community and implementing agencies.

Two estimates are presented to represent potential incremental indirect costs on an annual basis. Each estimate shares a common baseline of 53,000[3] acres of wetland mitigation and 530 miles of stream mitigation to represent activity in the baseline period. This baseline level of mitigation was apportioned to each state, in proportion to the number of positive jurisdictional determination (JD) status[4] records (FY2009-10) for wetland aquatic resources.

To estimate state-specific per-acre costs of wetland mitigation and per linear foot estimates of stream mitigation, the Corps examined published studies and survey results, made phone inquiries to Corps Districts and mitigation banks, and researched web sites. A team of Corps experts came to agreement on a range of values for each state. For this analysis, the midpoint of this range was also used. The "high" of this range represents the most expensive mitigation found for each state. The midpoint likely represents more of a high-end value because for a majority of projects, costs are expected to be in the lower half of the range.[5] Thus, EPA

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[3] Based on approximately 44,000 acres of permittee responsible mitigation documented in the ORM2 data base in FY2010, approximately 7,000 acres of bank mitigation documented in the RIBITS data base in FY2009, and 2,000 of in-lieu fee (ILF) mitigation estimated from the ratio of ORM entries for banks (26%) and ILF (7%) in FY2010. This total may be incomplete, but it is consistent with the level of mitigation the Corps has estimated for the past 10-15 years, for example as presented in the 2008 Compensatory Mitigation Rule economic analysis.

[4] For this report, JDs mean the jurisdictional authority decision (Y/N) entered for all aquatic resource (AR) types in the ORM2 database. It does not represent the number of Corps JDs completed and provided to applicants that are reported in various annual reports. There may be multiple ARs associated with a JD.

[5] This is based on the judgment of the team that examined the range of per acre cost estimates; the primary intent was to identify the range, yet most of the costs would be anticipated to be in the lower half of the range.

and the Corps consider cost estimates based on the low to mid range to be most representative of actual costs in the aggregate.

Each estimate represents a different incremental amount of acres and stream miles mitigated. The increment is determined using data records (FY2009-10) of Corps jurisdictional status decisions associated with various aquatic resource types: "isolated waters" (a term used in ORM2 data base to represent intrastate, non-navigable, waters that lack a direct surface connection to other waterways; consistent with the usage in the proposed guidance, these waters are hereafter referred to as "other waters"), relatively permanent waters, traditional navigable waters, non-relatively permanent waters, and wetlands associated with these categories. The method assumes that all permits associated with projected additional jurisdictional waters would require mitigation at the same rate as baseline jurisdictional waters. The estimates build upon one other, with estimate 1 representing only the changes that may result from application of the proposed guidance to waters not in the "other waters" category and estimate 2 representing an additional increment from applying the proposed guidance to the "other waters" category. estimate 2 represents the best estimate of changes that may result from application of the proposed guidance. The difference between estimate 1 and estimate 2 helps show the potential impact of applying the guidance to "other waters" and highlights the uncertainty in knowing precisely how many of these waters would be considered jurisdictional if the new guidance is implemented. The full results of this analysis are presented in Appendix A.

<u>Estimate 1- "Significant Nexus Test" Waters</u>

In estimate 1, it is assumed that all negative JDs for aquatic resources not in the "other waters" category are instead determined to be jurisdictional. For example, some wetlands adjacent to relatively permanent waters or associated with non-relatively permanent waters are associated with a negative JD in the ORM data base (FY 2009-2010). In estimate 1, it is assumed that these negative JDs would be determined to be jurisdictional. The level of incremental wetland acres mitigated is calculated in proportion to the subsequent percent increase in wetlands that are assumed to be determined jurisdictional.[6] Nationally, 1.5 percent of JDs are negative for non-isolated wetlands.[7] The increase in jurisdictional wetlands corresponds to an estimated increase of 803 acres of wetland mitigation (a 1.5 percent increase from the baseline of 53,000 acres of estimated wetlands mitigation per year under current guidance).

All streams in the non-relatively permanent water, relatively permanent water, and traditionally navigable water categories were assumed to be determined to be jurisdictional in this estimate. On the national level, 2 percent of records in these categories of streams are associated with negative JDs in ORM data from FY2009-2010[8]. Assuming these are determined to be jurisdictional, and applying stream mitigation to the same extent as associated with the jurisdictional streams in FY2009-2010, this results in 9.3 miles of additional stream mitigation (a

[6] The formula used to make this calculation is presented in Appendix A.

[7] Percent is calculated by taking the number of "no" responses for aquatic resource (AR) jurisdictional authority for wetlands adjacent to non-RPWs, wetlands abutting and adjacent to (not abutting) RPWs, and wetlands adjacent to TNWs, and dividing by the total of all of these AR types.

[8] For streams, the percent is calculated by taking the total number of "no" responses for non-RPWs, RPWs, TNWs, and combinations of both non-RPWs and RPWs, and dividing by the total for these types.

2 percent increase from baseline of 530 miles of estimated stream mitigation per year under current guidance). In estimate 1, no other waters are assumed to be determined jurisdictional.

Estimate 2 – "Significant Nexus Test" Waters +17% of Other Waters

Estimate 2 includes the incremental increase in mitigation (acres of wetlands and miles of streams) calculated in estimate 1, and adds additional acres of wetland mitigation assuming 17 percent of aquatic resource records in the "other waters" category from ORM FY2009-2010 data are determined to be jurisdictional. These "other waters" comprise less than 5 percent of all aquatic resource records in the ORM data base (FY 2009-2010). EPA and the Corps assumed all waters in this "other waters" category are non-jurisdictional in the baseline. Additional acres of wetland mitigation are added proportionally by state based on the number of "other water" records associated with JDs in each state. The increase in wetlands that are assumed to be jurisdictional corresponds to an estimated increase of 2,517 acres of wetland mitigation (a 5.0 percent increase from baseline), including the 803 acres for "significant nexus test waters" in estimate 1. The 9.3 miles of additional stream mitigation for "significant nexus test" waters from estimate 1 are also included in estimate 2.

To select a percent increase in other waters for this estimate, a team of Corps experts examined a sample of 262 project files previously coordinated with Corps headquarters from June 2008 – January 2011, representing over 1,000 individual waters in 30 states. Based on data available in record files, the team judged whether or not the Agencies would determine the waters to be jurisdictional using the new proposed guidance. Overall, the team found that 17 percent of these other waters would be determined to be jurisdictional using the new proposed guidance.[9] Additional details on the methods and results of this analysis are presented in Appendix B. An EPA team independently examined a sub-sample of 50 JD project files and similarly estimated that 15 percent of those other waters would become jurisdictional. Of the other waters examined by the Corps, 73 percent were wetlands, and the remaining waters were ponds, streams, or other resource types. To be conservative for this analysis, EPA assumed that wetlands mitigation would be required for all other waters determined to be jurisdictional. EPA further assumed the amount of mitigation per jurisdictional decision on these other waters would be to the same extent as jurisdictional wetlands in FY2009-2010.

It is also possible that impacts are currently occurring without going through the JD process at all. Landowners and developers could be assuming that waters on their property are non-jurisdictional and not request a JD or engage in the permitting process, and thus not be represented in the ORM 2009-2010 data base. While such landowners might continue to assume that their waters are not jurisdictional, some may request a JD from the Corps or otherwise have their waters determined jurisdictional as a result of implementation of this guidance. To account for this contingency, mitigation costs were increased an additional 10 percent to calculate the

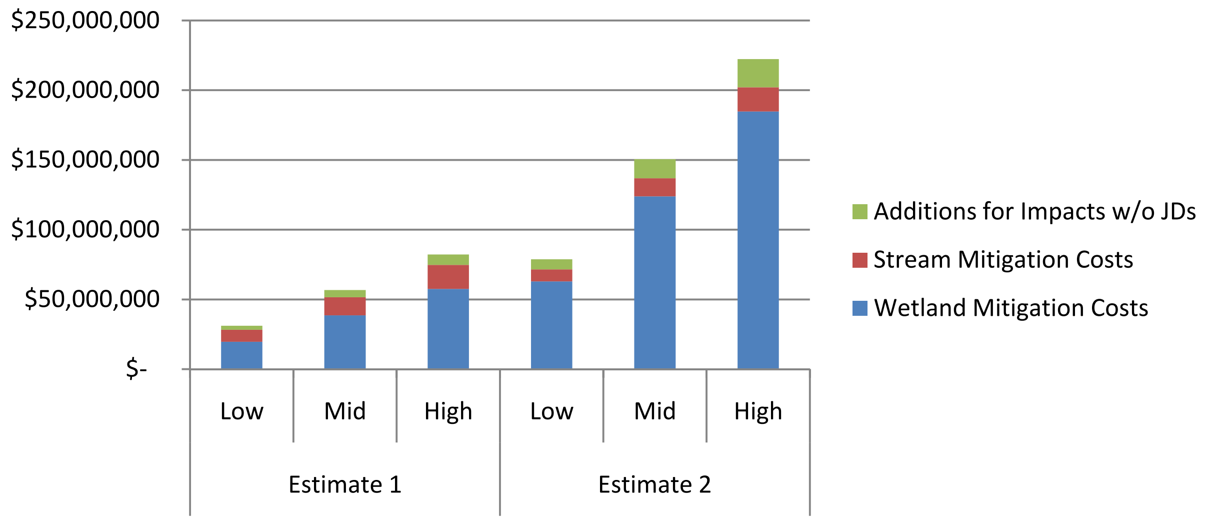
[9] The analysis indicated than none of the 145 waters examined in the state of California would become jurisdictional. As a result, an alternative percent increase was assigned for CA mitigation increase. Rather than apply a 0 percent increase, 5 percent was selected as a conservative estimate.

total cost estimate for each scenario.[10] To the extent unknown impacts are occurring and to the extent that these activities would be subject to permitting, the amount of mitigation potentially required would be reduced by efforts to avoid and minimize impacts, which are the first steps in the 404 process.

Estimate 1	Low	Mid	High
Wetland Mitigation Costs	$19,604,617	$38,551,811	$57,499,006
Stream Mitigation Costs	$8,690,922	$12,983,640	$17,276,358
Additions for Impacts w/o JDs	$2,829,554	$5,153,545	$7,477,536
Total Mitigation Cost:	**$31,125,093**	**$56,688,996**	**$82,252,900**

Estimate 2	Low	Mid	High
Wetland Mitigation Costs	$62,901,417	$123,863,396	$184,825,374
Stream Mitigation Costs	$8,690,922	$12,983,640	$17,276,358
Additions for Impacts w/o JDs	$7,159,234	$13,684,704	$20,210,173
Total Mitigation Cost:	**$78,751,573**	**$150,531,739**	**$222,311,906**

Figure 1. Preliminary Estimate of Incremental Indirect Annual 404 Mitigation Costs



[10] Some stakeholders assert there is a substantial amount of impacts to waters that project proponents believe are beyond the scope of CWA under current post-*SWANCC* and *Rapanos* policies. While not possible to quantify absent a major independent study, informed observers conclude some level of impacts to waters for which JDs are not now being requested is likely. Without an ability to specifically estimate the degree, yet to avoid a systematic source of error, the cost analysis assumes a 10 percent increase in the number of JDs. This provides a reasonably safe margin to capture these difficult to quantify impacts.

Summary of Mitigation Cost Estimates

Overall, the best representation of potential indirect mitigation costs is the low-mid range of estimate 2: $79-$151 million. This suggests a small increase (approximately 4%) in proportion to the current baseline estimate of between $2.1 and $3.9 billion. The baseline cost range is calculated by summing the products of the low and mid-range unit cost estimate for each state multiplied by the baseline mitigation apportioned to each state. The total estimated baseline mitigation is 53,000 wetland acres and 530 stream miles. Detailed results of this analysis are in Appendix A. In addition, the amount of incremental acres mitigated is within the range of inter-annual variability based on Corps estimates over the past 10-15 years.

Administrative Costs

It is also important to address governmental costs that may be incurred in managing the program and administrative costs to permit applicants. The following discussion focuses on the costs to the federal government of administering the CWA 404 program, but it is important to note that states and tribes may also incur additional costs as part of the CWA Section 401 certification process.

Additional Federal agency costs may result from additional jurisdictional determination (JD) requests. The increase in waters determined by the agencies to be jurisdictional from the 2008 guidance may result in an increase in requests for JDs. Some changes contained in the proposed guidance, such as the expectation that tributaries of specified physical characteristics will generally satisfy the significant nexus test, have the potential to reduce the administrative costs of establishing jurisdiction. If such changes balance the expected increase in JD requests, no incremental administrative costs would occur. Alternatively, administrative costs could either increase or decrease.[11] The Corps expects that more waters determined to be jurisdictional by the agencies will lead to an increase in permit applications and JD documentation. This, in turn, will increase the need for required consultations under the Endangered Species Act (ESA) and section 106 of the National Historic Preservation Act. This could increase costs for other federal agencies, such as the Fish and Wildlife Service. There may also be an increase in enforcement situations, potentially increasing the after-the-fact permit workload.

In addition to the number of permit applications, the complexity of permit applications may increase. A greater abundance of waters determined by the agencies to be jurisdictional on a project site may reduce the ability to avoid or minimize impacts. As a result, there may be a larger scope of analysis. The increase in waters on a site may increase impacts such that an individual permit is required rather than general permit coverage, or that an Environmental Impact Statement (EIS) is required in some cases. The increase in waters at a site could also result in increases in the amount of mitigation required.

The Corps expects that applicants will continue to use “preliminary JDs” (PJDs), whereby a permit applicant elects to set aside the jurisdictional question, and voluntarily “opts in” to the permitting process because it can be faster in terms of the permit evaluation process. Because most non-isolated waters are expected to be jurisdictional following the proposed

[11] Further analysis and deliberation may inform any future quantitative assessment of these administrative costs.

guidance, PJDs may continue to be an attractive option for applicants to avoid a longer "approved JD" (AJD) process. In FY 2010, 58 percent of JDs were PJDs (42 percent were AJDs). PJDs are less time-consuming to document than AJDs, but application processing may require more information describing jurisdictional waters (e.g., to assess impacts and formulate compensatory mitigation requirements). Alternatively, some applicants may request an AJD as a means to potentially reduce mitigation requirements and associated costs. If more landowners elect to request AJDs, the workload and administrative costs will increase.

An additional effect on costs is that many AJDs may become easier to document on the one hand, but some may become more costly and time consuming on the other (because of the larger potential scope). The agencies are likely to determine more waters to be traditionally navigable waters (TNWs), so those TNWs and their adjacent wetlands will be jurisdictional without the need for significant nexus (SN) evaluation, and the distance to the nearest TNW will be shorter for many waters. The larger watershed scale for SN evaluations, coupled with the broader interpretation of significant functions, will make SN determinations less time-consuming. Furthermore, once a SN has been demonstrated in a watershed, future JDs in that watershed may be able to incorporate or reference it, rather than requiring the Corps to conduct an entirely new analysis. There may also be an increase in appeals of AJDs. However, the increased clarity of the proposed guidance may mean more appeals are able to be resolved expeditiously.

The Corps estimates the costs incurred by both the Corps and applicants (excluding costs for compensatory mitigation) to range between approximately $7,900,000 and $20,000,000. The estimates are based on noting the incremental increase in workload associated with implementing the proposed guidance, and applying low end and high end cost estimates to applicants based on previous cost determinations.[12] These totals are comprised of a $4,800,000 to $8,700,000 in Corps costs (incremental increase in workload related tasks, low and high end estimates for HQ review of more JDs and additional time to conduct a SN for isolated waters) and a range of $3,100,000 to $11,300,000 in applicant costs (not including compensatory mitigation costs) for permit and JD associated costs. If these costs are added to the mitigation cost estimate range of $79-151 million per year previously presented, the result is $87-171 million per year.

[12] Costs to the Corps were determined by applying an incremental increase to certain baseline task hour formulas used in the current budget allocation process. Costs to applicants were determined using "Cost Analysis for the 2000 Issuance and Modification of Nationwide Permits" (IWR unpublished draft report, 2001}. The 2001 report estimates were based on data and information gathered in informal interviews with wetland permitting consultants and Corps district regulatory staff. The unit costs estimated for the different permit types were presented in a low to high range. While 10 years has passed since that report, the likely increases in costs are presumed to within an order of magnitude for the purpose of this cost estimate and consistent with other levels of uncertainty for this analysis. Direct costs to permit applicants, excluding compensatory mitigation costs, can be broken out into several application components: (1) delineation and survey of special aquatic sites; (2) project/impact drawings; (3) alternatives analysis; (4) preparation of the compensatory mitigation proposal; and (5) application submission. Costs for each of these can vary widely and in terms of order of magnitude among the components for different permit types.

III. Assessing Potential Indirect Benefits

Although costs are a very important component of any economic analysis, equally important is the value of the benefits received. Failure to account for the full economic values of ecosystems could result from a lack of recognition of benefits that 1) may not be adequately captured by traditional market valuation techniques, 2) may be public goods[13] that are not subject to any valuation reporting, or 3) may be intangible by their nature (these categories are not mutually exclusive). A common concern is that Agencies might not effectively manage what they do not measure, and they might undervalue resources that are not identified or quantified.

Valid procedures for estimation of economic benefits are described in EPA's *Guidelines for Preparing Economic Analyses* (2011). Many of the procedures from the *Guidelines* could be applied to estimating the benefits of following the proposed guidance. However, there are several difficulties to briefly mention. One is that the benefits of water quality improvement are generally spread diffusely over large populations. It is difficult to quantify the generally small benefits enjoyed by generally large numbers of people and aggregate up to a meaningful overall number. More importantly, the great majority of benefits from water quality improvements are typically public goods – things that cannot be bought and sold in markets – and so must be estimated by indirect means rather than observed in market prices. The *Guidelines* anticipate this possibility, and note several things. First, the fact that values are not easily estimated does not mean that they do not exist, nor even that they are small. Second, when it is not possible to monetize benefits – that is, to express them in dollar terms – it may still be useful to present whatever quantitative physical, chemical, or biological information is available.

A. Categories of Benefits

One category of benefits includes goods and services that are generated by a proposed action or activity. Although potentially easier to identify than other categories, these benefits may or may not be easy to measure or ascribe value. In terms of protecting small streams and wetlands, an example benefit might be the support of fish and shellfish populations in downstream waters as well as protection of the waters themselves. These types of waters provide habitat for a robust and diverse assemblage of organisms that are necessary to support the whole aquatic community structure and ecological function. Some associated attributes may have market value (such as the fish themselves) and some may have non-market value (such as biodiversity).

A related economic impact is the stream of revenues that are supported by the action taken. These are activities that may increase in occurrence and value as a resource is protected, or that may decrease in value or not happen at all if the resource is not protected. Provisioning of water supply for manufacturing, energy generation, and agriculture is an example of a benefit that may be affected. Tourism is perhaps the best example of this type of benefit. It is often the natural beauty or recreational opportunities provided by nature that spur the investment and revenue generated by tourism. The revenue streams supported include not just fees for the

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[13] A public good is a good that is non-rival (my enjoyment of clean water does not prevent you from enjoying it as well) and nonexclusive (when water is cleaned so that I may enjoy, it is also available for you to enjoy).

recreational activity itself, but also the hotels, restaurants, and other support services provided. The multi-billion dollar sport fishing industry is an example of a revenue stream supported by small streams and wetlands. It is essential to distinguish the marginal or incremental contribution of environmental factors to such values. For example, the value of a hotel is not, in general, entirely attributable to the environmental conditions of its locale.

Another category of benefits are costs avoided. Costs avoided represent what you don't have to pay because of the action you have taken. An ecosystem function that has an effect of resulting in "costs avoided" is floodplain preservation and avoidance of more frequent or severe flooding due to failure to preserve floodplains. Although dams and levees are built to control potential flooding, much of the alteration of the natural hydrologic regime has contributed to the potential for flooding. Small streams and wetlands serve to store water and slow down its movement across the landscape. When these systems no longer perform this function, the potential losses from flooding may increase

Protection of small streams and wetlands may be an effective "insurance policy" when considering the flooding losses already manifested and the potential magnitude of losses in the future if a great deal more of these small stream and wetland systems are lost without appropriate mitigation. These gains in avoided costs would not only apply to individuals directly affected by a flood, but also to society as a whole because everyone ultimately pays the price of lost revenues and lost investment to fellow members in some way. For example, where people are insured or governments compensate for losses, the insurance company could raise premiums, lose shareholder value, or reduce investments or the government could reduce services, incur debt, or have to find revenue to cover expenses from other sources.

1. Ecosystem Services and Public Welfare

The term "ecosystem services**"** refers to the many natural processes by which ecosystems, and the species they include, sustain and fulfill human life.[14] In other words, ecosystem services are the direct or indirect contributions that ecosystems make to the well-being of human populations.[15] Protection of these waters is important for public health, safety, and quality of life. Pollution or destruction of these waterways can affect drinking water, places where people recreate, the fish and shellfish people eat, the irrigation water used on food crops, and how floods affect people and property. About 60% of streams are intermittent or ephemeral and they contribute to water supplies that provide, at least in part, drinking water for 117 million people. While a substantial majority of these intermittent and ephemeral streams are already being found jurisdictional under current guidance, those that are currently not being found jurisdictional may be found to be so under the proposed guidance. Small streams and wetlands also provide habitat and biodiversity, support recreational fishing and hunting, filter sediment and contaminants, reduce flooding, stabilize shorelines and prevent erosion, recharge ground water, and maintain biogeochemical cycling. Estimates of fishing and hunting expenditures, major flood losses, and the value of wetlands for storm protection services all total in the tens of billions of dollars per year. In any economic valuation exercise, the incremental portion of these

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[14] Daily, G. (1997) Nature's services: Societal dependence on natural ecosystems. Island Press: Washington D.C.
[15] U.S. EPA (2009) Valuing the Protection of Ecological Systems and Services: A Report of the EPA Science Advisory Board. EPA-SAB-09-012.

values attributable to the incremental number of small streams and wetlands protected by implementing the new proposed guidance versus the previous guidance would have to be taken into account. Appendix C of this document provides additional details on specific ecosystem services.

2. Administrative Cost Savings to Government

The federal government and states are currently spending significant resources on site-by-site evaluations of jurisdiction against a standard that is unclear and somewhat ambiguous. This represents an investment of resources that could be put to other use (and may in fact be needed to process additional 404 permits) if the decision criteria were more clearly articulated. While potentially incurring additional costs to process additional permits, and potentially having a short-term backlog of actions as the federal government transitions to implementing new guidance, the proposed guidance may reduce some permitting costs and speed the permit review process in the long-term by clarifying jurisdictional matters that have been time-consuming and confusing for field staff and the regulated community. The effect of the two Supreme Court cases and subsequent guidance has, in some circumstances, required agency staff to spend limited resources to understand and apply complex jurisdictional standards. The uncertainty surrounding jurisdictional questions has increased the paperwork, costs, and time associated with jurisdictional determinations. However, any cost savings will be at least partially offset by increases in mitigation planning and implementation costs, associated environmental compliance for larger permit areas, and additional documentation and data management requirements.

3. Prevention, Enforcement, and Cleanup Facilitation

The U.S. government is shifting enforcement priorities away from waters where jurisdiction is a potential issue because of the uncertainty in realizing the benefits. Because of difficulties establishing where the CWA applies after the Supreme Court's decisions in *SWANCC* in 2001 and *Rapanos* in 2006, EPA enforcement managers have indicated that enforcement efforts are shifting from protecting small streams high in the watershed and instead are moving down river. In short, EPA is focusing efforts on larger streams and rivers, where there is more certainty of establishing jurisdiction. Guidance to more clearly identify and protect small streams and wetlands may ultimately save the costs of additional drinking water filtration, stream restoration, and other costs of repairing damage caused by pollution. CWA jurisdiction is necessary to apply CWA programs, including water pollution protection, oil spill prevention and response, and protection of streams, rivers, lakes, and wetlands.

4. Certainty in Business Investment and Planning

Land developers and other businesses face uncertainty surrounding the jurisdiction question that may lead to reduced willingness to invest in projects or lost investment when project plans must be altered or abandoned. Businesses operate best in an environment of regulatory certainty. Business professionals are equipped to plan accordingly for known factors. However, uncertainty can lead businesses to sit on capital rather than take unknown risks. The current lack of clarity in where the CWA applies can delay building roads and houses, developing natural resources, and engaging in other activities where CWA 404 permits are needed. Guidance to more clearly identify and protect small streams and wetlands that require protection under the CWA may reduce uncertainty and the costs that go with it. As noted in the discussion of costs, permit applicant costs associated with the new guidance are estimated to be between $3 and $11 million. Depending on how significant costs related to uncertainty prove to be, the proposed guidance might ultimately reduce net costs for people seeking CWA permits, and increase consistency, predictability, and timeliness of the permitting process.

B. Example Valuation of Benefits

The benefits calculated in a cost-benefit analysis are a monetized measure of the societal gains realized from adoption of a proposed policy relative to those that would have been realized in the absence of the policy. Such gains are always calculated as an increment to a baseline describing what would have happened if the policy had not been adopted. It is essential to bear this in mind when reviewing aggregate statistics. Intermittent or ephemeral streams contribute to the drinking water supplies consumed by 117 million Americans. Freshwater anglers spent over $25 billion on trips and equipment in 2006, and almost two and a half million Americans hunted migratory birds. However, absent a determination of how much water quality would change in areas affected by the proposed guidance, these values cannot be used to adduce monetary benefits.

In addition to confining analysis to the incremental effects of proposed policy changes, benefit estimation also requires careful evaluation and categorization of expenditures. The $25 billion spent on fishing trips and equipment is not itself an estimate of value; consumer value is typically measured not by what consumers spend on something, but by the excess of what they would be willing to spend over what they actually do spend. As the former is typically not directly observed, inferring consumer willingness to pay from observed data often requires drawing some subtle inferences.

One way to attempt an estimate of potential incremental indirect benefits is to examine studies of ecosystem services that report a monetized value on a per unit basis, such as a dollar value per wetland acre, or a dollar value per wetland acre per year. For this exercise, it is necessary to express values on a “per acre” basis rather than a “per acre per year” basis to be comparable to the cost figures presented in section IV. The cost figures are annual values, but they reflect an annual summation of one-time compensatory mitigation costs. These “unit costs” are established as the one-time cost per acre to maintain the services provided in perpetuity. Thus, a proper comparison would be to derive marginal benefits as the product of the estimated marginal number of acres affected each year and a “unit benefit” dollar value per acre. Dollar values expressed as “per acre per year” can be converted to a present value dollar value “per acre” by dividing by a discount rate (typically between 3 percent and 7 percent).

Researchers have published a great deal of studies on the values of ecosystem services provided by wetlands, and these studies offer the most readily available basis for comparison to potential costs. Appendix D provides a literature review of potentially relevant studies. Estimation of benefits varies widely and suffers from incomplete knowledge of factors affecting the total value. Wetlands vary greatly in their functionality and relative value based on their relative scarcity, location within a watershed, and the degree of human impacts in their vicinity.

As such, estimates of their worth can vary by several orders of magnitude. The following are important points to keep in mind when considering these indirect benefit estimates:

- Not all wetlands provide all the service categories examined in the literature. In addition, the relative value of each type of service varies from wetland to wetland. For some, the value for flood protection may be the greatest benefit, whereas for others the value of habitat provisioning may be greatest.
- Variability in benefit estimates may reflect flaws in the estimation methods, incomplete knowledge of survey responders or the source of the estimate, or real variation in the physical attributes and their associated values.[16]
- Values published in the literature may have a selection bias, where wetlands are chosen for study because they have a perceived value.[17]
- Limitations on determining "willingness to pay" include that most wetland services are not traded in markets and their value cannot be revealed, people may not be aware of all their services and unable to express how much they would be willing to pay if they were, estimates based on "replacement costs" do not necessarily reflect an actual willingness to pay that amount, and it may not be possible to trace and measure the value of all the myriad services that a wetland provides.[18]
- The relative value of wetland depends in part on relative scarcity within its watershed and the degree of human impact on the watershed. In general, a temperate-zone watershed should optimally have between 3 and 7 percent of its area covered by wetlands to provide adequate services. [19] A wetland's value will likely reflect the extent to which it is "in excess" or very scarce. However, as a landscape becomes highly modified and a wetland is small, fragmented and cut off from other waters, its value diminishes rapidly because it can no longer provide any of the valued services regardless of its relative scarcity.[20]

The overall message is that determining the precise value of a particular wetland is very site-specific exercise, and one that poses many challenges.

Most published studies tend to examine a portion of the services provided by a wetland. A few have undertaken a holistic assessment, although they are still considered incomplete by their authors. One synthesis study[21] presents average wetland function values for a fairly comprehensive set of categories. While these authors do not present an aggregate, the following examination of data presented in this paper yields the following composite:

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[16] Heimlich, R.E., R. Claassen, K.D. Wiebe, D. Gadsby, and R.M. House. 1998. Wetlands and Agriculture: Private Interests and Public Benefits. AER-765, U.S. Dept. Agr. Econ. Res. Serv., Aug.

[17] Brouwer et al. (1999). "A meta-analysis of wetland valuation studies." Regional Environmental Change (1): 47-57..

[18] King, Dennis. The Dollar Value of Wetlands: Trap Set, Bait Taken, Don't Swallow. 1998. National Wetlands Newsletter, vol 20, no 4.

[19] Mitsch and Gosselink. Ecological Economics 35 (2000) 25-33.

[20] Mitsch and Gosselink. Ecological Economics 35 (2000) 25-33.

[21] Heimlich, R.E., R. Claassen, K.D. Wiebe, D. Gadsby, and R.M. House. 1998. Wetlands and Agriculture: Private Interests and Public Benefits. AER-765, U.S. Dept. Agr. Econ. Res. Serv., Aug.

Heimlich et al data (6% discount over 50 years in 1992$)

	Mean	**Low**	**High**	**Location**
market fish	7	**7**	**7**	FL
	22	16	30	FL
	547	**547**	**547**	LA
	702	651	702	LA
	1,205	35	4,372	VA
	1,259	**1,259**	**1,259**	FL
	1,390	696	2,783	MI
	43,928	**43,928**	**43,928**	Australia
AVERAGE	6,133	5,892	6,704	ALL
market fur	137	13	261	US, LA
nonmarket nonuser habitat	115	88	154	Scotland
	15,956	10,079	21,857	Austria
	49,850	31,489	68,386	Austria
	68,055	42,989	93,223	Austria
	133,860	84,558	183,366	Austria
	1,248	865	1,632	Canada
	2,850	1,165	4,536	NE
	14,916	7,487	22,345	NE
	1,155	**1,155**	**1,155**	New England
	52,848	24,679	80,532	Kentucky
	309,511	250,459	382,816	CA
	347,548	325,394	371,087	CA
AVERAGE	83,159	65,034	102,591	ALL
fishing	95	**95**	**95**	LA
	356	**356**	**356**	LA
	273	224	323	MI
	362	280	444	MA
	942	**942**	**942**	Canada
	15,126	3,725	26,528	FL
	28,845	14,413	43,257	MI
AVERAGE	6,571	2,862	10,278	ALL
hunting	1,019	1,019	1,019	US/Can
recreation	1,139	1,139	1,139	US
filtering	3,965	2,428	5,501	Cornbelt
flood control	35,075	3,916	66,233	MA
scenic	2,722	2,722	2,722	US
ALL (1992$)	133,348	82,163	186,169	
2010 $	209,356	128,996	292,286	

*Numbers in bold represent mean values reported in Heimlich et al applied to both low and high columns

Existing studies offer a basis for a first order approximation of partial potential indirect benefits of implementing the new proposed guidance based on an average composite value and a range inferred from selected literature values. While there may be some overlap in these categories, adding up the categories from Heimlich et al yields a rough "unit benefit" range from $129,000-$292,000 ($2010). This total "unit benefit" above is comparable to the wetland value ($148,000 in 2010$ at a 6 percent discount rate) reported in another synthesis study.[22]

This unit benefit estimate can be applied to the potential incremental number of wetland mitigation acres (i.e., 803 acres for estimate 1 and 2,517 acres for estimate 2) to estimate potential indirect benefits (see Figure 2). Because the unit benefit presumably applies to the pre-project wetlands that will be impacted at the site, and typically more mitigation acreage is required to compensate for a given amount of impacted acres, an assumed ratio of mitigation acres to impacted acres of 2:1 is applied for purposes of the benefit calculation.[23] This analysis suggests that the indirect benefits of increased coverage of wetlands under the CWA derived from implementation of this new guidance will exceed the indirect costs. Note that indirect benefits of incremental stream mitigation resulting from the proposed guidance are not considered.

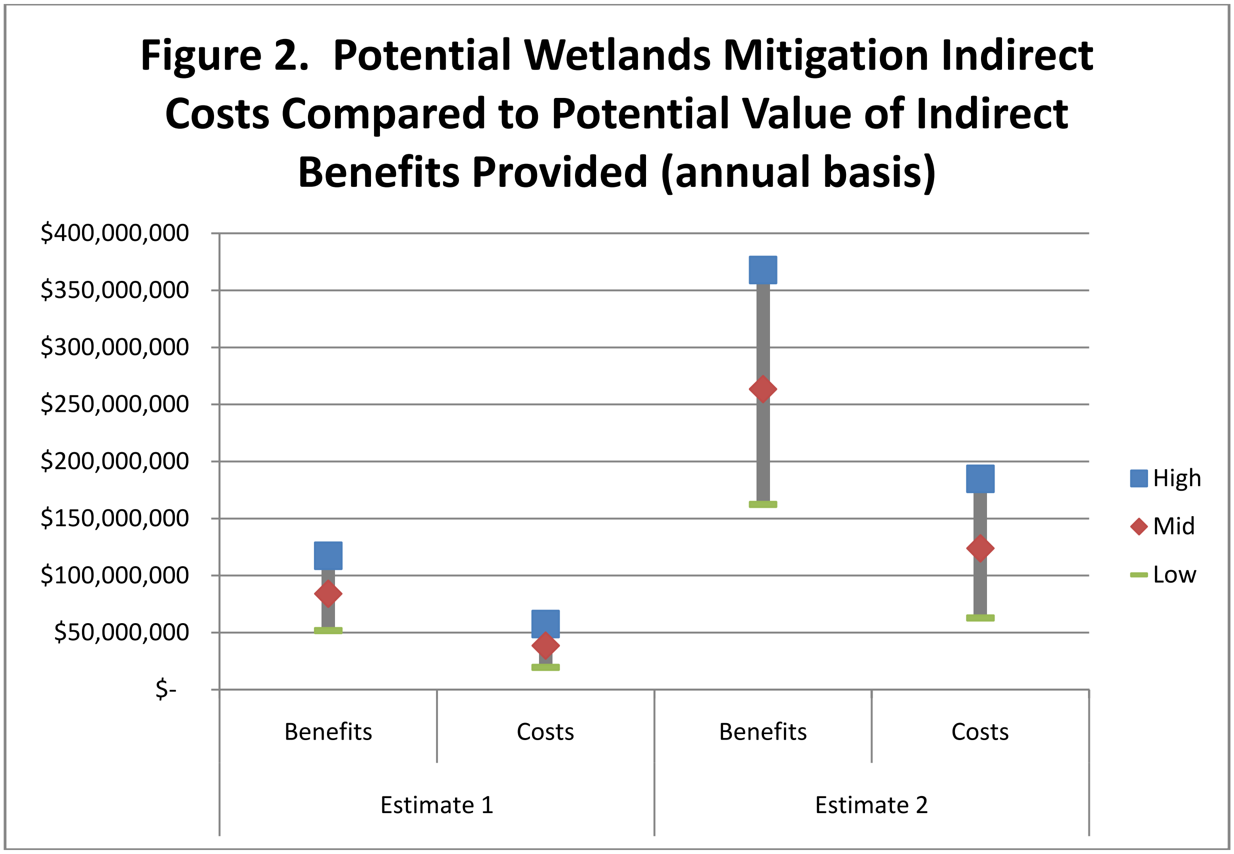
Potential Indirect Wetland Mitigation Costs

	Estimate 1	Estimate 2
High	$57,499,006	$184,825,374
Mid	$38,551,811	$123,863,396
Low	$19,604,617	$62,901,417

Potential Indirect Wetland Mitigation Benefits

	Estimate 1	Estimate 2
High	$117,352,718	$367,841,582
Mid	$84,056,473	$263,474,650
Low	$51,792,042	$162,341,929

[22] Costanza et al., The value of the world's ecosystem services and natural capital. Nature. Vol 387. 15 May 1997.
[23] In other words, the "unit benefit" applies to the number of "impacted" acres not the number of "mitigation" acres, which is typically larger. So for estimate 2, for example, the 2,517 acres of projected new mitigation are adjusted downward by a factor of 2 to reflect the presumed number of impacted acres these are intended to compensate for. A 2:1 mitigated to impacted acre ratio may be a conservative assumption. A recent Ecosystem Marketplace study (2010) puts this ratio at approximately 5:4. Using a lower ratio would raise the benefits estimates because it would mean that the 2,517 acres of projected new mitigation correspond to a higher number of impacted acres.



Because the circumstances of different wetlands and other areas that might be found jurisdictional under the proposed guidance vary so greatly from one locality to another, it is difficult to derive estimates of nationwide benefits of the proposed guidance. Economists are wary of benefits transfer in general, and of large scale benefits transfer without knowledge of how comparable situations are between where benefits are assessed and where they are applied in particular. Although the "unit benefit" aggregation avoids use of replacement cost studies and avoids double-counting to the best of our knowledge, it must be emphasized that values from many disparate locations and studies are combined and then applied to wholly distinct locations. This is indeed a speculative application and, as such, the accuracy and precision of results are highly uncertain. However, even considering this uncertainty, this analysis does suggest that benefits are likely to justify costs.

An alternative approach would be to look at states or regions for which some data are available and consider the relationship of benefits to costs by state or region. Examples for the handful of states/regions for which such information is available are presented below. A number of caveats should be kept in mind in interpreting this analysis, including:

- It is difficult to link the types of wetlands and water bodies for which economic analyses have been conducted with the types likely to be found jurisdictional under the proposed guidance. For this reason, we need to take care in our inferences, e. g., fishery values to waters that might or might not be instrumental in fish reproduction (and similarly for water purification, storm protection, etc.)

- These examples should be regarded as illustrative, not dispositive.

- The above and all other caveats notwithstanding, there is no existing study that estimates *all* of the benefits provided by potentially jurisdictional water bodies. Whatever other issues might arise in interpreting these examples, it should be remembered that estimates of benefits are necessarily incomplete.

All values are in 2010 $/acre. Benefits accrue in perpetuity at a 5% discount rate. All estimates in this section are total (not annual) values per acre. The costs presented below are the state-specific mitigation cost estimates used in the cost estimate portion of this analysis (see Section II and Appendix A). They are provided here for comparison purposes; costs of mitigation were not estimated by the various study authors, whose focus was rather on estimating benefits.

Example 1: Coastal wetlands of Louisiana

A couple of studies have estimated the benefits of wetlands along the Louisiana coast. In 1987 Stephen Farber and Robert Costanza estimated the value of recreational and storm protection services of coastal wetlands. In 1996 Farber conducted another study of the region, which was also informed by his 1989 storm protection study. The 1987 Farber and Costanza and the 1996 Farber papers differ by about a factor of five in their estimates of value, but this difference is almost entirely explained by the more robust estimate of storm protection values in the later study. The results of the later study have also been buttressed by subsequent work on storm protection services of coastal wetlands (Costanza, *et al*. 2008).

Low estimate of benefits	High estimate of benefits	Low estimate of costs	High estimate of costs
$2,465	$19,704	$15,000	$50,000

In this case only the higher estimate of benefits exceeds the lower estimate of costs, although the caveat above that benefit estimates are necessarily incomplete should always be borne in mind.

Example 2: Wetlands in the "cornbelt"

In 1997 Poor presented a paper on the value of wetlands in Nebraska. Three years later Lant and Richards published a paper on wetlands in the "cornbelt". Poor focused on nonuse values of wildlife, Lant and Richards on water quality and recreation.

Low estimate of benefits	High estimate of benefits	Cost
$18,967	$42,892	$15,000

The low and high benefit estimates differ in which of the benefit estimates from the Poor study are included, as he cited a range. In either case, however, benefits exceed costs.

Example 3: Florida coastal wetlands

Lynne, *et al*. (1981), Fischer *et al*. (1989), and Bell (1989) have estimated the value of wetland contributions to commercial and recreational fisheries for the state of Florida. The low value estimate below comes from summing the lower of the non-overlapping values generated for commercial and recreational fisheries. The high value estimate comes from summing the higher values plus extrapolating storm protection services as estimated by Farber (1989) for the Louisiana coast, and nutrient retention services as estimated by Jenkins *et al*. (2008) for the Mississippi Alluvial Valley, to the coast of Florida.

Low estimate of benefits	High estimate of benefits	Low estimate of costs	High estimate of costs
$30,007	$59,200	$35,000	$145,000

The low estimate of benefits approaches that of the low estimate of costs, while the high estimate of benefits exceed the low estimate of costs. The high estimate of costs exceeds either estimate of benefits. Note that these estimates are based only on commercial and recreational fishing benefits.

Example 4: Wetlands surrounding Lake St. Clair Michigan/Ontario

Lake St. Clair is located near Detroit, MI. Its basin lies in both the state of Michigan and the Canadian province of Ontario. Studies of the benefits of its surrounding wetlands in the state of Michigan have been conducted by Amacher, *et al*. (1989), and by Van Vuren and Roy (1993). The latter study is used to generate the lower estimate of benefits. Amacher, *et al*. estimate almost $60,000 in fishery-related benefits to the U.S. wetlands. It is not clear if this would be indicative of the value of jurisdictional wetlands under the proposed guidance, as such waters may not support fisheries. At the same time, however, neither Amacher nor Van Vuren and Roy have estimated the water purification values of these wetlands, and it seems very likely that wetlands in the Midwest would provide the service of nutrient retention. As noted above, Jenkins, *et al*. estimate the value of this service to be some worth some $10,000 per acre on the lower Mississippi River, while Thibodeau and Ostro (1981) value it at over $100,000 per acre for riverine wetlands in Massachusetts (although, because Thibodeau and Ostro adopt a replacement cost approach to valuation, they may overstate true social benefits). It may be reasonable, then, to add the Jenkins, *et al*. (2008) estimate of nutrient retention value to the Amacher *et al*. (1989) fisheries value to arrive at the high estimate of benefits

Low estimate of benefits	High estimate of benefits	Low estimate of costs	High estimate of costs
$6,395	$67,346	$40,000	$80,000

Example 5: Riverine wetlands in Massachusetts

In 1981 Thibodeau and Ostro completed a very thorough study of the value of riverine wetlands in Massachusetts. The catalogued several categories of recreational, amenity, flood control, and water quality benefits. Regrettably, however, they estimated water purification and nutrient retention values using replacement cost approaches. Replacement costs may or may not reflect true social values; they are only valid if society would, in fact, pay to replace such lost services. So, we form our low and high estimates of benefits by either excluding the replacement-cost-based estimates or including them, respectively. Because it seems unlikely that there would be no benefit to the nutrient retention/water purification services of such wetlands, we substitute the Jenkins *et al*. (2008) estimates of values to form the low estimate.

Low estimate of benefits	High estimate of benefits	Low estimate of costs	High estimate of costs
$153,620	$645,051	$124,000	$160,000

The higher benefit estimation figure may beg again the question of whether the wetlands considered in this study would be representative of those likely to be found jurisdictional under the guidance. More generally, however, the Massachusetts example underscores a general principle: the costs and benefits of wetland preservation are likely to be correlated. Wetlands are valuable largely inasmuch as they provide goods and services that can be enjoyed by people nearby: if they purify water, protect against storms, provide recreational and scenic amenities, etc., in locations where there large numbers of people. However, locations in which there are large numbers of people are also locations in which property values, and hence the opportunity costs of wetland preservation, are high.

Studies cited:

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APPENDIX A: Indirect Cost Estimate Tables

Preliminary Estimate of 404 Wetland Mitigation Costs: Baseline

	Baseline Mitigation		**Baseline Costs**			**Wetland Mitigation Unit Cost**		**Stream Mitigation Unit Cost**	
	Wetland Acres	**Stream Linear Feet**	**Wetlands low**	**Wetlands mid-range**	**Streams mid-range**	**per acre Low**	**per acre High**	**per lin. ft. Low**	**per lin. ft. High**
STATE	BASE WETMIT	BASE STRMIT	BASE$ LOW	BASE$ MID	BASE STR COST	UC LOW	UC HIGH	UC LOW	UC HIGH
AK	1065.4	3,834.7	$532,685	$ 16,246,877	$ 931,839	$ 500	$ 30,000	$ 170	$ 316
AL	638.1	69,808.0	$6,380,970	$ 9,571,455	$ 43,211,152	$ 10,000	$ 20,000	$ 350	$ 888
AR	504.6	25,200.7	$1,009,149	$ 1,766,011	$ 6,123,758	$ 2,000	$ 5,000	$ 170	$ 316
AZ	43.6	36.0	$392,135	$ 697,128	$ 8,748	$ 9,000	$ 23,000	$ 170	$ 316
CA	5585.5	192,492.4	$103,330,955	$ 889,484,036	$ 46,775,658	$ 18,500	$ 300,000	$ 170	$ 316
CO	1113.2	9,945.0	$35,620,992	$ 73,468,297	$ 2,416,635	$ 32,000	$ 100,000	$ 170	$ 316
CT	125.1		$15,511,098	$ 17,762,709	$ -	$ 124,000	$ 160,000	$ 170	$ 316
DE	136.3		$5,453,340	$ 5,453,340	$ -	$ 40,000	$ 40,000	$ 170	$ 316
FL	2823.6	30,582.4	$98,827,733	$ 254,128,457	$ 7,431,533	$ 35,000	$ 145,000	$ 170	$ 316
GA	1983.2	109,443.2	$23,797,926	$ 132,871,755	$ 21,833,912	$ 12,000	$ 122,000	$ 106	$ 293
IA	653.6	18,040.5	$9,803,363	$ 9,803,363	$ 4,383,842	$ 15,000	$ 15,000	$ 170	$ 316
ID	337.3	46,406.0	$13,492,800	$ 13,492,800	$ 11,276,658	$ 40,000	$ 40,000	$ 170	$ 316
IL	756.2	26,249.0	$30,246,360	$ 90,739,081	$ 6,378,507	$ 40,000	$ 200,000	$ 170	$ 316
IN	1232.6	384,647.7	$49,304,940	$ 73,957,411	$ 93,469,391	$ 40,000	$ 80,000	$ 170	$ 316
KS	357.0	328,949.3	$17,849,850	$ 17,849,850	$ 79,934,687	$ 50,000	$ 50,000	$ 170	$ 316
KY	477.9	195,235.0	$14,336,100	$ 14,336,100	$ 55,251,511	$ 30,000	$ 30,000	$ 170	$ 396
LA	2756.2	53,874.8	$41,342,783	$ 89,576,030	$ 13,091,586	$ 15,000	$ 50,000	$ 170	$ 316
MA	95.6	0.0	$11,851,176	$ 13,571,508	$ -	$ 124,000	$ 160,000	$ 170	$ 316
MD	378.1	11,210.0	$4,158,875	$ 13,043,743	$ 4,954,820	$ 11,000	$ 58,000	$ 250	$ 634
ME	278.3	3,905.6	$34,786,125	$ 38,125,593	$ 949,056	$ 125,000	$ 149,000	$ 170	$ 316
MI	189.7	2,935.0	$7,589,700	$ 11,384,550	$ 713,205	$ 40,000	$ 80,000	$ 170	$ 316
MN	1955.1	1,200.0	$7,820,202	$ 92,864,900	$ 291,600	$ 4,000	$ 91,000	$ 170	$ 316
MO	746.3	53,585.0	$11,194,808	$ 14,926,410	$ 7,769,825	$ 15,000	$ 25,000	$ 90	$ 200
MS	988.1	14,360.3	$2,964,200	$ 13,832,931	$ 3,489,560	$ 3,000	$ 25,000	$ 170	$ 316
MT	576.3	14,472.0	$23,050,200	$ 23,050,200	$ 3,516,696	$ 40,000	$ 40,000	$ 170	$ 316
NC	2061.9	138,035.1	$47,422,976	$ 87,629,412	$ 40,996,413	$ 23,000	$ 62,000	$ 256	$ 338
ND	847.5	14,049.8	$12,712,748	$ 12,712,748	$ 3,414,089	$ 15,000	$ 15,000	$ 170	$ 316
NE	723.8	3,994.0	$10,857,488	$ 10,857,488	$ 970,542	$ 15,000	$ 15,000	$ 170	$ 316
NH	247.4	22,214.0	$34,136,784	$ 41,557,824	$ 5,398,002	$ 138,000	$ 198,000	$ 170	$ 316
NJ	125.1		$10,007,160	$ 30,021,480	$ -	$ 80,000	$ 400,000	$ 170	$ 316
NM	74.5	12,277.6	$2,979,660	$ 3,724,575	$ 2,983,445	$ 40,000	$ 60,000	$ 170	$ 316
NV	87.1	900.0	$4,792,755	$ 5,228,460	$ 218,700	$ 55,000	$ 65,000	$ 170	$ 316
NY	1903.0	23,163.9	$95,152,351	$ 114,182,821	$ 5,628,818	$ 50,000	$ 70,000	$ 170	$ 316
OH	1963.5	90,969.9	$29,452,253	$ 29,452,253	$ 22,105,688	$ 15,000	$ 15,000	$ 170	$ 316
OK	59.0	19,847.0	$708,372	$ 1,829,961	$ 4,822,821	$ 12,000	$ 50,000	$ 170	$ 316
OR	952.9	4,200.2	$40,975,947	$ 80,046,037	$ 1,020,641	$ 43,000	$ 125,000	$ 170	$ 316
PA	3374.6	229,011.2	$40,495,266	$ 45,557,175	$ 55,649,712	$ 12,000	$ 15,000	$ 170	$ 316
RI	49.2		$6,099,870	$ 6,985,335	$ -	$ 124,000	$ 160,000	$ 170	$ 316
SC	2820.8	6,450.2	$70,520,963	$ 176,302,408	$ 886,903	$ 25,000	$ 100,000	$ 75	$ 200
SD	358.4	0.0	$5,376,038	$ 5,376,038	$ -	$ 15,000	$ 15,000	$ 170	$ 316
TN	591.7	54,712.0	$4,142,009	$ 7,988,159	$ 6,839,000	$ 7,000	$ 20,000	$ 50	$ 200
TX	3255.1	185,639.3	$48,827,070	$ 97,654,141	$ 26,267,960	$ 15,000	$ 45,000	$ 80	$ 203
UT	1381.6	263,404.8	$75,988,358	$ 82,896,391	$ 64,007,366	$ 55,000	$ 65,000	$ 170	$ 316
VA	1815.9	48,455.0	$29,054,496	$ 141,640,669	$ 29,073,000	$ 16,000	$ 140,000	$ 300	$ 900
VT	160.2		$17,624,970	$ 19,387,467	$ -	$ 110,000	$ 132,000	$ 170	$ 316
WA	986.7	37,774.9	$98,666,101	$ 172,665,677	$ 9,179,296	$ 100,000	$ 250,000	$ 170	$ 316
WI	2246.0		$89,839,561	$ 89,839,561	$ -	$ 40,000	$ 40,000	$ 170	$ 316
WV	278.3	45,665.0	$8,348,670	$ 12,523,005	$ 27,399,000	$ 30,000	$ 60,000	$ 400	$ 800
WY	839.1	20.0	$12,586,253	$ 12,586,253	$ 4,860	$ 15,000	$ 15,000	$ 170	$ 316
	53000	**2,797,196**	**$1,367,416,585**	**$ 3,220,649,871**	**$ 721,070,435**				
		Average Cost per Acre:	**$25,800**	**$ 60,767**					
		Average Cost per Linear Foot:			**$ 258**				
		Total Wetland and Stream Baseline Cost:	**$2,088,487,020**	**$3,941,720,306**					

Preliminary Estimate of 404 Wetland Mitigation Costs

Preliminary Estimate of 404 Wetland Mitigation Costs: Estimate 1 - Significant Nexus Waters

	2009-2010 Aquatic Resource/JD Records, ACOE				Amount of Wetland Acres Mitigated		Increased Annual Costs			Unit Cost Per Acre Mitigated	
	Total Isolated	Total Wetland	Neg JD Wetland	% Neg JD Wetland	Baseline Mitigation	Increased Wetlands	Low Cost	Mid Cost	High Cost	Unit Cost Low	Unit Cost High
STATE	ISO TOT	WET TOT	WET NO	%WET NO	BASE MIT	WET INC	WET COSTS LOW	WET COSTS MID	WET COSTS HIGH	UNIT COST LOW	UNIT COST HIGH
AK	14	760	2	0.3%	1065.4	2.8	$ 1,406	$ 42,868	$ 84,330	$ 500	$ 30,000
AL	7	460	6	1.3%	638.1	8.4	$ 84,330	$ 126,495	$ 168,660	$ 10,000	$ 20,000
AR	13	363	4	1.1%	504.6	5.6	$ 11,244	$ 19,677	$ 28,110	$ 2,000	$ 5,000
AZ	0	31	0	0.0%	43.6	0.0	$ -	$ -	$ -	$ 9,000	$ 23,000
CA	1463	3991	17	0.4%	5585.5	23.9	$ 442,030	$ 3,805,040	$ 7,168,050	$ 18,500	$ 300,000
CO	215	837	45	5.4%	1113.2	63.2	$ 2,023,920	$ 4,174,335	$ 6,324,750	$ 32,000	$ 100,000
CT	5	92	3	3.3%	125.1	4.2	$ 522,846	$ 598,743	$ 674,640	$ 124,000	$ 160,000
DE	14	98	1	1.0%	136.3	1.4	$ 56,220	$ 56,220	$ 56,220	$ 40,000	$ 40,000
FL	309	2033	24	1.2%	2823.6	33.7	$ 1,180,620	$ 3,035,880	$ 4,891,140	$ 35,000	$ 145,000
GA	100	1432	21	1.5%	1983.2	29.5	$ 354,186	$ 1,977,539	$ 3,600,891	$ 12,000	$ 122,000
IA	52	469	4	0.9%	653.6	5.6	$ 84,330	$ 84,330	$ 84,330	$ 15,000	$ 15,000
ID	22	244	4	1.6%	337.3	5.6	$ 224,880	$ 224,880	$ 224,880	$ 40,000	$ 40,000
IL	277	547	9	1.6%	756.2	12.6	$ 505,980	$ 1,517,940	$ 2,529,900	$ 40,000	$ 200,000
IN	320	891	14	1.6%	1232.6	19.7	$ 787,080	$ 1,180,620	$ 1,574,160	$ 40,000	$ 80,000
KS	19	257	3	1.2%	357.0	4.2	$ 210,825	$ 210,825	$ 210,825	$ 50,000	$ 50,000
KY	58	341	1	0.3%	477.9	1.4	$ 42,165	$ 42,165	$ 42,165	$ 30,000	$ 30,000
LA	28	1990	29	1.5%	2756.2	40.8	$ 611,393	$ 1,324,684	$ 2,037,975	$ 15,000	$ 50,000
MA	1	68	0	0.0%	95.6	0.0	$ -	$ -	$ -	$ 124,000	$ 160,000
MD	5	349	80	22.9%	378.1	112.4	$ 1,236,840	$ 3,879,180	$ 6,521,520	$ 11,000	$ 58,000
ME	0	200	2	1.0%	278.3	2.8	$ 351,375	$ 385,107	$ 418,839	$ 125,000	$ 149,000
MI	2	139	4	2.9%	189.7	5.6	$ 224,880	$ 337,320	$ 449,760	$ 40,000	$ 80,000
MN	198	1422	31	2.2%	1955.1	43.6	$ 174,282	$ 2,069,599	$ 3,964,916	$ 4,000	$ 91,000
MO	53	538	7	1.3%	746.3	9.8	$ 147,578	$ 196,770	$ 245,963	$ 15,000	$ 25,000
MS	10	705	2	0.3%	988.1	2.8	$ 8,433	$ 39,354	$ 70,275	$ 3,000	$ 25,000
MT	49	410	0	0.0%	576.3	0.0	$ -	$ -	$ -	$ 40,000	$ 40,000
NC	59	1473	6	0.4%	2061.9	8.4	$ 193,959	$ 358,403	$ 522,846	$ 23,000	$ 62,000
ND	1388	612	9	1.5%	847.5	12.6	$ 189,743	$ 189,743	$ 189,743	$ 15,000	$ 15,000
NE	157	517	2	0.4%	723.8	2.8	$ 42,165	$ 42,165	$ 42,165	$ 15,000	$ 15,000
NH	0	178	2	1.1%	247.4	2.8	$ 387,918	$ 472,248	$ 556,578	$ 138,000	$ 198,000
NJ	34	89	0	0.0%	125.1	0.0	$ -	$ -	$ -	$ 80,000	$ 400,000
NM	14	53	0	0.0%	74.5	0.0	$ -	$ -	$ -	$ 40,000	$ 60,000
NV	237	62	0	0.0%	87.1	0.0	$ -	$ -	$ -	$ 55,000	$ 65,000
NY	530	1382	28	2.0%	1903.0	39.4	$ 1,967,700	$ 2,361,240	$ 2,754,780	$ 50,000	$ 70,000
OH	582	1438	41	2.9%	1963.5	57.6	$ 864,383	$ 864,383	$ 864,383	$ 15,000	$ 15,000
OK	2	47	5	10.6%	59.0	7.0	$ 84,330	$ 217,853	$ 351,375	$ 12,000	$ 50,000
OR	37	682	4	0.6%	952.9	5.6	$ 241,746	$ 472,248	$ 702,750	$ 43,000	$ 125,000
PA	375	2410	9	0.4%	3374.6	12.6	$ 151,794	$ 170,768	$ 189,743	$ 12,000	$ 15,000
RI	2	35	0	0.0%	49.2	0.0	$ -	$ -	$ -	$ 124,000	$ 160,000
SC	474	2021	14	0.7%	2820.8	19.7	$ 491,925	$ 1,229,813	$ 1,967,700	$ 25,000	$ 100,000
SD	310	260	5	1.9%	358.4	7.0	$ 105,413	$ 105,413	$ 105,413	$ 15,000	$ 15,000
TN	31	425	4	0.9%	591.7	5.6	$ 39,354	$ 75,897	$ 112,440	$ 7,000	$ 20,000
TX	266	2332	16	0.7%	3255.1	22.5	$ 337,320	$ 674,640	$ 1,011,960	$ 15,000	$ 45,000
UT	53	991	8	0.8%	1381.6	11.2	$ 618,420	$ 674,640	$ 730,860	$ 55,000	$ 65,000
VA	91	1296	4	0.3%	1815.9	5.6	$ 89,952	$ 438,516	$ 787,080	$ 16,000	$ 140,000
VT	6	117	3	2.6%	160.2	4.2	$ 463,815	$ 510,197	$ 556,578	$ 110,000	$ 132,000
WA	25	703	1	0.1%	986.7	1.4	$ 140,550	$ 245,963	$ 351,375	$ 100,000	$ 250,000
WI	146	1645	47	2.9%	2246.0	66.1	$ 2,642,340	$ 2,642,340	$ 2,642,340	$ 40,000	$ 40,000
WV	115	208	10	4.8%	278.3	14.1	$ 421,650	$ 632,475	$ 843,300	$ 30,000	$ 60,000
WY	41	637	40	6.3%	839.1	56.2	$ 843,300	$ 843,300	$ 843,300	$ 15,000	$ 15,000
	8209	**38280**	**571**	**1.5%**	**53000.0**	**802.5**	**$ 19,604,617**	**$ 38,551,811**	**$ 57,499,006**		
					Average Cost per Acre:		**$ 24,428**	**$ 48,037**	**$ 71,646**		
					Total Cost, Including Stream Mitigation:		**$ 28,295,539**	**$ 51,535,451**	**$ 74,775,364**		
					Plus 10% Allowance for Current Impacts w/o JDs:		**$ 31,125,093**	**$ 56,688,996**	**$ 82,252,900**		

Preliminary Estimate of 404 Wetland Mitigation Costs: Estimate 2 - Significant Nexus Waters and 17% of Isolated Waters

	2009-2010 Aquatic Resource/JD Records, ACOE				**Amount of Wetland Acres**		**Increased Annual Costs**			**Unit Cost Per Acre Mitigated**	
	Total Isolated	**Total Wetland**	**Neg JD Wetland**	**% Neg JD Wetland**	**Baseline Mitigation**	**Plus 17% Isolated**	**Low Cost**	**Mid Cost**	**High Cost**	**Unit Cost Low**	**Unit Cost High**
STATE	ISO TOT	WET TOT	WET NO	%WET NO	BASE MIT	+0.17 ISO INC	WET COSTS LOW	WET COSTS MID	WET COSTS HIGH	UNIT COST LOW	UNIT COST HIGH
AK	14	760	2	0.3%	1065.4	6.2	$ 3,078	$ 93,880	$ 184,683	$ 500	$ 30,000
AL	7	460	6	1.3%	638.1	10.1	$ 101,055	$ 151,583	$ 202,111	$ 10,000	$ 20,000
AR	13	363	4	1.1%	504.6	8.7	$ 17,456	$ 30,549	$ 43,641	$ 2,000	$ 5,000
AZ	0	31	0	0.0%	43.6	0.0	$ -	$ -	$ -	$ 9,000	$ 23,000
CA	1463	3991	17	0.4%	5585.5	126.7	$ 2,344,058	$ 20,177,903	$ 38,011,748	$ 18,500	$ 300,000
CO	215	837	45	5.4%	1113.2	114.6	$ 3,667,793	$ 7,564,823	$ 11,461,853	$ 32,000	$ 100,000
CT	5	92	3	3.3%	125.1	5.4	$ 670,986	$ 768,387	$ 865,788	$ 124,000	$ 160,000
DE	14	98	1	1.0%	136.3	4.8	$ 190,024	$ 190,024	$ 190,024	$ 40,000	$ 40,000
FL	309	2033	24	1.2%	2823.6	107.6	$ 3,764,702	$ 9,680,662	$ 15,596,623	$ 35,000	$ 145,000
GA	100	1432	21	1.5%	1983.2	53.4	$ 640,908	$ 3,578,403	$ 6,515,898	$ 12,000	$ 122,000
IA	52	469	4	0.9%	653.6	18.0	$ 270,699	$ 270,699	$ 270,699	$ 15,000	$ 15,000
ID	22	244	4	1.6%	337.3	10.9	$ 435,143	$ 435,143	$ 435,143	$ 40,000	$ 40,000
IL	277	547	9	1.6%	756.2	78.8	$ 3,153,380	$ 9,460,139	$ 15,766,899	$ 40,000	$ 200,000
IN	320	891	14	1.6%	1232.6	96.1	$ 3,845,448	$ 5,768,172	$ 7,690,896	$ 40,000	$ 80,000
KS	19	257	3	1.2%	357.0	8.8	$ 437,813	$ 437,813	$ 437,813	$ 50,000	$ 50,000
KY	58	341	1	0.3%	477.9	15.3	$ 457,912	$ 457,912	$ 457,912	$ 30,000	$ 30,000
LA	28	1990	29	1.5%	2756.2	47.4	$ 711,745	$ 1,542,115	$ 2,372,484	$ 15,000	$ 50,000
MA	1	68	0	0.0%	95.6	0.2	$ 29,628	$ 33,929	$ 38,230	$ 124,000	$ 160,000
MD	5	349	80	22.9%	378.1	113.6	$ 1,249,981	$ 3,920,396	$ 6,590,811	$ 11,000	$ 58,000
ME	0	200	2	1.0%	278.3	2.8	$ 351,375	$ 385,107	$ 418,839	$ 125,000	$ 149,000
MI	2	139	4	2.9%	189.7	6.1	$ 243,995	$ 365,992	$ 487,990	$ 40,000	$ 80,000
MN	198	1422	31	2.2%	1955.1	90.9	$ 363,519	$ 4,316,782	$ 8,270,046	$ 4,000	$ 91,000
MO	53	538	7	1.3%	746.3	22.5	$ 337,531	$ 450,041	$ 562,551	$ 15,000	$ 25,000
MS	10	705	2	0.3%	988.1	5.2	$ 15,601	$ 72,805	$ 130,009	$ 3,000	$ 25,000
MT	49	410	0	0.0%	576.3	11.7	$ 468,313	$ 468,313	$ 468,313	$ 40,000	$ 40,000
NC	59	1473	6	0.4%	2061.9	22.5	$ 518,194	$ 957,532	$ 1,396,870	$ 23,000	$ 62,000
ND	1388	612	9	1.5%	847.5	344.3	$ 5,164,369	$ 5,164,369	$ 5,164,369	$ 15,000	$ 15,000
NE	157	517	2	0.4%	723.8	40.3	$ 604,857	$ 604,857	$ 604,857	$ 15,000	$ 15,000
NH	0	178	2	1.1%	247.4	2.8	$ 387,918	$ 472,248	$ 556,578	$ 138,000	$ 198,000
NJ	34	89	0	0.0%	125.1	8.1	$ 649,903	$ 1,949,710	$ 3,249,516	$ 80,000	$ 400,000
NM	14	53	0	0.0%	74.5	3.3	$ 133,804	$ 167,255	$ 200,705	$ 40,000	$ 60,000
NV	237	62	0	0.0%	87.1	56.6	$ 3,114,518	$ 3,397,656	$ 3,680,794	$ 55,000	$ 65,000
NY	530	1382	28	2.0%	1903.0	166.0	$ 8,299,478	$ 9,959,373	$ 11,619,269	$ 50,000	$ 70,000
OH	582	1438	41	2.9%	1963.5	196.7	$ 2,950,285	$ 2,950,285	$ 2,950,285	$ 15,000	$ 15,000
OK	2	47	5	10.6%	59.0	7.5	$ 90,064	$ 232,666	$ 375,269	$ 12,000	$ 50,000
OR	37	682	4	0.6%	952.9	14.5	$ 621,892	$ 1,214,858	$ 1,807,824	$ 43,000	$ 125,000
PA	375	2410	9	0.4%	3374.6	102.3	$ 1,227,002	$ 1,380,377	$ 1,533,752	$ 12,000	$ 15,000
RI	2	35	0	0.0%	49.2	0.5	$ 59,256	$ 67,858	$ 76,459	$ 124,000	$ 160,000
SC	474	2021	14	0.7%	2820.8	132.9	$ 3,323,305	$ 8,308,262	$ 13,293,219	$ 25,000	$ 100,000
SD	310	260	5	1.9%	358.4	81.1	$ 1,216,460	$ 1,216,460	$ 1,216,460	$ 15,000	$ 15,000
TN	31	425	4	0.9%	591.7	13.0	$ 91,203	$ 175,891	$ 260,580	$ 7,000	$ 20,000
TX	266	2332	16	0.7%	3255.1	86.0	$ 1,290,671	$ 2,581,341	$ 3,872,012	$ 15,000	$ 45,000
UT	53	991	8	0.8%	1381.6	23.9	$ 1,314,916	$ 1,434,453	$ 1,553,991	$ 55,000	$ 65,000
VA	91	1296	4	0.3%	1815.9	27.4	$ 437,841	$ 2,134,477	$ 3,831,112	$ 16,000	$ 140,000
VT	6	117	3	2.6%	160.2	5.7	$ 621,512	$ 683,663	$ 745,815	$ 110,000	$ 132,000
WA	25	703	1	0.1%	986.7	7.4	$ 737,888	$ 1,291,303	$ 1,844,719	$ 100,000	$ 250,000
WI	146	1645	47	2.9%	2246.0	100.9	$ 4,037,720	$ 4,037,720	$ 4,037,720	$ 40,000	$ 40,000
WV	115	208	10	4.8%	278.3	41.5	$ 1,245,976	$ 1,868,964	$ 2,491,952	$ 30,000	$ 60,000
WY	41	637	40	6.3%	839.1	66.0	$ 990,245	$ 990,245	$ 990,245	$ 15,000	$ 15,000
	8209	**38280**	**571**	**1.5%**	**53000**	**2517**	**$ 62,901,417**	**$ 123,863,396**	**$ 184,825,374**	**$ 39,286**	**$ 85,102**
						Average Cost per Acre:	**$ 24,989**	**$ 49,207**	**$ 73,425**		
						Total Cost, Including Stream Mitigation:	**$ 71,592,339**	**$ 136,847,036**	**$ 202,101,732**		
						Plus 10% Allowance for Current Impacts w/o JDs:	**$ 78,751,573**	**$ 150,531,739**	**$ 222,311,906**		

Preliminary Estimate of 404 Stream Mitigation Costs

	2009-2010 Aquatic Resource/JD Records, ACOE			**Amount of Stream Linear Feet Mitigated**		**Increased Annual Costs**		**Unit Cost Per Linear Foot Mitigated**	
	Total Streams	**Neg JD Streams**	**% Neg JD Streams**	**Baseline Mitigation**	**Increased Streams**	**Low Cost**	**High Cost**	**Unit Cost Low**	**Unit Cost High**
STATE	STR TOT	STR NO	%STR NO	BASE MIT	STR INC	STR COSTS LOW	STR COSTS HIGH	UNIT COST LOW	UNIT COST HIGH
AK	1060	7	0.7%	3,834.7	25.5	$ 4,334	$ 8,055	$ 170	$ 316
AL	1335	11	0.8%	69,808.0	580.0	$ 202,992	$ 515,019	$ 350	$ 888
AR	2968	78	2.6%	25,200.7	680.2	$ 115,627	$ 214,929	$ 170	$ 316
AZ	417	46	11.0%	36.0	4.5	$ 759	$ 1,411	$ 170	$ 316
CA	3452	113	3.3%	192,492.4	6514.4	$ 1,107,451	$ 2,058,556	$ 170	$ 316
CO	2068	62	3.0%	9,945.0	307.4	$ 52,253	$ 97,130	$ 170	$ 316
CT	604	1	0.2%		0.0	$ -	$ -	$ 170	$ 316
DE	143	2	1.4%		0.0	$ -	$ -	$ 170	$ 316
FL	5053	32	0.6%	30,582.4	194.9	$ 33,135	$ 61,591	$ 170	$ 316
GA	2588	40	1.5%	109,443.2	1718.1	$ 182,119	$ 503,404	$ 106	$ 293
IA	787	20	2.5%	18,040.5	470.4	$ 79,971	$ 148,652	$ 170	$ 316
ID	1319	22	1.7%	46,406.0	787.1	$ 133,815	$ 248,739	$ 170	$ 316
IL	1982	22	1.1%	26,249.0	294.6	$ 50,087	$ 93,104	$ 170	$ 316
IN	2746	19	0.7%	384,647.7	2680.0	$ 455,597	$ 846,874	$ 170	$ 316
KS	2085	54	2.6%	328,949.3	8746.1	$ 1,486,832	$ 2,763,757	$ 170	$ 316
KY	2294	10	0.4%	195,235.0	854.8	$ 145,315	$ 338,499	$ 170	$ 396
LA	3784	63	1.7%	53,874.8	912.2	$ 155,066	$ 288,240	$ 170	$ 316
MA	508	5	1.0%	0.0	0.0	$ -	$ -	$ 170	$ 316
MD	894	2	0.2%	11,210.0	25.1	$ 6,284	$ 15,935	$ 250	$ 634
ME	755	14	1.9%	3,905.6	73.8	$ 12,544	$ 23,318	$ 170	$ 316
MI	1424	8	0.6%	2,935.0	16.6	$ 2,819	$ 5,240	$ 170	$ 316
MN	1360	20	1.5%	1,200.0	17.9	$ 3,045	$ 5,660	$ 170	$ 316
MO	4352	66	1.5%	53,585.0	825.2	$ 74,264	$ 165,031	$ 90	$ 200
MS	1679	29	1.7%	14,360.3	252.4	$ 42,907	$ 79,756	$ 170	$ 316
MT	1167	12	1.0%	14,472.0	150.4	$ 25,561	$ 47,513	$ 170	$ 316
NC	2240	12	0.5%	138,035.1	743.5	$ 190,325	$ 251,288	$ 256	$ 338
ND	802	7	0.9%	14,049.8	123.7	$ 21,030	$ 39,092	$ 170	$ 316
NE	1325	29	2.2%	3,994.0	89.4	$ 15,193	$ 28,242	$ 170	$ 316
NH	441	89	20.2%	22,214.0	5616.6	$ 954,823	$ 1,774,848	$ 170	$ 316
NJ	252	1	0.4%		0.0	$ -	$ -	$ 170	$ 316
NM	635	10	1.6%	12,277.6	196.4	$ 33,395	$ 62,075	$ 170	$ 316
NV	592	72	12.2%	900.0	124.6	$ 21,185	$ 39,378	$ 170	$ 316
NY	3521	125	3.6%	23,163.9	852.6	$ 144,945	$ 269,427	$ 170	$ 316
OH	2363	39	1.7%	90,969.9	1526.6	$ 259,523	$ 482,407	$ 170	$ 316
OK	1482	57	3.8%	19,847.0	793.9	$ 134,960	$ 250,866	$ 170	$ 316
OR	1646	9	0.5%	4,200.2	23.1	$ 3,926	$ 7,297	$ 170	$ 316
PA	6403	114	1.8%	229,011.2	4151.3	$ 705,714	$ 1,311,798	$ 170	$ 316
RI	117	0	0.0%		0.0	$ -	$ -	$ 170	$ 316
SC	2097	17	0.8%	6,450.2	52.7	$ 3,954	$ 10,544	$ 75	$ 200
SD	599	11	1.8%	0.0	0.0	$ -	$ -	$ 170	$ 316
TN	3606	57	1.6%	54,712.0	878.7	$ 43,936	$ 175,744	$ 50	$ 200
TX	4171	77	1.8%	185,639.3	3491.5	$ 279,320	$ 708,776	$ 80	$ 203
UT	1878	2	0.1%	263,404.8	280.8	$ 47,739	$ 88,738	$ 170	$ 316
VA	4386	98	2.2%	48,455.0	1107.4	$ 332,224	$ 996,672	$ 300	$ 900
VT	425	24	5.6%		0.0	$ -	$ -	$ 170	$ 316
WA	1742	6	0.3%	37,774.9	130.6	$ 22,195	$ 41,256	$ 170	$ 316
WI	3029	60	2.0%		0.0	$ -	$ -	$ 170	$ 316
WV	2896	165	5.7%	45,665.0	2759.0	$ 1,103,585	$ 2,207,170	$ 400	$ 800
WY	2004	99	4.9%	20.0	1.0	$ 177	$ 328	$ 170	$ 316
	95476	**1938**	**2.0%**	**2,797,196**	**49,075**	**$ 8,690,922**	**$ 17,276,358**		

ISO TOT	Total number of records in Army Corp JD Database associated with aquatic resoure type "Isolated Waters" (inclu
WET TOT	Total number of records in Army Corp JD Database associated with wetland aquatic resoure types (1)
WET NO	Number of those total wetland records that have a negative JD associated with them (2)
%WET NO	Percent of isolated water records with negative JD, [ISO NO]/[ISO TOT]
BASE MIT	This is the total area of compensatory wetland mitigation (53,000) apportioned by state in proportion to [WET T
WET INC	Incremental Increase in Number Acres of Non-Isolated Wetlands Mitigated (3) =[WET TOT]/([WET TOT]-[WET NO
+0.17 ISO INC	Incremental Increase in Number Acres of Isolated Wetlands Mitigated = ([WET TOT]+0.17*[ISO NO])/([WET TOT]
WET COSTS	Annual costs associated with [WET INC]
0.17 ISO COSTS	Annual costs associated with [+0.2 ISO INC]

(1) Includes NRPW associated wetlands, wetlands abutting and adjacent to RPWs, TNW associated wetlands

(2) In theory, wetlands abutting an RPW and TNW-wetlands should all be jurisdictional
Wetlands adjacent to RPWs and associated with NRPW are subject to the significant nexus test

(3) Assumes all negative JDs within [WET TOT] are jurisdictional under revised guidance, including all subject to SN t

APPENDIX B: Corps Analysis of Sample Jurisdictional Determinations for "Other Waters"

To better understand the effect of the proposed guidance on the outcome of jurisdictional determination decisions, the Corps of Engineers evaluated a random sample of project files previously determined to be non-jurisdictional under the 2008 guidance. The randomly selected files were chosen from a comprehensive list of 2,617 "isolated" (other water) project files previously elevated to headquarters between the period of June 2008 and January 2011. The Corps evaluated 10% or 262 of these files. The 262 project files contained approximately 1,211 aquatic resources (many files contained multiple types of waters, including streams, wetlands, and non-wetland other waters (i.e. lakes/ponds and prairie potholes). The Corps evaluated whether the jurisdictional status of these waters would change based on application of the proposed guidance. Potential changes to the jurisdictional status were evaluated in terms of the following:

1. the water had the capacity to provide commercial waterborne recreation and thus would be considered a Traditional Navigable Water (TNW) (Section 1 of the proposed guidance);
2. the water was a tributary to a newly identified TNW (Section 1 and Section 4 of the proposed guidance;
3. the water would now be considered adjacent or physically proximate due to the presence of hydrological or ecological connection and when considered in aggregate, may have a significant nexus (SN) to a TNW (Section 3, 5, 6 of the proposed guidance); or
4. the water was isolated/not physically proximate but when considered individually may have a SN. (Section 6 of the proposed guidance.)

For those waters that required a significant nexus (SN) evaluation (#3 and #4 listed above), the Corps presumed adjacent wetlands would have a SN to a TNW and would be jurisdictional so no SN evaluation was formally conducted. For all proximate non-wetland other waters, we conducted a SN evaluation in accordance with the guidance and if an SN was found, the water was jurisdictional and if a SN was not found, the water was determined not -jurisdictional. For all isolated (not adjacent/not physically proximate) wetlands and other non-wetland waters, we presumed that those waters would not have a SN to a TNW and would not be -jurisdictional so we did not conduct a SN evaluation.

Approximately 17% (204) of the 1,211 waters reviewed became jurisdictional under the proposed guidance while 83% (1007) of the previously determined non-jurisdictional waters under the 2008 guidance remained non-jurisdictional. This is broken down as follows:

Jurisdictional: Fourteen (14) out of 1,211 (1.2%) other waters were determined to be TNWs using the proposed guidance; about 5 out of 1,211 (0.4%) would be considered tributaries to the newly identified TNWs and thus jurisdictional under the proposed guidance; twelve (12) out of 1,211 or (1%) were determined to be "physically proximate non-wetland waters" and were evaluated and determined to have a significant nexus to a TNW when aggregated in the single point of entry watershed; and 173 out of 1,211(14.3%) were wetlands that were determined to be adjacent to jurisdictional waters with a hydrologic or ecological connection using the proposed guidance and were presumed to have a significant nexus when aggregated in the single point of entry watershed. The review results noted that these adjacent wetland determinations were due to a more robust description of the term adjacency, specifically, the potential hydrologic or ecological connections to existing jurisdictional non-wetland waters (84%) or were now considered adjacent to a newly identified TNW (16%).

Non-Jurisdictional: 717 out of 1,211 (59.2%) of the other waters were wetlands that remained non-jurisdictional using the proposed guidance because they were not adjacent to jurisdictional waters (i.e. no apparent hydrologic or ecological connection); 282 out of 1,211 (23.3%) of the other waters were non-wetland waters that were not proximate and were presumed not to have a significant nexus to a TNW; and eight (8) out of 1,211 (0.7%) were determined to be physically proximate non-wetland waters and were evaluated and determined to not have a significant nexus to a TNW when aggregated in the single point of entry watershed.

APPENDIX C: Ecosystem Services Associated with Small Streams and Wetlands

Applying economic study and concepts to ecosystem services helps illustrate two major points: that prosperity depends on maintaining the flow of benefits from ecosystems and that successful environmental protection needs to be grounded in sound economics that includes recognizing costs and benefits.[24] This appendix briefly describes some of the most relevant ecosystem services provided by small streams and wetlands.

A. Habitat and Biodiversity (genetic resources)

Small streams and wetlands meet a variety of habitat needs for many plants, fish, amphibians, birds, mammals, macroinvertebrates, and microorganisms. They provide shelter, food, spawning sties, and nursery areas. These systems also often provide refuge for fish from predators and downstream disturbances such as floods, as well as critical life-stage habitat found nowhere else in the watershed. Some organisms spend a significant part of their lives in non-isolated aquatic systems, but require geographically isolated wetlands to complete their life cycles.

Because small streams and wetlands typically exhibit variable conditions over time and space, the type of habitat they provide is much different than what is provided by other water systems. Small streams and wetlands contribute to maintaining species diversity in a landscape by providing distinct habitat for native plants and animals, providing seasonally important refuge, serving as stepping stones between aquatic habitats, and holding water to supply terrestrial and avian species that live in the larger, and typically drier, ecosystem. These species collectively store a diversity of genetic material that defines important components of the ecosystem at large and specific communities within the larger system. On a smaller scale, individual waters may include populations or sub-populations with unique genetic resources, which ultimately may be needed for re-colonization. A loss of species or populations ultimately affects the resilience, adaptability, and sustainability of ecological structure and function by reducing the diversity of genetic material to draw upon to meet naturally dynamic and/or human altered circumstances.

B. Recreation and Fish and Game

Small streams and wetlands enhance opportunities for outdoor recreation such as fishing, swimming, hunting, boating, and wildlife viewing. They also protect multi-billion dollar fishing, shellfishing, and tourism industries. The money spent on outdoor water-related recreation like waterfowl hunting, fishing and boating supports major manufacturers, retailers, and small businesses in communities across the country, as well as generating state and local tax revenues. Provisioning for recreation and fish and game supplies supports several large revenue streams. Freshwater anglers spent $26.3 billion in 2006 on equipment, travel, licenses, guide fees, bait, and other fishing-related expenditures.[25] More than 2.3 million Americans age 16 or older

[24] TTEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach. conclusions, and recommendations of TEEB.
[25] 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

hunted migratory birds last year, spending about $1.3 billion on their trips and equipment, supporting many private sector jobs in the process.[26]

Fishing is an American pastime and a business that directly depends on good water quality. Salmon, for example, are the third largest commercial catch (by weight) in the U.S., and they reproduce in small streams, including many that do not flow year-round. Small and intermittent streams are precisely those whose jurisdictional status is most likely to be clarified by this guidance. .The 40 million U.S anglers spend $45 billion annually to fish all kinds of waters. The commercial salmon fishery is valued at $381 million annually.

Expenditures for hunting and fishing have a ripple effect on the economy. For example, a 2006 estimate of the economic impacts of waterfowl hunting (ducks and geese) indicated that total annual expenditures of $900 million result in a total economic activity of over $2.3 billion.[27] This is a result of what economists refer to as the "multiplier effect". In addition, the same study estimates that waterfowl hunting creates over 27,000 jobs, annual employment income of over $800 million and annual state and federal tax revenue of almost $250 million.

Over 50 percent of the nation's ducks are born in the prairie potholes region of the northern Great Plains. However, about two-thirds of the prairie potholes have already been mined, drained, plowed under, or built on. One study found that, because of these kinds of impacts, a Midwestern pothole area once supporting about two million breeding pairs now supports less than ten percent of that number. While many prairie potholes are isolated from navigable waters, and thus not likely to be affected by this guidance, some may be deemed "proximate" and thus jurisdictional if they have a significant nexus to navigable waters.

The values reported above are related to products and services that are affected by water quality. A specific valuation would estimate how changes in water quality that might result would shift demand curves for these products and services. Thus, the total figures reported above are not benefit values directly attributable to the proposed guidance. However, it is likely that some incremental portion of those amounts would be associated with the expected incremental increases in waters determined to be jurisdictional as a result of using the proposed guidance.

C. Water Supply (Drinking, Irrigation, Industrial)

Headwater streams and wetlands play a crucial role in providing a continual flow to downstream freshwater systems, as well as recharge of groundwater systems. Alteration of small streams and wetlands disrupts the quantity and availability of fresh water. One of the intended outcomes of the proposed guidance is to help provide clean, safe water for public water supply as well as manufacturing, irrigated agriculture, and other business sectors that use water. In the continental United States, about 117 million people, over one third of the total U.S. population, get some or all of their drinking water from lakes and rivers that rely at least in part on intermittent, ephemeral, or headwater streams.[28] In the continental U.S., 357,404 total miles of

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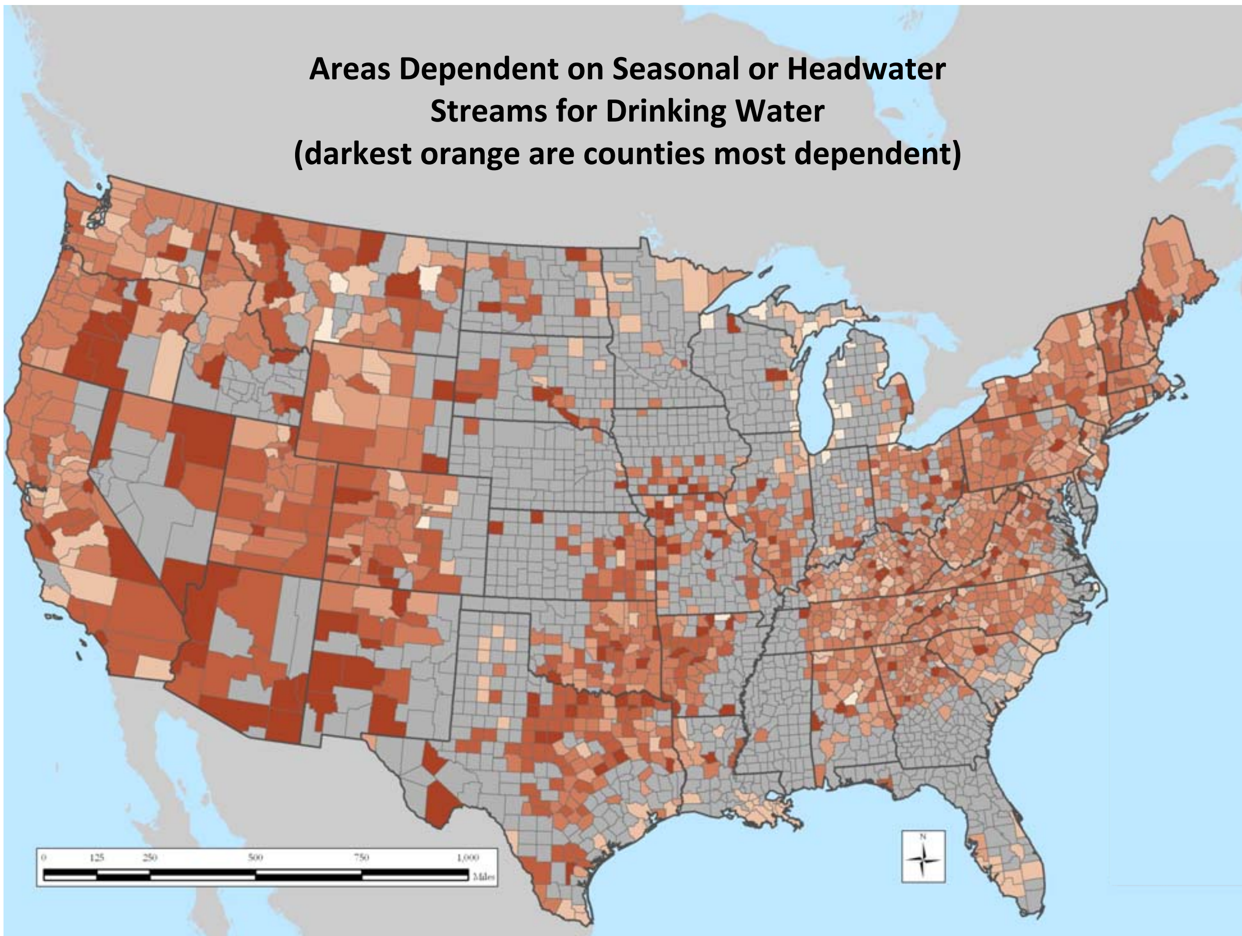
[26] 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation
[27] 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation
[28] http://water.epa.gov/lawsregs/guidance/wetlands/surface_drinking_water_index.cfm

streams contribute water to lakes and rivers that supply public drinking water systems. Of that total, 58% (207,476 miles) are intermittent, ephemeral, or headwater streams. Application of the guidance and including more waters under CWA jurisdiction helps protect the supply and prevent contamination of drinking water for these 117 million Americans. Figure 2 shows the areas of the country where drinking water supply is most dependent on these types of stream systems.

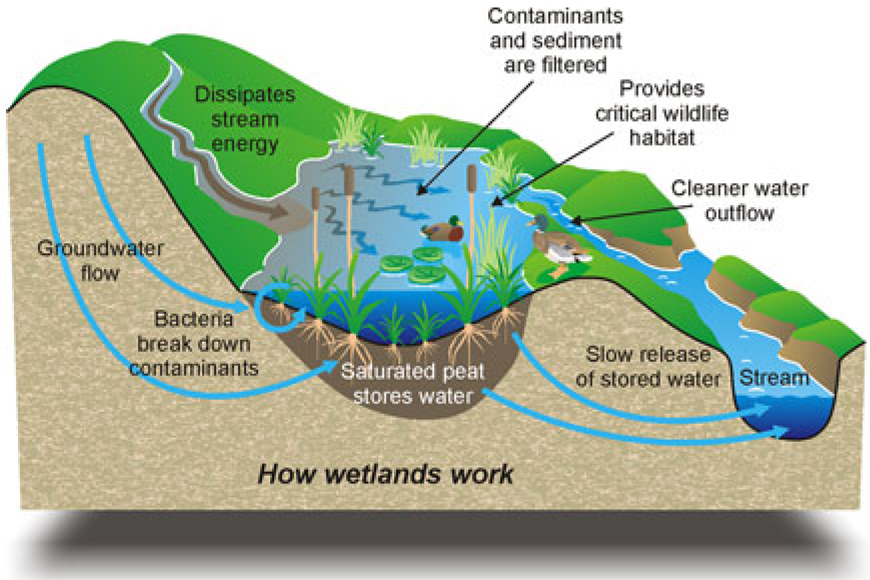
Figure C-1: Illustration of Contribution of Seasonal and Headwater Streams to Water Supply



D. Water Regulation and Purification

Headwater streams, headwater wetlands, and other seemingly isolated wetlands significantly influence water quality of downstream aquatic ecosystems. As depicted in Figure 3, these small streams and wetlands filter and cleanse water that pass through them and function as the site of a large number of physical, chemical, and biological processes and transformations. One commonly cited feature of wetlands is their ability to improve water quality by acting as sediment sinks. Wetlands are particularly effective at trapping sediments in slow moving water, as the wetland vegetation slows water velocity and particles settle out. Processes in headwaters largely establish the physical and chemical composition of natural streams. Among the many important water-quality related processes in small streams and wetlands are water chemistry regulation, nutrient cycling, solute retention, organic matter (OM) production, OM processing, and pollutant assimilation. Each of these processes have an influence on downstream water quality, organic matter content, nutrient levels, and productivity. The services these processes provide can reduce the cost of dredging and water treatment, decrease human health risks, and promote healthy fish and wildlife populations in lakes and rivers. These are closely related to the supporting services related to nutrient cycling/storage and sustained productivity of downstream waters.

Figure C-2: General Hydrology and Function of a Typical Inland Wetland[29]



A related service provided by wetlands is carbon sequestration and its effect on climate control. There is much ongoing research to investigate natural and artificial means of removing carbon from the atmosphere and maintaining it in the land and water. Based on their potential for primary production to exceed respiration, wetlands can naturally sequester carbon. The massive peat bogs in the northern U.S. and Canada are evidence of this service on a significant scale. Filling, clearing, and draining wetlands releases carbon dioxide to the atmosphere.

[29] Image appears in many locations on the internet (such as http://microbewiki.kenyon.edu/index.php/Wetlands) without clear attribution of original source.

E. Floodplain Protection

Small streams and wetlands mitigate the downstream impacts of floods through the retention of surface water. Wetlands hold excess runoff after a storm and then slowly release it into receiving waters or groundwater. These systems do not prevent all flooding, but they do lower flood peaks. It is generally the higher flood peaks that cause the most significant damage.

Flooding damages crops, roads, and property. Small streams and adjacent wetlands act as sponges, soaking up rainfall and snowmelt. They help prevent flooding downstream, especially after small and medium-sized storms. For example, prairie potholes and other isolated wetlands hold onto water during and after intense rains, so not all of the water ends up in major rivers at the same time. Flooding very often is an interstate issue. Destruction of small streams and prairie potholes in one state may lead to flooding in another. Floods lead to significant crop and property damage across the United States each year. For example, the great Midwest flood of 1993 (see Figure 4) caused nearly $20 billion of economic damage, damaging or destroying more than 50,000 homes and leaving at least 38 people dead.[30] Some increment of economic damage such as this may be attributable to loss of small streams and wetlands. While it is unlikely that floods of this magnitude would be eliminated by greater preservation of headwater streams and wetlands, protecting these kinds of waters would help to mitigate such flooding, and perhaps eliminate smaller floods altogether.

Figure C-3: Image of Midwest Flooding[31]

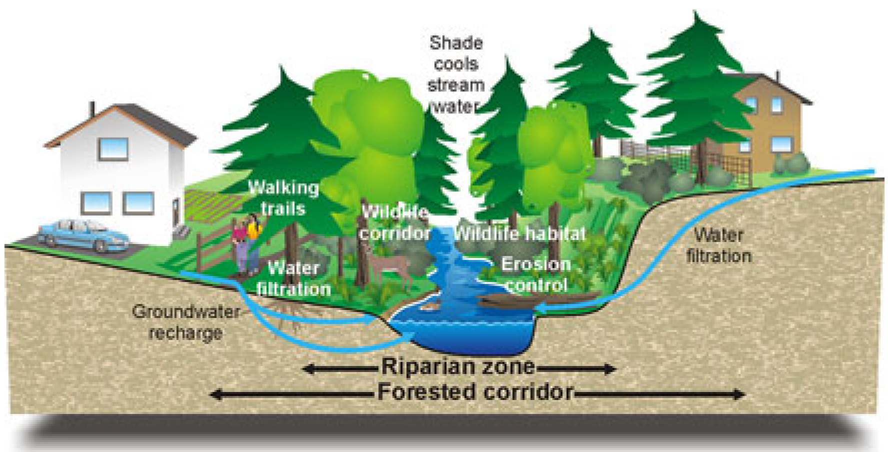
Figure 49. Flooding in the Upper Mississippi River Basin, summer 1993.
(Photograph © Cameron Davidson, 1993.)

The importance of floodplain protection magnifies when considering the likely future demand for land development. For example, an examination of future U.S. housing trends helps illustrate development pressure and reveals enormous potential consequences. Projections of growth in U.S. households from 2000 to 2025, along with allowances for demolition and conversion, point to new construction needs for almost 60 million housing units (compared to approximately 45 million built between 1980 and 2005). When considering associated commercial and industrial facilities, the authors of these studies project that “over half of all

[30] Fitzpatrick, Tony. “Geologist decries floodplain development: lessons unlearned from 1993 flood”. Washington University in St Louis Newsroom. April 1, 2008.
[31] http://water.usgs.gov/nwsum/WSP2425/functions.html

development on the ground in 2025 will not have existed in 2000".[32] Even with the economic downturn subsequent to this study, this demand will eventually manifest itself in some manner. Based on preferences and prices, the authors also report an expected complete reversal of trends that had been toward expansion into less dense suburbs and exurbs rather than urban centers. This potentially offers an unparalleled opportunity for spatial reconfiguration. Clarifying CWA jurisdiction and thus providing Section 404 protection to small streams and wetlands that may be candidates for dredge and fill, along with enlightened planning of development within the floodplain itself, will be important to avoid and/or mitigate future losses from flooding. Stronger protection for small streams and wetlands can help direct growth to locations more beneficial to society (e.g., away from floodplains, in areas with existing infrastructure). Figure 5 depicts a variety of ecosystem services protected by maintaining natural functions within in a floodplain.

Figure C-4: Illustration of Floodplain Protection



F. Shoreline Stabilization and Erosion Regulation

Wetlands at the margins of lakes, rivers, bays, and the ocean protect shorelines and stream banks against erosion.[33] Wetland plants hold the soil in place with their roots, absorb the energy of waves, and break up the flow of stream or river currents. When small streams and wetlands are lost or altered in ways that diminish their retention ability, the resulting increased flows can erode adjacent land and de-stabilize shorelines. The erosion can send excess sediment downstream where increased dredging costs and habitat loss may result. In addition, property loss and diminished land value cannot be overlooked, and represents a large potential avoided cost.

[32] Reported in Pitkin and Myers (2008). U.S Housing Trends: Generational Changes and the Outlook to 2050.
[33] Note that the proposed guidance should not affect determinations regarding tidal wetlands, which should already be considered jurisdictional in the baseline.

G. Groundwater Recharge/Water Cycling

Aquifers and groundwater are "re-charged" or replenished with water from precipitation and surface flow that seeps into the ground. Wetlands connected to groundwater systems or aquifers are important areas for groundwater exchange because they provide time for the infiltration or seepage to occur. Groundwater provides water supply for drinking and irrigation and helps maintain streamflow and lake and reservoir levels.

Waters that appear geographically isolated on the surface may be connected to other aquatic ecosystems through groundwater flows and intermittently through surface water flow. Nearly all freshwater surface water features (streams, lakes, and wetlands) interact with groundwater throughout a watershed – and even across surface watershed boundaries. Groundwater moves underground from areas of recharge to areas of discharge, often providing connections to surface water features. Likewise, surface waters are often integral parts of groundwater systems, providing important recharge, purification, and maintenance of aquifer depths and levels. The role of wetlands in recharging groundwater varies widely, but can be significant.

H. Sustained Productivity of Downstream Waters

Small streams and wetlands contribute significantly to the productivity of stream ecosystem food webs by providing energy resources (e.g., organic matter) to downstream ecosystems. In addition, small streams and wetlands provide sediment and large woody debris to downstream channels during infrequent, but necessary high flow events. Under more typical conditions, these systems trap and retain sediment, essentially filtering sediment rather than flushing it downstream. In a similar manner, these systems will filter pollutants, such as heavy metals and organic compounds, and prevent excess nitrogen and phosphorus from being delivered downstream on a regular basis. The timing and amount of delivery of sediment and nutrients to downstream waters is crucial to their well being. Either too much or too little at the wrong time is a problem. Too little and downstream waters cannot sustain productivity because of lack of provisions from upstream sources. Too much and habitat gets smothered, waters get choked, and algal boom and bust cycles deplete dissolved oxygen levels in water and disrupt the balance of natural flora and fauna. These problems may arise when connectivity between small streams and wetlands and other waters goes unrecognized and is lost, or when modifications of the landscape alters peak velocity and overall flow levels.

APPENDIX D: Literature Review of Benefits Quantification

EPA's *Guidelines for Preparing Economic Analyses* (2011) suggest adopting an effect-by-effect approach to benefit estimation, identifying the specific effects of policy options and evaluating each in turn.[34] The first step to implement this approach for the proposed guidance is to identify the most significant categories of effects. Waters affected by the proposed guidance may confer a number of benefits to society, among them:

- Recharging groundwater
- Purifying water by trapping and neutralizing pollutants (including excessive nutrients)
- Enhancing the propagation of species that may be important in recreation and assuring the survival of species whose continued existence may be valued for ethical or aesthetic reasons
- Mitigating impacts of storms and flooding

The benefits provided by jurisdictional waters depend crucially on the context in which they are placed. This is a restatement of the principle that economic value depends on relatively scarcity. Things that are available in abundance relative to the demand for them are cheap. Things that are rare relative to the demand for them are expensive. Plentiful wetlands may provide little value if no nearby population benefits from their services.[35] Conversely, a wetland near a major city might provide a number of valuable functions in providing water purification, storm and flood protection, and recreational amenities.

The goal of the proposed guidance is to preserve water resources and their associated ecological assets in perpetuity. The benefits from doing so will, then, also accrue in perpetuity, and must be discounted. The *Guidelines* also offer guidance for discounting.

Benefits might be affected by stochastic factors over time and protection of jurisdictional waters might also afford insurance against adverse random events. These are important considerations in inferring some types of benefits.

Groundwater recharge

Wetlands slow the transmission of surface water. Because water is retained in the landscape for longer periods, more infiltrates and enters groundwater reservoirs. This

[34] The *Guidelines* also note that in some instances a more overarching or top-down approach to benefit estimation might be adopted, as might occur with the application of stated preference methods, where it is often impossible to distinguish between the various values survey respondents might be considering in forming their answers.

[35] A conspicuous exception to this observation might appear to be found in the case of an isolated wetland that shelters endangered species. This is actually the exception that proves the rule, however: endangered species are, by definition scarce. Moreover, the existence value assigned to such species is really the canonical public good: something that might be enjoyed by people all over the world.

groundwater may be a valuable resource, both because it is retained in or near areas that can use the water and because it may be left underground until such as time as it is required for use. Moreover, the higher is the volume of groundwater retained in an aquifer, the lower are typically the costs of extracting it.

These values have been studies in a developing country by Acharya (2000), and Acharya and Barbier (2000, 2002), who relate agricultural production to water availability and groundwater availability to wetland preservation, finding that wetlands contribute significant value to agriculture. Similar results might arise from comparable studies in the United States. As always, values are dependent on context. If water is abundant, the service of groundwater recharge would not be very valuable. Conversely, in areas in which water is chronically or seasonally scarce, groundwater recharge could be considerably more valuable. Groundwater could be important as a type of "insurance policy" against a lack of precipitation and surface water.

Water purification

Natural wetlands can purify water by holding it until pollutants settle out, are taken up in the growth of vegetation, or biochemically degrade into less damaging forms. A number of biological studies have documented the ability of wetlands to perform this service (see, e. g., the surveys in Mayer, *et al*. 2007; Rupprecht, *et al*. 2009). Economists have attempted to value such services. Breaux, Farber, and Day (1995) find that wetlands can be more valuable if preserved to remove pollutants than if converted to other uses. In a widely cited study in France Perrot-Maître (2006) reported that the Vittel bottled water company found it profitable to compensate local farmers for preserving the landscape around its wells.

In a recent study of wetlands along the lower Mississippi Jenkins, *et al*. (2010) estimated that the nitrogen retention service provided by wetlands near the river could be valued at as much as $500 per acre per year. While some of the areas considered in the Jenkins, *et al*., study might be comparable to areas that could become jurisdictional under the proposed guidance, the results of the study should be interpreted with some caution for two reasons. First, the values derived in the study are based on prices that would obtain under pollution control markets that do not presently exist. Jenkins, *et al*. extrapolate from an earlier study by Ribaudo, Heimlich, and Peters (2005) that simulated prices in a hypothetical permit market for nitrogen loading in the Gulf of Mexico. Such prices would only arise if the market were, in fact, created. Second, as is often the case with a number of the services generated be wetlands, different areas – in some instances, even relative nearby areas – may generated radically different values depending on land use, topography, etc. Estimates of denitrification rates differ by three orders of magnitude (a factor of 1,000) between areas.

A closely related literature considers the use of retained natural areas in cost-effective pollution control programs. A celebrated case is found in New York City's efforts to assure the retention of drinking water quality in its Catskills watershed reservoir by enacting land use restrictions (Chichilnisky and Heal 1998). Ribaudo, *et al*. (2001) use a large simulation model of Midwestern agriculture and land use to show that retaining natural wetlands may be less expensive than reducing the use of inputs in controlling the delivery of the nutrients to the "dead zone" at the mouth of the Mississippi River. Mitsch and Gosselink (2001) report a number of studies that find that the optimal area of wetlands to preserve in various nations of the world would be something between current areas and the historic extent of wetlands in the area.

Similarly, comparisons of alternative measures for nutrient loading reductions to the Chesapeake Bay suggest that recently announced TMDL targets might be most cost-effectively met by preserving wetlands in combination with other measures (Jones, *et al*. 2010; Simpson in press). The studies cited in this paragraph fall somewhat short of full valuation exercises in that they document the ability of preserved natural systems to meet regulatory requirements at lower costs than alternatives. However, one may reasonable surmise either that such regulatory requirements are set so as to achieve benefits that justify the costs of their imposition, or that, however they are set, they must be met and hence that the opportunity cost savings of not having to implement more costly measures represents an incremental social benefit.

Of course, the benefits of water purification arise only when 1) there are pollutants that must be removed from the water; and 2) such pollutants would impose costs on society if they are not removed. Such circumstances do not necessarily obtain for all waters and all locations (Sagoff 2002; Plummer 2009; Simpson 2010). It would, then, be improper to extrapolate water purification values universally. By the same token, however, there are certainly instances in which such services could be extremely valuable.

Wildlife habitat

Natural wetlands, small streams, and isolated water bodies are very important in the reproduction and life cycles of many organisms. These plants and animals may be economically valuable for several reasons. First, some, such as the various species of Pacific Salmon, are caught and sold commercially. Second, others are important in recreation, either for consumption in hunting and fishing, or for nonconsumptive enjoyment, as in birdwatching or tourism. Finally, many people attach a nonuse, or existence value to species on the basis of their perceived ethical obligation to preserve other species.

An extensive literature in economics has attempted to estimate the value of natural habitat in the provision of commercially or recreationally important species. In some instances reported values are relatively modest. In an early study Lynne, Conroy, and Prochaska (1981) found that coastal marshes on the Gulf Coast of Florida only contributed about $ 0.30 per acre in terms of the value of enhanced blue crab production. Even adjusting for the considerable inflation of the last 30 years, this would not be a large number. Similarly, while Jenkins *et al*. (2010) found relatively high values for the nutrient reduction services of wetlands near the Mississippi, the estimated the value of increased waterfowl hunting was considerably lower, at about $6.50 per acre per year. An exception to these somewhat low estimates is found in Bell (1997), who estimates values of approximately $6500 per acre for coastal wetlands supporting recreational fisheries (coastal wetlands should not be affected by the proposed guidance as they should be jurisdictional under the current guidance).

In each of these studies the researchers apply a similar method for estimating the value of environmental improvement to fisheries or other wildlife-based commercial activities.[36] A schematic overview of that procedure is as follows. Fish and other living resources have a natural reproductive process. Economically optimal management of the population involves a tradeoff between catching more fish now and leaving enough fish as to assure a thriving population later (see, e. g., Clark 1990). The rate at which population grows typically depends on the size of the population, a species-specific biological parameter that measures the inherent fecundity of the animal, and the carrying capacity of the environment – a biophysical limit on the population that can be sustained. Environmental conditions affect carrying capacity. In this case the extent of jurisdictional waters will determine the populations of fish, waterfowl, and other organisms that can be sustained, and the harvests that will then be allowed. As in all exercises in economic valuation, context is crucial. When habitat, and, by extension, target species populations are abundant relative to the demand for them, values will not be greater. Conversely, as land and animals get scarce, their values increase.

Factors other than just the biological parameters can affect the estimation of wildlife harvesting benefits. One is the institutional context. When wildlife are subject to open access competition between would-be harvesters may dissipate any benefits regardless of environmental circumstances (Freeman 1991). However, fisheries are increasingly coming under more rational management (Costello 2008). Over and above the benefits with respect to the maintenance of the target species and the long-term satisfaction of consumer preferences, such improved management may also mean that preserving natural habitats may be more valuable.

Another consideration is that much of the harvesting of natural resources occurs outside of the formal market economy. Recreational or subsistence hunting and fishing may also be important activities. Benefit estimates analogous to those for commercial harvesting may also be derived by substituting nonmarket valuation estimates of willingness to pay to hunt and fish for market prices. For example, Massey, Newbold, and Gentner 2008 estimate the relationship between water quality, fish population, and angler trip demand and show that anglers have a positive willingness to pay for improvements in water quality. This result is common in the literature. Other examples are provided in the literature reviews and meta-analysis conducted by Van Houtven, Powers, and Pattanayak 2007 and Freeman (1995).

Existence and bequest values, which are often grouped together as non-use values, may also arise when natural wetlands, small streams, and isolated water bodies are either rare or unique in their own right or if they provide habitat and shelter to rare and endangered species. In this situation, existence values are the amount an individual would be willing to pay to ensure that a native species exists in its native habitat. Bequest value is the amount an individual would be willing to pay to preserve a species or its habitat for future generations. As stated earlier the magnitude of existence or bequest values is closely tied to the scarcity of the resources. Because estimation requires using stated preference methods, non-use values are generally more difficult and uncertain to estimate than use values. This difficulty and uncertainty has not prevented multiple studies from appearing in the literature. A number of wetland use and non-use valuation studes are reviewed and included in a meta-analysis by Brouwer et al. (1999). They

[36] There are also other studies in which less conceptually defensible approaches are taken. See, e. g., Lynne, Conroy, and Prochaska (1981).

estimate that non-use values are roughly half the magnitude of use values. Loomis and White (1996) conduct a similar review of the literature and meta-analysis on the economic benefits of rare and endangered species. They find significant WTP values across species, and not surprisingly, over half of the variation in those estimates can be explained by the species population levels.

Mitigation and Prevention of Flooding

Another service provided by natural wetlands is the mitigation and prevention of floods. Resultant downstream damages can be extreme. The Midwest flooding of 1993 caused nearly $20 billion of economic damage, damaged or destroyed more than 50,000 homes and left at least 38 people dead (Fitzpatrick 2008).

Again, however, the economically relevant concern is not the total damages from flooding, but rather the incremental damages that could be avoided by preserving more waters. Consideration of extreme cases underscores the point of incremental analysis. If weather is favorable and precipitation is moderate there would be no flooding, and hence no flood protection service. Conversely, if weather is so extreme that precipitation would overwhelm all natural or man-made flood-control measures anyway, preserving wetlands for flood control might make little difference to the extent of damages.

It can be helpful to think of the flood control services of natural wetlands as a form of insurance policy. As such, their value is determined by the interaction of three factors: the level of damages that would occur without the wetlands in place; the probability that such damage will occur without the wetlands in place; and the incremental effect of the wetlands in reducing that probability. Wetlands will be most valuable for the flood protection services they provide if they significantly reduce the likelihood that flood waters would otherwise reach levels at which damages are greatest. For example, Hey and Philippi (1995) estimate that if wetland acres in the Mississippi Basin had been roughly doubled, to about seven percent of the total land area, the floods of 1993 would have been avoided. Even if increased to this level, the area in wetlands would still represent only about 70% of their extent before European settlement

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