Exhibit D

Final Review of the 2018 EPA Economic Analysis for the Proposed Revised Definition of "Waters of the United States"

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Executive Summary

In December 2018, the EPA and the Army published an Economic Analysis for the Proposed Revised Definition of "Waters of the United States" (hereafter referred to as the "December 2018 EA"). The proposed, revised definition to WOTUS evaluated in the December 2018 EA was formally proposed in 2019 and is referred to as the 2019 Rule, hereafter. The December 2018 EA takes a two-stage approach to evaluating the annual avoided costs and foregone benefits of implementing the 2019 Rule. Breaking the analysis into two stages rather than evaluating the proposed rule change as a single action has implications for the results, as do several subjective yet critical parameter choices, especially the baseline acreage.

Stage 1 of the December 2018 EA uses the May 2015 EA as a baseline to estimate the annual foregone benefits and avoided costs of rescinding the 2015 Rule, thereby returning to the pre-2015 WOTUS definition. For CWA 404 provisions, Stage 1 also includes documentation of a meta-analysis for evaluating annual foregone benefits of rescinding the 2015 Rule. The meta-analysis estimates household (HH) willingness to pay (WTP) for preserving a given number of wetland acres. These estimates are then translated into state-level WTP per HH per wetland acre.

Stage 2 of the December 2018 EA estimates the annual avoided costs and foregone benefits of implementing the proposed 2019 Rule after the 2015 Rule has been rescinded. In other words, Stage 2 estimates the annual avoided costs and foregone benefits of the proposed 2019 Rule with the pre-2015 Rule as the baseline. Stage 2 conducts several watershed-level case studies, but ultimately uses the results from the Stage 1 meta-analysis to estimate the annual avoided costs and foregone benefits at the national level.

This two-stage approach I call “rescind-and-replace.” It is clear the proposed 2019 Rule is meant to be the final and immediate regulatory outcome. In other words, the proposed 2019 Rule is meant to replace the 2015 Rule, not to revert back to the pre-2015 Rule WOTUS definition for some unspecified but meaningful period of time before implementing the proposed 2019 Rule. As such, breaking the analysis into two separate stages is inappropriate.

Both stages of the December 2018 EA examine 4 scenarios related to the extent the protections reduced under the proposed 2019 Rule are replaced by equivalent state-level protections: Scenario 0, 1, 2, and 3. Scenario 0 assumes no states adopt standards more protective than the proposed 2019 Rule; the subsequent scenarios increase the number of states adopting new protections in light of the proposed rule.

The meta-analysis has several important issues of concern. First and foremost, despite extensive attempts to do so, the results presented in Table III-9 (p. 77) and Table F-5 (p.285) could not be replicated using the mean variable values and model coefficient estimates presented in Table III-6 (p. 72), Table III-7 (p. 73), and Table III-8 (p. 74). This should be a straight-forward exercise. The lack of replicability raises the possibility that the December 2018 EA is missing important information. The agencies need to demonstrate how Tables III-6, -7, and -8 are used to generate Table III-9 and Table F-5.

A second concern relates to the data. One of the most important factors in the analysis is the change in the number of wetland acres that would be affected by the various Rule changes. The Stage 2 analysis uses permitting activity from 2011 through 2015 to estimate the number of affected acres. As such, it is likely to have under-estimated the number of acres impacted by moving from the pre-2015 Rule to the 2019 Rule. This is because, in addition to actual permit applications, the permitting and mitigation costs may have deterred some wetland conversion activity, activity that may arise under the proposed 2019 Rule. While the Stage 2 analysis likely under-estimates the number of affected acres, the December 2018 EA does not explain how the affected acres in the Stage 1 analysis (moving from the 2015 Rule to the pre-2015 Rule) were established. This is a critical parameter for their analysis, the estimation of which needs to be explained and justified. As with the Stage 2 analysis, if the number of affected acres is based on previous permitting activity, then it is likely to generate an under-estimate.

Another data concern related to acres has to do with the baseline acres. To apply the results of the meta-analysis to each state, the December 2018 EA says it assumes the baseline acres of wetlands for each state is 10,000 acres (p. 73), although it appears the real assumption is 40,000 acres. Either way, every state does not have the same number of baseline wetland acres. This is evident from Table A-1 of the appendix. The December 2018 EA argues that the National Wetland Inventory (NWI) is not a regulatory database. While that may be true, it does shed some light on how wetland acres vary across the states, and how likely 40,000 acres is to be an appropriate baseline. The average number of NWI wetland acres reported in Table A-1 is 2.4 million, with a minimum of 57,000 and a maximum of 12.2 million. The baseline acreage is an exceptionally influential parameter in the meta-analysis' estimation of foregone benefits – an increase in baseline acreage results in larger foregone benefits. If the December 2018 EA were conducted exactly the same as presented in that document but the baseline acres were set to 220,000 instead of 40,000 for Stage 1, the annual foregone benefits would increase from $59.4 million to $204.8 million for Scenario 0, from $16.7 million to $74.9 million for Scenario 1, from $14.3 million to $64.6 million for Scenario 2, and from $1.2 million to $5.1 million for Scenario 3. For Stage 2 the annual foregone benefits would increase from $135.6 million to

$567.9 million for Scenario 0, from $46.8 million to $200.3 million for Scenario 1, from $41.7 million to $179.4 million for Scenario 2, and from $6.9 million to $24.7 million for Scenario 3. Using a low level of baseline acres systematically under-estimates the annual foregone benefits of both rescinding the 2015 Rule and implementing the proposed 2019 Rule. Coupling the single regulatory action issue discussed above with the baseline acreage issue compounds the under-estimation of annual foregone benefits.

A separate data concern has to do with the CPI-U values used to inflate dollar values from earlier years to 2017-dollar levels. The CPI-U values employed for the meta-analysis are lower than the values reported by the Census Bureau. This leads to a systematic under-estimate of WTP/HH, and annual foregone benefits of the Rule changes in both Stage 1 and Stage 2.

A third concern relates to the selection and robustness of the econometric model used in the meta-analysis. Wetland functions are divided into four general categories: regulating, supporting, provisioning, and cultural. The econometric model includes three of these functions, but not the "supporting" function. Omission of this variable would likely bias the results. Why the supporting function was not included in the model needs to be explained and justified. The counter-intuitive signs and lack of statistical significance for several of the model coefficients brings the model results further into question. The potential effects of these issues can be seen in the exceptionally wide range for the state-level 95% confidence intervals of annual foregone benefits presented in Table III-9 (p. 78) and Table F-5 (p. 285).

A fourth concern is the scope of the meta-analysis. On page 69, the report states, "Wetland benefits are, in general, a more local commodity." This may be true for some of the functions wetlands serve, but for other functions the value of a wetland may have significant geographic scope. For example, the Prairie Pothole Region (PPR) of the northern plains serves as an important breeding ground for migratory game birds. Duck hunters in Pennsylvania, thousands of miles from the PPR derive direct benefits from those wetlands (see, for example, Kinnell et al., 2002). Ironically, North Dakota, in the heart of the PPR, is projected to lose the most wetland acres of any state in the nation if the 2015 Rule is rescinded. Yet the agencies explicitly assume the benefits of wetland preservation in a given state are restricted to residents of that state; households outside of that state are assumed to have WTP/HH = 0. This leads to further systematic under-estimation of foregone benefits. If, rather than assuming foregone benefits are restricted to residents of a given state, the residents of neighboring states are also assumed to value the benefits in that given state – an assumption employed earlier in the December 2018 EA – the Stage 1 conclusions of Scenario 0 (p. 222), and Scenarios 1, 2, and 3 (pp. 81-83) as well as the Stage 2 conclusions of Scenarios 0, 1, 2, and 3 (pp. 207-208) are all undermined. Specifically, the Stage 1 CWA 404 foregone benefits in Scenario 0 increase from $59.4 million to $216.6 million; from $16.7 million to $90.4 million for Scenario 1; from $14.3 million to $56 million in Scenario 2; and from $1.2 million to $11.8 million in Scenario 3. The Stage 2 CW 404 foregone benefits in Scenario 0 increase from $135.4 million to $419.5 million; from $46.8 million to $233.9 million for Scenario 1; from $41.7 million to $193.4 million in Scenario 2; and from $6.9 million to $74.3 million in Scenario 3. (Also note that Pennsylvania is not adjacent to North Dakota.)

In summary, the meta-analysis and subsequent calculations used to estimate foregone benefits in both Stage 1 and Stage 2 of the December 2018 EA suffer from systematic under-estimation of the benefits, lack of transparency in the determination of the number of affected acres (Stage 1 only) and the calculation of state-level benefits, a highly consequential and dubious assumption related to baseline acres, insufficient scope of benefits, and demonstrable evidence of the model's lack of precision. In addition, the two-stage approach employed by the December 2018 EA leads to lower annual foregone benefits than a single stage approach would. A two-stage approach would only be appropriate if the proposed 2019 Rule actually constitutes a "rescind-and-replace" action that results in the pre-2015 WOTUS definition being in effect for a significant period of time. The agencies need to explain the extent to which the proposed 2019 Rule will result in the pre-2015 WOTUS definition being in effect and justify why the two-stage is appropriate in that circumstance.

1. Overview of the December 2018 EA, Stage 1 Analysis

The December 2018 EA evaluates a 2-stage process that one could call “rescind-and-replace.” Stage 1 estimates the annual avoided costs and foregone benefits of rescinding the 2015 Rule thereby returning to the pre-2015 Rule (hereafter referred to as rescinding the 2015 Rule). Stage 2 estimates the annual avoided costs and foregone benefits of moving from the pre-2015 Rule to the proposed 2019 Rule. This section focuses on the Stage 1 analysis.

One of the fundamental differences between the June 2017 EA and the December 2018 EA is the development of a set of scenarios for examining state-level responses to the Rule changes. The Army and EPA argue in the December 2018 EA that even though some waters will no longer be regulated under the CWA as “waters of the United States” with either the pre-2015 Rule or the 2019 Rule, the change in the WOTUS definition will not affect the definition of “waters of the State” for many states. In fact, some states currently have more stringent regulatory requirements related to waters of the State than the 2015 Rule. Other states, however, have specific language that automatically adopts the prevailing WOTUS definition for waters of the State. As a result, the change in the definition of WOTUS will have different regulatory implications in different states.

Four categories of state-level response related to dredge/fill activities and three categories related to surface water discharges are created. These categories are then used to develop state-level response scenarios to evaluate the annual avoided costs and foregone benefits of the 2017 Rule.

1.1 Lack of Replicability

<u>Main Conclusions:</u> Despite extensive attempts to do so, the results presented in Table III-9 (p. 77) could not be replicated using the mean variable values and model coefficient estimates

presented in Table III-6 (p. 72), Table III-7 (p. 73), and Table III-8 (p. 74). This should be a straight-forward exercise. The lack of replicability raises the possibility that the December 2018 EA is missing important information. It is incumbent upon the agencies to explicitly detail how the coefficient estimates from the meta-analysis are used to generate the results of Table III-9.

Detailed Discussion: Section III.C.2.2.3.2 of the December 2018 EA presents a new meta-analysis for estimating the foregone benefits of rescinding the 2015 Rule. A meta-analysis is, in effect, a "study of studies"; it uses the results of prior empirical research (called "primary studies") to identify over-arching results from the empirical literature. As with all econometric studies, the meta-analysis estimated a specific mathematical relationship between a "dependent variable" and a set of "explanatory variables." The dependent variable in the meta-analysis was WTP/household/year estimated by a given primary study, and the explanatory variables were defining characteristics of that study. Specific variables included in the analysis are shown in Table III-6 (p. 72) of the December 2018 EA and reprinted in Table 1.1 below.

The general form of the model presented in the December 2018 EA is shown as Equation (1)

$$(1)\ y_s = X_s\beta + \ln\left(\gamma^{-1}\left(exp(\gamma q_{1,s}) - exp(\gamma q_{0,s})\right)\right) + \varepsilon_s$$

where y_s is the natural log of WTP (per household per year) from study s, X_s is a vector of variables describing the context of the study s, $q_{1,s}$ is the post-policy wetland area, and $q_{0,s}$ is the baseline wetland area. As such, ($q_{1,s} - q_{0,s}$) is the number of wetland acres affected by the policy. The estimates of the econometric coefficients (β's, and γ) are presented in Table III-7 (p. 73) of the December 2018 EA, and reprinted here in Table 1.2.

Table 1.1: Variables in the December 2018 Meta-Analysis

	Description	Mean	Min	Max
Lnwtp	log(total wtp in 2017 dollars)	3.56	1.05	6.06
Lnyear	log(year of data collection - oldest year +1)	1.57	0.00	2.89
Lninc	log(income in 2017 dollars)	10.97	10.64	11.48
Sagulf	1 = S-Atlantic/Gulf (AL,GA,SC,LA)	0.19	0.00	1.00
Nema	1 = NE/mid-Atlantic,(DE,MD,NJ,PA,RI)	0.14	0.00	1.00
Nmw	N/Mid-West (KY,MI,NE,OH,WI)	0.57	0.00	1.00
Local	1 = target population at sub-state level	0.33	0.00	1.00
Prov	1 = provisioning function affected	0.24	0.00	1.00
Reg	1 = regulating function affected	0.52	0.00	1.00
Cult	1 = cultural function affected	0.76	0.00	1.00
Forest	1 = forested wetland	0.52	0.00	1.00
q0	baseline acres (1000s)	40	0	220
q1	policy acres (1000s)	51	1	220
Volunt	1 = payment mechanism = voluntary contribution	0.43	0.00	1.00
lumpsum	1 = payment frequency = lump sum (single payment)	0.43	0.00	1.00
Ce	1 = elicitation method = choice experiment	0.14	0.00	1.00
Nrev	1 = study was not peer-reviewed	0.24	0.00	1.00
median	1 = wtp estimate = median	0.33	0.00	1.00

Table 1.2: Parameter Estimates for the Meta-Analysis

	mean	std.	p(> 0)[1]
Constant	-0.546	3.097	0.430
context-specific			
Lnyear	-0.359	0.667	0.281
Lninc	0.211	0.363	0.723
Sagulf	-0.406	1.743	0.405
Nema	-0.784	1.538	0.295
Nmw	-1.073	1.556	0.244
Local	3.130	0.895	0.999
Prov	-2.273	0.876	0.009
Reg	1.632	0.850	0.970
Cult	-0.317	1.563	0.413
Forest	1.118	0.726	0.937
Moderators			
Volunt	-0.016	1.038	0.495
lumpsum	1.486	0.771	0.968
ϒ	0.008	0.007	0.883
σ_{ϵ}^{2}	0.474	0.260	1.000

The first column of Table 1.2, above, reports all of the explanatory variables used in the final meta-analysis. The second column reports the mean estimated value of the coefficient for each variable. Using those results, we can re-write the general equation (1) as the estimated equation (2). Equation (2) was used to generate the WTP/HH/acre for each state presented in Table III-9 (pp. 77-78).

$$(2)\ \ln(WTP) = -0.546 - 0.359 * \ln(year) + 0.211 * \ln(inc) - 0.406 * Sagulf - 0.784 * Nema - 1.073 * Nmw + 3.130 * Local - 2.273 * Prov + 1.632 * Reg - 0.317 * Cult + 1.118 * Forest - 0.016 * Volunt + 1.486 * Lumpsum + \ln(0.008^{-1} * (\exp(0.008 * q_1) - \exp(0.008 * q_0)))$$

The variables Sagulf, Nema and Nmw indicate whether a state is located in a particular region. The values of these variables for each state are presented in Table III-8 (pp. 74-75). That table also presents values for the other state-specific explanatory variables: log of average income ln(inc), proportion of forested acres (Forest), and change in wetland acres ($q_1 - q_0$).

The variables ln(year), local, volunt, and lumpsum are related to how the original empirical studies used in the meta-analysis were conducted. Those variables are not state-specific but, because they show up in the estimated equation, i.e., equation (2), a value must be assumed for each in order to generate an estimate of the dependent variable. In situations such as this, the mean value of the variable is conventionally used. The mean values are reported in Table 1.1, above.

The variables Prov (provisioning), Reg (regulating), and Cult (cultural) describe the functions of the wetlands affected by the policy change in the original empirical studies. Ideally, these would be state-specific variables, identifying the extent to which the wetlands affected by rescinding the 2015 Rule perform those functions. The December 2018 EA, however, does not provide any information about the functions of the affected wetlands. Therefore, one is left to assume the mean value for each of those variables was used for every state to estimate the dependent variable. The December 2018 EA also states, "the mean value for baseline acres from the primary studies is used for q_0 which is 10,000 acres…The value for q_1 for each state is 10,000 acres plus the expected change in jurisdictional wetland acres for each state." (pp. 73-74). Using the state-specific values in Table III-8 (p. 74) for Alabama along with the mean values for the other variables, equation (2) can be used to estimate ln(WTP) for Alabama as in equation (3).

$$(3)\ \ln(WTP) = -0.546 - 0.359 * 1.57 + 0.211 * 47{,}221 - 0.406 * 1 - 0.784 * 0 - 1.073 * 0 + 3.130 * 0.33 - 2.273 * 0.24 + 1.632 * 0.52 - 0.317 * 0.76 + 1.118 * 0.9632 - 0.016 * 0.43 + 1.486 * 0.43 + \ln(0.008^{-1} * (\exp(0.008 * 10{,}007.3) - \exp(0.008 * 10{,}000)))$$

Equation (3) provides an estimate of ln(WTP) for all of the affected acres. Taking the anti-log of that value and dividing by the number of affected acres (7.3 in the case of Alabama) will yield an estimate of WTP/household/acre. For Alabama, equation 3 yields a value of \$0.037/HH/acre. This is different than the Mean WTP/household/acre reported in Table III-9 (pp. 77 and 78), which is \$0.030. In fact, the estimate using equation (3) is different than the value reported in Table III-9 for every state.

One problem may be that the mean value for baseline acres reported in Table III-6 (p. 72) should be 40,000 acres, not 10,000 acres as stated. Changing the value of q_0 to 40,000 leads equation (3) to generate estimates that are closer to those in Table III-9, but still considerably different. Digging deeper, the closest equation (3) can come to the estimated in Table III-9 is to have 40,000 baseline acres and assume values of zero for the variables Volunt and Lumpsum, although there are still up to *three-fold* differences for some states. If that is, in fact, what was done, a multitude of questions arise.

In short, there is no clear way to replicate the results of Table III-9 using the information presented in Section III.C.2.2.3.2 of the December 2018 EA. The agencies must explicitly demonstrate how the coefficient estimates from the meta-analysis are used to generate the results of Table III-9, and, if they did not use specific variables, clearly justify why.

1.2 Scope of the Analysis

Main Conclusion: Wetland values do not stop at the state border. Assuming household WTP = 0 for households outside of the state systematically under-estimates the foregone benefits of rescinding the 2015 Rule. Including adjacent states in the analysis leads foregone benefits to: (i) exceed "Low" avoided costs for the CWA 404 program across all scenarios (0, 1, 2, and 3); (ii) exceed "High" avoided costs in Scenario 3; (iii) nearly equal "High" avoided costs in Scenario 0 and Scenario 1; (iv) lie within 20% of the "High" avoided costs in Scenario 2. Considering this, plus the lack of precision regarding the estimated foregone benefits (see section 1.4 below) it is not at all clear that the avoided costs exceed the foregone benefits for any scenario. Additionally, ignoring economies of scale related to the costs of administering and enforcing regulations will lead to further under-estimation of the foregone benefits. (Also see critique of avoided cost estimates in Appendix Section 4.)

Detailed Discussion: The December 2018 EA meta-analysis employs a troubling assumption about the value of wetlands across state lines. On page 69, the report states, "Wetland benefits are, in general, a more local commodity." This may be true for some of the functions wetlands serve, but for other functions the value of a wetland may have significant geographic scope. For example, the Prairie Pothole Region (PPR) of the northern plains serves as an important breeding ground for migratory game birds. Duck hunters in Pennsylvania, thousands of miles from the PPR derive direct benefits from those wetlands (Kinnell et al., 2002). Ironically, North Dakota, in the heart of the PPR, is projected to lose the most wetland acres of any state in the nation if the 2015 Rule is rescinded. (Note: Pennsylvania is not adjacent to North Dakota)

Pate and Loomis (1997) also found residents in Oregon had non-zero willingness to pay for wetland preservation in California. In fact, one of the primary conclusions of that study is "…restricting benefits to just the political jurisdiction in which the site is located would understate the benefits…" (Pate and Loomis, 1997, p. 206). The notion that wetland benefits are restricted to residents of a state is especially difficult to conceive in densely populated corridors like the Northeast and Mid-Atlantic states that are relatively small in land area.

In the unit value transfer analysis presented in Table III-4 (p. 70), the annual foregone benefits for a state are estimated for that state alone, along with regional estimates that include the population of adjacent states. Applying the same scope of adjacent states to the meta-analysis leads to considerably different results for Scenario 0 (Table B-1, p. 222), and Scenarios 1, 2, and 3 (Tables III-10 through III-12, pp. 81-83).

Table 1.3, below, presents the "Low" and "High" annual avoided costs, as well as the annual foregone benefits for each of these scenarios, focusing exclusively on the CWA 404 program.

Oddly, the “Low” and “High” annual foregone benefits reported in Tables III-10 through III-12, as well as in Table B-1, are all based on the mean estimate of foregone benefits from Table III-9 (pp. 77-78). This is despite the fact that Table III-9 also presents an upper 95th estimate of foregone benefits, which would serve as a logical “High” annual foregone benefit estimate. Therefore, these “High” annual foregone benefits are also presented in Table 1.3.

The final two columns of Table 1.3 show the mean and upper 95th of annual foregone benefits for the CWA 404 under the adjacent state scope. The WTP/household/acre for adjacent states are generated using the elasticity of WTP with respect to income estimated by the meta-analysis (technical details available upon request).

The following points can be made using the results of Table 1.3:

- Using the upper 95th WTP/household/acre estimates more than doubles the annual foregone benefits, compared to the mean, under all four scenarios and both scopes of analysis.
- Expanding the scope of the analysis to include adjacent states increases annual foregone benefits by *three*- to *ten*-fold, under all four scenarios and both foregone benefits levels.
- Expanding the scope of analysis to include adjacent states and using mean WTP/household/acre, leads to annual foregone benefits that are
    - greater than the low avoided cost levels across all scenarios
    - greater than the high avoided cost in Scenario 3
    - nearly equal to the high avoided cost in Scenarios 0, 1, and 2
- Using the upper 95th WTP/household/acre estimates and expanding the scope of the analysis to include adjacent states leads to annual foregone benefits that are more than

double the high annual avoided costs across all scenarios, and more than *eight*-times the low avoided costs.

Table 1.3: Stage 1 Annual Avoided Costs and Annual Foregone Benefits by Scenario and Scope, (q_0 = 40,000 acres)

2017$ millions	Annual Avoided Costs[a]		Annual Foregone Benefits		Annual Foregone Benefits	
			Scope = Single State		Scope = Adjacent States	
Scenario 0	Low	High	Mean[b]	High[c]	Mean[d]	High[e]
Permit	$29.8	$74.7				
Mitigation	$57.4	$159.7				
CWA 404 Total	$87.2	$234.4	$59.4	$121.4	$216.6	$445.8
Scenario 1	Low	High	Mean	High	Mean	High
Permit	$15.7	$39.5				
Mitigation	$37.7	$57.6				
CWA 404 Total	$53.4	$97.1	$16.7	$38.6	$90.4	$207.7
Scenario 2	Low	High	Mean	High	Mean	High
Permit	$10.2	$25.5				
Mitigation	$26.7	$42.1				
CWA 404 Total	$36.9	$67.6	$14.3	$33.1	$56.0	$127.3
Scenario 3	Low	High	Mean	High	Mean	High
Permit	$1.5	$3.8				
Mitigation	$2.3	$2.9				
CWA 404 Total	$3.8	$6.7	$1.2	$2.8	$11.8	$26.5

a: As reported in Tables III-10 through III-12 and Table B-1.
b: As reported in Tables III-10 through III-12 and Table B-1.
c: Uses Upper 95th WTP/household/acre from Table III-9; assumes WTP=0 for residents outside of the state.
d: Uses mean WTP/household/acre from Table III-9; includes WTP>0 for residents outside of the state.
e: Uses Upper 95th WTP/household/acre from Table III-9; includes WTP>0 for residents outside of the state.

With respect to costs to states that continue to regulate waters that are no longer protected by the 2015 Rule (Category 4 dredge/fill states), the December 2018 EA assumes there are no costs or benefits from the Rule change. While it is true that there would be no foregone benefits generated by wetlands in such states – the same set of waters would continue to be regulated – the assumption implies that the presence of federal regulations has no impact on the regulatory costs at the state level. This is unlikely to be true. States may require significant additional resources to fill the regulatory void left by the federal government. Additionally, there are likely to be economies of scale related to regulatory scope so that the total regulatory costs of a federal regulation are lower than the sum of the regulatory costs of implementing the same regulation at the state level in every state. In other words, there is likely to be an economy of scale with respect to the regulating entity. The increase in regulatory costs to states that continue to implement the 2015, therefore, is a foregone benefit which, if excluded, will lead to further underestimation of the foregone benefits of rescinding the 2015 Rule.

1.3 Data Issues: CPI, Affected Acres

Main Conclusions: The CPI used to inflate WTP values for the meta-analysis are too low, leading to a systematic under-estimation of annual foregone benefits. Considering the central nature of affected acres to the analysis, it is essential the agencies fully explain and justify the methodology used to estimate that parameter for each state. Basing the number of acres affected by rescinding the 2015 Rule on previous permitting activity will likely under-estimate affected acres. And finally, assuming a baseline acreage of 10,000 acres (or is it 40,000 as noted in section 1.2 above?) for every state is absurd and leads to further under-estimation of the foregone benefits.

Detailed Discussion: Table III-3 (p. 69) appears to have used the wrong inflation factor for adjusting the values from the Blomquist and Whitehead 1998 study. In that paper, the WTP estimates are reported in 1990$'s. The inflation factor for 1990 to 2017 reported in the US Census Bureau CPI-U-RS table (https://www.census.gov/topics/income-poverty/income/guidance/current-vs-constant-dollars.html) is 1.82. The December 2018 EA uses four values from that study. In the original paper those values are $1.69, $4.69, $3.68, and $11.12 in 1990$'s ($3.08, $8.53, $6.70, and $20.40, respectively in 2017$'s). The values used in the December 2018 EA's meta-analysis, as reported in Table III-5 (p. 71), are all lower than these values. In fact, all of the WTP values reported in Table III-5 are lower than the values reported in the original papers inflated to 2017$'s using the CPI-U-RS inflation factors. As a result, the WTP estimates generated by the meta-analysis used in the December 2018 EA are systematically under-estimated. This needs to be reconciled.

The agencies use the estimates from the meta-analysis to generate state-level estimates of the foregone benefits that would occur if the 2015 Rule were to be rescinded. They do this by multiplying WTP/household/acre by the number of households and the number of impacted acres. There is, however, no explanation in the December 2018 EA of how the number of impacted acres was estimated at the state-level. On page 18, the agencies state, "fewer wetlands would be considered jurisdictional under the proposed Rule for this category of wetlands, but the agencies are not able to quantify this change." This is a critical parameter for their analysis, the estimation of which needs to be fully justified. If it is based on permitting activity under the 2015 Rule, then it is likely to systematically under-estimate the number of acres impacted by returning to the pre-2015 Rule. This is because, in addition to actual permit applications, the permitting costs may have deterred some wetland conversion activity, activity that may arise -

under the pre-2015 Rule. It is essential for the agencies to address how such an important component of the analysis was established.

More importantly, the December 2018 EA assumes 10,000 acres as the baseline (q_0) for every state. This variable has an exceptional influence on the estimated annual foregone benefits. Wetland acres certainly vary by state, and most states have considerably more than 10,000. Table A-1 (pp. 219-221) of the appendix reports the wetlands acres by state from the National Wetland Inventory (NWI). The agencies argue that the NWI is not a regulatory database and should not be used to set the baseline acreage for the December 2018 EA. Accepting that, the NWI does provide significant information about the appropriateness of using 40,000 acres as a baseline for every state. The NWI wetland acres range from 57,000 acres in West Virginia up to 12.2 million acres in Florida, with an average of 2.4 million acres across all states.

The December 2018 EA explains the 10,000-acre baseline is used to avoid out-of-sample prediction. Considering the vast difference in NWI acres across states and the fact that all states have NWI acreage greater than 10,000 acres (and greater than 40,000 acres), it is inappropriate to use such a low value for the baseline acreage. The agencies could partly rectify this situation and still comply with their out-of-sample prediction concerns by simply using the maximum number of baseline acres (q_0) reported in Table III-6 (p. 72) as the baseline acreage for every state. This would still likely underestimate the annual foregone benefits, but it would be a step in the right direction.

Table 1.4 presents the results of changing the baseline acreage (q_0) from 40,000 to 220,000 acres.

Table 1.4: Stage 1 Annual Avoided Costs and Mean Annual Foregone Benefits by Scenario and Scope and Baseline Acreage

2017$ millions	Annual Avoided Costs[a]		Annual Foregone Benefits		Annual Foregone Benefits	
			Scope = Single State		Scope = Adjacent States	
Scenario 0	Low	High	Mean 40[b]	Mean 220[c]	Mean 40[d]	Mean 220[e]
Permit	$29.8	$74.7				
Mitigation	$57.4	$159.7				
CWA 404 Total	$87.2	$234.4	$59.4	$204.8	$216.6	$754.6
Scenario 1	Low	High	Mean 40	Mean 220	Mean 40	Mean 220
Permit	$15.7	$39.5				
Mitigation	$37.7	$57.6				
CWA 404 Total	$53.4	$97.1	$16.7	$74.9	$90.4	$389.0
Scenario 2	Low	High	Mean 40	Mean 220	Mean 40	Mean 220
Permit	$10.2	$25.5				
Mitigation	$26.7	$42.1				
CWA 404 Total	$36.9	$67.6	$14.3	$64.6	$56.0	$240.9
Scenario 3	Low	High	Mean 40	Mean 220	Mean 40	Mean 220
Permit	$1.5	$3.8				
Mitigation	$2.3	$2.9				
CWA 404 Total	$3.8	$6.7	$1.2	$5.1	$11.8	$48.5

a: As reported in Tables III-10 through III-12 and Table B-1.
b: As reported in Tables III-10 through III-12 and Table B-1.
c: Re-estimates mean WTP/household/acre with baseline acreage set to 220,000; assumes WTP=0 for residents outside of the state.
d: Uses mean WTP/household/acre from Table III-9; includes WTP>0 for residents outside of the state.
e: Re-estimates mean WTP/household/acre with baseline acreage set to 220,000; includes WTP>0 for residents outside of the state.

One way the variation in baseline acres across states could be addressed would be to use the relative number of wetland acres listed in the National Wetland Inventory as a proxy. It is imperative the agencies address this issue.

1.4 Model Robustness: Theoretical Consistency (Concavity of benefit function), Counter-Intuitive Signs, Statistically Insignificant Variables, Wide CIs, Variable Selection

Main Conclusion: There are fundamental questions about the robustness of the meta-analysis used to estimate the foregone benefits based on the reported statistics and estimated coefficients.

Detailed Discussion – Variable Selection: The meta-analysis used an econometric technique called stochastic search variable selection (SSVS) to select the combination of variables listed in Table 1.1, above, that lead to the best-performing model. The criteria used to select the model are not detailed in the December 2018 EA, but the model selection was most likely based on either the Bayesian Information Criterion (BIC) or the Akaike Information Criterion (AIC) – conventional methods for model selection. This should be explicitly noted.

The general form of the model presented in the December 2018 EA is shown as Equation (1)

$$(1)\ y_s = X_s\beta + \ln\left(\gamma^{-1}\left(exp\left(\gamma q_{1,s}\right) - exp\left(\gamma q_{0,s}\right)\right)\right) + \varepsilon_s$$

where y_s is the natural log of WTP (per household per year) from study s, X_s is a vector of variables describing the context of the study s, $q_{1,s}$ is the post-policy wetland area, and $q_{0,s}$ is the baseline wetland area. As such, $(q_{1,s} - q_{0,s})$ is the number of wetland acres affected by the policy. The estimates of the econometric coefficients (β's, and γ) are presented in Table III-7 (p. 73) of the December 2018 EA, and reprinted in Table 1.2, below.

Table 1.1: Variables in the December 2018 Meta-Analysis

	Description	Mean	Min	Max
Lnwtp	log(total wtp in 2017 dollars)	3.56	1.05	6.06
Lnyear	log(year of data collection - oldest year +1)	1.57	0.00	2.89
Lninc	log(income in 2017 dollars)	10.97	10.64	11.48
Sagulf	1 = S-Atlantic/Gulf (AL,GA,SC,LA)	0.19	0.00	1.00
Nema	1 = NE/mid-Atlantic,(DE,MD,NJ,PA,RI)	0.14	0.00	1.00
Nmw	N/Mid-West (KY,MI,NE,OH,WI)	0.57	0.00	1.00
Local	1 = target population at sub-state level	0.33	0.00	1.00
Prov	1 = provisioning function affected	0.24	0.00	1.00
Reg	1 = regulating function affected	0.52	0.00	1.00
Cult	1 = cultural function affected	0.76	0.00	1.00
Forest	1 = forested wetland	0.52	0.00	1.00
q0	baseline acres (1000s)	40	0	220
q1	policy acres (1000s)	51	1	220
Volunt	1 = payment mechanism = voluntary contribution	0.43	0.00	1.00
lumpsum	1 = payment frequency = lump sum (single payment)	0.43	0.00	1.00
Ce	1 = elicitation method = choice experiment	0.14	0.00	1.00
Nrev	1 = study was not peer-reviewed	0.24	0.00	1.00
median	1 = wtp estimate = median	0.33	0.00	1.00

Table 1.2: Parameter Estimates for the Meta-Analysis

	mean	std.	p(> 0)[1]
Constant	-0.546	3.097	0.430
context-specific			
Lnyear	-0.359	0.667	0.281
Lninc	0.211	0.363	0.723
Sagulf	-0.406	1.743	0.405
Nema	-0.784	1.538	0.295
Nmw	-1.073	1.556	0.244
Local	3.130	0.895	0.999
Prov	-2.273	0.876	0.009
Reg	1.632	0.850	0.970
Cult	-0.317	1.563	0.413
Forest	1.118	0.726	0.937
Moderators			
Volunt	-0.016	1.038	0.495
lumpsum	1.486	0.771	0.968
Υ	0.008	0.007	0.883
σ_{ϵ}^2	0.474	0.260	1.000

The variables listed in Table 1.2 are the same as in Table 1.1, but without the Ce, Nrev, and Median variables. In other words, the model selected by the SSVS procedure did not include those variables (i.e., they do not influence the dependent variable, WTP/household/year).

The Mean column of Table 1.2 shows the expected value of each of the coefficients in the model. These are the expected impact of a unit change in the value of the variable on y. Note that y was expressed as the natural log of WTP for the model estimation. Likewise, year and income were also expressed in natural logs. We'll set those aside for the moment.

Let's start with the regional variables (Sagulf, Nema, Nmw). The Mean estimate of the coefficient for each of these regional variables is a measure of how the natural log of WTP changes for households within those regions compared to households not in those regions. So, households in the South Atlantic/Gulf region on average have a natural-logged willingness-to-pay that is 0.406 less than (note the negative sign on the coefficient) households that are not in Sagulf or Nema or Nmw. We can convert this to an impact on WTP itself (as opposed to the natural log of WTP) by taking the exponential function of the parameter (exp(-0.406) = 0.6663). Now, it is important to remember that these coefficients represent differences under *ceteris paribus* (i.e., all other things remaining the same) conditions. So, if two households have the same income and are evaluating the same change in wetland acres in the same year, etc., and the only difference is that one of them is located in the South Atlantic/Gulf region and the other is not located in either the Sagulf, Nema, or Nmw, then the household in Sagulf is only willing to pay $0.6663 for every dollar that the other household is willing to pay. That is, the Sagulf household's WTP is 66.63% of the other household's WTP.

Similarly, households in NE/mid-Atlantic region on average have a natural-logged willingness-to-pay that is 0.784 less than households that are not in Sagulf or Nema or Nmw. That is Nema households are only willing to pay $0.4566 for every dollar a household outside of Sagulf, Nema, and Nmw is willing to pay. And, finally, households in N/Mid-West region on average have a natural-logged willingness-to-pay that is 1.073 less than households that are not in Sagulf or Nema or Nmw, which translates to $0.3420 for every dollar of households outside Sagulf, Nema, and Nmw are willing to pay.

Now let's look at the Forest coefficient (1.118). We have the same interpretation as above. Namely, we can take the exponential function of the coefficient and determine how willingness-to-pay is affected by the wetland acre being forested versus non-forested, *ceteris paribus*. Here exp(1.118)=3.0587, so households are willing to pay 3.0587 times as much for forested wetlands as for non-forested wetlands. This has considerable implications for the development of the state-level WTP per household per acre estimates presented in Table III-9 (pp. 77-78) of the December 2018 EA.

Local, Volunt, and lumpsum variables pertain to how a particular study was conducted, and the coefficients can all be interpreted in the same manner as above.

I have questions about the Lnyear variable. It is unclear what is meant by "oldest year," and there is no information about that variable in the meta-analysis data file titled EPA-HQ-OW-2018-0149-0087-1-Wetland Valuation Studies Meta-Data for Proposed Rule EA. The agencies need to explain how this variable was used in to generate the results in Table III-9.

According to Table 1.2 the Prov, Reg, and Cult variables take on a value of 1 (zero, otherwise) if provisioning, regulating, or cultural functions, respectively, are "affected." In the data file referenced above, the description of those variables is that they take on a value of 1 if the study "describes" those functions to the respondent. These are very different things, and the inconsistency should be clarified. Nonetheless, the coefficient of the Prov variable is negative, meaning households value wetlands that directly provide services less (depending on the definition of Prov) than wetlands that do not. According to the coefficient estimate, provisioning wetlands are only worth 10.3% of the value of a non-provisioning wetland, *ceteris paribus.* This is a very counter-intuitive and brings into question the veracity of the results.

Similarly, wetlands that serve cultural functions are valued at only 72.83% of the value of wetlands that do not serve cultural functions, another counter-intuitive result. However, the counter-intuitive sign on the Cult coefficient is less troubling than the coefficient on Prov. To understand why, let's look at the last column of Table 1.2. That column shows the proportion of the distribution of the coefficient that lies above 0 on the number line.

It is important to recognize that the *estimated* coefficients (β's and γ) are random variables. As such, they have a mean (expected value) but also variation around that mean (std. in Table 1.2). The p(>0) values in Table 1.2 represent how confident we are that the true coefficient (not it's estimate) is greater than zero. So, the p(>0) value of 0.413 for the Cult variable means that we are 41.3% confident that the coefficient is positive, and 58.7% (100%-41.3%) confident that it is negative. Now, conventional confidence levels used in empirical analysis are 95% or 99%, and occasionally 90%. So, by conventional measures we would not be convinced that the Cult coefficient is positive, nor would we be convinced that it is negative. In other words, we are not convinced that it is not, in fact, equal to zero! A coefficient of zero would mean that wetlands that serve cultural functions do not affect a household's willingness to pay for wetlands. This may be unexpected, but it is easier to reconcile than a negative coefficient.

The p(>0) value for the Prov coefficient, however, is 0.009. In other words, we are 99.1% sure that the true coefficient for the Prov variable is negative. When a statistical analysis strongly suggests a counter-intuitive result, in the absence of a rationale or explanation to support the result, one begins to suspect that there may be something fundamentally wrong with the model used in the statistical analysis (for example bias associated with omitted variables).

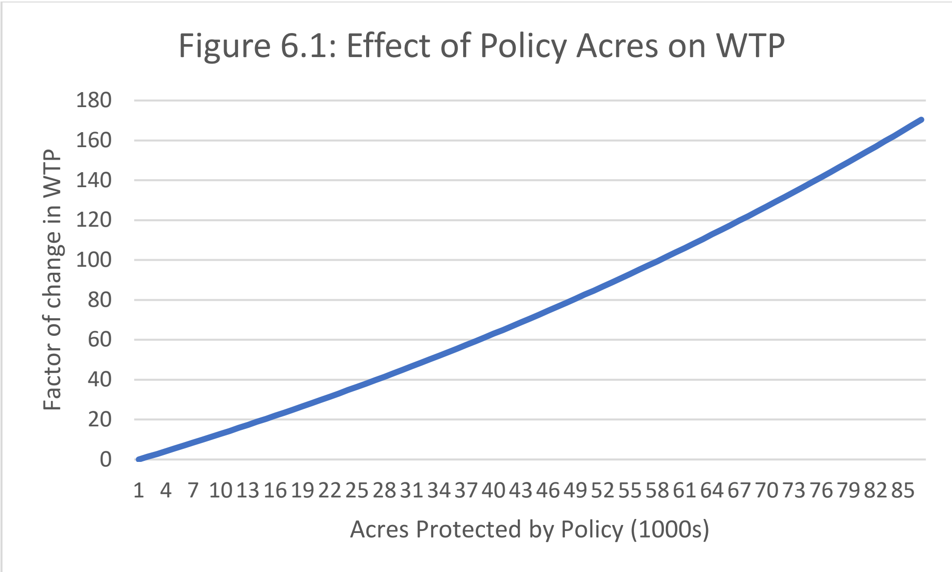
In line with the explanation above, there is convincing evidence that the coefficients for the Local, Reg, Forest, and lumpsum variables are greater zero, and the Prov coefficient is less than zero. The other coefficients (including the regional variables discussed above), however, are not convincingly different than zero.

Nonetheless, let's look at the two remaining variables, Lninc and γ. The coefficient for Lninc has a special interpretation because Lninc, like y (WTP/household/year), is measured in natural logs. This means that the coefficient represents the percentage change in WTP due to a 1% change in household income. This relationship is known as an "elasticity" in economics. The estimated coefficient of 0.211 suggests that a 1% increase in household income will result in a 0.211% increase in WTP. This elasticity can be exploited to develop estimates of foregone benefits that include households in neighboring states, as presented in section 1.2, above. The technical details of that can be provided upon request. Let's discuss the γ parameter.

The γ parameter reflects how the scope of the policy (number of wetlands protected) affects a household's willingness-to-pay. Looking at the p(>0) value for this parameter, we are only 88% sure that it is not zero, outside of the least conservative conventional level, but close to it. If we accept that γ is positive, then as the number of acres affected by the policy increases, the willingness to pay for the policy also increases. This is perfectly intuitive and consistent with economic theory (i.e., more of a good thing is preferred to less). On page 70, the December 2018 EA, however, states the following:

> "The study performs a Bayesian non-linear meta-regression that ensures the benefits function meets a set of utility theoretic validity criteria. Those criteria are: concavity of the benefits function over wetland acres…"

In lay terms, concavity of the benefits function means that benefits are increasing at a decreasing rate. In other words, the marginal benefits of regulating wetlands decline as the number of regulated acres increase. The December 2018 EA argues on page 55, "If the marginal benefits of regulating water decline as smaller waterbodies are regulated (which would be a common assumption of diminishing marginal benefits) then the benefits of the 2015 Rule and 2017 Proposal may be overstated." The curious thing is that the econometric model estimated in the meta-analysis is actually *convex* in the number of acres regulated, not concave. This can be shown mathematically by taking the anti-log of Equation (1), above, and then taking the derivative of the anti-log with respect to q_1, the post-policy number of protected wetland acres. The first derivative is strictly positive, regardless of the sign of γ. The sign of the second derivative, however, depends on the sign of γ. The meta-analysis estimates $\gamma = 0.008 > 0$. When γ is positive the second derivative is also positive, meaning the WTP for a policy is increasing at an *increasing* rate as the scope of the policy widens. In other words, the marginal benefits are increasing. The increasing marginal benefits can also be demonstrated numerically by choosing values for q_1, calculating the resulting y, and plotting the relationship between the two. This relationship is illustrated in Figure 1.1 below. This relationship is independent of the value of any other variables (Sagulf, Nema, Nmw, Prov, Forest, etc.).



The desire to model the benefit function as concave is rooted in the December 2018 EA identification of "potential biases" in the EAs of the 2015 Rule and proposed 2017 Rule. As noted above, one of the concerns is expressed on p. 55 of the December EA as follows:

> "If the marginal benefits of regulating water decline as smaller waterbodies are regulated (which would be a common assumption of diminishing marginal benefits) then the benefits of the 2015 Rule and 2017 Proposal may be overstated. If the costs of regulating increases as smaller water bodies are regulated (an assumption of increasing marginal costs) then the costs of these two actions would have been underestimated."

The problem with this statement is that the size of the waterbody is not used to establish a jurisdictional determination – none of the WOTUS Rules, including the proposed 2017 Rule and the proposed 2019 Rule, define WOTUS based on size – nor are the benefits of a waterbody solely a function of its size. The 2015 Rule may have brought waters of exceptional value under regulation. Because the 2015 Rule classifies new waters as WOTUS based on a variety of factors, it is entirely plausible that the marginal benefit function could be increasing, i.e., the waters protected under the 2015 Rule are more valuable than the least valuable waters protected under the pre-2015 Rule. Similarly, the marginal cost curve may be negatively sloped. The odd thing is that the December 2018 EA first asserts that the marginal benefit function should be decreasing (i.e., a concave benefit function), then claims to estimate a benefit model that is concave but actually estimates a benefit function that is convex. The agencies need to address these contradictions and explain the implications of a convex benefit function for the analysis.

The income variable, measured in natural log, is important in the calculation of the of WTP per household per acre. As we see from Table 1.2, the p(>0) value is only 0.723, meaning we are only 72.3% sure it is positive. From a "statistical significance" perspective we would not be willing to conclude that it is, in fact, different from zero. That is, there is not convincing evidence that household income has an effect on household WTP.

As discussed above, I have been unable to replicate the results using the estimated coefficients. Nonetheless, the December 2018 EA claims, "Using the results of the meta-analysis to estimate a change in benefits for each state resulting from a change in wetland area requires the following state-specific variables: change in wetland acres because of CWA jurisdictional changes, average household income, number of households, proportion of changes in acres that is forested, and region of the United States" (p. 73). So, at the state level, the key drivers of the estimated WTP per household per acre are the region the state is located in, it's average household income, it's proportion of forested wetlands, and the number of acres affected by the policy change even though there is not convincing evidence that the region, income or number of acres actually influence WTP. (Actually, another important state-level parameter, as demonstrated in Table 1.4, is the baseline acreage parameter q_0.)

The effect of the uncertainty related to these variables in particular, and the model in general, can be seen in the confidence intervals for the WTP/household/acre. The lower bound of the 95% confidence interval is zero for many states, while the upper bound is generally more than twice as much as the mean. In other words, the meta-analysis lacks precision. This is reinforced when one looks at the 95% confidence interval for the annual foregone benefits, also presented in Table III-9. For California, for example, the lower bound of annual foregone benefits is just over $37,000 while the upper bound is more than $20.2 million! Given the lack of precision of the estimates from the meta-analysis, it is entirely inappropriate to treat the mean annual foregone benefit estimates as both the “Low” and “High” estimates in Scenarios 0, 1, 2, and 3. (See Section 1.2, Table 1.3, above.)

2. Critique of the December 2018 EA, Stage 2 Analysis

Stage 2 of the December 2018 EA focuses on the replace component of rescind-and-replace, i.e., the annual avoided costs and foregone benefits of moving from the pre-2015 Rule to the proposed 2019 Rule. For this analysis, the December 2018 EA conducted three watershed-level case studies. For each of the case studies, a single study from the empirical literature was used to generate estimates of the annual foregone benefits for a specific watershed. At the end of the day, however, the Stage 2 analysis utilizes the results of the meta-analysis from Stage 1 to generate the annual foregone benefits in each state and at the national level. As such, all of the criticisms of both the meta-analysis and the Stage 1 results discussed above also pertain to the Stage 2 analysis.

Tables 2.1 and 2.2 present the results for Stage 2 under the same conditions as Tables 1.3 and 1.4, respectively, with similar conclusions. Namely, that the scope of the analysis and the baseline acreage have dramatic effects on the estimated annual foregone benefits. Furthermore, the annual foregone benefits can easily exceed the annual avoided costs under Scenarios that are equally plausible to the scenarios presented in the December 2018 EA.

Table 2.1: Stage 2 Annual Avoided Costs and Annual Foregone Benefits by Scenario and Scope, q_0 = 40,000 acres

2017$ millions	Annual Avoided Costs[a]		Annual Foregone Benefits		Annual Foregone Benefits	
			Scope = Single State		Scope = Adjacent States	
Scenario 0	Low	High	Mean[b]	High[c]	Mean[d]	High[e]
Permit[f]	$26.6	$26.2				
Mitigation[g]	$209.9	$470.0				
CWA 404 Total	$236.5	$496.6	$135.6	$300.3	$419.5	$898.3
Scenario 1	Low	High	Mean	High	Mean	High
Permit	$16.0	$16.0				
Mitigation	$118.6	$249.7				
CWA 404 Total	$134.6	$265.7	$46.8	$104.0	$233.9	$496.4
Scenario 2	Low	High	Mean	High	Mean	High
Permit	$10.6	$10.6				
Mitigation	$101.9	$204.3				
CWA 404 Total	$112.5	$214.9	$41.7	$92.7	$193.4	$408.3
Scenario 3	Low	High	Mean	High	Mean	High
Permit	$2.4	$2.4				
Mitigation	$25.3	$60.2				
CWA 404 Total	$27.6	$62.6	$6.9	$14.2	$74.3	$152.9

a: As reported in Table IV-61.
b: As reported in Table IV-62.
c: Uses Upper 95th WTP/household/acre from Table IV-62.
d: Uses mean WTP/household/acre from Table IV-62; includes WTP>0 for residents outside of the state.
e: Uses Upper 95th WTP/household/acre from Table IV-62; includes WTP>0 for residents in adjacent states.

Table 2.2: Stage 2 Annual Avoided Costs and Mean Annual Foregone Benefits by Scenario and Scope and Baseline Acreage

2017$ millions	Annual Avoided Costs[a]		Annual Foregone Benefits		Annual Foregone Benefits	
			Scope = Single State		Scope = Adjacent States	
Scenario 0	Low	High	Mean 40[b]	Mean 220[c]	Mean 40[d]	Mean 220[e]
Permit	$26.6	$26.2				
Mitigation	$209.9	$470.0				
CWA 404 Total	$236.5	$496.6	$135.6	$567.9	$419.5	$1,648
Scenario 1	Low	High	Mean	Mean 220	Mean	Mean 220
Permit	$16.0	$16.0				
Mitigation	$118.6	$249.7				
CWA 404 Total	$134.6	$265.7	$46.8	$200.3	$233.9	$905.7
Scenario 2	Low	High	Mean	Mean 220	Mean	Mean 220
Permit	$10.6	$10.6				
Mitigation	$101.9	$204.3				
CWA 404 Total	$112.5	$214.9	$41.7	$179.4	$193.4	$742.7
Scenario 3	Low	High	Mean	Mean 220	Mean	Mean 220
Permit	$2.4	$2.4				
Mitigation	$25.3	$60.2				
CWA 404 Total	$3.8	$6.7	$6.9	$24.7	$74.3	$266.6

a: As reported in Table IV-61.
b: As reported in Table IV-62.
c: Re-estimates mean WTP/household/acre with baseline acreage set to 220,000; assumes WTP=0 for residents outside of the state.
d: Uses mean WTP/household/acre from Table IV-62; includes WTP>0 for residents outside of the state.
e: Re-estimates mean WTP/household/acre with baseline acreage set to 220,000; includes WTP>0 for residents outside of the state.

8. A Single Action, Not a 2-Stage Process

The idea that the proposed 2019 Rule actually constitutes a two-stage process is difficult to believe. The goal of the proposed 2019 Rule is to change the WOTUS definition to something less strict than the pre-2015 Rule. Breaking the December 2018 EA into two stages seems disingenuous, especially because the estimates of annual foregone benefits are affected by that approach. The reason for that is related to the convexity of the estimated benefit function and the baseline acres, discussed above. In particular, if the benefit function is convex and the proposed 2019 Rule actually constitutes a single rescind-and-replace action then treating the Stage 2 analysis as separate from the Stage 1 analysis will systematically under estimate the total effect of rescind-and-replace. To understand how, let's look at Florida. Table III-9 (p. 77) estimates 28.6 acres will be affected by rescinding the 2015 Rule. Table F-5 estimates the proposed 2019 Rule will affect an additional 439.5 acres. The December 2018 EA calculates Florida's mean WTP/household/acre to be $0.0190 in Stage 1 and $0.0195 in Stage 2, a 2.5% increase. As we can see, the WTP/household/acre is increasing in the number of affected acres. As such, treating the proposed 2019 Rule as a single rescind-and-replace action resulting in 468.1 affected acres will lead to an even larger WTP/household/acre and larger annual foregone benefits than treating the two actions separately. The systematic under-estimation of annual foregone benefits from using this two-stage is compounded by the low assumed value of the baseline acreage, again due to the convexity of the estimated benefit function.

Table 8.1 presents mean estimated annual foregone benefits for a single-stage analysis of the CWA 404 programs using 220,000 acres as the baseline. This is done for both the single-state scope as well as including adjacent states, as in the preceding analyses.

Table 8.1: Single Stage Annual Foregone Benefits by Scenario and Scope (q_0 = 220,000)

2017$ millions	Annual Foregone Benefits	
	Scope = Single State	Scope = Adjacent States
Scenario 0	$772.9	$2,403.4
Scenario 1	$275.2	$1,295.2
Scenario 2	$244.2	$984.1
Scenario 3	$29.8	$315.1

9. Conclusions

The December 2018 EA has some fundamental flaws, all of which lead to systematic under-estimation of the annual foregone benefits of rescinding the 2015 Rule and replacing it with the proposed 2019 Rule. Given these problems it is inappropriate to make a regulatory decision based on the benefits presented in the December 2018 EA.

The agencies are urged to do the following:

1. Provide an additional analysis estimating the annual foregone benefits of the CWA 404 programs as a single transition from the 2015 Rule to the proposed 2019 Rule.
2. Explicitly show how the results of the meta-analysis can be used to replicate Table III-9 and Table F-5.
3. Considering the fundamental importance of the baseline acreage, provide additional analyses using 220,000 acres as the baseline for each state.
4. Conduct sensitivity analysis around the affected acres parameters for each state, acknowledging the use of historical permitting data will under-estimate this important parameter.
5. Explain why the CPI-U values used in the December 2018 EA are not the same as those published by the Census Bureau.

6. Include “High” estimates of the annual foregone benefits for Stage 1.
7. Re-estimate the econometric model in the meta-analysis including the supporting function of wetlands as an explanatory variable.
8. Expand the scope of the benefits to include residents in adjacent states.

In summary, the meta-analysis and subsequent calculations used to estimate foregone benefits in both Stage 1 and Stage 2 of the December 2018 EA suffer from systematic under-estimation of the benefits, a highly consequential and dubious assumption related to baseline acres, and demonstrable evidence of the model’s lack of precision. In addition, the two-stage approach employed by the December 2018 EA leads to lower annual foregone benefits than a single stage approach would. A two-stage approach would only be appropriate if the proposed 2019 Rule actually constitutes a “rescind-and-replace” action that results in the pre-2015 WOTUS definition being in effect for a significant period of time. The agencies need to explain the extent to which the proposed 2019 Rule will result in the pre-2015 WOTUS definition being in effect and justify why the two-stage is appropriate in that circumstance.

References Cited

Kinnell, J., J. K. Lazo, D. J. Epp, A. Fisher, and J. S. Shortle. 2002. Perception and value for preventing ecosystem change: Pennsylvania duck hunters and the prairie pothole region. Land Economics 78:228–244.

Pate, J. and J. Loomis. 1997. The effect of distance on willingness to pay values: a case study of wetlands and salmon in California. Ecological Economics 20:199–207.

Appendix

A1. Introduction

The term "waters of the United States" (WOTUS) is used to determine whether a water body is governed by the requirements of the federal Clean Water Act (CWA). The exact scope of the term WOTUS has been in fluctuation since a 2001 Supreme Court decision and was further complicated by a subsequent Supreme Court case in 2006. In 2015, the Environmental Protection Agency (EPA) and the Department of the Army (Army) prepared a final Clean Water Rule (CWR) that sought to identify waters that are and are not WOTUS, thereby identifying which waters are subject to the CWA. EPA and the Army subsequently prepared a set of economic analyses to estimate the costs and benefits of implementing the new CWR, the most recent of which was completed in May 2015 (hereafter referred to as the "May 2015 EA").

In October of 2015, the U.S. Sixth Circuit Court of Appeals issued a stay on the new definition of WOTUS detailed by the 2015 CWR. As a result, the pre-2015 CWR definition of WOTUS is currently in effect.

In February 2017, President Trump signed Executive Order 13778 requiring the review of the "Waters of the United States Rule." In response, the EPA and the Army have initiated a two-step process to review and revise the definition of WOTUS established in the 2015 CWR. The first step entails re-codifying the definition of WOTUS to reflect the 2001 and 2006 Supreme Court decisions, overriding the definition promulgated by the 2015 CWR even if the current stay were lifted.

In June 2017, the EPA and the Army published an Economic Analysis for the Proposed Definition of "Waters of the United States" – Recodification of Pre-Existing Rules (hereafter referred to as the “June 2017 EA”). The June 2017 EA uses the May 2015 EA as a baseline to estimate the foregone benefits and avoided costs of not implementing the 2015 CWR.

In December 2018, the EPA and the Army published an Economic Analysis for the Proposed Definition of “Waters of the United States” – Recodification of Pre-Existing Rules (hereafter referred to as the “December 2018 EA”). The December 2018 EA uses the May 2015 EA as a baseline to estimate the foregone benefits and avoided costs of not implementing the 2015 CWR.

Both the May 2015 EA and the June 2017 EA focused on four sections of the CWA: Sections 311, 401, 402, and 404. The only substantive difference between the results of those two analyses has to do with their treatment of the potential costs and benefits associated with Section 404. As such, this report focuses exclusively on the Section 404 cost and benefit estimates.

A2. Overview of the May 2015 EA

The May 2015 EA estimates the potential costs and benefits of implementing the 2015 CWR. These are the costs and benefits that are expected to be realized if the 2015 CWR were to take effect.

A2.1 Cost Estimation under CWA Section 404

The May 2015 EA breaks the potential costs of implementing the 2015 CWR that are attributable to CWA Section 404 into three categories: wetland mitigation costs, stream mitigation costs, and permit application costs. Wetland mitigation costs were estimated at the state level and calculated as the product of additional state-level mitigated wetland acres and state-level costs per mitigated wetland acre. To estimate the total wetland mitigation costs for the country, the state-level mitigation costs were summed over all 50 states and the District of Columbia. Data from fiscal year 2009 (FY09) to FY14 were used to estimate the number of additional mitigated wetland acres due to the 2015 CWR, by state, as well as state-specific costs per mitigated wetland acre.

Stream mitigation costs were calculated in a similar manner. Utilizing data from FY13 and FY14 the number of additional linear feet of stream mitigation due to the 2015 CWR were estimated by state. This was then multiplied by a state-specific estimate of the mitigation cost per linear foot of stream, using the most up-to-date data available, to estimate the state-level total stream mitigation cost. The state-level costs were then summed to generate an estimated stream mitigation cost for the country.

There are two types of permits issued under CWA Section 404, general permits and individual permits. General permits are typically used to cover projects that are expected to have minimal impacts on WOTUS, and therefore require less documentation. Individual permits are required for projects that are expected to have more than minimal impacts. The individual permit application and review are more data-intensive and require significantly more documentation, and are typically more costly to obtain than general permits.

To estimate the additional permit application costs attributable to the 2015 CWR, the May 2015 EA used two different methodologies. In 1999, the US Army Corps of Engineers (USACE) conducted a review of permitting costs for "typical" projects up to three acres in size by interviewing Corps District staff and consulting firms that specialize in CWA Section 404 permit applications. This review resulted in a range of costs for a general permit ($3,00 - $10,000) and a range of costs for an individual permit ($10,000 - $24,000), both expressed in 1999 dollars. The 2015 EA provides some ad hoc rationale for using the upper value of these ranges – $10,000 for a general permit, and $24,000 for an individual permit – and inflates those values to 2014 dollars for one estimate of the additional application costs per permit type. Multiplying the estimated number of additional general and individual permits by their respective additional permit costs due to the 2015 CWR gives one estimate of the CWA Section 404 total additional permitting costs. This is referred to as the Low scenario in both the May 2015 EA and the June 2017 EA.

The other methodology uses a set of estimates from Sunding and Zilberman (2002). That study relied on data from a 1999 survey of private developers and wetland consultants detailing application costs for both general and individual permits. The sample of 103 survey responses represented applications from across the country, and generally reflected the mix of applicants (private entities v. public agencies), types of activities (flood control, quarry expansion, school construction, etc.), project size, impacted acres, and regional distribution of wetland permits in the late 1990s (Sunding and Zilberman, 2002). That study reports several sample statistics, broken down by permit type, as reported in Table 1. While these statistics are of interest, it would be informative if the standard deviation were also reported. It would also be helpful to know how many of the sample observations were general versus individual permits. It is also unclear how many entities provided the data. A select few developers and consultants may have provided information on multiple applications to generate the 103 observations, or each developer/consultant may have provided a single observation. This is not documented in either Sunding and Zilberman (2002) or the May 2015 EA.

Table 1: Sample Statistics of Permit Application Costs from the Sunding and Zilberman Survey

Permit Type	Cost per Permit (1999 dollars)			
	Minimum	Maximum	Median	Mean
General	$2,000	$140,076	$11,800	$28,915
Individual	$7,000	$1,530,000	$155,000	$271,596

Sunding and Zilberman (2002) argue against using the sample mean as an estimate of the average cost of a permit because permit costs are likely to vary by the size of the project. They then report the barest results from a statistical analysis aimed at deconstructing permit costs into a fixed cost and a cost per acre of impact.

> "The acreage of waters of the United States impacted by a project has a statistically significant effect on the cost of both the nationwide [general] and individual permit preparation costs. Utilizing the survey data, we determined a statistical relationship between these factors for both types of permits. For individual permits, application costs were measured as $43,687 plus $11,797 for each acre of impact. For nationwide [general] permits, costs were measured as $16,869 plus $9285 for each acre of waters of the United States impacted. Thus, permitting costs have statistically significant fixed and variable components and permits are more expensive to obtain for larger projects." (p. 74)

There is no information on the level of statistical significance of the fixed and per acre cost estimates by permit type. Nor is there any information about the statistical methods used to generate those estimates. The May 2015 EA uses these estimates in the following manner: the projected number of additional general permits due to the 2015 CWR (2,791) is multiplied by the fixed cost of a general permit ($16,869) to get a total general permit fixed cost; the average impacted acres per general permit (0.43) (based on FY13 data) is multiplied by the per acre cost of a general permit ($9,285) and by the number of additional general permits (2,791); these are then added together to estimate the total additional general permitting costs due to the 2015 CWR, and inflated to 2014 dollars. The same is done for individual permits using the projected additional individual permits (217), fixed individual permit cost ($43,687), individual permit average impacted acreage (5.94), and per acre cost of an individual permit ($11,797). These estimates are referred to as the High scenario in the May 2015 EA and the June 2017 EA.

A2.2 Benefit Estimation under CWA Section 404

Potential benefits of the 2015 CWR under CWA Section 404 result from the avoidance and minimization of project impacts as well as compensatory mitigation associated with the expansion of jurisdictional waters. The potential benefits of wetland impact avoidance and compensatory mitigation were estimated using the benefit transfer method in which the results from a study in one location are transferred to another study area, adjusting for differences in the characteristics of the two study areas. The potential benefits of stream impact avoidance and compensatory mitigation were not estimated.

Ten contingent valuation studies were used to develop willingness to pay (WTP) estimates per household per acre of wetland mitigation for the benefit transfer estimates. Four of those studies were used to estimate per household per acre benefits for Freshwater Forested wetlands; six studies were used to estimate per household per acre benefits for Freshwater Emergent wetlands. The studies used were summarized in Appendix B of the May 2015 EA, and that information is reprinted here in the Appendix.

The benefit transfer analysis accounts for state and regional variation in the WTP per household per acre estimates as well as the expected number of mitigated acres by wetland type to generate regional WTP per household estimates for the increase in mitigated acres due to the 2015 CWR. These are then multiplied by the number of households in the region to estimate total regional benefits. Summing across all regions leads to total projected CWA Section 404 wetland mitigation benefits attributable to the 2015 CWR.

A3. Overview of the June 2017 EA

The June 2017 EA considers the same policy change as the May 2015 EA but from the perspective of rescinding the 2015 CWR, as opposed to implementing it. As a result, the June 2017 EA calculates the costs avoided and the benefits foregone from not implementing the 2015 CWR. The methodology used in the June 2017 EA to estimate the costs avoided for each of the relevant CWA Sections (311, 401, 402, and 404) is identical to the methodology used in the May 2015 EA, merely inflating those results to report them in 2016 dollars.

The methodology for estimating the foregone benefits is also the same in the June 2017 EA as that of the May 2015 EA, with one exception – the foregone benefits of wetland mitigation under CWA Section 404. For this line item in the economic assessment, the value is deemed larger than zero but not estimated. To justify this omission, the June 2017 EA states:

> “The 2015 CWR wetland benefits were derived through a benefit transfer exercise using 22 estimates from 10 studies, examining households’ willingness to pay for wetland preservation. The studies were published between 1986 and 2000, although the agencies attempted to find more recent studies. More recent wetland studies were not available. The age of these studies introduces uncertainty…the limited number of studies available also restricts the application of common tests…necessary to validate the results.” (p. 8-9)

A4. Critique of the June 2017 EA

The June 2017 EA effectively made one change to the May 2015 EA: it removed the estimates of the benefits of the 2015 CWR for CWA Section 404. It is, however, difficult to reconcile this omission while retaining the CWA Section 404 permit cost estimates from that study. There were four general rationales for the benefit estimate omission: it is based on too few studies, the data are old, the methodology may be insufficient, and there are no recent studies available. Each of these criticisms can be levied at the CW Section 404 permit cost estimates as well.

The benefit estimates were derived from 22 sets of results generated by 10 different studies. The cost estimates were based on results of 2 studies.

The data for the benefit estimates are from surveys conducted between 1986 and 1999. The data for both the Low and High cost scenario estimates are from surveys conducted in 1999.

The benefit estimates used for the benefit transfer exercise may not have been collected and analyzed under what currently constitute best practices. While this may be true of the data collection, there is no reason the analysis could not be updated to reflect current practice. On the cost side, however, the Low cost scenario estimates were selected in a completely arbitrary manner, absent of any sound methodology. A range of cost estimates were solicited from USACE regulators for each permit type, and the highest value was selected to represent the Low cost scenario estimate. For the High cost estimates, the reported results are frustratingly opaque and prohibit any serious evaluation of their robustness or theoretical consistency. Sunding and Zilberman (2002) state that there is a "statistically significant" permit cost that is dependent on the impacted acres, but they do not state what the level of significance is. While the general convention for statistical significance is a p-value of 0.05, many studies highlight estimates as being statistically significant with p-values as high as 0.10. Because statistical significance is a subjective term, it is standard practice to report the p-value and/or the standard deviation of a parameter when claiming "statistical significance." Similarly, the authors report the range (min and max) of permit application costs from their survey as well as the mean and median by permit type, but they fail to report the standard deviations or the number of observations for each permit type. This omission prohibits investigating hypotheses related to the difference in the two means. Furthermore, it is left to the reader to assume that the fixed permit application cost estimates and the cost per impacted acre estimates were generated by a linear regression model. There is no mention of how those estimates were generated. Assuming it was through a linear regression model, there is no information about the functional form of the model or standard statistics regarding model performance such as R^2, F-statistic for the model, or t-statistics for the parameter estimates; neither is there any discussion of the other variables included in the model, results of tests for heteroskedasticity of the error term, or the potential for omitted variables bias. The authors report the results only for a linear relationship between permit application costs and impacted acres. It is, however, quite possible that a logarithmic relationship, quadratic or exponential relationship could perform better, and lead to dramatically different results.

While we have been unable to identify any new CWA Section 404 permit application cost studies since the two (based on 1999 survey data) mentioned above, there have been numerous peer-reviewed studies estimating the value of wetlands since 2000. These studies, referenced in Section 5, could certainly form the foundation for updating the benefits associated with wetland mitigation from the 2015 CWR.

A5. More Studies Related to Wetland Valuation

*Barbier, E.B., 2007. Valuing ecosystem services as productive inputs. *Economic Policy* 49: 178–229.

*Bin, O. 2005. "A semiparametric hedonic model for valuing wetlands," *Applied Economics Letters*, 12:10, 597-601.

*Carlsson F, P. Frykblom, and C. Lijenstolpe. 2003. "Valuing wetland attributes: an application of choice experiments," *Ecological Economics,* 47: 95–103.

*Costanza, R., O. Perez-Maqueo, M.L. Martinez, P. Sutton, S.J. Anderson, and K. Mulder. 2008. "The value of coastal wetlands for hurricane protection," *AMBIO: A Journal of the Human Environment*, 37(4):241-248.

*Gascoigne, W.R., D. Hoag, L. Koontz, B.A. Tangen, T.L. Shaffer, and R.A. Gleason. 2011. "Valuing ecosystem and economic services across land-use scenarios in the Prairie Pothole Region of the Dakotas, USA," *Ecological Economics*, 70:1715-1725.

*Jenkins, W.A., Murray, B.C., Kramer, R.A., Faulkner, S.P., 2010. "Valuing ecosystem services from wetlands restoration in the Mississippi Alluvial Valley," *Ecological Economics*, doi:10.1016/j.ecolecon.2009.11.022

*Kaffashi, S., Shamsudin, M. N., Radam, A., Rahim, K. A., and Yacob, M. R. (2015). "Users and non-users of wetland area: Willingness to pay and demand elasticity." J. Sustain. Develop., 8(8), 56–69.

*Yi, H., B. Güneralp, A.M. Filippi, U.P. Kreuter, and I. Güneralp. 2017, "Impacts of land change on ecosystem services in the San Antonio River Basin, Texas, from 1984 to 2010," *Ecological Economics* 135: 125-135.

*Turner, K.R., Georgiou, S., Fisher, B., 2008. Valuing ecosystem service: the case of multifunctional wetlands. Earthscan, London, UK.

*Moeltner, K. and R. Woodward. 2009. "Meta-functional benefit transfer for wetland valuation: making the most of small samples," *Environmental and Resource Economics*, 42:89-108.

*Liu, S., R. Costanza, A. Troy, J. D'Aagostino, and W. Mates. 2010. "Valuing New Jersey's Ecosystem Services and Natural Capital: A Spatially Explicit Benefit Transfer Approach," *Environmental Management*, 45:1271–1285.

*Mahan, B.L., S. Polasky, and R.M. Adams. 2000. "Valuing Urban Wetlands: A Property Price Approach," *Land Economics*, Vol. 76, No. 1, pp. 100-113.

*Johnston, R.J., J.J. Opaluch, M.J. Mazzotta, and G. Magnusson. 2005. Who Are Resource Nonusers and What Can They Tell Us About Nonuse Values? Decomposing User and Nonuser Willingness to Pay for Coastal Wetland Restoration. Water Resources Research 41(7): W07017.

*Costanza, R., R. deGroot, P. Sutton, S. van der Ploeg, S.J. Anderson, I. Kubiszewski, S. Farber, and R.K. Turner. 2014. "Changes in the global value of ecosystem services," *Global Environmental Change*, 26:152-158.

*Kubiszewski, I., R. Costanza, S. Anderson, and P. Sutton. 2017. "The future value of ecosystem services: Global scenarios and national implications," *Ecosystem Services*, 26:289-301.

*Frey, E.F., M.B. Palin, P.J. Walsh, and C.R. Whitcraft. 2013. "Spatial Hedonic Valuation of a Multi-use Urban Wetland in Southern California," *Agricultural and Resource Economics Review*, 42(2):387-402.

Baifu, X. 2007. "An hedonic analysis of southwest Louisiana wetland prices using GIS," *LSU Master's Theses.* 3475.

Frey, E.F., M.B. Palin, P.J. Walsh, and C.R. Whitcraft. 2013. "Spatial Hedonic Valuation of a Multi-use Urban Wetland in Southern California," *Agricultural and Resource Economics Review*, 42(2):387-402.

Lewis, S.E., J.S. Popp, L.A. English, and T.O. Odetola. 2017. "Willingness to Pay for Riparian Zones in an Ozark Watershed," *Journal of Water Resources Planning and Management*, 143(5).

*Petrolia, D., M.G. Interis, J. Hwang, M.K. Hidrue, R.G. Moore, and G.S. Kim. 2013. "America's Wetland? A National Survey of Willingness to Pay for Restoration of Louisiana's Coastal Wetlands," Final Project Report, Northern Gulf Institute, available at: https://www.americaswetland.com/photos/article/Report_4_1_13.pdf.

Brander, L., R.J.G.M. Florax, and J.E. Vermaat. 2006. "The empirics of wetland valuation: A comprehensive summary and a meta-analysis of the literature," *Environmental and Resource Economics*, 33: 223-250.

Woodward, R.T., and Y. Wui. 2001. "The economic value of wetland services: a meta-analysis," *Ecological Economics*, 37: 257-270.

Kreuter, Urs P., H.G. Harris, M.D. Matlock, and R.E. Lacey. 2001. "Change in ecosystem service values in the San Antonio area, Texas," *Ecological Economics,* 39: 333–346.

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In addition to his research, Dr. Mullen has taught a wide variety of graduate and undergraduate courses, including environmental economics, quantitative methods, econometrics, production economics, energy economics, and water resource economics.