CHAPTER 6

SMALL BUSINESS ANALYSIS

6.1 INTRODUCTION

The Regulatory Flexibility Act (RFA) (5 U.S.C. 601 et seq., Public Law 96-354) as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA) (Public Law 104-121) requires agencies to analyze how a regulation will affect small entities. The purpose of the RFA is to establish as a principle of regulation that agencies should tailor regulatory and informational requirements to the size of entities, consistent with the objectives of a particular regulation and applicable statutes. If, based on an initial assessment, a proposed regulation is likely to have a significant economic impact on a substantial number of small entities, the RFA requires an initial regulatory flexibility analysis.[1] The requirement to prepare an initial regulatory flexibility analysis does not apply to a proposed rule if the head of the agency certifies that the proposal will not, if promulgated, have a significant impact on a substantial number of small entities.

EPA performed an initial assessment and a small business analysis of impacts. The first steps in an initial assessment are presented in Section 6.2. Section 6.3 describes the methodology for the identifying small businesses in the MPP industry. Section 6.4 presents the results of the analysis and Section 6.5 reviews the steps EPA took to provide regulatory flexibility to the MPP industry.

6.2 INITIAL ASSESSMENT

EPA guidance on implementing RFA requirements suggests the following must be addressed in an initial assessment. First, EPA must indicate whether the proposal is a rule subject to notice-and-comment rulemaking requirements. EPA has determined that the proposed meat products effluent limitations guidelines (ELG) are subject to notice-and-comment rulemaking requirements. Second, EPA

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[1] The preparation of an initial regulatory flexibility analysis for a proposed rule does not legally foreclose certifying no significant impact for the final rule (EPA, 1999).

should develop a profile of the affected small entities. EPA has developed a profile of the meat products industry, which includes all affected operations as well as small businesses. Information specific to small business owned facilities is included in Section 6.3 after a description of the data and procedures that EPA used to identify the number of small entities. Third, EPA's assessment needs to determine whether the rule would affect small entities. EPA determined that the rule would affect small entities. Fourth, EPA determined whether the rule would have a significant adverse economic impact on a substantial number of small entities. Chapter 5 of this EA presents the analysis of projected economic impacts to the industry as a whole, including both small and large businesses. Much of the information covered in these chapters applies to small businesses. Additional information on small businesses in the meat products industry is provided in Section 6.4 of this chapter.

6.3 SMALL BUSINESS IDENTIFICATION AND PROFILE

6.3.1 Classification

The RFA defines a "small entity" is defined as: (1) a small business according to RFA default definitions for small business (based on Small Business Administration (SBA) size standards); (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field. EPA identified no small entities in the MPP industry that are governments or organizations.

The Small Business Administration (SBA) sets size standards to define whether a business entity is small and publishes these standards in 13 CFR 121. The standards are based either on the number of employees or receipts. When making classification determinations, SBA counts receipts or employees of the entity and all of its domestic and foreign affiliates (13 CFR.121.103(a)(4))). Under NAICS codes 311611, 311612, 311613, and 311615, a small business is defined as one with fewer than **500 employees**. Note that a facility may employ fewer than 500 employees but not be considered "small" by this standard if it is owned by a larger parent company and total employment among all facilities that company owns exceeds 500 workers (U.S. SBA, 2000).

6.3.1.1 Distinction between Small Business Analysis and MPP ELG Definitions for "Small"

The SBA definition for a "small business" for the MPP industry depends on whether the *company* has more than **500 employees**. For the MPP Industry, EPA has exercised its ability for regulatory flexibility by considering *facilities* than **produce less than a threshold amount (lb/yr)** ("small" facilities) to be outside of the scope of this regulation. The thresholds vary by subcategory, see Table 4-2. The focus of this chapter, then, is the impacts of the final rule on small business entities whose facilities produce more than threshold amounts of meat and poultry products.

6.3.1.2 Facilities in Subcategories A - D and K

Facilities that received the detailed survey were asked to provided information on corporate ownership. EPA could therefore identify corporate parents and the associated total company employment. As described more fully in Chapter 2, almost all the facilities that received a detailed survey were classified in Subcategories A - D and Subcategory K.

From this group of 57 surveys, EPA identified 4 small businesses that own meat or poultry facilities, however all of these facilities had production below the threshold being considered for this effluent guideline and are out of scope. **Therefore, EPA found no small business owned facilities in Subcategories A - D or Subcategory K that would be affected by this effluent guideline**.

6.3.1.3 Facilities in Subcategory F - I, J, and L

As described more fully in Chapter 2, analysis for facilities in Subcategories F - I, J, and L were based on screener survey data. Estimates of employment and revenue for these facilities were derived from Census data and can be found in Section 2.3. Average employment at nonsmall facilities in these subcategories does not exceed 400 workers.

Facilities that did not receive a detailed survey could be classified as a small or large entity only on the facility level information collected in the screener survey. An individual facility that employs more than 500 workers is owned by a large business whether or not that business owns any other facilities. EPA could therefore remove facilities clearly owned by large businesses from consideration. In order to overestimate, rather than underestimate, the number of small businesses in this group, EPA considered all remaining facilities as belonging to small businesses. This approach provides a maximum number of small businesses because there cannot be more businesses than facilities. On the other hand, any of the remaining facilities with 500 or fewer employees could easily belong to a company with more than 500 employees (e.g., the business owns multiple facilities but only one received a screener survey). EPA identified 33 potential small businesses among the facilities without detailed survey information.

6.3.1.4 Revenue and Employment Data for Small Business Owned Facilities

Based on the assumptions described above, EPA considers all 33 facilities identified in Subcategories F - I, J, and L to be small business owned. Of these, facilities in Subcategories F - I have the largest revenue and employment in both gross and average terms. On average, Subcategory L facilities have the next highest employment and revenues; however, in gross terms Subcategory J has larger revenues and employment. Full results are contained in Table 6-1.

Table 6-1
Employment and Revenue Data for Small Business Owned Facilities within the Scope of the Effluent Guideline by Subcategory

Subcategory	Number of Facilities	Employment	Average Facility Employment	Revenues ($000)	Average Facility Revenue ($000)
A - D	0	0	NA	$0	NA
F - I	4	1,506	377	$448,654	$112,164
J	19	1,123	59	$274,270	$14,435
K	0	0	NA	$0	NA
L	10	974	97	$223,663	$22,366
Totals	**33**	**3,603**	**NA**	**$946,587**	**NA**

6.4 IMPACTS FROM THE PROMULGATED RULE ON FACILITIES OWNED BY SMALL BUSINESSES

EPA identified 33 potential small businesses for facilities without detailed survey data (e.g., Subcategories E - I, Subcategory J, and Subcategory L). For these 33 potential small businesses, the promulgated rule leads to:

- 2 entities incurring pre-tax annualized costs in excess of 3 percent of revenues
- 7 entities incurring pre-tax annualized costs between 1 percent and 3 percent of revenues.

6.5 REGULATORY FLEXIBILITY

EPA exercised considerable regulatory flexibility in the development of this rule. First, EPA is not promulgating pretreatment standards, thus exempting about 95 percent of the industry at this step. Second, the final rule will include subcategory-specific production thresholds that will allow smaller direct discharging facilities to retain their existing limitations or to remain without national effluent limitations. In total, EPA is excluding approximately 97 percent of the MPP facilities from the scope of this rule.

6.6 REFERENCES

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CHAPTER 7

ENVIRONMENTAL IMPACTS AND POTENTIAL BENEFITS

7.1 MPP POLLUTANTS

The primary pollutants associated with MPP wastes are nutrients (particularly nitrogen and phosphorus), organic matter, solids, and pathogens. EPA identified 30 pollutants of concern for the meat processing segment of the industry and 27 pollutants of concern for the poultry processing segment of the industry. This list includes ammonia (as nitrogen), carbonaceous five-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), nitrate and nitrite (as nitrogen), oil and grease, pH, temperature, total nitrogen, and total phosphorus (as PO_4). The following sections include information from the *National Water Quality Inventory: 2000 Report*, (U.S. EPA 2000) or the *"2000 Inventory*," and introduce the main constituents of MPP industry waste streams. Prepared every two years under § 305(b) of the Clean Water Act, the *Inventory* summarizes state reports on the impairment of water bodies and suspected stressors.

7.1.1 Nutrients

The *2000 Inventory* lists nutrients as the leading stressor of impaired lakes, ponds, and reservoirs. Nutrients are also the fifth leading stressor of impaired rivers and streams, among the top 10 stressors of impaired estuaries, and the second leading stressor reported for the Great Lakes.

Nitrogen occurs in several forms, including ammonia and nitrate. These forms of nitrogen can produce adverse environmental impacts when they are transported in excess quantities to the environment. Ammonia is of environmental concern because it is toxic to aquatic life and exerts a direct oxygen demand on the receiving water as it is broken down, thereby reducing dissolved oxygen levels and the ability of a water body to support aquatic life. Excessive amounts of ammonia and other forms of nitrogen can lead to eutrophication, or nutrient overenrichment, of surface waters. Eutrophication is the most documented impact of nutrient pollution. Excess nutrients in surface water can also cause algal blooms, which depress oxygen levels and contribute further to eutrophication.

Phosphorus is of concern in surface waters because it is a nutrient that can lead to eutrophication and the resulting adverse impacts such as fish kills, reduced biodiversity, objectionable tastes and odors, increased drinking water treatment costs, and growth of toxic organisms. At concentrations greater than 1.0 milligram per liter, phosphorus could interfere with the coagulation process in drinking water treatment plants, reducing treatment efficiency. Phosphorus is of particular concern in fresh water, where plant growth is typically limited by phosphorus levels. Under high pollutant loads of phosphorus, however, fresh water could become nitrogen-limited. Thus, both nitrogen and phosphorus loads contribute to eutrophication.

7.1.2 Organic matter

BOD_5 and COD are important measures of the organic content of an effluent. The *2000 Inventory* indicates that low dissolved oxygen levels caused by organic enrichment (oxygen-depleting substances) are the third leading stressor in impaired estuaries. They are the fourth greatest stressor in impaired rivers and streams and the fifth leading stressor in impaired lakes, ponds, and reservoirs. Severe reductions in dissolved oxygen levels could lead to fish kills. Even moderate decreases in oxygen levels could adversely affect water bodies through decreases in biodiversity characterized by the loss of fish and other aquatic animals and a dominance of species that can tolerate low levels of dissolved oxygen.

7.1.3 Solids

The *2000 Inventory* indicates that dissolved solids are the fourth leading stressor in impaired lakes, ponds, and reservoirs. In general, solids can increase cloudiness of surface waters, physically damage aquatic plants and animals, and provide a protected environment for pathogens. Increased cloudiness reduces penetration of light through the water column and limits the growth of desirable aquatic plants that are critical habitat for fish, shellfish, and other aquatic organisms. Solids that settle out as bottom deposits can alter or destroy habitat for fish and organisms that live at the bottom.

7.1.4 Oil and Grease

Oil and grease could have toxic effects on aquatic organisms (i.e., fish, Crustacea, larvae and eggs, gastropods, bivalves, invertebrates, and flora). Marine larvae and benthic invertebrates appear to be the most intolerant of oil and grease, particularly water-soluble compounds, at concentrations ranging from 0.1 parts per million to 25 parts per million and 1 part per million to 6,100 parts per million, respectively. The oil and grease designation includes many organic compounds with varying physical, chemical, and toxicological properties, and EPA has not established a numerical criterion applicable to all types of oil and grease. Water quality standards and some permit limits, therefore, are described as requiring "no visible sheen." For this assessment, EPA did not model the effects of oil and grease on the environment.

7.1.5 Pathogens

Pathogens are defined as disease-causing microorganisms. A subset of microorganisms, including species of bacteria, viruses, and parasites, can cause sickness and disease in humans. The *2000 Inventory* indicates that pathogens (specifically bacteria) are the leading stressor in impaired rivers and streams and the fourth leading stressor in impaired estuaries. Water-born pathogens are known to impact aquatic life, drinking water supplies, and human activities such as fishing (Docket No. W-01-06, Record No. 10024 - Pathogen TMDL report). There are numerous reports associating *E. coli* 0157-caused illness with consumption of contaminated beef (Valcour et al., 2002; Michino et al., 1999; Tuttle et al., 1999), wild meats (Gagliardi et al., 1999), or under-processed fruit juice (Kudva et al., 1998). Additional cases of illness have been caused by drinking water contaminated with the pathogen (Novello, 1999; Bruce-Grey Owen Sound Health Unit, 2000; Jackson, et al., 1998). In most of these reports, animal feces, particularly bovine feces, were the probable vehicle for transmitting *E. coli* 0157:H7 to other animals, food, and the environment. Epidemiological investigations have demonstrated that cattle, particularly young animals, are a principal reservoir of *E. coli* 0157:H7 (Wang et al., 1996).

7.1.6 Other potential contaminants

Surfactants have been identified as an emerging issue related to water quality from waste effluent. Alkylphenol polyethoxylates (AP) are nonionic industrial surfactants used globally in detergents, paints, herbicides, and cosmetics. All categories and subcategories of the MPP industry addressed in this final rule conduct relatively thorough sanitation processes, involving large amounts of chemical cleansers. Alkylphenols such as octylphenol, nonylphenol, and nonylphenol diethoxylate are commonly found in sewage treatment plant effluents and river waters as microbial breakdown products of these surfactants. Researchers have shown that these degradation products inadvertently mimic the biological activity of the female hormone estrogen in *in vitro* fish, avian, and mammalian assays. They are estrogenic as their molecular action is mediated through the estrogen receptor (White et al., 1994). Findings of AP estrogenicity *in vitro* have been substantiated by reports of inhibited testicular growth after AP exposure of rats (Sharpe et al., 1995) and fish (Jobling et al., 1996) *in vivo*. The potential impacts of estrogen receptor binding chemicals include altered protein expression on the cellular level, changes in hormone levels in the ova and testis, expression of secondary sex characteristics, and altered reproductive capability of individuals. These impacts could lead to skewed genders within a population and ultimately impact the long-term efficacy of the population. While these chemicals are relatively weak estrogen receptor binders, they could be of concern due to their hydrophobic tendency and potential to bioaccumulate. (Schmeider et al., 2000). Tighter discharge limits and effluent treatment processes to reduce the concentration of AP and its degradation products have been shown to reduce the estrogenic activity of the watercourses into which the effluents are discharged. (Sheehan et al., 2002)

Growth promoters (e.g., trenbolone acetate—a synthetic anabolic steroid used to promote growth in cattle) are extensively used in the United States. Researchers have shown that these steroids, and more importantly their metabolites (e.g. 17-beta-trenbolone from trenbolone acetate), are comparatively stable in animal waste, suggesting the potential for exposure to aquatic animals via direct discharge, runoff, or both. Reproductive alterations have been reported in fish living in waters receiving cattle feedlot effluent (Jegou et al., 2001). In addition, feedlot effluent samples have displayed androgenic activity *in vitro* (Gray et al., 2001). Little is known of the toxicity of these promoters and metabolites. Recent studies, however, on one such chemical—17- beta-trenbolone—indicate the potential for androgenic activity in *in vitro* and *in vivo* assays and induction of developmental abnormalities (Wilson et al., 2002). Furthermore, 17-beta-trenbolone researchers observed androgenic activity in the fathead minnow as evidenced by secondary sex characteristics in females (production of dorsal nuptial tubercles, structures normally present only on the heads of males) and altered reproductive physiology of males (Ankley et al., 2003). The presence of these chemicals in the environment and their potential toxicity are the subject of further study.

7.2 WATER QUALITY IMPAIRMENT AND MPP DISCHARGE LOCATIONS

EPA identified 10 articles documenting the environmental impacts of meat and poultry processing facilities. Documented impacts include four reaches with nutrient loadings, two sites with contaminated well water, one site with contaminated groundwater, and one lake threatened by nutrient loadings. See Appendix 7-A of this document for a summary of the articles.

EPA has made significant progress in implementing Clean Water Act programs and in reducing water pollution. Despite such progress, however, serious water quality problems persist throughout the country. The *2000 Inventory* data identify the leading pollutants impairing surface water quality in the United States to include nutrients, pathogens, sediment/siltation, and oxygen-depleting substances. These pollutants originate from many different sources, including the animal production industry.

More than 40 percent of our assessed waters still do not meet the applicable water quality standards, amounting to more than 20,000 individual river segments, lakes, and estuaries. These impaired waters include approximately 300,000 miles of rivers and shorelines and approximately 5 million acres of lakes. An overwhelming majority of the population—218 million—live within 10 miles of the impaired waters.

Under section 303(d) of the 1972 Clean Water Act, states, territories, and authorized tribes are required to assess and develop lists of waters that do not meet water quality standards after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters and develop total maximum daily loads (TMDLs) for them. A TMDL specifies the maximum amount of a single pollutant that a water body can receive and still attain its applicable standard. The calculation of the TMDL must include a margin of safety to ensure that the water body can be used for the purposes the jurisdiction has designated. The calculation must also account for seasonal variation in water quality.

MPP facilities primarily discharge pollutants to rivers and streams. For those MPP facilities for which EPA had location information, 66 of the 112 water bodies to which they discharge are listed as impaired. MPP facilities discharging to an impaired water body could be subject to requirements to reduce their discharges. Of the 66 impaired water bodies, 19 have proposed or promulgated TMDLs; 11 of the 19 are impaired by nutrients. Eight water bodies are scheduled for TMDLs; 5 of the 8 are impaired by nutrients. Eighteen of the remaining 39 water bodies are impaired because of nutrients. The TMDLs for some of these water bodies are not scheduled. TMDL schedules are not available for all of the impaired water bodies.

7.3 WATER QUALITY AND HUMAN HEALTH IMPROVEMENTS FROM THIS RULE

7.3.1 Reductions in pollutant discharges from this rule

The pollutant reductions achieved by the final rule will reflect the additional wastewater treatment at MPP facilities. See Section VIII A of the preamble of the final rule for discussion of pollutant loading reduction. The pollutant reductions are used in the water quality models and environmental benefit assessment models to estimate the human health and environmental benefits accruing from the rule.

EPA quantified the reduction of nitrogen loads associated with the rule. Reductions of discharges of the metals barium, chromium, copper, manganese, molybdenum, nickel, titanium, vanadium, and zinc were also analyzed for the final rule. Fecal coliform served as a surrogate measure of pathogen reductions that would be achieved by this rule. EPA expects that other pathogens (e.g., *E. coli*) will be reduced to a similar degree due to disinfection requirements. Table 7-1 presents the pollutant reductions expected to result from the rule.

Table 7-1
Pollutant reductions: Combined total for all MPP Facilities

Parameter	Baseline Pollutant Loading (Pre-regulation)	Post-regulation Pollutant Loading	Pollutant Reduction
Nitrogen (million lb)	48.4	20.0	28.5
Pathogens (10^{18} cfu)	1,340.2	249.0	1,091.2
Sediment (million lb)	8.5	6.1	2.4

The following chapters describe the methods EPA used to estimate the effect of pollutant reductions and other environmental improvements on human health and the ecosystem. They also describe how EPA assigned a monetary value to these benefits. In some cases, EPA could identify an improvement that would result from the rule, but could not estimate the monetary value of the improvement or quantify the amount of improvement to expect. Chapters 9 through 12 illustrate some of these non-monetized and/or non-quantified benefits.

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CHAPTER 7: APPENDIX A
DOCUMENTED ENVIRONMENTAL IMPACTS AND PERMIT VIOLATIONS

In addition to modeling environmental effects of MPP facilities using the NWPCAM model, EPA performed a literature search to document cases where MPP facilities have been identified as sources of water quality impairment. The results of this literature search are published in the Administrative Record as part of the public docket (DCN 317,601).

While the literature search was not comprehensive and was limited mostly to newspaper articles and government press releases covering the last five years, EPA found 19 cases in which plant operators were cited for a variety of permit violations. One meat processing facility was cited for more than 5,000 permit violations, which led to degradation of water quality in the affected river. In fact, this facility received the highest fine ever issued under the Clean Water Act. Other documented impacts cited in the articles included 10 stream reaches with nutrient loadings, two sites with contaminated well water, one site with contaminated groundwater, and one lake threatened by nutrient loadings. In all cases, the identified source of contamination or perceived threat was an MPP facility. In cases in which permit levels were violated or alleged to be violated, ammonia (NH_3-N), phosphate (PO_4), fecal coliform bacteria, and total suspended solids (TSS) were the most common contaminants of concern.

Eighteen of the articles document legal action in criminal cases taken against MPP facility owners or operators. Documented legal action targeted: (1) the conspiracy of five facilities to violate the Clean Water Act; (2) illegal dumping of waste (one case); and (3) falsifying records, diluting waste samples, and/or destroying records (five cases). These legal actions resulted in possible incarceration and fines ranging from $0.25 million to $12.6 million. Table 7-A summarizes the environmental impacts identified and type of legal action pursued.

Table 7-A
Documented Environmental Effects of MPP Wastes on Water Quality

	Identified Impacts
Case #1	High concentrations of fecal coliform, an indicator of the presence of animal intestinal waste, found in receiving waters. Also excessive discharges of phosphorus, ammonia, cyanide, oil, and grease. Plant was fined $12.6 million, the largest Clean Water Act fine ever assessed (1997).
Case #2	Operators of five poultry processing facilities were indicted for actions leading to more than 5,000 permit violations during a 20-year period (from 1975-1995). Indictment (01/2000) alleged one of the plants discharged pollutants, including ammonia, fecal coliform, oil and grease, suspended solids, and other rotting materials, directly into receiving waters.
Case #3	Poultry processing plant agreed to pay $500,000 (1998) for permit violations. Parameters on the discharge of phosphorus were also established for the first time for this facility.
Case #4	Meat processing facility operators agreed to pay fine of $250,000 for permit violations. Permit violations included falsification of discharge monitoring reports, exceedances of effluent limitations, and inadequate record-keeping practices (1998).
Case #5	Turkey processor agreed to make improvements in wastewater treatment system and pay $300,000 fine for permit violations. Violations included exceeding limitations for phosphorus and ammonia (1997). High levels of these pollutants were found downstream of the plant. Biologists also found a dearth of aquatic insects.
Case #6	Rendering facility officials agreed to pay $600,000 in fines for polluting river with dead animal parts and falsifying sewer discharge records (2000).
Case #7	Chicken processing plant was fined $10,800 for permit violations. Wastewater exceeded fecal coliform limits and volume limits. During 1998, a fish kill caused by oxygen depleted water was tied to facility's treatment plant.
Case #8	Two poultry plants were fined more than $46,000 for 206 water quality violations that took place during 1998 and 1999. Waste with high bacteria levels was running off sprayed fields.
Case #9	A poultry plant was fined $6 million for allowing excessive runoff from its farms and processing plants.
Case #10	Pork processing plant cited 20 times since 1994 for permit violations. Tests of receiving water body indicated high levels of several pollutants, including ammonia and fecal bacteria.

Table 7-A continued

	Identified Impacts
Case #11	High levels of phosphorous were detected downstream from poultry processing plant. In addition, state alleged that high levels of ammonia and high temperatures resulted from plant's discharges.
Case #12	State Conservation Commission study indicated that waste from poultry processing plants threatened viability of lake due to discharges of phosphorous and nitrogen.
Case #13	Water quality data collected by EPA indicated marked increase in phosphorous in many areas downstream from chicken plants.
Case #14	State Department of Natural Resources obtained a court order to compel poultry processor to adhere to state water quality laws. The plant will reduce its discharge by approximately 50 percent under the court order.
Case #15	State environmental official filed suit against poultry processor for willfully contaminating groundwater in the vicinity of fields where the plant had sprayed wastewater. Wastewater was laden with nitrates (1998).
Case #16	Owner of meat slaughter house indicted for allegedly dumping blood and other animal waste products into nearby water bodies (2000).
Case #17	State issued an order containing a $25,000 fine for violating permit limits for ammonia, solids, and other pollutants.
Case #18	Operator of rendering plant sentenced to one month in prison for illegally discharging pollutants into river (1998). Ammonia and other pollutants were discharged and monitoring reports falsified.
Case #19	Meat processing firm was fined $28,000 for failing to file proper forms for discharge of oil, grease, TSS, and BOD (1998). Consent agreement also required company to install pollution control equipment.

CHAPTER 8

WATER QUALITY BENEFITS MEASURED USING NWPCAM

8.1 NWPCAM ANALYSIS

The National Water Pollution Control Assessment Model (NWPCAM) is a national surface water quality model that simulates water quality improvements and economic benefits that result from water pollution control policies. NWPCAM is designed to characterize water quality for the nation's network of rivers, streams, and lakes. NWPCAM incorporates a water quality model into a system designed for conducting national policy simulations and benefits assessments. NWPCAM is able to translate spatially varying water quality changes into willingness-to-pay values that reflect the value that individuals place on water quality improvements. In this way, NWPCAM is capable of deriving economic benefits estimates for a wide variety of water pollution control policies.

NWPCAM's national-scale framework allows hydraulic transport, routing, and connectivity of surface waters to be simulated in the 48 contiguous states. The model can be used to characterize source loadings (e.g., point sources) under a number of alternative policy scenarios (e.g., loadings with controls). These loadings are processed through the NWPCAM water quality modeling system to estimate instream pollutant concentrations on a detailed spatial scale and to estimate policy-induced changes in water quality. The model incorporates routines to translate estimated concentrations into a six-parameter water quality index (WQI6) that provides a composite measure of overall water quality. The WQI6 allows for the calculation of economic benefits associated with the estimated water quality improvements. NWPCAM can be used to assess both the water quality impacts and the social welfare implications of alternative policy scenarios.

EPA has modified NWPCAM to model national surface water quality based on proposed changes in ELGs for the MPP industry. Modeling analyses for the proposed rulemaking process were conducted using NWPCAM 1.1. Since that time, a new version of the model (NWPCAM 2.1) was developed and is being applied for the final rulemaking analysis. To update the model, EPA:

- Incorporated the use of Reach File 3 (RF3) to route pollutant loadings and conduct instream modeling.
- Added new methodologies for estimating stream flow, velocity, channel properties, and time-of-travel.
- Updated the point source loadings.
- Revised the nonpoint source loadings based on land-cover export coefficients.
- Included the use of the Spatially Referenced Regressions On Watershed (SPARROW) model for nonpoint source nutrient loadings.
- Updated the loads from animal feeding operations (AFOs) based on the AFO final rulemaking process.
- Incorporated the Eutro-WASP kinetics model for nutrients, conventional pollutants, and fecal coliform bacteria.
- Integrated economic benefits estimates using the six-parameter WQI6, in addition to the Water Quality Ladder (WQL) approach.

Appendix 8-A provides a component-by-component summary of the changes in NWPCAM from Version 1.1 (used for the proposed rule) to Version 2.1 (used for the final rule). The "Effect" column indicates why each change was made and its effect on the operation of the model.

8.1.1 Use of NWPCAM 2.1

NWPCAM 2.1 uses the RF3 database routing and connectivity information to assign hydrologic sequencing numbers to each RF3 reach. The RF3 network includes 1,817,988 reaches totaling 2,655,437 miles within the contiguous 48 states. A subset of this network, including only streams greater than 10 miles in length and the small streams connecting them, was extracted for this analysis. The subset, RF3Lite, capitalizes on the information in the RF3 database while limiting the computational burden of coping with the full network. The RF3Lite network includes 575,991 reaches totaling 835,312 miles, or approximately one-third of the RF3 network. NWPCAM 2.1 includes instream routing routines to connect point source and nonpoint source loads from the RF3 network to RF3Lite. These routines rely primarily on first-order kinetics, using RF3 time of travel estimates to model processes occurring outside of the RF3Lite network. Point source modeling includes first-order loss of nitrogen and phosphorous, as well as dissolved oxygen modeling. Thus, some environmental impacts and mitigation could be occurring in RF3 reaches not included in the RF3Lite network.

For the final rulemaking process, NWPCAM 2.1 was modified such that point source loadings for MPP facilities were taken from a loads file developed by EPA, rather than the NWPCAM 2.1 point source inventory. The analysis only considered direct discharge facilities. As such, the loads developed by EPA were incorporated for 65 non-small, direct discharge facilities (Option Loads_NS Further and REND (09-17-03).xls; Option Loads_NS Slaughter (11-20-03).xls; received November 20, 2001). Loads were supplied under current regulations (Baseline Average Concentrations, or BAC) and under four technology options aimed at reducing pollutant loads. The correspondence between technical descriptions and NWPCAM runs follows:

- BAC = Baseline
- Opt 2 = Best Available Technology (BAT)
- Opt 2.5 = BAT3
- Opt 2.5 + P = BAT4
- Opt 4 = BAT5

All modeling runs were conducted using the mean summer flow condition because it is a more appropriate analysis for point source discharge. It is also consistent with the proposed rulemaking analysis.

Baseline load inputs to the NWPCAM 2.1 model include AFO nonpoint source loads, non-AFO nonpoint source loads, combined sewer overflow (CSO) loads, non-MPP point source (PS) loads, and MPP point source loads. Table 8-1 lists the AFO nonpoint source loads used in the analysis. These loads were selected due to the results of the final AFO/CAFO rulemaking process with EPA's guidance. Table 8-2 contains the non-AFO nonpoint source loads. Table 8-3 contains the raw non-MPP point source loads and CSO loads. Table 8-4 contains the MPP point source loads under each technology option. Option 2 indicates the smallest reduction in loads compared to baseline, and would be expected to result in the smallest water quality improvement. Option 4 shows the largest reduction in loads compared to baseline. Table 8-5 lists the final total point source load in the RF3Lite network (non-MPP PS + MPP PS + CSO). Option 2.5 results in a 1.4 percent reduction in total nitrogen (TN), small reductions in TSS and BOD_5, and no change in total phosphorus (TP) or FEC at this scale. The benefits of the rule, however, are based on changes at the reach level, not in overall national load reductions.

Table 8-1
AFO/CAFO Nonpoint Source Loads

Constituent (g/s or MPN/s)	Land Use Cell	RF3		RF3Lite	
		Load	Delivery Ratio	Load	Delivery Ratio
Total Nitrogen (TN)	2,942	2,383	0.81	2,122	0.72
Total Phosphorus (TP)	4,271	3,242	0.76	2,958	0.69
Total Suspended Solids (TSS)	929,519	732,633	0.79	669,283	0.72
Biochemical Oxygen Demand (BOD_5)	744	656	0.88	634	0.85
Fecal Coliform (FEC)	2.79×10^{14}	2.10×10^{14}	0.75	1.72×10^{14}	0.62
Fecal Streptococci	3.30×10^{15}	2.85×10^{15}	0.86	2.68×10^{15}	0.81

Table 8-2
Non-AFO/CAFO Nonpoint Source loads

Constituent (g/s or MPN/s)	Land Use Cell	RF3		RF3Lite	
		Load	Delivery Ratio	Load	Delivery Ratio
TN	165,572	134,388	0.81	131,775	0.80
TP	12,382	9,555	0.77	9,366	0.76
TSS	15,033,394	11,076,412	0.74	10,105,756	0.67
BOD_5	226,526	170,227	0.75	163,237	0.72
FEC	N/A	N/A	N/A	5.343×10^{10}	N/A

Table 8-3
Combined Sewer Overflow (CSO) and Non-MPP Point Source (PS)Loads

Constituent (g/s or MPN/s)	CSO Raw	non-MPP PS Raw
TN	643	23,440
TP	248	5,617
TSS	13,613	214,912
BOD_5	3,707	58,761
FEC	7.639×10^6	1.96×10^{12}

Table 8-4
MPP Point Source Loads

Constituent (g/s or MPN/s)	Baseline (BAC)	Option 2 (BAT)	Option 2.5 (BAT3)	Option 2.5+P (BAT4)	Option 4 (BAT5)
TN	328	297	98	98	24
TP	78	78	78	18	11
TSS	58	38	38	38	30
BOD_5	**31**	**19**	**19**	**19**	17
FEC	10.2×10^6	2.67×10^6	2.67×10^6	2.67×10^6	2.67×10^6

Table 8-5
Routed Point Sources in the RF3Lite Network (CSO, non-MPP PS, MPP PS)

Constituent (g/s or MPN/s)	Baseline (BAC)	Option 2 (BAT)	Option 2.5 (BAT3)	Option 2.5+P (BAT4)	Option 4 (BAT5)
TN	14,972	14,941	14,765	14,765	14,707
TP	3,591	3,591	3,591	3,538	3,532
TSS	127,448	127,428	127,428	127,428	127,422
BOD_5	31,264	31,252	31,252	31,252	31,251
FEC	2.24×10^{11}	2.24×10^{11}	2.24×10^{11}	2.24×10^{11}	2.24×10^{11}

NWPCAM 2.1 uses this loading data to generate input and output files for thousands of Eutro-WASP5 model runs. Eutro-WASP5 calculates the decay and dispersion dynamics of the six water quality indicators of WQI6 by modeling the mixing, exchange, chemical, and biological processes occurring as the effluent flows through the surface water network. Many characteristics of the waterways and their environment contribute to the process models. Further operation details for NWPCAM 2.1 and Eutro-WASP5 can be found in the report, "Estimation of National Economic Benefits Using the National Water Pollution Control Assessment Model to Evaluate Regulatory Options for the Meat and Poultry Processing Industry" (DCN 317,603:[RTI report, 2/2004]).

The original WQI included nine water quality parameters: five-day biochemical oxygen demand (BOD_5), percent dissolved oxygen saturation (%DOsat), fecal coliform bacteria (FEC), total solids (TS), nitrate (NO_3), phosphate (PO_4), temperature, turbidity, and pH. The WQI score was derived by converting concentrations of each water quality characteristic into a corresponding number between 0 and 100. McClelland (1974) derived the functional relationship between the conventional measure and the 0 to 100 score by averaging the judgments from 142 water quality experts. Weights to combine each of the nine scores into an overall 0 to 100 indicator of water quality were derived, again, based on the summary judgments of the expert panel.

NWPCAM 2.1 does not model all nine parameters, so a modified WQI formulation was developed based on six of the parameters. For the MPP analysis, WQI6 incorporates BOD_5, %DOsat, FEC, NO_3, PO_4, and TSS. McClelland (1974) used turbidity in her assessment rather than TSS. To incorporate TSS, a regression equation was used to convert the original graph of water quality against turbidity into a graph of water quality against TSS. The weight on each indicator was also recalculated so that the index continued on a 0 to 100 basis, although it had fewer components.

Carson and Mitchell (1993) derived an equation to assess the value of increasing water quality along the continuous WQI scale from national survey data. Assuming that the proportion of families engaging in water-based recreation and the proportion of respondents who feel a national goal of protecting nature and controlling pollution is very important are the same as when the Carson and Mitchell survey was completed, the incremental value associated with increasing WQI from WQI_0 to WQI_1 can be calculated as:

$$WTP_{TOT} = \exp[0.8341 + 0.819\log(\tfrac{WQI_1}{10}) + 0.959\log(\tfrac{Y}{1000}) - \exp[0.8341 + 0.819\log(\tfrac{WQI_0}{10}) + 0.959\log(\tfrac{Y}{1000})]$$

where

WTP_{TOT} = a household's willingness-to-pay for increasing water quality (1983 dollars)
Y = household income (sample average = $35,370 in 1983 dollars)
WQI_1 = Composite water quality index under regulatory scenario
WQI_0 = Composite water quality index under baseline

In this case, Y was selected to correspond to an estimated median household income of $35,370 in 2003 (expressed as 1983 dollars). The resulting value estimates were inflated to 2003 dollars using the growth rate in the consumer price index (CPI), 1.8574 since 1983.

Benefits were calculated state-by-state and were broken down into local and non-local benefits. Carson and Mitchell (1993) found that respondents were willing to pay more for water quality improvements within their own state, and estimated that two-thirds of the total willingness-to-pay applied to local effects. Non-local benefits correspond to the amount a population is willing to pay for water quality improvements outside of their own state and were estimated as one-third of the total willingness-to-pay.

Table 8-6 lists the economic benefits estimates based on this approach. Benefits estimates ranged from $63,000 for Option 2 to $4,335,000 for Option 4. Note that these estimates include only the sample of facilities modeled by NWPCAM. These results are scaled up in Section 8.2 using revised sample weights.

Table 8-6
Economic Benefits
(2003$)

WQI6 Range[1]	Option 2 (BAT)	Option 2.5 (BAT3)	Option 2.5+P (BAT4)	Option 4 (BAT 5)
< 26	0	$38,000	$130,000	$152,000
26 < WQI6 < 70	$42,000	$587,000	$1,916,000	$2,430,000
>70	$20,000	$216,000	$1,279,000	$1,753,000
Total	$63,000	$840,000	$3,325,000	$4,335,000

Note: numbers may not add up due to rounding.
1.Values are provided to show benefits for ranges of index values representing thresholds for boatable (25), fishable (50); swimmable (75) conditions as characterized in Carson and Mitchell (1993).

Detailed tables identifying instream pollutant concentrations for all RF3Lite reaches modeled by NWPCAM 2.1 and impaired reaches, and more detailed summaries of WQI benefits are available in the docket (DCN 317,603:*Estimation of National Economic Benefits Using NWPCAM to Evaluate Options for the MPP Industry*).

8.2 NATIONAL BENEFIT EXTRAPOLATION

This section documents the methods used to develop benefit-related weighting factors for the MPP industry effluent limitation guideline (ELG). The method closely follows the methods described for the Metal Products and Machinery (MP&M) industry ELG in the MP&M Economic Environmental and Benefits Analysis (EEBA) for the final rule (Appendix G). The basic concept of the raking method is that facility sample weights derived from the size of the plant and type of production may not be the most appropriate for extrapolating benefits to non-sample plants. Other factors influence the occurrence and size of benefits, so their omission can lead to a conditional bias in the extrapolated results. For any aggregation of benefits from a sample of facilities to the population of facilities, the weights given to each sample facility should reflect aspects of the plant that relate to its production of benefits. There is a need, therefore, to post-stratify and develop revised sample weights.

The MP&M analysis based its post-stratification on the type of receiving water body and size of the population residing in the vicinity of the sample facility. For the MPP post-stratification, EPA adopted the same factors. For the current analysis, EPA characterized the receiving water body type by the 7Q10 flow of the receiving reach in cubic feet per second (cfs) for each plant. EPA identified the location of each in-scope and sample facility in terms of latitude, longitude, and receiving reach. This information was derived largely from the Permit Compliance System (PCS) database, supplemented with information from the Toxic Release Inventory (TRI) and Total Maximum Daily Load (TMDL) information. A summary table, FacilityInfo3b.xls, was the basis for all locations, Reach File 1 (RF1) identification numbers, and flow rates.

The MP&M analysis used the population of counties abutting the receiving reach as its population indicator. For the MPP analysis, EPA adopted the technique of estimating the population within 10 miles of the facility location to characterize the affected population. The 10-mile buffer ensures the geographic area considered for each plant is the same. This standardization reduces the distortion when a receiving reach abuts a very large or small county. Using ArcMap geographic information system (GIS) software, EPA drew 10 mile buffers around each facility location. For each county intersecting one of these buffer zones, EPA calculated the proportion of county land area within the buffer and multiplied by the county's population to estimate the population in the portion of the buffer zone. EPA used county population figures from the 2000 Census. For each facility, EPA summed all of the county-buffer zone population estimates to estimate the total population within the 10-mile buffer zone. This method assumes that population is spread evenly across the land area of each county, which seems reasonable for this purpose.

The raking process proceeds by categorizing all of the facilities that will be affected by the regulation by their receiving waters and local population. The goal of the post-stratification weighting process is to ensure that the revised sample weights generate the same marginal percentages for the receiving waters and local population categorization as found in the affected population. Table 8-7 shows the distribution for the MPP facilities. (At the time this table was created, information elements for five of the 112 facilities in scope were missing.)

Table 8-7
MPP Raking Adjustment Goal Distribution from All Facilities

Population Class	Receiving Water Flow (7Q10, cfs)				
	<20	**20-99**	**100+**	**Row Sum**	**Population Pct**
<10,000	15	3	4	22	20.6%
10,000-49,999	42	11	12	65	60.7%
50,000+	12	4	4	20	18.7%
Column Sum	69	18	20	107	100.0%
Waters Pct	64.5%	16.8%	18.7%	100.0%	

Source: Spreadsheet FacilityInfo3b.xls, September 22, 2003.

The starting point for the raking adjustment is the sum of facility weights among the sample facilities from the survey statistical analyses. Table 8-8 shows the starting point for the MPP raking adjustment. At least one sample facility must occur in each cell of the table to generate a result from which to extrapolate. This constraint limits the number of categories into which the affected plants can be divided. The categories in these tables were selected by eliminating smaller categories that did not contain sample facilities.

Table 8-8
Sum of Sample Facility Weights by Receiving Water Flow and Population

Population Class	Receiving Water Flow (7Q10, cfs) <20	20-99	100+	Row Sum	Population Pct
<10,000	24.24	9.31	20.71	54.26	29.5%
10,000-49,999	65.63	16.14	25.57	107.34	58.3%
50,000+	15.95	4.63	2.00	22.58	12.3%
Column Sum	105.82	30.08	48.28	184.18	100.0%
Waters Pct	57.5%	16.3%	26.2%	100.0%	

Source: Spreadsheet FacilityInfo3b.xls, September 22, 2003,(DCN 316003) and NewWeights4.xls, October 31, 2003 (DCN 333151CBI)

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A comparison of the marginal percentages in Table 8-8 with those in Table 8-7 shows how the post-stratification weights will change the estimation of the rule's benefits. Using the weights indicated by Table 8-8, benefits would have been scaled such that plants with fewer than 10,000 people in the vicinity were 29.5 percent of the total. Table 8-7 indicates that a smaller proportion of the population of facilities, 20.6 percent, is actually located in such places. Similarly, the survey sample weights put more emphasis on large streams, 26.2 percent, when 18.7 percent of the facilities are actually discharging to that size stream. If benefits are more closely related to population and stream flow than the survey categorization, then the post-stratification process will yield results more closely related to these measures.

Raking is an iterative process that calculates an adjusting factor for each cell in the table. The adjusting factor is applied to the sample weights that fall within that cell. At each step, a re-weighting factor is calculated as the ratio between the current distribution's marginal percentage and the goal marginal percentage. EPA chose to re-weight by population first, so the first re-weighting factors are the row percentages in Table 8-7 divided by the row percentages in Table 8-8 (e.g., 20.6/29.5 = 0.698). Multiplying each cell in the row by these re-weighting factors ensures that the row will now have those marginal percentages. The process changes the column marginal percentages, however, so re-weighting factors must be calculated for the columns and multiplied through each cell in the column to generate the correct column marginal percentages. This step changes the row percentages, necessitating another iteration. The process iterates until all of the row and column marginal percentages are "close" to the goal percentages. In this case, EPA defined "close" as within one one-thousandth of the goal percentage (i.e., equal when rounded to three decimal places).

Table 8-9 shows the sums of weights from Table 8-8 revised through the iterative raking process to yield the same marginal percentages as Table 8-7. Dividing each of these revised weights by the corresponding sum of survey weights in Table 8-8 (e.g., 19.25/24.24 = 0.794) yields a raking factor to adjust all of the survey weights that constituted that total so that they will now add up to the adjusted sum. Multiplying the survey weight by the raking factor yields a new weight for each sample facility.

Table 8-9. Revised Sums of Weights After Raking

	Receiving Water Flow				
Population Class	**<20**	**20-99**	**100+**	**Row Sum**	**Population Pct**
<10,000	19.25	6.95	11.67	37.87	20.6%
10,000-49,999	74.23	17.14	20.51	111.88	60.7%
50,000+	25.28	6.90	2.25	34.43	18.7%
Column Sum	118.77	30.98	34.43	184.18	100.0%
Waters Pct	64.5%	16.8%	18.7%	100.0%	

Source: Calculated in Spreadsheet MPP_Rake_2.xls, November 20, 2003.

The revised weights are applied to sample facilities to generate a national total. NWPCAM, however, calculates changes in water quality by river reach rather than facility. Using network analysis tools, EPA identified the MPP model facilities upstream from each affected reach. Up to six facilities could have contributed to the changes in any particular reach. For most reaches, there was only one model facility upstream so only that weight was used. Otherwise, the average raking weight for all of the facilities upstream of the reach was applied to aggregate the benefits estimated for reaches affected by the model facilities and produce an estimate for all of the facilities within the scope of the rule. Results for weighted benefits are provided on Table 8-10.

Table 8-10

Economic Benefits - Comparison of Unweighted and Weighted Results

(2003$)

	Option 2 (BAT)	Option 2.5 (BAT3)	Option 2.5+P (BAT4)	Option 4 (BAT 5)
Total Unweighted	$63,000	$842,000	$3,330,000	$4,341,000
Total Weighted[1]	$251,000	$3,270,000	$12,300,000	$15,700,000

1. Weighted benefits based on raking procedure.

8.3 UNCERTAINTY ANALYSIS - WATER QUALITY MODELING

NWPCAM, as with any model, contains prediction error. Consequently, there is some degree of uncertainty associated with calculated values of benefits. Monte Carlo analysis is a tool that can be used to better characterize the uncertainty and compute error bounds around calculated benefit values. Monte Carlo analysis adds randomly generated error values to predicted concentrations (error values may be positive or negative). EPA used Monte Carlo analysis to evaluate the impacts of water quality modeling uncertainty on benefits estimated for Option 2.5 for the final MPP rule.

8.3.1 Characterizing NWPCAM Prediction Errors

EPA estimated prediction errors for each simulation round using linear functions that describe pollutant-specific modeling errors as a function of predicted NWPCAM concentrations. Coefficients of linear regression functions were estimated as follows:

- EPA identified the large scale U.S. Geological Survey (USGS) hydroregions that contain MPP facilities modeled by NWPCAM. EPA then identified a subset of RF3Lite stream reaches within those regions that have a minimum of three monitoring observations of pollutants of concern, during summer months, in the USGS National Water Quality Assessment (NAWQA) database. EPA did not use data collected before 1998.

- The average of the observed concentrations was subtracted from the NWPCAM predicted concentration to estimate a prediction error for each reach with at least three observations. Under the given data limitations, EPA was able to estimate prediction errors for 52 reaches for TSS, nitrate, and phosphate and 62 reaches for dissolved oxygen.

- EPA observed that prediction errors tended to be biased for nitrate-N (NO_3), phosphate-P (PO_4), dissolved oxygen (DO), and total suspended solids (TSS) (i.e., predicted concentrations from NWPCAM Version 1.6 over or under-predict observed USGS NAWQA pollutant concentrations). Lacking a clear relationship, EPA modeled pollutant-specific prediction errors for NO_3 and DO as mean errors with a standard deviation derived from respective standard errors. Prediction errors were correlated with predicted NWPCAM concentrations for TSS and PO_4. EPA modeled errors for TSS and PO_4 as a function of predicted NWPCAM concentrations, using simple linear regression:

$$\text{Prediction Error} = \alpha + \beta * \text{Predicted NWPCAM Concentration} \qquad (1)$$

- The coefficients (constants (α) and slopes (β)) of the linear regressions are assumed to be random variables distributed normally with parameters derived from the regression analyses.

NAWQA data was not available for fecal coliform bacteria or BOD, so EPA was unable to address uncertainty associated with these indicators. Table 8-11 summarizes the prediction error information used in the Monte Carlo analysis.

Table 8-11
Summary of Prediction Error Information

		Regression Parameters[3]				Error Parameters	
Parameter[1]	**Error Correlated?[2]**	**Constant**	**Std Dev.**	**Slope**	**Std Dev.**	**Mean**	**Std Dev.**
TSS	YES	50.86	145.48	-0.86	0.751	NA	NA
NO_3[4]	NO	NA	NA	NA	NA	0.107	1.469
PO_4	YES	0.003	0.094	-0.549	0.31	NA	NA
DO	NO	NA	NA	NA	NA	-0.837	1.24

1. Fecal coliform and BOD errors not addressed because NAWQA data not available.
2. Is prediction error (i.e., NAWQA - NWPCAM) correlated with magnitude of predicted NWPCAM concentration? If yes, then regressions are used to characterize errors. If no, then mean errors are used.
3. Only applies if error correlated with predicted concentration.
4. Errors for nitrate (as mgN/l) are estimated as difference between nitrate concentrations from NAWQA data and nitrate+nitrite concentrations from NWPCAM. Errors from hydroregion 07 are excluded from the analysis because observed data was significantly different from other regions. Reasons could include storm and/or agricultural runoff events.

8.3.2 Monte Carlo Analysis

Monte Carlo analysis was conducted using Crystal Ball Pro 2000 to produce 10,000 simulations. During each Monte Carlo simulation, a new prediction error and concentration for a given pollutant and watershed, is predicted using:

Predicted Conc.(i,k) = Prediction Error(i,k) + Predicted NWPCAM Conc.(i,k)

where, i describes a watershed, as defined by the sub-hydroregion identified by the four digit hydrologic cataloguing unit codes where MPP facilities, modeled by NWPCAM, are located (Meats facilities are located in 23 watersheds affected under Option 2.5) and k refers to one of the four pollutants of concern for which NAWQA data is available (i.e., TSS, NO_3, PO_4 and TSS). At the beginning of each Monte-Carlo simulation, errors for NO_3 and DO and regression parameter values for TSS and PO_4 are randomly selected from probability distributions characterized by the information in Table 8-7 and used to adjust NWPCAM predictions. The same random error values are applied to all reaches within the same watershed for any given simulation (there are 510 stream reaches affected under option 2.5, located within 23 watersheds). Re-estimation of modeling errors for each iteration allows for repeated estimation of predicted concentrations and corresponding WQI values for baseline loading conditions and post-compliance loading conditions.

This Monte Carlo analysis assumed that modeling errors for baseline and post-compliance conditions are correlated, with a correlation coefficient of 0.5. A large number of environmental factors account for the prediction error within any given reach. EPA assumes that a significant number of these factors remain in place and have similar effects on pollutant fate and transport under future post-compliance conditions. Measuring prediction errors for future conditions (e.g., post-compliance scenarios for this rule) is not possible. A greater positive correlation between baseline and post-compliance conditions, however, would lead to tighter uncertainty bounds. EPA chose a correlation coefficient of 0.5 to prevent underestimating uncertainty bounds.

The Monte Carlo analysis generates 10,000 pollutant concentrations and WQI values for baseline and post-compliance conditions and 10,000 estimates of corresponding benefits for a given option under the rule. Uncertainty bounds are computed using the distribution of calculated benefit values, thus helping to characterize the uncertainty surrounding the benefit estimates for a given option.

8.3.3 Monte Carlo Results

The basic calculations for estimating benefits are the same as those summarized in the preamble for and in the *Economic and Environmental Benefits Analysis* for the final rule. Benefits for Option 2.5 are estimated to be $2,597,000 (in 2003 dollars) after adjusting predicted concentrations with expected errors (i.e., prediction errors assumed constant). Benefits are estimated to have 10 percent and 90 percent bounds of (- $4,966,000) and $9,769,000 respectively. The 25 percent and 75 percent bounds are estimated to be -$1,405,000 and $6,329,000 respectively. Given that negative benefits are not feasible, the lower bound estimates can be interpreted to be $0. The broad range of values is not uncommon for national level water quality models and is expected given the relatively small number of facilities affected by the rule. Detailed uncertainty results are provided in Appendix 8-B.

8.4 ADDITIONAL CONSIDERATIONS AND LIMITATIONS

EPA relies on a willingness to pay function derived by Carson and Mitchell to value changes in the water quality index for reaches affected by this rule. This equation specifies household willingness to pay (WTP) for improved water quality as a function of the level of water quality to be achieved (as represented by the water quality index value), household income, and other attributes (i.e., household participation in water-based recreation and respondents' attitudes toward environmental protection). As a consequence, this function has the ability to capture benefits of marginal changes in water quality. EPA estimates changes in index values using NWPCAM, and applies the willingness to pay function to estimate benefits. Based on this approach, EPA is able to assess the value of improvements in water quality along the continuous 0 to 100 point scale. The calculation of benefits is completed separately for each State and takes into account differences in willingness to pay for local and non-local water quality improvements (i.e., it assumes households will allocate two-thirds of their willingness to pay to improvements in in-State waters). Note that the WTP function assumes decreasing marginal benefits with respect to water quality index values; this is consistent with consumer demand theory and implies that willingness to pay for incremental changes in water quality decreases as index values increase. There are a number of other issues associated with the transfer of values from the Carson and Mitchell survey results that affect benefit estimates for this final rule, and these issues are discussed below.

Economic benefits of the this rule can be broadly defined according to categories of goods and services provided by improved water quality: use and nonuse benefits. The first category includes benefits that pertain to the use (direct or indirect) of the affected resources. The direct use benefits can be further categorized according to whether or not affected goods and services are traded in the market. For this rule, EPA has not identified any goods that are traded. The non-traded or non-market "use" benefits assessed in this final rule include recreational activities and drinking water (treatment). Nonuse benefits occur when environmental improvements affect a person's value for a natural resource that is independent of that person's present use of the resource. Nonuse values derive from people's desire to bequeath resources to future generations, vicarious consumption through others, a sense of stewardship or responsibility for preserving ecological resources, and the simple knowledge that a resource exists in an improved state.

When estimating nonuse benefits, we cannot directly observe people using the good or resource, therefore, the more traditional revealed preferences economic methods (preferred method for estimating non-market use values) are not applicable to the derivation of nonuse values. In their place, we survey people and directly ask them to state their preferences or willingness to pay for an environmental improvement (e.g., what are you willing to pay to improve water quality from boatable to swimmable). Statistical models are used to compile these survey responses and derive nonuse values for the resource improvements specified in the survey questions[1]. The values estimated from stated preference surveys may capture both use and nonuse values depending on how the survey is implemented.

The Carson and Mitchell stated preference study is a case were both use and nonuse benefits were estimated. The willingness to pay values developed in their national survey are the basis for the benefits transfer, which produced the total benefit values sited in this report. Carson and Mitchell asked respondents how they would divide their total willingness to pay values for improved water quality between their home state and the rest of the nation. They found that on average people designated 67% of the total willingness to pay for in state use verses 33% for out of state use. These findings have been used in our analysis as a proxy representing for how individuals divide their stated total willingness to pay between use and nonuse values.

The fact that Carson and Mitchell were asking people to value significant changes in water quality across the nation can present a source of error in the estimation of the benefits for today's rule. This is due to the imprecise fit between the scenario presented in their survey questions and the more narrow scope, both in terms of the number of water bodies and the size of the water quality change, of the meat and poultry produces rule. The direction of the impact produced by this difference between the survey and policy scenarios on our estimated use and nonuse benefits, for today's rule, is unclear.

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[1]In 1993, the National Oceanic and Atmospheric Administration (NOAA) convened a panel of economists to evaluate a form of stated preference methods (*contingent valuation* (CV)) and to devise a set of "best practices" for designing and implementing CV surveys. The NOAA recommendations are in the Federal Register (1994). EPA has subsequently published "considerations in evaluating CV studies" and discusses other stated preference methods in the agency's *Guidelines for Preparing Economic Analyses* (2000). OMB's most recent draft of "best practices" for conducting regulatory analysis, recognizes nonuse values and provides guarded acceptance of stated preference methods by listing "principles that should be considered" when evaluating the quality of such a study (Draft OMB Circular A-4, 9/17/03).

EPA notes that an additional source of indeterminate error is imposed by the benefits transfer framework stems from the assumption that willingness to pay for the same level of water quality improvements, from the same baseline level of quality, are constant across all water-bodies. This restriction implies that people have the same value for an improvement in water quality weather it occurred on the Houston Ship Channel or the Yellowstone River.

Two additional sources of error can be identified that would tend to produce an underestimate of use and nonuse benefits for the rule. Values returned by stated preference studies are sensitive to the language used to inform respondents about the baseline conditions and the changes in resource produced by the policy being evaluated. As part of the information given to respondents they were told that surface water quality throughout the United States was high for a large percentage of water bodies. When people are asked to value improving water resources in the face of generally high starting values for water quality willingness to pay is often reduced. In our rulemaking we are starting with degraded water quality. This fact would lead, through the use of Carson and Mitchell willingness to pay, to an under estimation of benefits for our policy scenario. In addition, the nonuse component of Carson and Mitchell's reported total willingness to pay may be under estimated because of the use of recreational activity based titles for differing water quality categories i.e. boatable, fishable, swimmable. These designations are likely to produce cognitive links in respondent's minds to benefits associated with recreational uses, and down play the role of nonuse benefits. Recreational "tags" may have lead to an incomplete recognition of nonuse benefits in Carson and Mitchell's total willingness to pay valuation and therefore under-estimation of benefits for the meat and poultry production rule.

An issue in applying the results of the Carson and Mitchell survey in the context of the water quality index is the treatment of water quality changes occurring below the boatable range and above the swimmable range. There are concerns that the survey's description of non-boatable conditions (i.e., index values less than 25) was exaggerated (i.e., unsafe for boating and swimming and unfishable), which implies that willingness-to-pay estimates for improving water to boatable conditions (i.e., index increases above 25) may be biased upwards. The survey did not ask respondents how much they would be willing to pay for improved water quality above the swimmable level.[2] These issues increase the uncertainty

[2] However, respondents were made aware of the potential for water quality to improve beyond swimmable in the ladder (e.g., drinkable).

associated with valuing water quality changes outside the boatable to swimmable range (i.e., for water quality index values below 26 or above 70). In recognition of this uncertainty, value estimates for changes in water quality within each range are presented separately (see Table 8-6); approximately 25 to 30 percent of monetized benefits are estimated to be outside the boatable to swimmable range.

In addition to the valuation function, there is also uncertainty associated with the water quality index. EPA's recently recommended section 304(a) ecoregional water quality criteria for nutrients define reference conditions for reducing and preventing cultural eutrophication (Chapter 9 for details about nutrient criteria analysis). In contrast, the water quality index used in monetization for the final MPP rule relies on judgements of water quality experts from the 1970's when they were asked to assign index values to different levels of individual pollutant parameters. Index values for nitrate nitrogen and phosphate phosphorus nutrient criteria representing 304(a) 50th percentile (i.e., median) reference conditions of 'least impacted' streams are relatively high as indicated in Table 8-12. Given that fishable water quality is designated as starting at an index value of 50, swimmable at 70, and water quality suitable for drinking without treatment at 95, these results suggest that the index is overestimating baseline water quality index values associated with nutrients. Overestimation of baseline index values potentially translates into underestimation of benefits given that marginal willingness to pay for incremental changes in water quality decreases as baseline water quality increases (i.e., demand decreases with quantity). This result may be offset to some extent by the possibility that modeled changes in nutrient concentrations will be translated into small changes in index value as the nonlinear index curve becomes more convex. In general, these results suggest that the water quality index may not reflect current evidence about the contribution of nutrients to water quality, as represented by recent 304(a) recommended ecoregional water quality criteria for nutrients.

Table 8-12.

Index Values for Nutrient Criteria

50% Reference Conditions[1]		Estimated 50% Criteria[2]		Parameter Index Values[3]	
Total P	**Total N**	**PO4-P**	**NO3-N**	**PO4-P**	**NO3-N**
0.07 mg/l	1.1 mg/l	0.053 mg/l	0.97 mg/l	92	93

1. Average of section 304(a) ecoregion water quality criteria representing 50th percentile reference conditions of 'least impacted' streams across 14 ecoregions.
2. Assumes [PO4-P] = 0.75*[TP], [NO3-N] = 0.9*[TN]
3. Index values estimated using regression functions fitted to index curves for PO4-P and NO3-N as described in *Estimation of National Economic Benefits Using NWPCAM to Evaluate Options for the MPP Industry* (DCN 317,603).

8.5 REFERENCES

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U.S. EPA, 2003. *Economic, Environmental and Benefits Analysis of the Final Metal Products and Machinery Rule (*EPA-821-B-03-002). Washington, DC.
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CHAPTER 8: APPENDIX A

SUMMARY OF DIFFERENCES BETWEEN NWPCAM VERSIONS

Table 8-A
Summary of Differences Between NWPCAM Versions 1.1, 1.6, and 2.1

Component	NWPCAM 1.1	NWPCAM 1.6	NWPCAM 2.1	Effect
Database Platform	Microsoft Access	Oracle	Same as NWPCAM 1.6	-Automated model runs -Streamlined quality control process -Simplified analysis of inputs or delivery ratios
Reach Network	-RF1 used to route loadings -RF1 used for instream modeling -Total stream length = 632,551.8 miles	-RF3 reach links to land cover -RF3 used to route loadings -Total RF3 stream length = 1.8 million miles -RF3Lite used for instream modeling -Total stream length for RF3Lite = 840,834.6 miles	-Same RF3 network as NWPCAM 1.6 -Same RF3Lite network as NWPCAM 1.6, except for 1,077 reaches not assigned WASP stream id numbers -Total RF3Lite stream length = 835,311.7 miles	-RF3 has a much more detailed stream network representation than RF1. -Provides estimates of drainage areas, land cover types draining to reaches, stream flow, and velocity. -RF3 has better coverage of open waters (lakes, reservoirs, wide rivers, estuaries) than RF1 -RF3Lite replaces RF1 for benefits analyses.

Component	NWPCAM 1.1	NWPCAM 1.6	NWPCAM 2.1	Effect
Stream Flow	RF1 stream flows based on RF1 characteristics data set	-RF3 stream flows validated using USGS gaging station data -Stream flows in western hydroregions adjusted for intermittent stream contribution	Same as NWPCAM 1.6	-Improved RF3 stream flow estimates -Improved hydrologic characterization and, therefore, improved modeling consistency and accuracy
Slope by Cataloging Unit	Used one-half of average slope of first-order streams in the cataloging unit	Slope estimates based on Digital Elevation Model (DEM)	Same as NWPCAM 1.6	-More accurate overland slope estimates -Higher channel velocities and delivery ratios from land cells to RF3
Stream Velocity	-Velocity estimates based on RF1characteristics file and Keup (1985) -Used RF1 characteristics database for instream modeling	All velocity estimates based on Jobson (1996)	Same as NWPCAM 1.6	Improved velocity estimates
Point Source Inventory	Used original point source inventory	Used updated point source inventory	Same as NWPCAM 1.6	More comprehensive accounting of point source loadings
Point Source Delivery	Point source loads routed directly to RF1	Point source loads routed from RF3 to RF3Lite with decay and transformation	Same as NWPCAM 1.6	Improved utilization of point source location information

Component	NWPCAM 1.1	NWPCAM 1.6	NWPCAM 2.1	Effect
Conventional Nonpoint Source (NPS) Loads	-Based on county-level loadings apportioned to reaches. -No capabilities to model NPS-related scenarios.	-Based on land-cover export coefficients -Incorporated the Revised Universal Soil Loss Equation (RUSLE) for TSS loads on agricultural cells	Same as NWPCAM 1.6, except calibrated in two NAWQA study units	-Improved spatial resolution -Provides capabilities to simulate NPS-related scenarios -Improved consistency with nutrient approach -More comprehensive DO modeling
Nutrient NPS Loads	-Loads for total nitrogen and total phosphorus only -No capabilities to model NPS-related scenarios.	-Loadings for all nitrogen and phosphorus species -Estimates developed based on SPARROW model and export coefficients calibrated by land-cover, hydroregion, and ecoregion combinations	Same as NWPCAM 1.6, except calibrated in two NAWQA study units	-Allows use of a water quality index (WQI6) that incorporates nutrient measures
Nonpoint Source Delivery	Nonpoint source loads routed to RF1 without decay and transformation	Nonpoint source loads routed to RF3 and RF3Lite with decay and transformation	Same as NWPCAM 1.6	Improved consistency with point source load approach
AFO/CAFO Load Processing	No AFO/CAFO background loads	AFO/CAFO loads based on CAFO Final Rule selection	Same as NWPCAM 1.6	Significantly higher background loads
Instream Modeling of Nutrients	Only TKN was modeled	-Includes transformation and decay between nutrient species -Does not model algae	-Includes transformation and decay between nutrient species -Also models algae -Algae included in TSS estimates	-Permits use of a water quality index that includes nitrates and phosphates

Component	NWPCAM 1.1	NWPCAM 1.6	NWPCAM 2.1	Effect
Conventional Pollutant Modeling	First-order kinetics	Same as NWPCAM 1.1, except TSS is modeled using SPARROW kinetic coefficients	Uses Eutro-WASP kinetics, default coefficient values in most of the country, calibrated coefficients in two NAWQA study units	-From 1.1 to 1.6, predicted TSS concentrations are higher -From 1.6 to 2.1, have advantage of calibrated coefficients
Water Quality Index (WQI)	Four-parameter WQI calculated, but no automated routines to estimate economic benefits	Benefits are estimated using six-parameter WQI and WQL	Same as NWPCAM 1.6	-Integrated economics benefits approach -Captures effect of nutrient reduction

CHAPTER 8: APPENDIX B

UNCERTAINTY ANALYSIS RESULTS

Simulation: 2/24/04 (File 14c)

Table 8-B1
Results for Total Aggregate Benefits

Summary:

Display Range is from ($12,470,507) to $18,235,447 $
Entire Range is from ($18,598,661) to $23,387,872 $
After 10,000 Trials, the Std. Error of the Mean is $57,529

Statistics:	Value
Trials	10000
Mean	$2,425,769
Median	$2,390,661
Mode	---
Standard Deviation	$5,752,903
Variance	3E+13
Skewness	-0.01
Kurtosis	2.96
Coeff. of Variability	2.37
Range Minimum	($18,598,661)
Range Maximum	$23,387,872
Range Width	$41,986,532
Mean Std. Error	$57,529.03

Percentiles:

Percentile	$
0%	($18,598,661)
5%	($7,137,907)
10%	($4,966,887)
15%	($3,481,430)
20%	($2,374,890)
25%	($1,405,868)
30%	($554,772)
35%	$206,114
40%	$988,121
45%	$1,735,541
50%	$2,390,661
55%	$3,098,318
60%	$3,857,403
65%	$4,592,283
70%	$5,416,541
75%	$6,329,726
80%	$7,304,886
85%	$8,440,580
90%	$9,769,252
95%	$11,851,959
100%	$23,387,872

Table 8-B2
Results for Aggregate Water Quality Index (Baseline)

Summary:

Display Range is from 48.79 to 60.92
Entire Range is from 47.02 to 62.53
After 10,000 Trials, the Std. Error of the Mean is 0.02

Statistics:	Value
Trials	10000
Mean	55.10
Median	55.14
Mode	54.94
Standard Deviation	2.31
Variance	5.32
Skewness	-0.10
Kurtosis	2.78
Coeff. of Variability	0.04
Range Minimum	47.02
Range Maximum	62.53
Range Width	15.51
Mean Std. Error	0.02

Percentiles:

Percentile	Value
0%	47.02
5%	51.23
10%	52.08
15%	52.65
20%	53.10
25%	53.50
30%	53.87
35%	54.20
40%	54.52
45%	54.84
50%	55.14
55%	55.45
60%	55.75
65%	56.06
70%	56.38
75%	56.73
80%	57.09
85%	57.53
90%	58.08
95%	58.79
100%	62.53

Table 8-B3
Results for Aggregate Water Quality Index (Post-compliance)

Summary:
Display Range is from 49.79 to 61.96
Entire Range is from 48.13 to 64.73
After 10,000 Trials, the Std. Error of the Mean is 0.02

Statistics:	Value
Trials	10000
Mean	56.22
Median	56.27
Mode	56.30
Standard Deviation	2.37
Variance	5.61
Skewness	-0.08
Kurtosis	2.81
Coeff. of Variability	0.04
Range Minimum	48.13
Range Maximum	64.73
Range Width	16.61
Mean Std. Error	0.02

Percentiles:

Percentile	Value
0%	48.13
5%	52.29
10%	53.11
15%	53.71
20%	54.20
25%	54.61
30%	54.97
35%	55.31
40%	55.65
45%	55.97
50%	56.27
55%	56.56
60%	56.89
65%	57.19
70%	57.51
75%	57.86
80%	58.26
85%	58.75
90%	59.25
95%	60.05
100%	64.73

CHAPTER 9

CHANGES IN WATER QUALITY MEASURED USING NUTRIENT CRITERIA ANALYSIS

9.1 INTRODUCTION

As discussed in Chapter 7, nutrients entering surface waters from MPP facilities can cause many problems for stream health and aquatic life. Excess nutrients can lead to eutrophication resulting in algal blooms, depleted oxygen levels, fish kills, and reduced biodiversity. For this final rule, EPA examined the potential water quality benefits of controlling nutrient discharges from MPP facilities to surface waters in an analysis that incorporated the use of EPA's recommended Section 304(a) ecoregional nutrient criteria and decay coefficients (Wickham, et al(2003)) in conjunction with a screening-level stream dilution model. This analysis is described in the following sections.

9.2 NUTRIENT CRITERIA

EPA's recommended Section 304(a) ecoregional water quality criteria for nutrients were developed with the aim of reducing and preventing cultural eutrophication (i.e., over enrichment of nutrient levels associated with human activities) on a national scale. The criteria were empirically derived to represent conditions of surface waters that are minimally impacted by human activities and protective of aquatic life and recreational uses. The nutrient criteria are numerical values for both causative (phosphorus and nitrogen) and response (chlorophyll a and turbidity) variables associated with the prevention and assessment of eutrophic conditions. They are not laws or regulations, but they represent a starting point for states and tribes to use in establishing (with assistance from EPA) more refined nutrient criteria. The problem of cultural eutrophication is national in scope, but specific levels of overenrichment leading to these problems vary from one region of the country to another because of factors such as geographical variations in geology, vegetation, climate, and soil types. EPA has therefore developed its recommended nutrient criteria on an ecoregional basis.

Ecoregions are a system of classification that are based on similarities of natural geographic factors and land use patterns. Ecoregions can be defined at multiple scales. For example, EPA has defined 14 nutrient ecoregions and 84 Level III subecoregions in the United States. Nutrient ecoregions are aggregations of Level III subecoregions where the characteristics affecting nutrient levels are expected to be similar.

For this analysis, EPA used determined reference conditions for total nitrogen and total phosphorous in rivers and streams for the 84 Level III subecoregions. The reference conditions represent the natural, least impacted conditions, or what is considered to be the most attainable condition. The reference conditions were statistically determined by EPA following analyses of EPA's STOrage and RETrieval (STORET) legacy data, USGS National Stream Quality Accounting Network (NASQAN) data, USGS National Water-Quality Assessment (NAWQA) data, and other relevant nutrient data from EPA regions, states, and universities. All descriptive statistics were calculated using the medians for each stream within a subecoregion, for which data existed. Each median from each stream was then used in calculating the percentiles for the Level III subecoregion by season over the period January 1990 to December 1999. More information on the calculation of the reference conditions can be found in EPA's published 14 ecoregional documents for rivers and streams available at http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/rivers/index.html (EPA, 2003a). The aggregate reference conditions for each Level III subecoregion were then calculated as the median value of the 25th percentiles and the 50th percentiles of the four seasons. These reference conditions were used in the stream dilution modeling as described in Section 9.4.

EPA used available data from STORET, NASQAN, NAWQA and other relevant nutrient data sources to calculate the 5th, 25th, 50th, 75th, and 95th percentiles of a distribution of samples from an entire population of waterbodies within a given physical classification (i.e., ecoregion/subecoregion). Percentiles were calculated for each of the four seasons. For the MPP analysis, a median for all seasons' percentiles, on a subecoregion level, was calculated from the four seasons' 25th percentiles and 50th percentiles. For example, if the seasonal 25th percentile (P25) TP values are spring 10 μg/L, summer 15μg/L, fall 12μg/L, and winter 5 μg/L, the median value of all seasons' P25 will be 11 μg/L.

In each of EPA's published 14 ecoregional documents for rivers and streams, reference conditions are summarized by ecoregion/subecoregion based on the 25th percentiles only. The 25th percentile of the entire population was chosen by EPA to represent reference conditions; the natural, least impacted conditions, or what is considered the most attainable conditions.

9.3 DECAY COEFFICIENTS

Several processes, such as denitrification, uptake by aquatic biota, and sedimentation, occur naturally in streams and rivers to reduce the available levels of nitrogen and phosphorus. Research indicates that the total effect of these processes can be modeled using a first-order decay reaction. As discussed in an analysis of the effects of nutrient export between subwatersheds that accounts for nutrient decay by Wickham, et al (2003), the amount of nitrogen and phosphorus delivered to a point downstream is an exponential function of travel time and a decay coefficient. Smith et al (1997) developed decay coefficient values for nitrogen and phosphorus to be used in the Spatially Referenced Regressions on Watershed Attributes (SPARROW) model. The values were developed using data from over 380 USGS NASQAN stations. The decay coefficients were developed for use with three stream flowrate categories: $<$1,000 ft^3/s, 1,000 - 10,000 ft^3/s, and $>$10,000 ft^3/s and are shown in Table 9-1. These values were also used in the development of the environmental assessment for Concentrated Animal Feeding Operations (see *Estimation of National Economic Benefits Using the National Water Pollution Control Assessment Model to Evaluate Regulatory Options for Concentrated Animal Feeding Operations (CAFOs, EPA-821-R-03-009)* December, 2002). For this analysis, only five of the 63 modeled MPP facilities were located on streams with a mean flow rate of greater than 10,000 ft^3/s, while there were no reaches with a 7Q10 flow rate greater than 10,000 ft^3/s. More than 70 percent of the receiving streams had mean flow rates and 7Q10 flow rates less than 1,000 ft^3/s.

Table 9-1
Decay Coefficients for Nitrogen and Phosphorus, Segregated by Stream Flowrate

Flowrate (ft^3/s)	Decay Coefficients (d^{-1})*	
	Nitrogen	Phosphorus
< 1,000	0.3842	0.2680
1,000 - 10,000	0.1227	0.0956
>10,000	0.0408	0.0156

* Values were taken from the Final Model Bootstrap Coefficient column reported in Tables 1 and 2 from Smith et al (1997). The report did not develop a phosphorus decay coefficient for flowrates >10,000 ft^3/s, so the Final Model Lower 90 percent Confidence Interval for flowrates between 1,000 and 10,000 ft^3/s is being applied. This application is reasonable as the faster the flow rate, the longer it would take for the decay process to occur. Therefore, it is assumed that the lower 90 percent confidence is representative of the higher flow rates (i.e., those close to 10,000 ft^3/s).

These decay coefficients were used in the stream dilution modeling.

9.4 STREAM DILUTION MODELING

Currently, the simplified stream dilution model used for the evaluation of aquatic and human toxicity does not incorporate the use of decay coefficients for pollutants (see Chapter 10 of this document). EPA incorporated exponential decay loss for total nitrogen and total phosphorus by examining the change in concentration, under 7Q10 low flow (lowest consecutive seven-day average flow during any 10-year period) and mean receiving stream flow conditions, at a distance (1,000 m) downstream from 63 of 65 direct discharging MPP facilities (Equations 1 and 2).

$$C_{is} = \frac{L / OD}{FF + SF} xCF \qquad \text{Eq. 1}$$

$$C_{ds} = C_{is} e^{-kt} \qquad \text{Eq. 2}$$

where

C_{is}	=	in-stream pollutant concentration (milligrams per liter [mg/L])
L	=	facility pollutant loading (pounds per year [lbs/yr])
OD	=	facility operating days (days per year [days/yr])
FF	=	facility effluent flow (million gallons per day [MGD])
SF	=	receiving stream flow (million gallons per day [MGD])
CF	=	conversion factors for units
C_{ds}	=	in-stream pollutant concentration 1,000 meters downstream (milligrams per liter [mg/L])
k	=	decay coefficient (days^{-1})
t	=	time to travel 1,000 meters (days)

These 63 facilities represent those non-small MPP facilities with detailed and/or screener surveys and available data for modeling (EPA, 2004). Receiving stream flow data were obtained from either the W.E. Gates study data or measured flow data, both of which are contained in EPA's GAGE File (EPA, 2000a). The 1,000 m distance represents the maximum distance that the stream flow rates and velocities for a particular reach were considered applicable. EPA then estimated the travel time required in the exponential decay equation by dividing the travel distance (1,000 m) by the reach velocity (available from EPA's GAGE File). The estimated in-stream concentrations were then compared to the appropriate total nitrogen and total phosphorous aggregate reference condition values to estimate the effects on the environment at baseline and at the regulatory option being assessed (Option 2.5). Each of the modeled MPP facilities was assigned to one of the 84 Level III subecoregions based on locational information. EPA identified the locations of MPP facilities on receiving streams using the U.S. Geological Survey (USGS) cataloging and stream segment (reach) numbers contained in EPA's REACH File (RF1) (EPA, 2000b). Estimated in-stream concentrations were compared directly to the 25th and 50th percentile aggregate reference condition values to determine impacts. To determine a water quality excursion, EPA divided the projected in-stream concentration by the reference condition value. A number greater than 1.0 indicated an excursion.

9.5 RESULTS

The results of this analysis indicate the potential water quality benefits of controlling nutrient discharges from MPP facilities to surface waters. The results are presented in Tables 9-2 through 9-5. Table 9-2 presents a summary of the overall projected criteria excursions for the 25th and 50th percentile reference concentrations under 7Q10 low flow and mean flow stream concentrations. Tables 9-3 and 9-4 present the projected criteria excursions, by subcategory. for the 25th and 50th percentile reference conditions, respectively. Projected improvements in receiving streams with no predicted excursions are summarized in Table 9-5. This analysis is not designed to predict actual in-stream concentrations, but instead evaluate, at a screening level, the relative impacts of MPP facilities and treatment controls required under this rule. (The regulatory option assessed (Option 2.5) does not address phosphorus discharges. Modeling results for phosphorus are presented, but are not discussed.)

Under baseline discharge levels, in the absence of all other sources of nitrogen and assuming 7Q10 low flow stream conditions, in-stream nitrogen concentrations resulting from discharges from 45 MPP facilities (out of 63 modeled), are projected to potentially exceed 304(a) nitrogen criteria (Tables 9-2 and 9-3). These criteria represent the upper 25th percentile reference conditions of 'least impacted' streams in their respective subecoregions. The number of excursions prior to the rule reduces to 41 facilities when estimated in-stream nitrogen concentrations are compared to the 50th (i.e., median) percentile reference conditions (Tables 9-2 and 9-4). It is possible that many of these receiving streams would exceed the 25th and 50th percentile reference conditions, even in the absence of MPP facility discharges, but these baseline results demonstrate the potential for MPP discharges to affect nutrient water quality.

When discharges from the MPP facilities are reduced in accordance with the requirements under this rule (Option 2.5), 6 of the 45 25th percentile excursions are projected to be eliminated under 7Q10 low flow stream conditions (Tables 9-2 and 9-3). Correspondingly, 4 of the 41 50th percentile excursions are projected to be eliminated (Tables 9-2 and 9-4). When mean stream flow conditions are assumed, 8 of the 16 projected 25th percentile excursions are projected to be eliminated, and 7 of the 14 50th percentile excursions are projected to be eliminated. In addition, a 60 to 69 percent reduction in the magnitude of the excursions of the 25th and 50th reference conditions under both 7Q10 low flow and mean flow stream conditions is projected. In reality, these excursions may not in fact be eliminated due to the assumptions of this analysis, but the results demonstrate the potential capacity of this rule to affect water quality related to nutrient discharges.

Improvements in water quality are also predicted in receiving streams where in-stream nitrogen concentrations are not projected to exceed 304(a) nitrogen criteria (Table 9-5). In-stream nitrogen concentrations are projected to be reduced in approximately 60 percent of the non-excursion streams under both 7Q10 low flow and mean flow stream conditions. A 9 to 90 percent reduction in nitrogen concentrations is projected, as well as a 23 to 56 percent reduction in the magnitude ranges (ratio of in-stream concentrations to reference concentrations). These projected reductions further demonstrate the potential water quality benefits that may be attributable to this rule.

Complete modeling results are available in the MPP rulemaking Docket (OW-2002-0014) (DCN 316,511).

Table 9-2
Summary of Projected Criteria Excursions for 63 MPP Direct Discharge Facilities

	25th Percentile Criteria			
	Total Nitrogen		**Total Phosphorus**	
	7Q10 Flow	**Mean Flow**	**7Q10 Flow**	**Mean Flow**
Baseline				
# of exceedences	45	16	45	30
Magnitude	1.0 - 279	1.4 - 59	1.2 - 2144	1.2 - 188
Option 2.5				
# of exceedences	39	8	45	30
Magnitude	1.1 - 92	1.0 - 19	1.2 - 2144	1.2 - 188

	50th Percentile Criteria			
	Total Nitrogen		**Total Phosphorus**	
	7Q10 Flow	**Mean Flow**	**7Q10 Flow**	**Mean Flow**
Baseline				
# of exceedences	41	14	42	25
Magnitude	1.0 - 181	1.1 - 35	1.1 - 768	1.2 - 94
Option 2.5				
# of exceedences	37	7	42	25
Magnitude	1.0 - 73	1.0 - 11	1.1 - 768	1.2 - 94

Note: Magnitude represents the range in the extent of the excursions.
Recommended criteria represent the 25th and 50th percentile of all nutrient data and Level III nutrient subecoregion reference conditions.

January, 2004, Loadings File

Table 9-3. Summary of Projected Criteria Excursions for 63 MPP Direct Dischargers (By Subcategory)

	25th Percentile Criteria			
	Total Nitrogen		Total Phosphorus	
	7Q10 Flow	Mean Flow	7Q10 Flow	Mean Flow
Current				
A - D				
# of exceedences	14	8	15	11
Magnitude	1.7 - 278.6	1.4 - 59.3	2.0 - 1706.1	2.5 - 188.5
E				
# of exceedences	0	0	0	0
Magnitude				
F - I				
# of exceedences	1	0	0	0
Magnitude	1.3			
J				
# of exceedences	3	0	2	2
Magnitude	1.0 - 87.2		46.2 - 823.5	3.1 - 6.7
K				
# of exceedences	25	8	25	16
Magnitude	1.3 - 229.1	1.5 - 9.7	1.2 - 2144.2	1.2 - 86.9
L				
# of exceedences	2	0	3	1
Magnitude	1.2 - 9.8		1.6 - 32.6	1.8
Option 2.5				
A - D				
# of exceedences	11	2	15	11
Magnitude	1.8 - 50.9	1.0 - 19.0	2.0 - 1706.1	2.5 - 188.5
E				
# of exceedences	0	0	0	0
Magnitude				
F - I				
# of exceedences	1	0	0	0
Magnitude	1.3			
J				
# of exceedences	2	0	2	2
Magnitude	2.1 - 8.8		46.2 - 823.5	3.1 - 6.7
K				
# of exceedences	24	6	25	16
Magnitude	1.1 - 92.4	1.5 - 3.8	1.2 - 2144.2	1.2 - 86.9
L				
# of exceedences	1	0	3	1
Magnitude	6.1		1.6 - 32.6	1.8

Note: Magnitude represents the range in the extent of the excursions.
Recommended criteria represent the 25th and 50th percentile of all nutrient data and Level III nutrient subecoregion reference conditions.
Number of Facilities Modeled: Subcategory A-D = 19; E = 0; F-I = 3; J = 5; K = 31; L = 5
January, 2004, Loadings File

Table 9-4. Summary of Projected Criteria Excursions for 63 MPP Direct Dischargers (By Subcategory)

	50th Percentile Criteria			
	Total Nitrogen		Total Phosphorus	
	7Q10 Flow	Mean Flow	7Q10 Flow	Mean Flow
Baseline				
A - D				
# of exceedences	14	7	15	10
Magnitude	1.2 - 149.7	1.2 - 35.1	1.1 - 767.8	1.4 - 93.7
E				
# of exceedences	0	0	0	0
Magnitude				
F - I				
# of exceedences	1	0	0	0
Magnitude	1.0			
J				
# of exceedences	2	0	2	2
Magnitude	5.5 - 64.4		30.8 - 370.6	2.0 - 3.0
K				
# of exceedences	23	7	23	13
Magnitude	1.0 - 180.9	1.1 - 7.4	1.8 - 647.4	1.2 - 36
L				
# of exceedences	1	0	2	0
Magnitude	5.4		1.9 - 15.6	
Option 2.5				
A - D				
# of exceedences	11	1	15	10
Magnitude	1.0 - 29.3	11.2	1.1 - 767.8	1.4 - 93.7
E				
# of exceedences	0	0	0	0
Magnitude				
F - I				
# of exceedences	1	0	0	0
Magnitude	1.0			
J				
# of exceedences	2	0	2	2
Magnitude	1.3 - 6.5		30.8 - 370.6	2.0 - 3.0
K				
# of exceedences	22	6	23	13
Magnitude	1.4 - 73.0	1.0 - 3.0	1.8 - 647.4	1.2 - 36.0
L				
# of exceedences	1	0	2	0
Magnitude	3.4		1.9 - 15.6	

Note: Magnitude represents the range in the extent of the excursions.
Recommended criteria represent the 25th and 50th percentile of all nutrient data and Level III nutrient subecoregion reference conditions.

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Table 9-5

Summary of Projected Improvements (Non-Excursion Streams) at Option 2.5 for 63 MPP Direct Discharge Facilities

	25th Percentile Criteria		50th Percentile Criteria	
	Total Nitrogen		Total Nitrogen	
	7Q10 Flow	Mean Flow	7Q10 Flow	Mean Flow
# of exceedences	18	47	22	49
Improved Streams (No. / %)	10 / 56	28 / 60	13 / 59	30 / 61
Reduction (%)	28 - 84	9 - 90	15 - 84	9 - 90
Magnitude				
Current	0.04 - 0.78	0.01 - 0.82	0.02- 0.88	0.01 - 0.97
Option 2.5	0.01 - 0.39	0.00 - 0.59	0.01 - 0.68	0.00- 0.43

Note: Magnitude represents the range in the ratio of in-stream concentrations to criteria. Recommended criteria represent the 25th and 50th percentile of all nutrient data and Level III nutrient subecoregion reference conditions.

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NOTE: These references are available in the MPP Rulemaking Docket (OW-2002-0014) (DCN 316,512 through DCN 316,517)

CHAPTER 10

TOXICITY ASSESSMENT OF CHANGES IN WATER QUALITY

10.1 INTRODUCTION

In response to concerns about pollutants of concern (POCs) that were not addressed in the proposed regulation for the MPP point source category, EPA conducted an exploratory analysis to assess the potential impacts of releases of 10 pollutants from the 53 MPP facilities for which sufficient data were available to model. EPA employed stream dilution techniques, which did not take into account fate processes other than complete immediate mixing, to conduct the analysis.

EPA used a screening-level model to assess the aquatic life and human health toxicity impacts of releases of ten pollutants—ammonia, barium, chromium, copper, manganese, molybdenum, nickel, titanium, vanadium, and zinc. The assessment evaluated the potential impacts to aquatic life by comparing the modeled in-stream pollutant concentrations under current (baseline) treatment levels to published EPA aquatic life criteria guidance or toxic effect levels. Impacts to human health were evaluated by (1) comparing estimated in-stream concentrations to health-based water quality toxic effect levels or EPA's published water quality criteria, and (2) estimating the potential noncarcinogenic hazard (systemic adverse effects such as reproductive toxicity) from consuming contaminated fish or drinking water. Potential carcinogenic risks were not evaluated since none of the pollutants modeled are classified by EPA as known or probable carcinogens.

The following sections summarize the methodologies used to evaluate projected water quality impacts (including aquatic life and human health) and provides a summary of the results of this assessment. For a complete description of the data sources and information used in the assessment and the toxicity of the POCs, see the *Toxicity Assessment in Support of the Notice of Data Availability for the Meat and Poultry Products (MPP) Point Source Category, Volumes I and II* (DCN 316,518; OW-2002-0014).

10.2 METHODOLOGY

EPA evaluated the water quality impacts and associated risks of MPP discharges at current (baseline) treatment levels by (1) comparing projected in-stream concentrations with ambient water quality criteria (AWQC),[3] and (2) estimating the human health risks (systemic) associated with the consumption of fish and drinking water from waterbodies impacted by MPP facilities. EPA analyzed the impacts and associated risks for 53 detailed survey MPP facilities (non-small meat and poultry slaughterhouses) that directly discharge wastewaters to 53 receiving streams. The following sections describe the methodologies used in this evaluation.

10.2.1 Comparison of In-stream Concentrations with Ambient Water Quality Criteria

The in-stream concentration analysis quantified current (baseline) pollutant releases and uses stream modeling techniques to evaluate potential aquatic life and human health impacts resulting from those releases. In the analysis, EPA compared projected in-stream concentrations for each pollutant to EPA water quality criteria or, for pollutants for which no water quality criteria have been developed, to toxic effect levels (i.e., lowest reported or estimated toxic concentration).

$$C_{is} = \frac{L/OD}{FF + SF} \; x \; CF \qquad \text{(Eq. 1)}$$

where:

C_{is} = in-stream pollutant concentration (micrograms per liter [μg/L])
L = facility pollutant loading (pounds/year [lb/year])
OD = facility operation (days/year)
FF = facility flow (million gallons/day [gal/day])
SF = receiving stream flow (million gal/day)
CF = conversion factors for units

[3] In performing this analysis, EPA used guidance documents published by EPA that recommend numeric human health and aquatic life water quality criteria for numerous pollutants. States often use these guidance documents when adopting criteria as part of their water quality standards. The simplified stream dilution techniques were used for screening priority pollutants. Therefore, EPA used the national criteria values in lieu of more site -specific values. The Agency did not use this as a comprehensive analysis, but rather as a trigger to identify potential impacts on aquatic life and human health. A more site-specific analysis could be undertaken if the simplified stream dilution technique projects in-stream excursions of national aquatic life and human health criteria.

EPA used various resources, as described in the *Toxicity Assessment in Support of the Notice of Data Availability for the Meat and Poultry Products (MPP) Point Source Category, Volumes I and II* (DCN 316,518; OW-2002-0014), to derive the facility-specific data (e.g., pollutant loading, operating days, facility flow, and stream flow) used in Eq. 1. One of three receiving stream flow conditions (1Q10 low flow, 7Q10 low flow, and harmonic mean flow) was used. Use depended on the type of criterion or toxic effect level intended for comparison. To estimate potential acute and chronic aquatic life impacts, EPA used the 1Q10 and 7Q10 flows, which are the lowest one-day and the lowest consecutive seven-day average flow during any 10-year period, respectively, as recommended in the *Technical Support Document for Water Quality-based Toxics Control* (EPA, 1991). EPA defines the harmonic mean flow as the inverse mean of reciprocal daily arithmetic mean flow values. EPA recommends the long-term harmonic mean flow as the design flow for assessing potential human health impacts because it provides a more conservative estimate than the arithmetic mean flow. Because 7Q10 flows have no consistent relationship with the long-term mean dilution, they are not appropriate for assessing potential human health impacts.

For assessing impacts on aquatic life, EPA used the facility operating days (i.e., 365 days) to represent the exposure duration; the calculated in-stream concentration was thus the average concentration *on days the facility is discharging wastewater*. For assuming long-term human health impacts, EPA set the operating days (exposure duration) at 365 days. The calculated in-stream concentration was thus the average concentration *on all days of the year* and is consistent with the conservative assumption that the target population is present to consume drinking water and contaminated fish every day for an entire lifetime.

EPA determined potential impacts on freshwater quality by comparing projected in-stream pollutant concentrations (Eq. 1) at reported facility flows, 1Q10 and 7Q10 low flows, and harmonic mean receiving stream flows with EPA AWQC or toxic effect levels for the protection of aquatic life and human health. To determine water quality criteria excursions, EPA divided the projected in-stream pollutant concentration by the EPA water quality criteria or toxic effect levels. A value greater than 1.0 indicated an excursion.

Assumptions and Caveats

In performing the in-stream analysis, EPA assumed the following:

- Background concentrations of each pollutant in the receiving stream are equal to zero; therefore, the analysis evaluates only the impacts of discharging facilities.

- EPA used an exposure duration of 365 days to determine the likelihood of actual excursions of human health criteria or toxic effect levels.

- Complete mixing of discharge flow and stream flow occurs across the stream at the discharge point; therefore, the analysis calculates an "average stream" concentration, even though the actual concentration may vary across the width and depth of the stream.

- The intake process water at each facility is obtained from a source other than the receiving stream.

- The pollutant load to the receiving stream is continuous and is representative of long-term facility operations. These assumptions may overestimate risks to human health and aquatic life, but may underestimate potential short-term effects.

- EPA used 1Q10 and 7Q10 receiving stream flow rates to estimate aquatic life impacts; harmonic mean flow rates are used to estimate human health impacts. EPA estimated 1Q10 low flows using the results of a regression analysis of 1Q10 and 7Q10 flows from representative U.S. rivers and stream (Versar, 1992). Harmonic mean flows were estimated from the mean and 7Q10 flows as recommended in the *Technical Support Document for Water Quality-based Toxics Control* (EPA, 1991). These flows may not be the same as those used by specific States to assess impacts.

- In performing the analysis, EPA did not consider pollutant fate processes such as sediment adsorption, volatilization, and hydrolysis. This omission may result in estimated in-stream concentrations that are environmentally conservative (higher).

10.2.2 Estimation of Human Health Risks

EPA evaluated the potential benefits to human health by estimating the noncarcinogenic risks associated with pollutant levels in fish tissue and drinking water at current treatment levels. Potential carcinogenic risks were not evaluated since none of the pollutants modeled are classified by EPA as known or probable carcinogens.

10.2.2.1 Fish Tissue

To determine the potential impact associated with pollutant levels in fish tissue, EPA estimated lifetime average daily doses (LADDs) and individual risk levels for each pollutant discharged from a facility on the basis of the in-stream pollutant concentrations calculated at current treatment levels in the site-specific stream dilution analysis (see Section 10.2.1). EPA estimated LADDs for sport anglers and their families, and subsistence anglers and their families. LADDs were calculated as follows:

$$LADD = (C \times IR \times BCF \times F \times D) / (BW \times LT) \qquad \text{(Eq. 2)}$$

where:

LADD	=	potential lifetime average daily dose (milligrams per kilogram per day [mg/kg-day])
C	=	exposure concentration (mg/L)
IR	=	ingestion rate (see Assumptions and Caveats)
BCF	=	bioconcentration factor (liters per kilogram [L/kg]; whole body x 0.5)
F	=	frequency duration (365 days/year)
D	=	exposure duration (70 years)
BW	=	body weight (70 kg)
LT	=	lifetime (70 years x 365 days/year)

EPA estimated potential reductions in risks due to reproductive, developmental, or other chronic and subchronic toxic effects by comparing the estimated lifetime average daily dose and the oral reference dose (RfD) for a given chemical pollutant as follows:

$$HQ = ORI / RfD \qquad \text{(Eq. 3)}$$

where:

HQ	=	hazard quotient
ORI	=	oral intake (LADD x BW, mg/day)
RfD	=	reference dose (mg/day assuming a body weight of 70 kg)

EPA then calculated a hazard index (i.e., sum of individual pollutant hazard quotients) for each facility or receiving stream. A hazard index greater than 1.0 indicated that toxic effects may occur in exposed populations.

10.2.2.2 Drinking Water

EPA determined potential benefits associated with pollutant levels in drinking water in a manner similar to that used for fish tissue. LADDs were calculated for drinking water consumption as follows:

$$LADD = (C \times IR \times F \times D) / (BW \times LT) \qquad \text{(Eq. 4)}$$

where:

LADD	=	potential lifetime average daily dose (mg/kg-day)
C	=	exposure concentration (mg/L)
IR	=	ingestion rate (2L/day)
F	=	frequency duration (365 days/year)
D	=	exposure duration (70 years)
BW	=	body weight (70 kg)
LT	=	lifetime (70 years x 365 days/year)

EPA then calculated a hazard index for each facility or receiving stream. A hazard index greater than 1.0 indicated that toxic effects may occur in exposed populations.

Assumptions and Caveats

EPA used the following assumptions in the analyses of human health risks:

- EPA did not assess synergistic effects of multiple chemicals on aquatic ecosystems; therefore, the total risk may be underestimated.

- Recreationally valuable species occur or are taken in the vicinity of the discharges included in the evaluation.

- In the analysis of fish tissue, EPA used average ingestion rates of 17.5 grams per day for sport anglers and 142.4 grams per day for subsistence anglers (U.S. EPA, 1998). These ingestion rates are based on uncooked, fresh and estuarine finfish and shellfish weights and use data from the adult population surveyed (age 18 and older). They represent the 90^{th} and the 99^{th} percentiles, respectively, of the empirical distribution of the U.S. per capita freshwater/estuarine finfish and shellfish consumption, and do not include the consumption of marine fish.

- When estimating the pollutant concentration in drinking water or fish, EPA did not consider pollutant fate processes (e.g., sediment adsorption, volatilization, hydrolysis); consequently, estimated concentrations are environmentally conservative (higher).

10.3 SUMMARY OF RESULTS

10.3.1 Comparison of In-stream Concentrations with Ambient Water Quality Criteria

The results of this analysis indicate the potential water quality benefits of controlling toxic discharges from MPP facilities to surface waters. EPA evaluated the effect of direct wastewater discharges on receiving stream water quality at current discharge levels for 53 MPP detailed surveyed facilities directly discharging 10 pollutants (i.e., ammonia, barium, chromium, copper, manganese, molybdenum, nickel, titanium, vanadium, and zinc) to 53 receiving streams. The appendices in the *Toxicity Assessment in Support of the Notice of Data Availability for the Meat and Poultry Products (MPP) Point Source Category, Volumes I and II* report (DCN 316,518; OW-2002-0014) present the complete results of the modeling.

EPA projects that modeled in-stream pollutant concentrations of one pollutant (copper) will slightly exceed (1.03 ratio) chronic aquatic life criteria or toxic effect levels in only one of the 53 receiving streams at current discharge levels (Tables 10-1 and 10-2). No excursions of acute aquatic life criteria or toxic effect levels are projected.

In addition, EPA projects that one pollutant (manganese) will marginally exceed (1.2 ratio) human health criteria or toxic levels (developed for consumption of water and organisms) in one of the 53 receiving streams at current discharge levels (Tables 10-1 and 10-2). No excursions of human health criteria or toxic effect levels (developed for consumption of organisms only) are projected.

Based on these results, EPA projects that there are no meaningful aquatic life benefits to be obtained and no further analyses of these types of impacts were considered.

10.3.2 Estimation of Human Health Risks and Benefits

The results of this analysis also indicate the potential benefits to human health by estimating the risks (systemic effects) associated with current pollutant levels in fish tissue and drinking water. EPA estimated risks for recreational (sport) and subsistence anglers and their families, as well as the general population (drinking water). The appendices in the *Toxicity Assessment in Support of the Notice of Data Availability for the Meat and Poultry Products (MPP) Point Source Category, Volumes I and II* report (DCN 316,518; OW-2002-0014) present the results of the modeling.

EPA projects no systemic toxicant effects (hazard index greater than 1.0) for sport or subsistence anglers consuming fish from any of the 53 receiving streams at current discharge levels (Table 10-3). In addition, no systemic effects to the general population from the consumption of drinking water are projected.

Based on these results, EPA projects that there are no meaningful human health benefits to be obtained and no further analyses of these types of impacts were considered.

Table 10-1. Summary of Projected Criteria Excursions for MPP Direct Dischargers (Current Discharge Levels)

	Acute Aquatic Life	Chronic Aquatic Life	Human Health Water and Orgs	Human Health Orgs. Only	Total
#of exceedences	0	1	1	0	2
Pollutants (No.)	0	1 (1.03)	1 (1.2)	0	2
Total Excursions	0	1	1	0	

NOTE: Number of streams evaluated = 53, number of facilities = 53, and number of pollutants = 10.
Numbers in parentheses represent the range in the magnitude of excursions.
April 10, 2003 Loadings File

Table 10-2
Summary of Pollutants Projected to Exceed Criteria for MPP Direct Dischargers
(Current Discharge Levels)

	Acute Aquatic Life	Chronic Aquatic Life	Human Health Water and Orgs.	Human Health Orgs. Only
Ammonia	0	0	0	0
Barium	0	0	0	0
Chromium	0	0	0	0
Copper	0	1 (1.0)	0	0
Manganese	0	0	1 (1.2)	0
Molybdenum	0	0	0	0
Nickel	0	0	0	0
Titanium	0	0	0	0
Vanadium	0	0	0	0
Zinc	0	0	0	0

NOTE: Number of pollutants evaluated = 10.
Numbers in parentheses represent the range in the magnitude of excursions.
April 10, 2003 Loadings File

Table 10-3
Summary of Potential Systemic Health Impacts for MPP Direct Dischargers
(Current Discharge Levels)
(Fish Tissue and Drinking Water Consumption)

	Fish Tissue Hazard Indices >1	Drinking Water Hazard Indices >1
# of exceedences	0	0
Pollutants (No.)	0	0
General Population	NA	0
Sport Anglers	0	NA
Subsistence Anglers	0	NA

NOTE: Number of streams evaluated = 53, number of facilities = 53 and number of pollutants = 10.
April 10, 2003 Loadings File

10.4 REFERENCES

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NOTE: Most of these references are available in the Environmental Assessment/Benefits Docket (W-99-24)

CHAPTER 11

BENEFITS FROM REDUCED DRINKING WATER TREATMENT COSTS

11.1 DRINKING WATER TREATMENT ANALYSIS

Total suspended solids (TSS) entering surface waters from MPP facilities can cause many problems for stream health and aquatic life. Suspended solids can also interfere with effective drinking water treatment. High sediment concentrations interfere with coagulation, filtration, and disinfection. Treatment costs can rise as a result. With more than 11,000 public drinking water systems throughout the United States relying on surface waters as a primary source, costs associated with removing large amounts of sediments can be substantial.

For the final rule, EPA estimated the monetary value associated with NWPCAM predicted reductions in TSS stream concentrations in terms of reduced drinking water treatment costs by relating the results of the surface water modeling effort with the operation and maintenance (O&M) costs associated with the conventional treatment technique of gravity filtration. These estimated annual avoided costs could be subject to a number of uncertainties, resulting in a range of estimated benefits.

The analytic approach includes identifying public drinking water systems and water supplies that are potentially impacted by discharges from MPP facilities, linking the water supplies to the TSS watershed concentrations projected by NWPCAM for the baseline and various regulatory scenarios, and estimating the reductions in drinking water treatment costs. This three-step approach is explained in detail below.

1. **Identification of Public Drinking Water Systems:** According to information reported under the Safe Drinking Water Information System (SDWIS) by states to EPA for the fiscal year ending in September 2000, there are approximately 170,000 public water systems in the United States that rely on surface water and groundwater. Of these systems, 11,403 are Community Water Systems (CWSs) (EPA, 2002a), which supply water to the same population year-round and rely on surface water to serve 178.1 million people. The water supplies of some of these

CWSs can be impacted by discharges from MPP facilities. First, EPA identified the CWSs and associated streams, populations served, and operating status. During this process, Agency researchers used two EPA databases: (1) Water Supply Database (WSDB) (EPA, 2000b) and (2) the Safe Drinking Water Information System (SDWIS) (EPA, 200a). Production capacities for each water utility were estimated based on the population served and a 1995 per capita water usage (including commercial) of 192 gallons per day (U.S. Census Bureau, 1995)

2. **Application of TSS Concentrations and Water System Data:** EPA estimated reduced drinking water treatment costs based on projected reductions in TSS stream concentrations. To estimate these reductions, EPA linked the site-specific water system data from WSDB and SDWIS with watershed-specific TSS concentrations projected by NWPCAM baseline and regulatory scenarios. For each watershed, EPA calculated a median TSS concentration for the baseline and regulatory scenarios. The median concentrations were applied to each of the public water utilities located within the watershed.

3. **Estimation of Drinking Water Treatment Costs:** EPA employed the Water Treatment Estimation Routine (WaTER), developed through a cooperative effort between the U.S. Department of the Interior, the Bureau of Reclamation, and the National Institute of Standards and Technology, to estimate reduced drinking water treatment costs based on projected reductions in TSS concentrations in streams (U.S. Bureau of Reclamation, 1999). Using production capacity and raw water composition (e.g., TSS stream concentrations), WaTER calculates dose rates and cost estimates for construction and annual O&M for 15 standard water treatment processes. Cost estimates are derived independently for each selected process. The program employs cost indices, as established by the *Engineering News Record*, Bureau of Labor Statistics, and the Producer Price Index, and derives cost data from *Estimating Water Treatment Costs* (U.S. EPA, 1979) and *Estimating Costs for Treatment Plant Construction* (Qasim et al., 1992).

EPA used costs associated with the conventional treatment technique of gravity filtration to estimate the reduction in O&M costs from TSS removal associated with the final rule. There are two components to gravity filtration: the backwashing system and the gravity filter structure. O&M costs are based on the TSS concentration and area of the filter bed, which has an applicable range of 13 square meters to 2600 square meters, depending on the system flow rate, or production capacity. The default design values are: a wash cycle of 24 hours; a TSS density of 35 grams per liter; a media depth of 1meter; and a maximum media capacity of 110 L-TSS/m^3 (Degrémont, 1991). Major O&M costs include materials, energy, and labor. The unit cost estimates and cost index values (September 2003) used for updating the 1979 EPA process costs were:

- Electricity Cost - 0.0909 ($/kWhr)
- ENR Labor Rate for Skilled Labor - 36.46 ($/hr)
- ENR Materials Index - 1974.25

These values were obtained from the *Engineering News Record* (ENR, 2003) and the U.S. Department of Energy (U.S. DOE, 2004). Off-site disposal costs, off-site pretreatment costs, and construction costs are not included in EPA's estimates. Cost savings estimates were derived from the change in O&M costs predicted under the baseline and regulatory scenarios.

11.2 RESULTS

Table 11-1 summarizes the estimated annual benefits associated with improvements in surface water quality (i.e., TSS concentrations and reduced drinking water treatment costs). The results are based on 53 sample facilities with detailed survey data. The results suggest that the cost savings from the reduction in TSS is very small. Table 11-2 expands these results to all facilities within the scope of the rule. The total cost savings under even the most stringent option amounts to $1,500 nationwide. For both tables, Scenarios 1-4 correspond to Option 2, Option 2+P, Option 2.5, and Option 2.5+P; Scenario 5 corresponds to Option 4. These results were based on the National Water Pollution Control Assessment Model (NWPCAM) output of estimated TSS concentrations, as supplied by the Office of Water, Engineering and Analysis Division on September 8, 2003.

Table 11-1. Estimated Avoided Costs of Drinking Water Treatment Associated with Reduced TSS Discharges from 53 MPP Facilities* (2003 $)

	Average Production Capacity (MGD)	Average TSS Reduction (mg/L)	Average Water System Benefit	Total Benefit
Scenarios 1-4	23.0** (0.005 to 112)	0.004	$24	$100 - $160
Scenario 5	13.9*** (0.005 to 112)	0.02	$71	$910 - $1,400

* Based on analysis of 53 MPP facilities (facilities with detailed survey data) and 5,509 public drinking water systems. Results for benefits are not extrapolated.

** Based on 5 drinking water utilities with reduced TSS concentrations.

*** Based on 15 drinking water utilities with reduced TSS concentrations.

Source: EPA, OW, EAD, September 8, 2003 NWPCAM estimated TSS concentrations

Table 11-2. Estimated Annual Benefits of Avoided Costs of Drinking Water Treatment Associated With Reduced TSS Discharges From All MPP Facilities* (2003 $)

	Average Production Capacity (MGD)	Average TSS Reduction (mg/L)	Average Water System Benefit	Total Benefit
Scenarios 1-4	16.1** (0.005 to 112)	0.003	$16	$100 - $160
Scenario 5	12.3*** (0.005 to 112)	0.02	$62	$950 - $1,500

* Based on analysis of 169 MPP facilities and 5,509 public drinking water systems. Results for benefits are not extrapolated.

** Based on 8 drinking water utilities with reduced TSS concentrations.

*** Based on 18 drinking water utilities with reduced TSS concentrations.

Source: EPA, OW, EAD, September 8, 2003 NWPCAM estimated TSS concentrations

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NOTE: These references are available in the MPP Rulemaking Docket (OW-2002-0014) (DCN 316,501 through DCN 316,510)

CHAPTER 12

NITROGEN LOADING REDUCTIONS ASSOCIATED WITH NEW TECHNOLOGY: An Analysis of 62 Watersheds and Associated Streams

12.1 INTRODUCTION

EPA evaluated the potential impacts and benefits of implementing best available technology at MPP facilities by modeling the resulting reduction in nutrients and pollutants entering streams and water bodies. A landscape characterization of the watersheds where 112 MPP facilities resided was initiated to evaluate the potential application of watershed models to estimate reduced nutrient and toxic substance loadings associated with the best available technology. This evaluation was necessary because the MPP facilities are located across the United States and could require different models depending upon the biophysical setting. MPP facility and loading information was obtained through the Confidential Business Information (CBI) program implemented by EPA's Office of Water.

12.2 METHODOLOGY

EPA's analysis was limited to evaluating landscape characteristics of the contributing area (i.e., watershed or catchment) upstream of each MPP facility and potential nitrogen (N) and phosphorus (P) discharge to channels immediately downstream from the plant. Both location and nutrient release information was available for only 62 of the 112 MPP sites. The 62 sites were located in 24 different states, but most were found in the Southeast, upper Midwest, and mid-Atlantic regions. Table 12-1 classifies land cover in the contributing areas as forest, urban, or agricultural. Land cover surrounding the plants varied widely.

Table 12-1
Land Cover in Contributing Areas

ID	Area (ha)	% Forest	% Urban	% Agriculture	ID	Area (ha)	% Forest	% Urban	% Agriculture
1	281.3	78.01	0.58	20.93	49	9.8	5.56	11.11	72.22
3	28993.8	75.92	3.27	17.44	50	107.6	30.79	0.34	62.25
4	18.8	81.64	1.45	16.91	52	249.5	15.57	54.70	27.46
6	21	0.00	52.36	46.35	53	21.9	4.53	88.48	7.00
7	14.2	19.62	0.00	80.38	57	66288.1	65.69	2.76	31.43
8	47.3	12.38	47.62	40.00	58	2918.4	25.03	63.49	6.94
9	12.3	1.46	5.84	86.13	60	5539.4	44.47	0.97	40.87
12	195.6	36.03	46.62	17.35	61	227.5	63.67	6.69	29.41
13	10.1	11.61	0.00	88.39	62	88861.1	42.23	4.25	32.23
15	1372.8	57.87	1.32	39.96	63	61.5	36.77	4.46	57.08
17	36.1	35.91	11.22	13.47	64	768.1	0.84	0.40	95.27
18	9.8	100.00	0.00	0.00	65	100.4	0.27	6.47	89.13
19	56.5	63.85	18.15	17.99	66	1618.2	0.18	23.46	76.35
21	47	47.01	39.31	13.68	68	28.1	0.96	16.67	64.74
23	331336	6.10	3.90	82.85	69	6666.7	9.41	1.84	88.67
25	10.7	0.84	26.05	71.43	70	10.5	0.86	75.00	11.21
26	7501.4	1.16	9.36	83.60	76	229322.3	72.06	1.25	25.84
28	56833.7	0.01	1.08	19.15	79	1564.7	24.16	21.84	53.87
29	36.6	3.69	6.88	87.22	81	54.6	13.93	26.37	59.70
30	12.1	0.00	74.63	25.37	83	54279.1	70.38	0.28	28.98
33	258.9	0.07	78.63	18.78	85	161239	0.75	4.37	90.98
35	88	16.58	12.54	70.88	88	1234.4	14.31	27.23	54.31
36	13.1	53.10	13.10	33.79	89	10.4	100.00	0.00	0.00
39	84.1	77.30	4.86	11.24	92	43.4	7.88	0.62	91.49
40	160.9	7.55	17.28	75.17	94	41	10.74	46.76	38.03
41	11.3	4.00	1.60	94.40	95	9.6	10.48	2.86	85.71
42	1044	28.31	1.61	48.35	96	34.1	49.73	17.91	32.09
44	231.3	30.08	0.08	59.16	98	59.9	17.42	2.10	80.03
45	12.3	0.00	97.08	2.92	101	56590.7	12.49	0.86	72.73
46	12.1	32.09	0.00	65.67	102	328.6	7.83	4.57	81.46
48	199777	51.95	0.99	44.00	103	510.5	18.22	4.71	75.79

EPA examined five technology options and determined that BAT Option 2.5 was the most cost-effective. Option 2.5 included biological treatment, nitrification, partial denitrification, and disinfection. Load reductions for N were provided for this option.

Load reductions for P were not available for Option 2.5. Although this chapter provides a summary of nonpoint and point source (MPP facilities) P loads, it only discusses potential reductions in N.

12.2.1 Estimation of N and P in the Contributing Area Upstream of MPP Facilities

For each of the 62 facilities, EPA used the National Elevation Dataset to delineate the contributing area (NED; USGS http://edcnts12.cr.usgs.gov/ned/default.asp). Researchers ensured proper delineation of streams and watersheds by using the FILL command in Arc Info Grid to correct small depressions in the data. They used the FLOWACCUMULATION function in Grid to generate drainage channels and relocate each site to the nearest point on a channel. All upstream area that drained to the site was delineated with the Grid WATERSHED command. EPA used 1992 National Land Cover Data (NLCD; http://www.epa.gov/mrlc) and the ATtILA ArcView extension to estimate the N and P loadings for each site in kilograms per hectare per year based on land cover in the contributing area. Table 12-2 shows area-normalized loads, based on Reckhow et al. (1980). EPA multiplied area-normalized loadings (kg/ha/yr) by watershed area to convert them to totals (kg/yr). This chapter refers to the total loads estimated for each watershed (Reckhow et al. 1980) upstream of MPP facilities as nonpoint source (NPS) loads.

Table 12-2
Loadings Used to Estimate Background N and P in kg/ha/yr.

Land Cover	P loading	N loading
Urban	1.2	5.5
Pasture	0.9	5.0
Row crop	2.3	8.5
Non-row crop	0.8	6.0
Forest	0.25	2.5
Shrubland	0.04	0.4
Grassland	0.06	0.3

12.2.2 Surrounding Area N and P Estimation

Some of the contributing areas were very small, less than 10 hectares for sites located on hills or near headwaters. For the 34 sites with contributing areas containing less than 160 hectares, EPA delineated larger contributing areas by theoretically relocating the sites downstream. The new contributing areas were a minimum of 160 hectares, provided contextual information on surrounding land cover, and increased the probability that the area delineated truly contained the area that drained to the plant. The revision, however, probably raised the estimated N and P NPS loads for the contributing areas.

12.2.3 Loading Reduction Estimates Using EPA Nutrient Criteria for Ecoregions and Decay Coefficients

Agency researchers sought to compare nutrient load input to surface waters from the MPP facilities with EPA-recommended nutrient concentrations converted to loads (U.S. EPA 1998). They separated the modeling effort into the following steps:

- Converting EPA-recommended nutrient concentrations to nutrient loads.

- Estimating Reach File 3 (RF3) stream distance from each MPP facility to the nearest Reach File 1 (RF1) stream. RF3 is discussed in detail in Section 8.1.1. RF1 is a similar national database that includes only larger streams.
- Routing and decaying facility-generated nutrient loads through the RF3 stream to the nearest RF1 stream.
- Comparing the routed and decayed load from each facility to the EPA-recommended nutrient load for the nearest RF1 stream.

EPA developed recommended nutrient concentrations (U.S. EPA 1998) to facilitate nationwide nutrient management. There are recommended concentrations for N and P for 14 nutrient ecoregions. To convert EPA-recommended nutrient concentrations to nutrient loads, Agency researchers multiplied the recommended concentrations by the published discharges for each RF1 stream (DeWald et al. 1985). This conversion permitted direct comparison of the nutrients produced by the MPP facilities with EPA recommended nutrient concentrations. This chapter refers to the nutrient loads developed through the conversion as background loads.

Researchers developed the RF1 stream data (DeWald 1985) using 1:250,000-scale U.S. Geological Survey topographic maps. To identify the correct receiving stream for the MPP facility discharge and estimate the distance of this RF3 stream to the nearest RF1 stream, researchers used higher resolution RF3 stream data and GIS techniques.

Nutrients are not conserved in smaller streams (Smith et al. 1997). A host of biotic and abiotic processes remove nutrients as they travel through a stream (Burns 1998). The amount of nutrients removed decreases as stream size and discharge increase (Smith et al. 1997). Researchers used empirical methods to route and decay, or remove, facility-generated nutrient loads as they traveled through the RF3 stream reach to the nearest RF1 stream (Wickham et al. 2003). This chapter refers to the amount of facility-generated nutrient loads reaching the nearest RF1 stream as facility loads.

Finally, researchers used simple arithmetic to compare the routed and decayed load from each facility to the EPA-recommended load for the nearest RF1 stream. When facility loads were greater than the background loads, the facility was generating loads in excess of EPA recommended nutrient concentrations and in-stream decay processes were not removing all of that excess. When the facility load was less than the background load, the facility was not generating loads in excess of EPA recommended nutrient concentrations.

For each MPP facility, researchers compared four scenarios for N and two for P to the EPA-recommended nutrient load. For each MPP facility, uncertainty in nutrient decay necessitated use of high and low decay scenarios for both N and P. Initially, the researchers assumed that each MPP facility did not adopt the best available technology (BAT), generating two scenarios for each nutrient. Later, they applied the BAT, creating two additional scenarios for N.

12.3 RESULTS AND DISCUSSION

12.3.1 Modeling Results from Estimated Upstream NPS Loads

Table 12-3 shows the estimated N and P NPS loads for the original and expanded contributing areas. It lists the area size, as larger areas generally have higher loads. The table also includes N and P discharges and the estimated N loads after implementing BAT Option 2.5.

Table 12-3
N and P Loads Discharged from Facility, Including Estimated N Loads After Technology Improvements (Opt 2.5 N Column) and Estimated NPS N and P Loads Based on Land Cover in Original and Expanded Contributing Areas

	Facility Discharge (kg/yr)			Estimated NPS Loads (kg/yr)			Estimated NPS Loads (kg/yr) for Expanded Areas		
ID	N	P	Opt 2.5 N	Area (ha)	N	P	Area (ha)	N	P
1	127961.14	23574.56	51626.53	281.3	952.6	150.0	281.3	952.6	150.0
3	173332.17	34719.32	69931.70	28993.8	90843.3	13250.2	28993.8	90843.3	13250.2
4	83943.17	19465.46	53298.92	18.8	57.5	7.7	323.0	1032.2	149.1
6	12820.79	3619.21	12820.79	21	112.9	23.4	8877.2	26429.3	3550.0
7	132777.84	39684.35	87819.12	14.2	67.0	12.1	166.5	754.3	147.9
8	164507.08	16952.11	67352.57	47.3	296.2	70.8	2306.0	9939.2	1879.1
9	43357.54	30392.51	43357.54	12.3	64.2	13.1	12337.9	50680.5	9247.3
12	68512.86	0.00	49140.84	195.6	922.5	187.7	195.6	922.5	187.7
13	8703.08	21735.24	8703.08	10.1	55.7	11.6	264.1	1476.6	332.3
15	126950.99	13070.27	51976.25	1372.8	5638.9	1027.2	1372.8	5624.1	1025.3
17	131693.75	27096.70	56228.67	36.1	97.7	19.6	172.2	470.5	94.6
18	127512.99	29224.96	53157.40	9.8	24.5	2.4	311884.7	994038.8	154850.7
19	72812.01	1452.86	66245.81	56.5	211.8	36.1	160.7	683.6	123.3
21	25455.15	20803.11	25455.15	47	198.3	36.0	200.7	767.2	127.2
23	134233.87	19512.18	57280.10	331336	2232840.1	560686.8	331336.0	2232840.1	560686.8
25	126330.93	65724.18	61009.99	10.7	80.2	20.7	272730.8	1425018.3	318549.6
26	444205.76	80389.73	68643.95	7501.4	54890.8	14164.1	7501.4	54890.8	14164.2
28	115663.34	15421.69	22160.71	56833.7	83090.8	13702.6	56833.7	83090.8	13702.6
29	216395.33	23725.15	70617.53	36.6	281.2	73.8	180.0	1381.0	360.9
30	238825.02	63613.16	60953.75	12.1	75.5	17.8	382.1	2627.8	635.2
33	616362.22	116612.26	112724.97	258.9	1413.8	283.6	258.9	1413.8	283.6
35	3147.48	61.69	3147.48	88	511.0	112.8	4121.0	11898.2	1532.2
36	29855.45	29173.70	29855.45	13.1	52.9	9.3	815.1	3064.4	522.8
39	8321.15	95.71	8321.15	84.1	232.2	29.7	10474.7	54399.1	12271.1
40	9980.85	552.48	9980.85	160.9	1076.1	260.4	160.9	1076.1	260.4
41	2578.22	1202.02	2578.22	11.3	71.2	16.3	8596.2	55312.9	13406.6
42	31255.24	9903.28	7560.02	1044	4627.1	1057.3	1044.0	4627.1	1057.3
44	77561.13	773.83	48416.00	231.3	1162.1	262.0	231.3	1162.1	262.0
45	6326.71	157.85	5397.75	12.3	68.0	14.7	160.3	1089.8	263.0
46	25519.56	8842.33	25519.56	12.1	64.1	14.0	262.9	1402.2	309.6

	Facility Discharge (kg/yr)			Estimated NPS Loads (kg/yr)			Estimated NPS Loads (kg/yr) for Expanded Areas		
ID	**N**	**P**	**Opt 2.5 N**	**Area (ha)**	**N**	**P**	**Area (ha)**	**N**	**P**
48	27582.05	4171.24	27582.05	199777	735479.2	115251.5	199777.0	734280.6	114572.1
49	33548.60	1950.45	33548.60	9.8	48.0	9.8	712.8	3322.5	584.3
50	63044.81	38301.34	25723.23	107.6	442.4	77.9	1801.3	8172.7	1481.3
52	310169.66	180543.84	117182.42	249.5	1248.7	244.6	249.5	1248.7	244.6
53	131224.28	103945.69	83728.62	21.9	118.1	24.7	46682.8	175350.0	28691.3
57	107852.03	37495.76	71207.20	66288.1	238239.3	37751.1	66288.1	238239.3	37751.1
58	191400.12	64727.64	19418.29	2918.4	13246.5	2630.4	2918.4	13246.5	2630.4
60	29337.90	4322.74	29337.90	5539.4	24502.5	5406.5	5539.4	24502.5	5406.5
61	32125.68	6633.79	20365.39	227.5	828.2	131.9	227.5	828.2	131.9
62	51871.01	49038.78	51871.01	88861.1	342310.4	73337.1	88861.1	342310.5	73337.0
63	35674.59	12621.66	35674.59	61.5	275.8	52.0	295381.2	959457.1	145091.2
64	208899.26	54426.55	49960.48	768.1	5632.3	1438.4	768.1	5632.3	1438.4
65	358460.01	120211.06	114820.11	100.4	776.8	205.3	2052.1	15948.4	4155.5
66	897763.69	143817.82	146193.28	1618.2	12216.1	3123.4	1618.2	12216.1	3123.5
68	1291723.20	270595.08	256276.53	28.1	154.0	34.4	186.7	1192.3	290.4
69	13976.54	232.24	5436.30	6666.7	48269.3	12211.4	6666.7	48269.3	12211.3
70	634.58	37.19	634.58	10.5	49.6	10.6	182.9	1328.7	335.6
76	103438.12	24058.99	65677.46	229322.3	769009.5	115532.5	229322.3	769009.5	115532.6
79	82452.21	733.01	31327.36	1564.7	7844.4	1585.5	1564.7	7844.4	1585.5
81	2440.33	402.34	2440.33	54.6	277.2	54.9	835.2	4109.1	775.8
83	204210.47	10315.60	23945.14	54279.1	184223.2	27579.2	54279.1	184223.2	27579.2
85	451083.13	143581.05	97639.39	161239	1138847.4	285473.9	161239.0	1138847.5	285473.7
88	8505.76	11923.58	5097.47	1234.4	5724.1	1079.5	1234.4	5724.1	1079.5
89	53408.69	59721.79	53408.69	10.4	25.9	2.6	5278.9	15165.6	2024.4
92	116621.78	5382.33	43829.27	43.4	234.3	47.2	71886.6	225982.7	30853.7
94	167367.88	2196.75	141753.07	41	242.3	57.3	164.3	887.9	194.4
95	19642.37	300.28	19642.37	9.6	45.3	8.0	169.9	558.2	81.8
96	143255.82	2535.58	43357.08	34.1	153.1	30.4	162.4	629.8	122.7
98	155564.05	58707.10	52165.85	59.9	277.3	49.1	20906.5	60447.1	7501.3
101	5075.70	160.12	5075.70	56590.7	307944.2	72011.7	56590.7	307944.2	72011.7
102	37896.74	1229.69	37896.74	328.6	2131.7	523.2	328.6	2131.7	523.2
103	19704.05	413.22	14132.58	510.5	3085.4	709.4	510.5	3085.4	709.4

The estimated NPS N loads (using the original, smaller contributing areas) were less than 1 percent of plant N loads for 30 of the 62 sites for which location and nutrient discharge information were available. The model predicts that Option 2.5 will reduce loads at 20 of these sites; implementation will not reduce N loads at the other 10 facilities. The estimated NPS N loads were between 1 percent and 25 percent of facility N loads for 19 of the 62 sites. The model predicts that Option 2.5 will reduce loads at 12 of those 19 sites. The estimated NPS N loads are 50 percent to 90 percent of facility N loads at 5 sites. Eight sites have estimated NPS N loads higher than facility N loads.

To further refine the optimal selection of plants, EPA compared the estimated NPS N loads from the expanded contributing areas to the facility N loads. Estimated NPS N loads were 1 percent or less of plant N loads at 10 sites. All of these sites benefitted from using Option 2.5. In addition, 25 sites had estimated NPS loads less than 25 percent of plant loads and Option 2.5 could reduce loads at 17 of them.

Based on this analysis, the best candidates for BAT Option 2.5 implementation include sites 1, 7, 17, 19, 29, 33, 52, 68, 94, and 96. At each of these plants, NPS loads are less than 1 percent of plant loads. Implementing BAT Option 2.5 at these sites would reduce plant N loads by 9 percent to 82 percent. The second group of candidates includes sites 4, 8, 12, 15, 26, 30, 42, 44, 45, 50, 58, 61, 64, 65, 66, 79, and 103, which have NPS N loads between 1 percent and 25 percent of plant N loads. Implementing BAT Option 2.5 at these sites would reduce plant N loads by 15 percent to 90 percent.

12.3.2 Modeling Results Using EPA Ecoregion for Nutrients and Decay Coefficients

Only 62 of the 103 plants reported facility-generated loads, and background loads could not be obtained for five of those sites. EPA researchers could only compare background and facility-generated loads for the 57 plants with the required data. Under the low decay scenario for N, plant loads were less than background loads for only 18 of the 57 sites. Thus the majority of facilities are delivering N loads in excess of EPA recommendations to their nearest RF1 stream. The high-decay scenario only improves the margin by 1, increasing the number of facilities whose source loads are less than background loads to 19.

Table 12-4 compares background loads with plant loads for the N and P scenarios. Under the BAT implementation scenario, the number of plant loads that exceeded background loads decreased for N. Under the low decay scenario, the number of plants producing loads that were less than background levels improved from 18 to 22. Under the high decay scenario, the number of plants producing loads that were less than background levels improved from 19 to 24. These results suggest that the BAT Option 2.5 scenario is a more effective means of reducing nutrient loads to background levels than instream processing.

Overall, the results for P are poorer than for N. Only 13 plant loads were less than background levels under the low decay scenario and only 16 plant loads were less than background levels under the high decay scenario. Lower decay rates could explain the poor results for P. Modeled decay coefficients are generally higher (more negative) for N than P, indicating that P is removed less effectively than N by instream processes.

Table 12-4
Background Loads (B) Versus Plant Loads (P)

	Low Decay		**High Decay**	
Nutrient	**B > P**	**B < P**	**B > P**	**B < P**
N	18	39	19	38
N with BMP	22	35	24	33
P	13	43	16	40

12.4 SUMMARY

BAT Option 2.5 can significantly improve water quality near some MPP facilities. Both the NPS and decay methods can be used to identify plants where implementation of BAT Option 2.5 would have the most impact. The two methods are complimentary. The NPS method quantifies the effect of the plant in terms of the surrounding watershed and the decay method quantifies downstream levels of plant-generated nutrients relative to established nutrient criteria. The NPS method identifies plants with high loads relative to NPS loads. It then allows EPA to determine which of those plants benefit from Option 2.5 implementation. The decay method identifies plants with loads that exceed established nutrient criteria levels. It then allows EPA to determine which of those plants' loads would drop below established nutrient levels after Option 2.5 implementation. The two methods provide different results because of their fundamentally different assumptions (surrounding watershed versus downstream loads), but each result helps EPA understand the landscape context of BAT application.

12.5 REFERENCES

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CHAPTER 13

COST-BENEFIT COMPARISON AND UNFUNDED MANDATES REFORM ACT ANALYSIS

13.1 COST-BENEFIT COMPARISON

The pretax annualized costs of the final rule is $52.6 million in 1999 dollars (see Table 5-3). The pretax cost is a proxy for the social cost of the regulation because it incorporates the cost to industry (posttax costs), and costs to State and Federal governments (i.e., lost income from tax shields).[1] In other words, the cost part of the equation is well-identified and estimated.

The estimated quantified and monetized benefits of the rule range from $0 to $9.1 million with a preferred point estimate of $2.4 million (adjusted from 2003 to 1999 dollars using CPI-U). This is an underestimate because EPA can fully characterize only a limited set of benefits to the point of monetization. Chapters 7 through 12 highlight efforts to quantify several changes in water quality from the rule. Chapter 7 describes the environmental effects of this rule and details how they impact ecological systems and human health. Chapter 8 focuses mainly on the public's willingness to pay for improvements in the recreational use of water bodies (e.g., boating, swimming). Chapter 9 estimates changes in exceedances of nutrient criteria. Chapter 10 considers changes in the amount of toxics entering waterways. Chapter 11 estimates the savings when water withdrawn for municipal or industrial uses needs less pretreatment. Chapter 12 evaluates the benefits of the best available technology at facilities using landscape characterization to estimate reduced nutrient and toxic substance loadings associated with the technology. Other benefits may accrue due to the final rule that are not included in these quantified or monetized values. Therefore, the reported benefit estimate understates the total benefits of this final rule.

[1] All sites are currently permitted and permits are reissued on a periodic basis, so incremental costs administrative costs of the regulation are negligible.

13.2 UNFUNDED MANDATES REFORM ACT ANALYSIS

Title II of the Unfunded Mandates Reform Act of 1995 (Public Law 104-4; UMRA) establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and tribal governments as well as the private sector. Under Section 202(a)(1) of UMRA, EPA must generally prepare a written statement, including a cost-benefit analysis, for proposed and final regulations that "includes any Federal mandate that may result in the expenditure by State, local, and tribal governments, in the aggregate or by the private sector" of annual costs in excess of $100 million.[2] As a general matter, a federal mandate includes Federal Regulations that impose enforceable duties on State, local, and tribal governments, or on the private sector (Katzen, 1996). Significant regulatory actions require Office of Management and Budget review and the preparation of a Regulatory Impact Assessment that compares the costs and benefits of the action.

The promulgated meat products industry effluent limitations guidelines are not an unfunded mandate on state, local, or tribal governments because industry bears the cost of the regulation. The pretax cost estimate to industry is $52.6 million per year, while posttax costs—costs out of industry's pocket—are $40.8 million. Thus, it is not clear that the final rule is an unfunded mandate on industry. EPA, however, is responsive to all required provisions of UMRA. In particular, this Economic Analysis (EA) addresses the requirements of UMRA:

- Section 202(a)(1) — authorizing legislation (Chapter 1 and the preamble to the rule);
- Section 202(a)(2) — a qualitative and quantitative assessment of the anticipated costs and benefits of the regulation, including administration costs to state and local governments (Chapters 5 and 7);
- Section 202(a)(3)(A) — accurate estimates of future compliance costs (as reasonably feasible; Chapter 5);
- Section 202(a)(3)(B) — disproportionate effects on particular regions or segments of the private sector. EPA projects no site closures as a result of the final rule. There are therefore no disproportionate effects on a particular region or segments of the private sector (Chapter 5);

[2] The $100 million in annual costs is the same threshold that identifies a "significant regulatory action" in Executive Order 12866.

- Section 202(a)(3)(B) — disproportionate effects on local communities. EPA projects no site closures as a result of the final rule. There are therefore no disproportionate effects on local communities (Chapter 5) .

- Section 202(a)(4) — estimated effects on the national economy (Chapter 5);

- Section 205(a) — least burdensome option or explanation required (this Chapter).

The preamble to the final rule summarizes the extent of EPA's consultation with stakeholders including industry, environmental groups, states, and local governments (UMRA, sections 202(a)(5) and 204). Because this rule does not "significantly or uniquely" affect small governments, section 203 of UMRA does not apply.

Pursuant to section 205(a)(1)-(2), EPA has selected the "least costly, most cost-effective or least burdensome alternative" consistent with the requirements of the Clean Water Act (CWA) for the reasons discussed in the preamble to the rule. EPA is required under the CWA (section 304, Best Available Technology Economically Achievable (BAT), and section 307, Pretreatment Standards for Existing Sources (PSES)) to set effluent limitations guidelines and standards based on BAT considering factors listed in the CWA such as age of equipment and facilities involved, and processes employed. EPA is also required under the CWA (section 306, New Source Performance Standards (NSPS), and section 307, Pretreatment Standards for New Sources (PSNS)) to set effluent limitations guidelines and standards based on Best Available Demonstrated Technology. EPA determined that the rule constitutes the least burdensome alternative consistent with the CWA.

13.3 REFERENCES

Katzen. 1996. Economic Analysis of Federal Regulations Under Executive Order No. 12866. Memorandum for Members of the Regulatory Work Group from Sally Katzen, Ad, OIRA. January 11, 1996.

APPENDIX A

COST EFFECTIVENESS ANALYSIS

A.1 INTRODUCTION

As part of the process of setting effluent limitations guidelines and developing standards, EPA uses cost effectiveness calculations to compare the efficiencies of regulatory options for removing priority and nonconventional pollutants.[1] This cost effectiveness (CE) analysis presents an evaluation of the technical efficiency of pollutant control options for the final effluent limitations guidelines and standards for the meat products industry based on Best Available Technology Economically Achievable (BAT). BAT standards set effluent limitations on toxic pollutants and nutrients for direct dischargers prior to wastewater discharge directly into a water body such as a stream, river, lake, estuary, or ocean. Indirect dischargers send wastewater to publicly owned treatment works (POTW) for further treatment prior to discharge to U.S. surface waters; EPA is not setting effluent limitations guidelines for indirect dischargers as part of this rule.

The analyses presented in this section include a standard cost effectiveness analysis, based on the approach EPA has historically used for developing an effluent guideline for toxic pollutants, an analysis of the cost reasonableness of nonconventional pollutant removals, and an analysis of the cost effectiveness of removing nutrients. This expanded approach is necessary to evaluate the broad range of pollutants in meat slaughtering and processing wastewater, for which nutrients, conventional pollutants, and nonconventional pollutants may be more significant than toxic pollutants. EPA's standard CE analysis is used for analyzing the removal of toxic pollutants and does not adequately address removals of nutrients, total suspended solids, and pathogens. To account for the estimated removals of nutrients under the final meat products regulation in the analysis, the Agency has developed an alternative approach to evaluate the pollutant removal effectiveness of nutrients relative to cost. Although

[1] A list of priority ("toxic") and conventional pollutants are defined in 40 CFR Part 401. There are more than 120 priority pollutants, including metals, pesticides, and organic and inorganic compounds. Conventional pollutants include biological oxygen demand (BOD), total suspended solids (TSS), pH, fecal coliform, and oil and grease. Nonconventional pollutants comprise all other pollutants, including nutrients (i.e., they do not include conventional and priority pollutants).

pathogens maybe an important constituent of meat processing wastewater, EPA has not at this time developed an approach that would allow a similar assessment of pathogen removals.

The organization of this chapter is as follows. Section A.2 discusses EPA's standard cost effectiveness methodology and presents the results of this analysis; this section also identifies the pollutants included in the analysis and presents EPA's toxic weighting factors for each pollutant. Section A.3 explains the cost reasonableness analysis and presents the results of this analysis. Section A.4 discusses EPA's cost effectiveness methodology for nutrients and contains the results of the nutrients cost effectiveness analysis. Section A.5 presents the results of the BCT cost test. Section A.6 contains supplementary data tables, while Section A.7 lists references.

A.2 COST EFFECTIVENESS METHODOLOGY AND RESULTS: TOXIC POLLUTANTS

A.2.1 Overview

Cost effectiveness is evaluated as the incremental annualized cost of a pollution control option in an industry or industry subcategory per incremental pound equivalent of pollutant (i.e., pound of pollutant adjusted for toxicity) removed by that control option. EPA uses the cost effectiveness analysis primarily to compare the removal efficiencies of regulatory options under consideration for a rule. A secondary and less effective use is to compare the cost effectiveness of the final options for the meat products industry to those for effluent limitation guidelines and standards for other industries.

To develop a cost effectiveness study for direct discharging facilities, the following steps must be taken to define the analysis or generate data used for calculating values:

- Determine the pollutants effectively removed from the wastewater.
- For each pollutant, identify the toxic weight (which adjusts the removals to reflect the relative toxicity of the pollutants). This is described in Section A.2.2.
- Define the regulatory pollution control options.
- Calculate pollutant removals for each pollution control option.

- Calculate the product of the pollutant removed (in pounds) and the toxic weighting factor. The resultant removal is specified in terms of "pounds equivalent" removed.

- Determine the annualized cost of each pollution control option.

- Calculate incremental CE for options.

Table A-1 presents the pollutants and their toxic weights used in the CE calculations for toxic pollutants as well as conventional and nonconventional pollutants.

Table A-1
Toxic Weighting Factors
Meat Products Industry Pollutants of Concern

POLLUTANT	Toxic Weighting Factor
TOXICS	
Ammonia as Nitrogen	1.8e-03
NUTRIENTS	
Total Phosphorus	NA
Total Nitrogen	NA
Total Kjeldahl Nitrogen (TKN) [1]	NA
CONVENTIONALS	
5-Day Biochemical Oxygen Demand (BOD)	NA
Oil & Grease (HEM)	NA
Total Suspended Solids (TSS)	NA
NONCONVENTIONALS	
Chemical Oxygen Demand (COD)	NA
Carbonaceous Biochemical Oxygen Demand (CBOD)	NA
Nitrate/Nitrite	6.2e-05
PATHOGENS	
Fecal Coliform (million cfu/day)	NA

[1] TKN is used to calculate Total Nitrogen for baseline loads.

A.2.2 Toxic Weighting Factors

Cost effectiveness analyses account for differences in toxicity among the pollutants using toxic weighting factors. Accounting for these differences is necessary because the potentially harmful effects on human and aquatic life are specific to the pollutant. For example, a pound of zinc in an effluent stream has a significantly different, less harmful effect than a pound of PCBs. Toxic weighting factors for pollutants are derived using ambient water quality criteria and toxicity values. For most industries, toxic weighting factors are developed from chronic freshwater aquatic criteria. In cases where a human health criterion has also been established for the consumption of fish, the sum of both the human and aquatic criteria are used to derive toxic weighting factors. The factors are standardized by relating them to a "benchmark" toxicity value, which was based on the toxicity of copper when the methodology was developed.[2]

Examples of the effects of different aquatic and human health criteria on freshwater toxic weighting factors are presented in Table A-2. As shown in this table, the toxic weighting factor is the sum of two criteria-weighted ratios: the former benchmark copper criterion divided by the human health criterion for the particular pollutant and the former benchmark copper criterion divided by the aquatic chronic criterion. For example, using the values reported in Table A-2, four pounds of the benchmark chemical (copper) pose the same relative hazard in freshwater as one pound of cadmium because cadmium has a freshwater toxic weight four times greater than the toxic weight of copper (2.6 divided by 0.63 equals 4.13).

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[2] Although the water quality criterion has been revised (to 9.0 µg/l), all cost effectiveness analyses for effluent guideline regulations continue to use the former criterion of 5.6 µg/l as a benchmark so that cost effectiveness values can continue to be compared to those for other effluent guidelines. Where copper is present in the effluent, the revised higher criterion for copper results in a toxic weighting factor for copper of 0.63 rather than 1.0.

Table A-2
Examples of Toxic Weighting Factors
Based on Copper Freshwater Chronic Criteria

Pollutant	Human Health Criteria (µg/l)	Aquatic Chronic Criteria (µg/l)	Weighting Calculation	Toxic Weighting Factor
Copper*	1,200	9.0	5.6/1,200 + 5.6/9.0	0.63
Cadmium	84	2.2	5.6/84 + 5.6/2.2	2.6
Naphthalene	21,000	370	5.6/21,000 + 5.6/370	0.015

* The water quality criterion has been revised (to 9.0 µg/l). Formerly, the weighting factor calculation led to a result of 0.47 as a toxic weighting factor for copper.
Notes: Human health and aquatic chronic criteria are maximum contamination thresholds. Units for criteria are micrograms of pollutant per liter of water.

A.2.3 Pollutant Removals And Pounds Equivalent Calculations

The pollutant loadings have been calculated for each facility under each regulatory pollution control option for comparison with baseline (i.e., current practice) loadings. Pollutant removals are calculated simply as the difference between current and post-treatment discharges. For toxic pollutants, these removals are converted into pounds equivalent for the cost effectiveness analysis. For direct dischargers, removals in pounds equivalent for toxic pollutants are calculated as:

$$\text{Removals}_{pe} = \text{Removals}_{pounds} \text{ x Toxic weighting factor}$$

Total removals for each option are then calculated by adding up the removals of all pollutants included in the cost effectiveness analysis for a given subcategory for both toxic pollutants and nutrients.

A.2.4 Calculation Of Incremental Cost Effectiveness Values

Cost effectiveness ratios are calculated separately for direct and indirect dischargers and by subcategory. Within each of these many groupings, the pollution control options are ranked in ascending order of pounds equivalent removed. The incremental cost effectiveness value for a particular control option is calculated as the ratio of the incremental annual cost to the incremental pounds equivalent removed. The incremental effectiveness may be viewed primarily in comparison to the baseline scenario and to other regulatory pollution control options. Cost effectiveness values are reported in units of dollars per pound equivalent of pollutant removed.

For the purpose of comparing cost effectiveness values of options under review to those of other promulgated rules, compliance costs used in the cost effectiveness analysis are adjusted to 1981 dollars using *Engineering News Record*'s Construction Cost Index (CCI; ENR 2000). The adjustment factor is calculated as follows:

Adjustment factor = 1981 CCI / 1999 CCI = 3535 / 6059 = 0.583

The equation used to calculate the incremental cost effectiveness of option k is:

$$CE_k = \frac{ATC_k - ATC_{k-1}}{PE_k - PE_{k-1}}$$

where:

CE_k	=	Cost effectiveness of Option k
ATC_k	=	Total pretax annualized treatment cost under Option k
PE_k	=	Pounds equivalent removed by Option k

Cost effectiveness measures the incremental unit cost of pollutant removal of Option k (in pounds equivalent) in comparison to Option k-1. The numerator of the equation, ATC_k minus ATC_{k-1}, is simply the incremental annualized treatment cost in moving from Option k-1 to Option k. Similarly, the denominator is the incremental removals achieved in going from Option k-1 to k. The lower the value of the incremental CE calculation, the lower the cost of each additional pound equivalent of pollutants removed under that option.

A.2.5 Cost-Effective Results for Toxic Pollutants

A.2.5.1 Subcategory Cost Effectiveness

Table A-3 shows the average and incremental CE figures for nonsmall direct dischargers in all subcategories using the “high” cost estimate for the selected option (see Section 5.1.1 for the distinction between the “high” and “low” cost estimates for Option 2.5). For direct dischargers, the incremental CE of Option 2.5 ranges from $6,500 per pound in Subcategories A - D to $26,100 in Subcategory L (both in 1981 dollars). Option 2.5 + P is dominated for all subcategories (as is Option 2.5 for Subcategories F - I) because it results in additional costs compared to Option 2.5, but removes no additional toxic or nonconventional pollutants.

Table A-4 shows the average and incremental CE figures for small direct dischargers in all subcategories. The smallest incremental CE value is $460 under Option 2 in Subcategories F - I.

Detailed tables containing pollutant removals and baseline loads for both nonsmall and small facilities in each subcategory can be found in Section A.6.

A.2.5.2 Industry Cost Effectiveness

Table A-5 presents the MPP industry-wide incremental cost-effectiveness calculation for nonsmall direct dischargers. Overall, the incremental cost of removing toxic pollutants from MPP wastewater under Option 2.5 is almost $9,700 per pound equivalent removed.

Table A-6 summarizes the cost effectiveness of the selected option for direct dischargers in the meat products industry relative to that of other industries.

Table A-3
Results of Cost Effective Analysis for Nonsmall Direct Dischargers

Regulatory Option	Pretax Annualized Costs (Millions of 1999$)	Pollutant Removals (Pounds Equivalent)	Pretax Average Cost Effectiveness (1981$ per Pound Equivalent Removed)	Pretax Incremental Cost Effectiveness (1981$ per Pound Equivalent Removed)
Subcategories A - D				
Option 2	$7.29	4,118	$1,032	$1,032
Option 2.5 (High)	$16.69	4,960	$1,963	$6,515
Option 2.5 + P	$42.91	4,960	$5,048	DOM
Option 4	$52.00	5,242	$5,787	$72,875
Subcategories F - I				
Option 2	$0.27	19	$8,018	$8,013
Option 2.5 (High)	$0.33	19	$9,917	DOM
Option 2.5 + P	$0.36	19	$10,818	DOM
Option 4	$0.80	25	$18,423	$52,550
Subcategory J				
Option 2	$0.63	90	$4,095	$4,095
Option 2.5 (High)	$2.83	180	$9,139	$14,115
Option 2.5 + P	$7.43	180	$24,035	DOM
Option 4	$10.17	205	$28,929	$173,529
Subcategory K				
Option 2	$17.74	608	$17,035	$17,035
Option 2.5 (High)	$31.82	1,235	$15,037	$13,100
Option 2.5 + P	$63.38	1,235	$29,955	DOM
Option 4	$109.08	2,165	$29,361	$48,431
Subcategory L				
Option 2	$0.56	17	$18,704	$18,704
Option 2.5 (High)	$0.98	27	$21,324	$26,105
Option 2.5 + P	$1.48	27	$32,012	DOM
Option 4	$3.27	50	$37,897	$56,902

DOM: dominated; option has higher cost than the previous option, but results in no additional removals.

Table A-4
Results of Cost Effective Analysis for Small Facilities

Regulatory Option	Pretax Annualized Costs (Millions of $1999)	Pollutant Removals (Pounds Equivalent)	Pretax Average Cost Effectiveness ($1981 Per Pound Equivalent Removed)	Pretax Incremental Cost Effectiveness ($1981 Per Pound Equivalent Removed)
Subcategories A - D[1]				
Option 1	$1.0 - $2.5	0	Undefined	DOM
Option 2	NA	NA	NA	NA
Subcategories F - I				
Option 1	$1.11	5	$129,281	$129,281
Option 2	$1.12	15	$42,885	$462
Subcategory K				
Option 1	$2.5 - $5.0	0	Undefined	DOM
Option 2	$2.5 - $5.0	CBI	$240,664	$240,664
Subcategory L				
Option 1	$0.01	0.3	$23,580	$23,580
Option 2	$0.01	0.3	$23,969	DOM

[1] Results presented as a range to prevent disclosure of confidential business information.
NA: Option 2 was not costed for small facilities in Subcategories A - D.
DOM: dominated; option has higher cost than the previous option, but results in no additional removals.

Table A-5
Industry Incremental Cost Effectiveness of Pollutant Control Options

Size	Regulatory Option	Incremental		
		Pretax Annualized Cost (Millions of $1999)	Pounds Equivalent Removed	Cost Effectiveness ($1981/Pounds Equivalent)
Subcategories A - D				
Nonsmalls	Option 2.5 (High)	$9.40	842	$6,515
Subcategories F - I				
Non-Small	Option 2.5 (High)	DOM	DOM	DOM
Subcategory J				
Nonsmalls	Option 2.5 (High)	$2.20	91	$14,115
Subcategory K				
Nonsmalls	Option 2.5 (High)	$14.08	627	$13,100
Subcategory L				
Nonsmalls	Option 2.5 (High)	$0.43	10	$26,105
Industry Total		**$26.10**	**1,570**	**$9,698**

DOM: dominated; option has higher cost than the previous option, but results in no additional removals.

Table A-6
Industry Comparison of BAT Cost Effectiveness
(Toxic and Nonconventional Pollutants Only; Copper-Based Weights[a]; $1981)

Industry	Pounds Equivalent Currently Discharged (thousands)	Pounds Equivalent Remaining at Selected Option (thousands)	Incremental Cost Effectiveness of Selected Option(s) ($ / Pounds Equivalent Removed)
Aluminum Forming	1,340	90	121
Battery Manufacturing	4,126	5	2
Canmaking	12	0.2	10
Centralized Waste Treatment[c]	3,372	1,261-1,267	5-7
Coal Mining	BAT=BPT	BAT=BPT	BAT=BPT
Coil Coating	2,289	9	49
Copper Forming	70	8	27
Electronics I	9	3	404
Electronics II	NA	NA	NA
Foundries	2,308	39	84
Inorganic Chemicals I	32,503	1,290	<1
Inorganic Chemicals II	605	27	6
Iron & Steel	1,740	1,214	66
Leather Tanning	259	112	BAT=BPT
Meat Products	**8**	**2**	**$9,698**
Metal Finishing	3,305	3,268	12
Metal Products and Machinery[c]	140	70	50
Nonferrous Metals Forming	34	2	69
Nonferrous Metals Mfg I	6,653	313	4
Nonferrous Metals Mfg II	1,004	12	6
Oil and Gas: Offshore[b] Coastal—Produced Water/TWC Drilling Waste	3,809 951 BAT = Current Practice	2,328 239 BAT = Current Practice	33 35 BAT = Current Practice
Organic Chemicals	54,225	9,735	5
Pesticides	2,461	371	14
Pharmaceuticals[c] A/C B/D	897 90	47 0.5	47 96
Plastics Molding & Forming	44	41	BAT=BPT
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp & Paper[c]	61,713	2,628	39
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT
Transportation Equipment Cleaning	BAT=BPT	BAT=BPT	BAT=BPT

[a]Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
[b]Produced water only; for produced sand and drilling fluids and drill cuttings, BAT=NSPS.
ND: Nondisclosed due to business confidentiality.

A.3 COST REASONABLENESS ANALYSIS

A.3.1 Pollutants of Concern and Methodology

EPA selected the following pollutants to perform the cost reasonableness analysis: 5-day biochemical oxygen demand (BOD_5), ammonia as nitrogen, total nitrogen and total phosphorus. EPA used these pollutants in the following combinations to evaluate each option:

- Option 1 (small facilities only): the sum of BOD_5 and ammonia as nitrogen;
- Option 2: the sum of BOD_5 and ammonia as nitrogen;
- Option 2.5: the sum of BOD_5 and total nitrogen;
- Option 2.5 + P: the sum of BOD_5, total nitrogen, and total phosphorus;
- Option 4: the sum of BOD_5, total nitrogen, and total phosphorus.

EPA calculates cost reasonableness as the average cost per pound removed of the selected pollutant under each regulatory option. EPA has historically considered ratios as high as $37 per pound to be cost reasonable.

A.3.2 Results

Table A-7 presents the cost reasonableness results using the "high" Option 2.5 cost estimate for nonsmall facilities in all subcategories. Under the selected option, the cost reasonableness values range from a high of $15.16 in Subcategories F - I, to a low of $1.04 in Subcategories A - D.

Table A-8 presents the cost reasonableness results for small facilities in all subcategories. BAT was not selected for small facilities. With the exception of Subcategories F - I, average cost per pound exceeds the $37 figure historically considered to be reasonable.

Table A-7
BPT Cost and Removal Comparison for Nonsmall Direct Dischargers

Option	Pretax Annualized Costs (Millions of 1999$)	Total Pounds Removed[1] (Millions)	Average BPT Cost & Removal Comparison (1999$/pound)	Incremental BPT Cost & Removal Comparison (1999$/pound)
Subcategories A-D				
Option 2	$7.29	2.86	$2.55	NA
Option 2.5 (High)	$16.69	16.01	$1.04	NA
Option 2.5+P	$42.91	20.53	$2.09	$5.80
Option 4	$52.00	24.07	$2.16	$2.57
Subcategories F-I				
Option 2	$0.27	0.03	$8.24	NA
Option 2.5 (High)	$0.33	0.02	$15.16	NA
Option 2.5+P	$0.36	0.02	$16.53	DOM
Option 4	$0.80	0.10	$7.66	$7.40
Subcategory J				
Option 2	$0.63	0.08	$7.56	NA
Option 2.5 (High)	$2.83	1.50	$1.88	NA
Option 2.5+P	$7.43	2.09	$3.55	$7.80
Option 4	$10.17	2.31	$4.40	$12.57
Subcategory K				
Option 2	$17.74	0.98	$18.18	NA
Option 2.5 (High)	$31.82	10.01	$3.18	NA
Option 2.5+P	$63.38	14.16	$4.48	$7.61
Option 4	$109.08	26.42	$4.13	$3.73
Subcategory L[2]				
Option 2	$5.57	0.02	$29.88	NA
Option 2.5 (High)	$0.98	0.16	$6.32	NA
Option 2.5+P	$1.48	0.18	$8.17	$19.69
Option 4	$3.27	0.40	$8.17	$8.17

[1] Total pounds removed equals the: sum of BOD_5 and ammonia (as nitrogen) for Option 2; sum of BOD_5 and total nitrogen for Option 2.5; and sum of BOD_5, total nitrogen, and total phosphorus for Options 2.5+P and 4.
[2] Includes costs and removals for mixed processors attributable to non-small production in Subcategory L.
DOM: dominated; option has higher cost than the previous option, but results in no additional removals.

NA: The incremental cost reasonableness from Option 2 to Option 2.5 cannot be calculated because the pollutants used as the basis for the analysis differs under the two options; the incremental cost reasonableness from Option 2.5 to Option 2.5+P can be calculated because total phosphorus removals are zero under Option 2.5.

Table A-8
BPT Cost and Removal Comparison for Small Direct Dischargers

Option	Pretax Annualized Costs (Millions of 1999$)	Total Pounds Removed[1]	Average BPT Cost & Removal Comparison (1999$/pound)	Incremental BPT Cost & Removal Comparison (1999$/pound)
Subcategories A - D[2]				
Option 1	$1.0 - $2.5	CBI	$198	$198
Option 2	NA	NA	NA	NA
Subcategories F - I				
Option 1	$1.11	47,997	$23	$23
Option 2	$1.12	53,562	$21	$1
Subcategory K[2]				
Option 1	$2.5 - $5.0	CBI	$1,487	DOM[1]
Option 2	$2.5 - $5.0	CBI	$501	$501
Subcategory L				
Option 1	$0.01	183	$73	$73
Option 2	$0.01	183	$74	DOM[2]

[1] Total pounds removed equals the: sum of BOD_5 and ammonia (as nitrogen) for Options 1 and 2.
[2] Results presented as a range to prevent disclosure of confidential business information.
NA: Option 2 was not costed for small facilities in Subcategories A - D.
DOM[1]: dominated; option has identical costs as the following option, but fewer removals.
DOM[2]: dominated; option has higher cost than the previous option, but results in no additional removals.

A.4 COST EFFECTIVENESS METHODOLOGY AND RESULTS: NUTRIENTS

In addition to conducting a standard CE analysis for selected toxic pollutants (Section A.2), EPA also evaluates the cost effectiveness of removing selected nonconventional pollutants: nutrients, primarily nitrogen and phosphorus. The methodology for this analysis has been drawn from the economic impact analysis of the Concentrated Animal Feeding Operations Industry (U.S. EPA, 2001).

The nutrient cost effectiveness analysis does not follow the methodological approach of a standard CE analysis. Instead, this analysis compares the estimated compliance cost per pound of pollutant removed to the cost per pound figures reported in available studies. A review of this literature is provided in Section A.4.1. EPA uses these estimates to evaluate the efficiency of regulatory options in removing nutrients and to compare the proposed BAT options to other regulatory alternatives (Section A.4.2).

A.4.1 Review of Literature

EPA has reviewed the available information on pollutant removal costs for nutrients. This research can be broadly grouped according to estimates derived for industrial point sources (PS) and various nonpoint sources (NPS), including agricultural operations. In general, the PS research provides information on technology and retrofitting costs — and in some cases, cost per pound of pollutant removed — at municipal facilities, including publicly owned treatment works (POTWs) and wastewater treatment plants (WWTPs). This research utilizes actual cost data collected at a particular facility undergoing an upgrade. Other cost effectiveness research is based on the effectiveness of various nonpoint source controls, such as Best Management Practices (BMPs) and other pollutant control technologies that are commonly used to control runoff from agricultural lands. This research typically uses a modeling approach and simulates costs for a representative facility. The latter studies are less relevant to the MPP industry effluent guidelines.

EPA reviewed the literature on nutrient cost-effectiveness; Table A-9 summarizes the cost effectiveness values reported in these studies. These studies estimate a wide range of costs per pound of pollutant removed, spanning both point source and nonpoint sources, as well as a range of municipal,

Table A-9
Summary of Pollutant Removal Cost Estimates and Benchmarks

Type of Pollutant	Low Estimate	High Estimate	Treatment Type	Literature Sources
	($ per pound removed)			
Total Nitrogen (TN)	($0.79)	$5.92	WWTPs	Randall et al (1999)
	--	$3.64	WWTPs	Wiedeman (2000)
	$0.91	$9.53	Aerobic Lagoon	Tippett and Dodd (1995)
Total Phosphorus (TP)	$9.64	$165.00	Ag.(low) to municipal	NEWWT 1994
	$270.34	$1,179.35	Large Point Source	LCBP (1995)
	$2.72	$135.17	Aerobic Lagoon	Tippett and Dodd (1995)

WWTPs = Waste Water Treatment Plants; POTWs = Publicly owned treatment works.
Full citations are provided in references. Timeframe of dollar values shown vary by source (shown below).
Notes summarize timeframe of analysis, study assumptions (where available), and range of sources/treatment.
Randall (2000): 1995-1998; 6% interest and 20-year capital renewal; BNR retrofits at WWTP only.
NEWWT (1994): 5% interest and 20-year capital renewal; low bound is agricultural BMPs and higher bound is municipal treatment facilities.
McCarthy, et. al. (1996): No discount rate was applied and annual cost equals total lifetime costs adjusted by design life (varies by practice); study also examined agricultural land application (both with varying increasing over-application of land applied manure under pre-existing conditions). Cost-effectiveness values that assume direct discharge of animal wastes are not shown.
LCBP (2000): 1995: No discount rate was applied and annual cost equals total lifetime costs adjusted by design life (varies by practice); study also examined agricultural BMPs.

urban, and agricultural practices. Annualized costs also vary widely depending on a variety of factors, including the type of treatment system or practice evaluated, and whether the costs are evaluated as a retrofit to an existing operation or as construction of a new facility.

Researchers at Virginia Tech compiled a series of case studies that evaluated total costs for biological nutrient removal (BNR) retrofits at WWTPs throughout the Chesapeake Bay Watershed (Randall et al., 1999). These case studies estimated a range of costs per pound of nitrogen removed at these facilities. This research was commissioned by EPA's Chesapeake Bay Program and was conducted with the assistance of the Maryland Department of the Environment and the Public Utilities Division of Anne Arundel County. As part of this work, the researchers estimate BNR retrofit costs for 51 WWTPs located in Maryland, Pennsylvania, Virginia, and New York. The final report in this series compares these costs to the projected change in effluent total nitrogen concentrations, assuming that the influent flow meets the design or projected flow after 20 years (Randall, et al., 1999).

As shown in Table A-9, this study concludes that the costs of nitrogen removal are very plant-specific and the costs per pound of addition nitrogen removal ranged from a projected savings of $0.79 per pound to a cost of 5.92 per pound (Randall et al., 1999).[3] The range of these estimates is comparatively narrow given that the study examines a single retrofit category across similar facilities. This study assumes a 20-year capital renewal period and interest and inflation rates of 6 and 3 percent, respectively (Randall, 2000). The primary emphasis in this study is nitrogen, since the cost to upgrade for phosphorus removal is both configuration- and site-specific (Randall, 2000).[4] Based on this analysis and other data from the Maryland Department of the Environment, EPA's Chesapeake Bay Program Office derived a cost effectiveness value for BNR of $3.64 per pound of nitrogen removed (Wiedeman, 1998).

A number of other studies have assessed the cost effectiveness of various state-level programs to reduce nutrients in Wisconsin (NEWWT, 1994) and Vermont (LCBP, 2000). In Wisconsin, a series of studies compared the cost effectiveness of point and nonpoint source controls across 41 subwatersheds in the Fox-Wolf watershed in Wisconsin (NEWWT, 1994). These studies estimated the cost of reducing phosphorus and suspended solids (TSS) loads from municipal treatment facilities and agricultural sources. Baseline projections were compared to necessary reductions to meet future water quality objectives (as mandated by that State's current regulations). Phosphorus removal costs for rural sources are estimated to be $9.64 per pound, while municipal treatment facilities have an estimated average annual cost of $165 per pound of phosphorus removed (NEWWT, 1994).

The Lake Champlain Basin Program (LCBP) conducted a similar study to evaluate costs to meet Vermont's water quality goals. This study estimated phosphorus removal costs ranging from $270 to more than $1,000 per pound at a large municipal facility, compared to $440 to $544 per pound of

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[3] The costs per pound of additional nitrogen removed were flow-weighted to determine the average for each state and for all plants evaluated.

[4] For conventional plug-flow activated sludge configurations, all that is required for phosphorous removal is the installation of relatively low-cost baffles and mixers; for oxidation ditches, the addition of an anaerobic reactor separate from the ditch is needed (Randall, 2000).

phosphorus removed using agricultural BMPs (LCBP, 2000). In addition, researchers at Virginia Tech who estimated removal costs for nitrogen at WWTPs conclude that it will cost about the same to remove a pound of phosphorus as it costs to remove a pound of nitrogen, if removing only one nutrient. If the facility is upgraded to remove both nitrogen and phosphorus, the cost typically will be only slightly more than the cost to remove nitrogen alone (Randall, 2000).

A.4.2 Results of Nutrient Cost-Effective Analysis

Table A-10 presents the cost per pound of total nitrogen removals by subcategory and option for nonsmall direct dischargers. The average cost per pound of nitrogen removed ranges from $1.08 in Subcategories A - D to $6.71 in Subcategory L under the selected option. There were no total nitrogen removals under Option 2.5 in Subcategories F - I, thus the CE is undefined for that subcategory.

Table A-11 presents the cost per pound of total phosphorus removals by subcategory and option for nonsmall direct dischargers. No total phosphorus is removed under the selected option in any subcategory.

EPA did not estimate total nitrogen or total phosphorus removals for small direct dischargers under Option 1 or Option 2. Therefore, no summary table is provided for small direct dischargers.

A.5 BCT COST TEST

Section 301(b)(4) of the 1977 CWA amendments establish BCT for discharges of conventional pollutants from existing point sources at a level no less stringent than limitations based on BPT. Thus, BPT sets a floor for the discharge of conventional pollutants below which BCT limitations cannot be established. However, if BCT limitations are set that exceed the BPT limitations, the amendments also require that the costs associated with those higher limitations be reasonable with respect to the cost of pollutant reductions under BPT.

Table A-10
Nutrient Cost-Effectiveness for Nonsmall Direct Dischargers: Total Nitrogen

Option	Pretax Annualized Costs (Millions of 1999$)	Total Pounds Removed (Millions)	Average Nutrient CE for TN (1999$/pound)	Incremental Nutrient CE for TN (1999$/pound)
Subcategories A - D				
Option 2	$7.29	0.00	Undefined	DOM
Option 2.5 (High)	$16.69	15.40	$1.08	$1.08
Option 2.5+P	$42.91	15.40	$2.79	DOM
Option 4	$52.00	18.46	$2.82	$11.56
Subcategories F - I				
Option 2	$0.27	0.00	Undefined	DOM
Option 2.5 (High)	$0.33	0.00	Undefined	DOM
Option 2.5+P	$0.36	0.00	Undefined	DOM
Option 4	$0.80	0.08	$10.02	$10.02
Subcategory J				
Option 2	$0.63	0.00	Undefined	DOM
Option 2.5 (High)	$2.83	1.47	$1.92	$1.92
Option 2.5+P	$7.43	1.47	$5.06	DOM
Option 4	$10.17	1.65	$6.16	$40.11
Subcategory K				
Option 2	$17.74	0.00	Undefined	DOM
Option 2.5 (High)	$31.82	9.37	$3.40	$3.40
Option 2.5+P	$63.38	9.37	$6.77	DOM
Option 4	$109.08	20.88	$5.22	$6.71
Subcategory L[1]				
Option 2	$5.57	0.02	Undefined	DOM
Option 2.5 (High)	$0.98	0.15	$6.71	$6.71
Option 2.5+P	$1.48	0.15	$10.08	DOM
Option 4	$3.27	0.36	$9.23	$10.99

[1] Includes costs and removals for mixed processors attributable to non-small production in Subcategory L.
DOM: dominated; option has higher cost than the previous option, but results in no additional removals.

Table A-11
Nutrient Cost-Effectiveness for Nonsmall Direct Dischargers: Total Phosphorus

Option	Pretax Annualized Costs (Millions of 1999$)	Total Pounds Removed (Millions)	Average Nutrient CE for TP (1999$/pound)	Incremental Nutrient CE for TP (1999$/pound)
Subcategories A - D				
Option 2	$7.29	0.00	Undefined	DOM
Option 2.5 (High)	$16.69	0.00	Undefined	DOM
Option 2.5+P	$42.91	4.52	$9.49	$9.49
Option 4	$52.00	4.97	$10.46	$20.09
Subcategories F - I				
Option 2	$0.27	0.00	Undefined	DOM
Option 2.5 (High)	$0.33	0.00	Undefined	DOM
Option 2.5+P	$0.36	0.00	Undefined	DOM
Option 4	$0.80	0.00	Undefined	DOM
Subcategory J				
Option 2	$0.63	0.00	Undefined	DOM
Option 2.5 (High)	$2.83	0.00	Undefined	DOM
Option 2.5+P	$7.43	0.59	$12.59	$12.59
Option 4	$10.17	0.62	$16.34	$85.16
Subcategory K				
Option 2	$17.74	0.00	Undefined	DOM
Option 2.5 (High)	$31.82	0.00	Undefined	DOM
Option 2.5+P	$63.38	4.15	$15.28	$15.28
Option 4	$109.08	4.67	$23.35	$87.17
Subcategory L[1]				
Option 2	$5.57	0.00	Undefined	DOM
Option 2.5 (High)	$0.98	0.00	Undefined	DOM
Option 2.5+P	$1.48	0.03	$58.98	$58.98
Option 4	$3.27	0.03	$121.09	$902.36

[1] Includes costs and removals for mixed processors attributable to non-small production in Subcategory L.
DOM: dominated; option has higher cost than the previous option, but results in no additional removals.

To determine if the cost of BCT is reasonable, EPA has developed a two stage test. The first stage, the "POTW Test" looks at the incremental cost per pound of conventional pollutants to move from BPT to BCT:

$$\frac{\text{Incremental cost to upgrade from BPT to BCT}}{\text{Incremental pounds of conventional pollutants removed upgrading from BPT to BCT}}$$

This incremental cost is compared to the incremental cost of a POTW to upgrade from secondary to advanced secondary treatment. The incremental cost of a POTW to upgrade from secondary to advanced secondary treatment is $0.63 per pound of conventional pollutants in 1999 dollars. If the incremental cost per pound to industry exceeds $0.63, the test is failed.

The second stage is called the "Industry Cost-effectiveness Test." This stage of the test compares the cost per pound for industry to upgrade from to BPT to BCT with the cost per pound to upgrade from no treatment to BPT:

$$\frac{\text{Cost per pound to upgrade from BPT to BCT}}{\text{Cost per pound to upgrade from no treatment to BPT}}$$

If this ratio exceeds 1.29, then the test is failed. The 1.29 figure represents the cost per pound for a POTW to upgrade from secondary to advanced secondary treatment divided by the cost per pound for the POTW to upgrade from no treatment to secondary treatment.

Table A-12 presents the results of the POTW test for nonsmall direct dischargers in all subcategories. For Subcategories A - D, F - I, and Subcategory J, BPT is equal to the current baseline limitations. In Subcategories K and L, there are no current limitations since these subcategories are new. EPA set Option 2 as BPT in these subcategories and examined the incremental costs and removals of moving to BCT set at Option 2 + F (Option 2 plus a filter). In all subcategories, the incremental cost of BCT exceeded $0.68 per pound, and thus failed the POTW test. Because BCT failed on the first stage, EPA did not perform the industry cost-effectiveness test.

Table A-12
Results of POTW Test for Nonsmall Direct Dischargers

Regulatory Option	Pretax Annualized Costs (Millions of 1999$)	Conventional Pollutant Removals (Pounds Removed)	Pretax Average Cost Effectiveness (1999$ per Pound Removed)	Pretax Incremental Cost Effectiveness (1999$ per Pound Removed)	Test Result
Subcategories A - D					
Baseline (BPT)	$0.00	0	NA	NA	Fail
Option 2 (BCT)	$7.29	1,576,757	$4.62	$4.62	
Subcategories F - I					
Baseline (BPT)	$0.00	0	NA	NA	Fail
Option 2 (BCT)	$0.27	21,703	$12.26	$12.26	
Subcategory J					
Baseline (BPT)	$0.00	0	NA	NA	Fail
Option 2 (BCT)	$0.63	34,176	$18.40	$18.40	
Subcategory K					
Option 2 (BPT)	$17.74	2,266,860	$7.83	NA	Fail
Option 2 + F (BCT)	$34.71	4,382,003	$7.92	$8.02	
Subcategory L					
Option 2 (BPT)	$0.56	9,279	$60.02	NA	Fail
Option 2 + F (BCT)	$1.49	81,700	$18.18	$12.82	

A.6 SUPPLEMENTAL TABLES

The supplement to Appendix A presents tables containing baseline loads and estimated pollutant removals for both small and non-small facilities in all subcategories. These supplementary tables present loads and removals in both pounds and pounds equivalent were appropriate.

A.7 REFERENCES

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APPENDIX A

SUPPLEMENT 1

SUPPORTING DOCUMENTATION FOR COST EFFECTIVENESS ANALYSIS: BASELINE LOADS AND POLLUTANT REMOVALS BY OPTION IN POUNDS AND POUNDS EQUIVALENT

Supplemental Table A-1
Baseline Loads and Option Removals by Subcategory for Nonsmall Direct Dischargers

Pollutants	Baseline Loads	Removals per Year			
		Option 2	Option 2.5	Option 2.5+P	Option 4
Subcategories A - D — Pounds					
5-Day Biochemical Oxygen Demand	1,311,100	609,665	609,665	609,665	640,054
Total Suspended Solids	2,930,465	967,092	967,092	967,092	1,116,025
Chemical Oxygen Demand	10,047,491	0	0	0	0
Carbonaceous Biochemical Oxygen Demand	1,104,139	511,342	511,342	511,342	511,342
Ammonia as Nitrogen	2,337,007	2,250,306	2,250,306	2,250,306	2,309,928
Total Nitrogen	20,452,594	0	15,400,791	15,400,791	18,456,984
Total Phosphorus	5,708,721	0	0	4,519,867	4,972,188
Nitrate/Nitrite	17,856,385	0	13,574,558	13,574,558	16,374,921
Total Kjeldahl Nitrogen	2,596,210	2,212,522	2,212,522	2,212,522	2,228,721
Oil & Grease (HEM)	736,139	0	0	0	0
Subcategories A - D — Pounds Equivalent					
Ammonia as Nitrogen	4,277	4,118	4,118	4,118	4,227
Nitrate/Nitrite	1,107	0	842	842	1,015
Subcategories F - I — Pounds					
5-Day Biochemical Oxygen Demand	55,333	21,703	21,703	21,703	24,467
Total Suspended Solids	72,440	0	0	0	0
Chemical Oxygen Demand	460,356	42,213	42,213	42,213	42,213
Carbonaceous Biochemical Oxygen Demand	46,863	18,395	18,395	18,395	18,395
Ammonia as Nitrogen	14,714	10,575	10,575	10,575	13,804
Total Nitrogen	144,729	0	0	0	79,677
Total Phosphorus	4,555	0	0	0	0
Nitrate/Nitrite	0	0	0	0	0
Total Kjeldahl Nitrogen	30,628	12,945	12,945	12,945	15,677
Oil & Grease (HEM)	25,058	0	0	0	0
Subcategories F - I — Pounds Equivalent					
Ammonia as Nitrogen	27	19	19	19	25
Nitrate/Nitrite	0	0	0	0	0

Supplemental Table A-1
Baseline Loads and Option Removals by Subcategory for Nonsmall Direct Dischargers

Pollutants	Baseline Loads	Removals per Year			
		Option 2	Option 2.5	Option 2.5+P	Option 4
Subcategory J — Pounds					
5-Day Biochemical Oxygen Demand	113,718	34,176	34,176	34,176	36,734
Total Suspended Solids	217,745	0	0	0	19,871
Chemical Oxygen Demand	1,038,669	0	0	0	0
Carbonaceous Biochemical Oxygen Demand	97,918	28,570	28,570	28,570	28,570
Ammonia as Nitrogen	58,886	48,965	48,965	48,965	56,388
Total Nitrogen	1,832,998	0	1,469,407	1,469,407	1,652,506
Total Phosphorus	678,766	0	0	590,434	622,583
Nitrate/Nitrite	1,736,512	0	1,465,011	1,465,011	1,644,216
Total Kjeldahl Nitrogen	96,486	51,819	51,819	51,819	54,788
Oil & Grease (HEM)	3,915	0	0	0	0
Subcategory J — Pounds Equivalent					
Ammonia as Nitrogen	108	90	90	90	103
Nitrate/Nitrite	108	0	91	91	102
Subcategory K — Pounds					
5-Day Biochemical Oxygen Demand	2,875,096	643,830	643,830	643,830	868,841
Total Suspended Solids	4,483,455	1,309,553	1,309,553	1,309,553	2,573,666
Chemical Oxygen Demand	18,017,632	6,513,778	6,513,778	6,513,778	11,244,275
Carbonaceous Biochemical Oxygen Demand	2,437,791	725,207	725,207	725,207	725,207
Ammonia as Nitrogen	568,305	331,973	331,973	331,973	502,103
Total Nitrogen	21,664,893	0	9,367,808	9,367,808	20,883,771
Total Phosphorus	5,371,454	0	0	4,147,385	4,671,571
Nitrate/Nitrite	20,361,743	0	10,112,961	10,112,961	20,103,140
Total Kjeldahl Nitrogen	1,301,194	223,255	223,255	223,255	800,944
Oil & Grease (HEM)	1,888,400	313,477	313,477	313,477	329,373
Subcategory K — Pounds Equivalent					
Ammonia as Nitrogen	1,040	608	608	608	919
Nitrate/Nitrite	1,262	0	627	627	1,246

Supplemental Table A-1
Baseline Loads and Option Removals by Subcategory for Nonsmall Direct Dischargers

Pollutants	Baseline Loads	Removals per Year			
		Option 2	Option 2.5	Option 2.5+P	Option 4
Subcategory L — Pounds					
5-Day Biochemical Oxygen Demand	75,755	9,143	9,143	9,143	18,672
Total Suspended Solids	58,445	135	135	135	3,923
Chemical Oxygen Demand	149,822	43,609	43,609	43,609	59,123
Carbonaceous Biochemical Oxygen Demand	64,261	13,889	13,889	13,889	13,889
Ammonia as Nitrogen	17,612	9,492	9,492	9,492	16,123
Total Nitrogen	406,651	0	146,364	146,364	354,355
Total Phosphorus	34,757	0	0	25,012	27,000
Nitrate/Nitrite	370,510	0	153,476	153,476	335,921
Total Kjeldahl Nitrogen	36,142	5,685	5,685	5,685	19,039
Oil & Grease (HEM)	42,411	0	0	0	0
Subcategory L — Pounds Equivalent					
Ammonia as Nitrogen	32	17	17	17	30
Nitrate/Nitrite	23	0	10	10	21

Supplemental Table A-2
Baseline Loads and Option Removals by Subcategory for Small Direct Dischargers

Pollutant	Baseline Loads	Removals per Year	
		Option 1	Option 2
Subcategories A - D — Pounds			
5-Day Biochemical Oxygen Demand	CBI	CBI	NA
Total Suspended Solids	CBI	CBI	NA
Chemical Oxygen Demand	CBI	0	NA
Carbonaceous Biochemical Oxygen Demand	CBI	CBI	NA
Ammonia as Nitrogen	CBI	0	NA
Total Nitrogen	CBI	0	NA
Total Phosphorus	0	0	NA
Nitrate/Nitrite	CBI	0	NA
Total Kjeldahl Nitrogen	CBI	0	NA
Oil & Grease (HEM)	CBI	0	NA
Subcategories A - D — Pounds Equivalent			
Ammonia as Nitrogen	CBI	0	NA
Nitrate/Nitrite	CBI	0	NA
Subcategories F - I — Pounds			
5-Day Biochemical Oxygen Demand	99,551	45,264	45,264
Total Suspended Solids	167,197	52,452	52,452
Chemical Oxygen Demand	362,008	0	0
Carbonaceous Biochemical Oxygen Demand	84,304	40,586	40,586
Ammonia as Nitrogen	14,129	2,732	8,297
Total Nitrogen	291,286	0	0
Total Phosphorus	195,521	0	0
Nitrate/Nitrite	250,869	0	0
Total Kjeldahl Nitrogen	40,418	12,423	16,616
Oil & Grease (HEM)	36,432	0	0
Subcategories F - I — Pounds Equivalent			
Ammonia as Nitrogen	26	5	15
Nitrate/Nitrite	16	0	0

Supplemental Table A-2
Baseline Loads and Option Removals by Subcategory for Small Direct Dischargers

Pollutant	Baseline Loads	Removals per Year	
		Option 1	Option 2
Subcategory K — Pounds			
5-Day Biochemical Oxygen Demand	CBI	CBI	CBI
Total Suspended Solids	CBI	CBI	CBI
Chemical Oxygen Demand	CBI	CBI	CBI
Carbonaceous Biochemical Oxygen Demand	CBI	CBI	CBI
Ammonia as Nitrogen	CBI	0	CBI
Total Nitrogen	CBI	0	0
Total Phosphorus	0	0	0
Nitrate/Nitrite	CBI	0	0
Total Kjeldahl Nitrogen	CBI	0	CBI
Oil & Grease (HEM)	CBI	0	0
Subcategory K — Pounds Equivalent			
Ammonia as Nitrogen	CBI	0	CBI
Nitrate/Nitrite	CBI	0	0
Subcategory L — Pounds			
5-Day Biochemical Oxygen Demand	316	3	3
Total Suspended Solids	503	0	0
Chemical Oxygen Demand	3,310	0	0
Carbonaceous Biochemical Oxygen Demand	268	11	11
Ammonia as Nitrogen	218	179	179
Total Nitrogen	2,314	0	0
Total Phosphorus	316	0	0
Nitrate/Nitrite	2,010	0	0
Total Kjeldahl Nitrogen	303	139	139
Oil & Grease (HEM)	214	0	0
Subcategory L — Pounds Equivalent			
Ammonia as Nitrogen	< 1	< 1	< 1
Nitrate/Nitrite	< 1	0	0

APPENDIX B

SUPPLEMENTAL COST ANALYSIS

B.1 ECONOMIC IMPACT TABLES

See Section 10.8 of the Technical Development Document for details on what was included in the supplemental cost runs.

Table B-1
Total and Average Compliance Costs for Nonsmall Processors by Subcategory and Option

Option	Total Costs (000)			Average Costs (000)		
	Capital	Post-tax Annualized	Pre-tax Annualized	Capital	Post-tax Annualized	Pre-tax Annualized
Subcategory A-D						
Option 2	$23,800	$4,644	$7,366	$821	$160	$254
Option 2.5	$57,316	$8,070	$11,813	$1,976	$278	$407
Subcategory F-I[1]						
Option 2	$1,588	$345	$345	$397	$86	$86
Option 2.5	$1,588	$409	$409	$397	$102	$102
Subcategory J[1]						
Option 2	$2,405	$777	$777	$127	$41	$41
Option 2.5	$7,499	$2,936	$2,936	$395	$155	$155
Subcategory K						
Option 2	$87,888	$15,442	$19,795	$916	$161	$206
Option 2.5	$125,356	$24,301	$30,902	$1,306	$253	$322
Subcategory L[1, 2]						
Option 2	$3,422	$753	$753	$342	$75	$75
Option 2.5	$4,401	$1,178	$1,178	$440	$118	$118

[1] For nonsmall facilities in Subcategories F - I, J, and L, post-tax annualized costs are equal to pre-tax annualized costs because the analysis is based on model facilities, and EPA assumed a tax shield of $0 to avoid underestimating impacts.
[2] Subcategory includes 7 mixed processor facilities with nonsmall levels of production in Subcategory L and small levels of production in Subcategory F - I; on average, 61 percent of their production falls into Subcategory L.

Table B-2
Summary of Projected Nonsmall Facility Closure Impacts by Option
Subcategories A - D

Option	Baseline Conditions and Projected Incremental Closure Impacts		
	Number of Facilities	Total Revenues (000)	Employees
Total Facilities Analyzed	31	$17,492,882	49,630
Baseline Closures[1]	5	$2,000-$4,000	13,000-15,000
Option 2 Closures	0	$0	0
Option 2.5 Closures	0	$0	0

[1] Revenues and employment are presented as a range to prevent the disclosure of confidential business information.

Table B-3
Summary of Projected Nonsmall Facility Closure Impacts by Option
Subcategory K

Option	Baseline Conditions and Projected Incremental Closure Impacts		
	Number of Facilities	Total Revenues (000)	Employees
Total Facilities Analyzed	105	$13,022,059	107,096
Baseline Closures	30	$4,326,777	41,038
Option 2 Closures	0	$0	0
Option 2.5 Closures	0	$0	0

Table B-4
Summary of Projected Nonsmall Facility Closure Impacts by Subcategory and Option
Subcategories F - I, Subcategory J, and Subcategory L

Option	Average Annualized Costs as Percent of Net Income[1]	Probability of Closure Due to Rule[1]	Number of Facilities[2]	Total Revenues (000)[2]	Employees[2]
Subcategory F - I					
Baseline	NA	NA	4	$448,654	1,506
Option 2	1.3	0.2%	0.01	$975	3
Option 2.5	1.5	0.3%	0.01	$1,155	4
Subcategory J					
Baseline	NA	NA	19	$274,270	1,123
Option 2	1.9	0.4%	0.07	$1,002	4
Option 2.5	6.9	1.3%	0.25	$3,826	17
Subcategory L					
Baseline	NA	NA	10	$223,663	974
Option 2	4.0	0.7%	0.07	$1,447	6
Option 2.5	6.3	1.1%	0.11	$2,256	9

[1] Presented as a weighted average of results over all model facilities in the subcategory.
[2] Calculated as the probability of closure for each individual model facility multiplied by the number of facilities, revenues and employment represented by that model facility. The results are then summed over all model facilities in the subcategory.

Table B-5
Projected Impacts on Companies with Nonsmall Facilities
Subcategories A-I, Subcategory K, Subcategory L, and Mixed Processors
Altman Z′-Score by Meat Type and Option

Option	Number of Companies with Baseline Altman Z' Score in Specified Range and Incremental Changes in Score		
	Financially Healthy	Indeterminate	Bankruptcy Likely
Meat (predominantly own facilities in Subcategories A-I)			
Baseline	7	1	1
Option 2	0	0	0
Option 2.5	0	0	0
Poultry (predominantly own facilities in Subcategories K and L)			
Baseline	8	4	0
Option 2	0	0	0
Option 2.5	0	0	0
Mixed (own facilities in both meat and poultry subcategories)			
Baseline	0	3	1
Option 2	0	0	0
Option 2.5	0	0	0

Note: A change from one state (e.g., financially healthy) to another state (e.g., indeterminate) is indicated by "-1" and "+1".

Table B-6
Projected Impacts to Return on Assets Ratio by Subcategory and Option
Companies with Nonsmall Facilities in Subcategories F - I, Subcategory J, and Subcategory L

Option	Median Return on Assets (percent)	Percent Change in Return on Assets
Subcategories F-I (4 Companies)[1]		
Baseline	5.50	NA
Option 2	5.41	-1.6
Option 2.5	5.40	-1.8
Subcategory J (19 Companies)[1]		
Baseline	2.00	NA
Option 2	1.96	-2.0
Option 2.5	1.86	-7.2
Subcategory L (3 Companies)[1]		
Baseline	4.43	NA
Option 2	4.19	-5.5
Option 2.5	4.06	-8.4

[1] For the purpose of this analysis, EPA assumes the companies are identical to the facilities.

Table B-7
Summary of Nonsmall Facility Level Ratio of Capital Costs to Assets (Barrier to Entry)[1]

Subcategory	Option 2	Option 2.5
A - D	0.4%	1.5%
K	3.2%	4.2%

[1] Percentages are based on those facilities for which EPA had asset data and compliance costs.

Table B-8
Summary of Nonsmall Company Level Ratio of Capital Costs to Assets (Barrier to Entry)[1]

Subcategory	Option 2	Options 2.5
Meat	0.6%	2.0%
Poultry	1.2%	1.5%
Mixed Meat	0.1%	0.1%

[1] Percentages are based on those facilities for which EPA had asset data and compliance costs.

Table B-9
Summary of Nonsmall Facility Level Ratio of Capital Costs to Assets (Barrier to Entry)
Screener Survey Facility Analysis

Subcategory	Option 2	Option 2.5
F - I	0.3%	0.3%
J	0.1%	0.3%
L[1]	0.1%	0.1%

[1] Results do not include mixed processor facilities.

B.2 COST EFFECTIVENESS AND COST REASONABLENESS TABLES

Table B-10
Supplemental Analysis: Results of Cost Effective Analysis for Nonsmall Direct Dischargers

Regulatory Option	Pretax Annualized Costs (Millions of 1999$)	Pollutant Removals (Pounds Equivalent)	Pretax Average Cost Effectiveness (1981$ per Pound Equivalent Removed)	Pretax Incremental Cost Effectiveness (1981$ per Pound Equivalent Removed)
Subcategories A - D				
Option 2	$7.37	4,118	$1,044	$1,044
Option 2.5	$11.81	4,864	$1,417	$3,478
Subcategories F - I				
Option 2	$0.34	19	$10,374	$10,374
Option 2.5	$0.41	19	$12,292	DOM
Subcategory J				
Option 2	$0.78	90	$5,060	$5,060
Option 2.5	$2.94	175	$9,798	$14,780
Subcategory K				
Option 2	$19.79	608	$19,010	$19,010
Option 2.5	$30.90	967	$18,654	$18,052
Subcategory L				
Option 2	$0.75	17	$25,302	$25,302
Option 2.5	$1.18	22	$31,469	$55,390

DOM: dominated; option has higher cost than the previous option, but results in no additional removals.

Table B-11
BPT Cost and Removal Comparison for Nonsmall Direct Dischargers

Option	Pretax Annualized Costs (Millions of 1999$)	Total Pounds Removed[1] (Millions)	Average BPT Cost & Removal Comparison (1999$/pound)	Incremental BPT Cost & Removal Comparison (1999$/pound)
Subcategories A-D				
Option 2	$7.37	2.86	$2.58	NA
Option 2.5	$11.81	14.36	$0.82	NA
Subcategories F-I				
Option 2	$0.34	0.03	$10.54	NA
Option 2.5	$0.41	0.02	$18.48	NA
Subcategory J				
Option 2	$0.78	0.08	$9.35	NA
Option 2.5	$2.94	1.41	$2.08	NA
Subcategory K				
Option 2	$19.79	0.95	$20.76	NA
Option 2.5	$30.90	6.02	$5.14	NA
Subcategory L[2]				
Option 2	$0.75	0.02	$40.42	NA
Option 2.5	$1.18	0.07	$15.78	NA

[1] Total pounds removed equals the: sum of BOD_5 and ammonia (as nitrogen) for Option 2; sum of BOD_5 and total nitrogen for Option 2.5.
[2] Includes costs and removals for mixed processors attributable to non-small production in Subcategory L.
DOM: dominated; option has higher cost than the previous option, but results in no additional removals.
NA: The incremental cost reasonableness from Option 2 to Option 2.5 cannot be calculated because the pollutants used as the basis for the analysis differs under the two options.

Table B-12
Nutrient Cost-Effectiveness for Nonsmall Direct Dischargers: Total Nitrogen

Option	Pretax Annualized Costs (Millions of 1999$)	Total Pounds Removed (Millions)	Average Nutrient CE for TN (1999$/pound)	Incremental Nutrient CE for TN (1999$/pound)
Subcategories A - D				
Option 2	$7.37	0.00	Undefined	DOM
Option 2.5	$11.81	13.75	$0.86	$0.86
Subcategories F - I				
Option 2	$0.34	0.00	Undefined	DOM
Option 2.5	$0.41	0.00	Undefined	DOM
Subcategory J				
Option 2	$0.78	0.00	Undefined	DOM
Option 2.5	$2.94	1.38	$2.13	$2.13
Subcategory K				
Option 2	$19.79	0.00	Undefined	DOM
Option 2.5	$30.90	5.40	$5.73	$5.73
Subcategory L[1]				
Option 2	$0.75	0.00	Undefined	DOM
Option 2.5	$1.18	0.07	$17.98	$17.98

[1] Includes costs and removals for mixed processors attributable to non-small production in Subcategory L.
DOM: dominated; option has higher cost than the previous option, but results in no additional removals.

Table B-13
Baseline Loads and Option Removals by Subcategory for Nonsmall Direct Dischargers

Pollutants	Baseline Loads	Removals per Year	
		Option 2	Option 2.5
Subcategories A - D — Pounds			
5-Day Biochemical Oxygen Demand	1,418,138	609,665	609,665
Total Suspended Solids	3,114,488	967,092	967,092
Chemical Oxygen Demand	10,768,983	0	0
Carbonaceous Biochemical Oxygen Demand	1,186,564	511,342	511,342
Ammonia as Nitrogen	2,407,427	2,250,306	2,250,306
Total Nitrogen	22,255,421	0	13,753,785
Total Phosphorus	6,193,936	0	0
Nitrate/Nitrite	19,574,090	0	12,032,630
Total Kjeldahl Nitrogen	2,681,331	2,212,522	2,212,522
Oil & Grease (HEM)	865,647	0	0
Subcategories A - D — Pounds Equivalent			
Ammonia as Nitrogen	4,406	4,118	4,118
Nitrate/Nitrite	1,214	0	853
Subcategories F - I — Pounds			
5-Day Biochemical Oxygen Demand	55,333	22,113	22,113
Total Suspended Solids	72,440	0	0
Chemical Oxygen Demand	460,356	42,213	42,213
Carbonaceous Biochemical Oxygen Demand	46,863	18,395	18,395
Ammonia as Nitrogen	14,714	10,599	10,599
Total Nitrogen	144,729	0	0
Total Phosphorus	4,555	0	0
Nitrate/Nitrite	0	0	0
Total Kjeldahl Nitrogen	30,628	13,254	13,254
Oil & Grease (HEM)	25,058	0	0
Subcategories F - I — Pounds Equivalent			
Ammonia as Nitrogen	27	19	19
Nitrate/Nitrite	0	0	0
Subcategory J — Pounds			
5-Day Biochemical Oxygen Demand	113,718	34,176	34,176

Table B-13
Baseline Loads and Option Removals by Subcategory for Nonsmall Direct Dischargers

Pollutants	Baseline Loads	Removals per Year	
		Option 2	Option 2.5
Total Suspended Solids	217,745	0	0
Chemical Oxygen Demand	1,038,669	0	0
Carbonaceous Biochemical Oxygen Demand	97,918	28,570	28,570
Ammonia as Nitrogen	58,886	48,965	48,965
Total Nitrogen	1,832,998	0	1,379,460
Total Phosphorus	678,766	0	0
Nitrate/Nitrite	1,736,512	0	1,374,491
Total Kjeldahl Nitrogen	96,486	51,819	51,819
Oil & Grease (HEM)	3,915	0	0
Subcategory J — Pounds Equivalent			
Ammonia as Nitrogen	108	90	90
Nitrate/Nitrite	108	0	85
Subcategory K — Pounds			
5-Day Biochemical Oxygen Demand	3,014,986	621,342	621,342
Total Suspended Solids	4,848,666	1,218,165	1,218,165
Chemical Oxygen Demand	19,452,371	6,294,892	6,294,892
Carbonaceous Biochemical Oxygen Demand	2,572,907	701,561	701,561
Ammonia as Nitrogen	759,513	331,973	331,973
Total Nitrogen	22,054,327	0	5,395,078
Total Phosphorus	5,385,822	0	0
Nitrate/Nitrite	20,417,969	0	5,790,244
Total Kjeldahl Nitrogen	1,634,401	276,699	267,699
Oil & Grease (HEM)	2,120,751	313,477	313,477
Subcategory K — Pounds Equivalent			
Ammonia as Nitrogen	1,390	608	608
Nitrate/Nitrite	1,266	0	627
Subcategory L — Pounds			
5-Day Biochemical Oxygen Demand	75,755	9,143	9,143
Total Suspended Solids	58,445	135	135
Chemical Oxygen Demand	149,822	43,609	43,609

Table B-13
Baseline Loads and Option Removals by Subcategory for Nonsmall Direct Dischargers

Pollutants	Baseline Loads	Removals per Year	
		Option 2	Option 2.5
Carbonaceous Biochemical Oxygen Demand	64,261	13,889	13,889
Ammonia as Nitrogen	17,612	9,492	9,492
Total Nitrogen	406,651	0	65,529
Total Phosphorus	34,757	0	0
Nitrate/Nitrite	370,510	0	72,229
Total Kjeldahl Nitrogen	36,142	5,685	5,685
Oil & Grease (HEM)	42,411	0	0
Subcategory L — Pounds Equivalent			
Ammonia as Nitrogen	32	17	17
Nitrate/Nitrite	23	0	10