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Economic and Environmental Benefits Analysis of the Final Meat and Poultry Products Rule

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FIGURES

INDEX OF ACRONYMS AND CHEMICAL FORMULAS

%DOsat	Percent Dissolved Oxygen Saturation
1Q10	Lowest 1-day average flow that occurs (on average) once every 10 years
7Q10	Lowest 7-day average flow that occurs (on average) once every 10 years
AFO	Animal Feeding Operation
AP	Alkylphenol Polyethoxylates
AQUIRE	Aquatic Information Retrieval System
ASTER	Assessment Tools for Environmental Risk
ATtILA	Analytical Tools Interface for Landscape Assessments
AWQC	Ambient Water Quality Criteria
BAC	Baseline Average Concentration
BAT	Best Available Technology
BCF	Bioconcentration Factor
BOD	Biochemical Oxygen Demand
BOD_5	Biochemical Oxygen Demand
CAFO	Confined Animal Feeding Operation
COD	Chemical Oxygen Demand
CSO	Combined Sewer Overflow
CWS	Community Water System
DAF	Dissolved Air Flotation
DEM	Digital Elevation Model
DO	Dissolved Oxygen
EAD	Engineering and Analysis Division
EC_{50}	Concentration that provokes a response halfway between baseline and maximum
EEBA	Economic and Environmental Benefits Analysis
ELG	Effluent Limitation Guideline
Eutro-WASP5	Eutrophication model in WASP5
FCB	Fecal Coliform Bacteria
FEC	Fecal Coliform
GIS	Geographic Information System
HEAST	Health Effects Assessment Summary Table
IFD	Industrial Facilities Discharge
IRIS	Integrated Risk Information System
LADD	Lifetime Average Daily Doses
LC_{50}	lethal concentration that kills 50% of the test animals
LOEC	Lowest-Observed-Effect Concentration
MATC	Maximum Allowable Toxicant Concentration
MP&M	Metal Products and Machinery
MPP	Meat and Poultry Products
N	Nitrogen
NASQAN	National Stream Quality Accounting Network
NAWQA	National Water Quality Assessment
NED	National Elevation Dataset
NH_3-N	Ammonia Nitrogen
NLCD	National Land Cover Data
NO_3	Nitrate
NODA	Notice of Data Availability

INDEX OF ACRONYMS AND CHEMICAL FORMULAS (cont.)

NOEC	No-Observed-Effect Concentration
NPS	Nonpoint Source
NWPCAM	National Water Pollution Control Assessment Model
O&M	Operation and maintenance
P	Phosphorus
PCS	Permit Compliance System
PO_4	Phosphate
POCs	Pollutants of Concern
PS	Point Source
QSAR	Quantitative Structure Activity Relationship
RBC	Risk-Based Concentration
RF1	Reach File 1
RF3	Reach File 3
RF3 Lite	Subset of Reach File 3
RfD	Reference Dose
RUSLE	Revised Universal Soil Loss Equation
SDWIS	Safe Drinking Water Information System
SF	Slope factor
SPARROW	Spatially Referenced Regressions On Watershed
STORET	Storage and Retrieval Repository for Water Quality and other Data
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TRI	Toxic Release Inventory
TS	Total Solids
TSS	Total Suspended Solids
USGS	U.S. Geological Survey
WASP	Water Quality Simulation Program
WaTER	Water Treatment Estimation Routine
WQI	Water Quality Index
WQL	Water Quality Ladder
WSDB	Water Supply Database
WTP	Willingness to Pay

EXECUTIVE SUMMARY

ES.1 BACKGROUND

The U.S. Environmental Protection Agency is promulgating revised subcategorization and effluent limitations guidelines and standards for the meat and poultry products (MPP) industry point source category. The current meat products rule, 40 CFR Part 432, sets effluent guidelines and limitations for the beef, pork, and rendering sectors of the meat products industry. These standards were set and revised over a number of years, most recently in 1995. This final rule revises the existing subcategories in the industry as well as guidelines for those subcategories, and sets new standards for facilities that perform poultry slaughter and processing operations. Prior to this rule, EPA had set no national effluent limitations guidelines or standards for poultry slaughterers or processors.

With the exception of small processors (Subcategory E), EPA is revising Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), and New Source Performance Standards (NSPS) in Subcategories A - D (meat facilities that perform slaughter operations), and Subcategories F - I (facilities that process meat not slaughtered at the facility). EPA is revising BAT and NSPS in Subcategory J (rendering facilities). EPA is creating two new subcategories (K and L) for facilities that slaughter and process poultry, and setting BPT, BAT, BCT, and NSPS for these poultry subcategories. EPA is not revising current guidelines and standards for indirect dischargers in the meat subcategories, nor is it setting standards for indirect dischargers in the poultry subcategories.

ES.2 INDUSTRY OVERVIEW

The meat products industry includes establishments that primarily slaughter livestock and/or process meat into products for further processing or for final sale to consumers. The industry can be roughly divided into meat facilities, primarily producing beef or pork products, and poultry facilities, which primarily produce chicken (excluding eggs) and turkey products. (Meat facilities may also process lamb or veal. Poultry facilities may also process other birds, such as ducks and geese, and also small game, such as rabbits.) Facilities may perform slaughtering operations, processing operations from carcasses slaughtered at other facilities, or both. In addition, rendering operations may be performed either at stand alone facilities, or in combination with slaughter and/or further processing operations. Companies that own meat product facilities may also own facilities that perform "upstream" or "downstream" operations involved in getting meat products from the farm to the consumer (e.g., livestock raising, wholesale distribution), but these facilities are not considered part of the meat products industry.

ES.3 DATA SOURCES

The economic analysis relies on a wide variety of sources. Both data availability and relevance determined the relative reliance EPA placed on different sources for various components of the economic profile, methodology, and analysis.

EPA surveyed the meat products industry under authority of the CWA Section 308 (U.S. EPA, 2002). EPA administered 1,650 screener surveys and 350 detailed surveys. EPA used data from the screener survey to classify and subcategorize facilities by meat type, processes performed, and facility size to determine the relevant industry population potentially affected by the final rule, and to provide a framework for the estimation of compliance costs and economic impacts. EPA used facility and company specific financial data from the detailed survey to develop models for estimating impacts of the final rule.

EPA used the U.S. Census Bureau's *1997 Economic Census* to develop economic model facilities for estimating impacts of the final rule in those subcategories for which detailed survey data were unavailable. EPA also obtained special tabulations of Census data to statistically model the distribution of facilities represented by each model facility. EPA used U.S. Department of Agriculture (USDA) publications as data sources for the baseline economic models and the analysis of changes and trends in the industry over time. Publications by USDA's Economic Research Service were a rich source of information and analysis on important issues such as the demand for meat products, industry concentration, competitiveness, and technological change.

Academic journals were an important source of information on the nature of competition in the meat products industry, technological change, and industry trends. EPA also used academic research to provide econometric estimates of key industry parameters — such as the price elasticities of demand and supply — for its economic impact models. EPA used industry sources such as trade journals and trade associations to develop its industry profile, and to formulate a better understanding of industry changes, trends, and concerns.

ES.4 ECONOMIC METHODOLOGY

EPA developed capital and operating and maintenance (O&M) costs for incremental pollution control. The capital cost, a one-time cost, is the initial investment needed to purchase and install equipment involved in pollution control. The O&M cost is the annual cost of operating and maintaining that equipment; a site incurs its O&M cost each year. For the final rule, EPA estimated facility-specific compliance costs (for details, see the Development Document, U.S. EPA, 2004).

EPA then annualized the estimated capital and O&M compliance costs. Annualized costs are calculated as the equal annual payments of an annuity that has the same present value as the stream of cash outflow over the project life and includes the opportunity cost of money or interest. An annualized cost is analogous to a mortgage payment that spreads the one-time investment of a home over a series of constant monthly payments. EPA annualizes capital and O&M costs because: (1) capital costs are incurred only once in the equipment's lifetime and the initial investment should be expended over the life of the equipment, and (2) money has a time-based value, so expenditures incurred at the end of the equipment's lifetime or O&M expenses in the future are not the same as expenses paid today.

EPA used its estimated annualized compliance costs in four different levels of analysis:

- Facility-level closure impacts model (see Section 3.3 for details),
- Company-level financial ratio analyses (see Section 3.4 for details),
- Market model (see Section 3.5 for details), and
- National impacts (see Section 3.7 for details).

Each is discussed briefly, below. For both the facility and company level analyses, EPA used two distinct sets of models. In Subcategories A - D and K, facility and company specific detailed survey financial data were available, and EPA used discounted cash flow and Altman Z models for the closure and financial ratio analyses respectively. For facilities in Subcategories F - I, J, and L, no detailed survey financial data were available, and EPA used a model facility approach to project impacts.

In Subcategories A - D, and K, EPA projects facility closures using a discounted cash flow analysis that compares the costs incurred during 16-year period from 2005 to 2020 to the net income accumulated during that same period. This analysis discounts both costs and earnings with the facility-specific discount rate reported in the detailed questionnaire to take into account the time value of money and place both time series on a comparable basis. To be considered a closure under the final rule, a facility has to show both (1) positive long-term earnings without the regulation and (2) negative long-term earnings as a result of the regulation in the majority of the forecasts. EPA used a forecasting model based on historical farm-to-wholesale price margin data (wholesale production cost and wholesale price margin for poultry) to project facility net income over the 16 year project life. To account for uncertainty in both the forecast future facility net income, and the appropriate start point of the forecast, EPA selected three methods for projecting future facility net income. EPA used the preponderance of evidence under different forecasting methods to determine if a facility is projected to close. That is, EPA projects a facility will close if the present value (PV) of future compliance costs exceeds the forecast PV of net income under two of the three forecasting methods.

In Subcategories F - I, J, and L, EPA did not receive detailed surveys from direct discharging facilities. On the basis of the screener survey, however, EPA believes that direct discharging facilities, although few, do exist in those subcategories. Therefore, EPA used the facility-level impact methodology from the proposed rule to project impacts in these subcategories (see Section 3.3.2 for details). EPA used *1997 Economic Census* data at the employment class level from the MPP industry NAICS codes to develop model facilities representing meat further processing plants (Subcategories F - I), rendering plants (Subcategory J), and poultry processing plants (Subcategory L). EPA used Census revenue and cost data to estimate net income, and Census special tabulations of the variance of key revenue and cost measures to estimate the variance of each model facility's income. Combining this with the assumption that facility income is normally distributed, EPA estimated a cumulative probability distribution function for each model facility. This allows EPA not only to estimate impacts to each model facility, but to the entire class of facilities the model represents as well. EPA presents two types of model facility impacts. First, EPA provides the ratio of annualized compliance costs to the net income of the model facility. Second, EPA uses its estimated probability distributions to project the percentage and number of facilities that incur costs exceeding 100 percent of net income.

EPA used financial ratio analysis to examine whether a company can afford the aggregate costs of upgrading all of its sites. Many banks use financial ratio analysis to assess the credit worthiness of a potential borrower. If regulatory costs cause a company's financial ratios to move into an unfavorable range, the company will find it more difficult to borrow money. EPA considers a company in such a condition to be in financial distress. Financial ratio analysis is performed at the company level rather than the facility level. This is because: (1) many firms maintain complete financial statements (balance sheet and income statement) at the business entity or corporate level, but not the site level, (2) significant financial decisions, such as expansion of a site's capacity, are typically made or approved at the corporate level, and (3) the business entity (or corporate parent) is the legal entity responsible for repayment of a loan, and therefore the lending institution evaluates the credit worthiness of the business entity, not the site. EPA selected the Altman Z′ score, a weighted-average of several financial ratios, to characterize the baseline and post-regulation financial conditions of potentially affected firms. The Altman Z′ score simultaneously considers measures of liquidity, leverage, profitability, and asset management. It addresses the problem of how to interpret the data when some financial ratios look "good" while other ratios look "bad." Also, it provides well defined thresholds for classifying firms as in good, indeterminate, and poor financial health.

In Subcategories F - I, J, and L, for which detailed survey data were not available, EPA could not perform an Altman's Z analysis. To analyze the parent companies of these facilities, EPA assumes the facility and company are identical. EPA combines Census data (via the model facilities developed for the closure analysis) with Dun & Bradstreet financial ratio data. For each model facility, EPA divides net income by the median value for return on assets reported by Dun & Bradstreet for the relevant industry to estimate the model facility's total assets. Given the model facility's net income and total assets, EPA calculates the post-regulatory return on assets as: (net income - posttax annualized costs)/(total assets + capital costs).

EPA developed a market model to examine the impacts of the meat products industry final effluent guidelines on the price and output of various meat products. The distinguishing feature of EPA's market model is that it explicitly incorporates cross-market impacts among meat types into the analysis. This is for two reasons. First, the demand for meat products such as beef, pork, broilers, and turkey is closely related; a change in the price of pork will also tend to cause a change in the demand for beef because it is a substitute for pork. Second, EPA's effluent guidelines will simultaneously affect the price of beef, pork, chicken, and turkey, thus the market analysis for each product depends not only on the compliance costs for that product but also on the impact of compliance costs on the prices of the other three meat products. The market model also examines international trade effects of the final rule; the export of meat products is becoming an increasingly important source of growth for U.S. meat producers.

Finally, EPA uses the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) "input-output" multipliers (RIMS II) to examine indirect and induced impacts of the final rule on the national economy. Impacts on the meat product industry are known as direct effects, impacts on industries that supply inputs to the meat products industry economy are known as indirect effects, and effects on consumer demand are known as induced effects.

ES.5 IMPACTS

ES.5.1 Regulatory Options

Table ES-1 presents EPA's revised subcategories for the meat products industry along with facility process combinations (meat type and process classes), production size, and EPA's count of potentially affected facilities (based on survey data) contained in each subcategory. By focusing on nonsmall direct dischargers, EPA projects that about 150 facilities out of the more than 6,600 MPP facilities will be affected by this final rule.

Table ES-2 summarizes the pollution control options considered for each subcategory. EPA set Option 2.5 as BAT and NSPS for nonsmall facilities in all subcategories. Option 2 was selected as BPT for nonsmall facilities in Subcategories A - D, K, and L, as well as BCT in Subcategories K and L. With the exception of NSPS in Subcategories K and L, no requirements were set for small facilities.

Table ES-1
Revised 40 CFR 432 Subcategories
Subcategory, Process, Discharge Type, and Size

Subcategory	Processes	Production Size	Annual Production	Direct Dischargers	Non-direct Dischargers	Total
Total	**NA**	**NA**	**NA**	**288**	**6,331**	**6,619**
Subtotal	**NA**	**Small**	**NA**	**134**	**5,670**	**5,804**
		Nonsmall	**NA**	**154**	**661**	**815**
A - D	Meat First Processing; alone or in combination with Further Processing; and/or Rendering	Small	< 50 million pounds live weight kill	63	1,668	1,731
		Nonsmall	≥ 50 million pounds live weight kill	47	92	139
E	Meat Further Processing; alone or in combination with Rendering	Small	≥ 1.56 million pounds of finished product	25	2,395	2,420
F - I		Small	> 1.56 million pounds of finished product < 50 million pounds of finished product	22	838	860
		Nonsmall	≥ 50 million pounds of finished product	4	146	150
J	Rendering	Small	< 10 million pounds of raw product	0	14	14
		Nonsmall	≥ 10 million pounds of raw product	19	98	117
K	Poultry First Processing; alone or in combination with Further Processing; and/or Rendering	Small	< 100 million pounds live weight kill	17	129	146
		Nonsmall	≥ 100 million pounds live weight kill	79	127	206
L	Poultry Further Processing; alone or in combination with Rendering	Small	< 7 million pounds of finished product	7	626	633
		Nonsmall	≥ 7 million pounds of finished product	5	198	203

Source: U.S. EPA MPP Screener Survey Database.

Table ES-2
Meat Products Industry Treatment Technology Options

Option	Treatment Unit
1 (Small Facilities Only)	Biological Treatment, Partial Nitrification, Disinfection
2	Biological Treatment, *More Complete Nitrification*, Disinfection
2.5[1]	**Biological Treatment, More Complete Nitrification, Disinfection, *Partial Denitrification***
2.5 + P	Biological Treatment, More Complete Nitrification, Disinfection, Partial Denitrification, *Chemical Phosphorus Removal*
4	Biological Treatment, More Complete Nitrification, Disinfection, *More Complete Denitrification*, Chemical Phosphorus Removal

Changes between technology options indicated by italics.
[1] Selected as BAT and NSPS for all nonsmall facilities.

ES.5.2 Impacts

Table ES-3 presents estimated compliance costs by subcategory, and Table ES-4 summarizes the projected economic impacts under the selected option. EPA calculated two cost estimates for the selected option: the "low" costs are based on EPA's selection of input parameters for the cost model, while the "high" cost estimate primarily incorporates industry's input parameters, with the exception of a few values. Total pretax annualized compliance costs are estimated to range from $38.1 million to $52.6 million (1999 dollars; $42.1 million to $58.2 million in 2003 dollars) under the selected option.

Table ES-3
Total Cost of the Rule by Subcategory

Subcategory	Promulgated Option	Pre-tax Annualized Cost (Thousands)			
		Low Estimate		High Estimate	
		1999 Dollars	2003 Dollars	1999 Dollars	2003 Dollars
A - D	2.5	13,242	14,629	16,686	18,435
F - I	2.5	289	319	329	363
J	2.5	1,919	2,120	2,826	3,123
K	2.5	21,906	24,201	31,817	35,151
L	2.5	747	825	983	1,086
Total		**38,103**	**42,095**	**52,641**	**58,158**

Table ES-4
Summary of Economic Impacts of the Rule

Subcategory	Impacts under Promulgated Option
Facility Level Closure Impacts	
Subcategories A - D Subcategory K	**No** facility closures
Subcategories F - I Subcategory J Subcategory L	Less than one facility closure (0.24 to 0.34 facilities) combined
Company Level Financial Ratio Impacts	
Subcategories A - D Subcategory K	**No** changes in company financial health as measured by the Altman Z′ score
Subcategories F - I Subcategory J Subcategory L	ROA decreases from 5.5 to 5.42 ROA decreases from 2.0 to 1.86 ROA decreases from 4.4 to 4.16
Market Level Impacts	
The maximum projected price increase is less than 0.05 percent of baseline price for all products.	
The overall domestic production of meat and poultry products, and therefore industry employment, is projected to decrease by about 0.02 percent	

ES.5.3 Small Business Impacts

According to Small Business Administration (SBA) size standards, a MPP facility is small business owned if the parent company employs less than 500 workers combined at all its facilities. EPA estimates that this final rule will regulate up to 33 small businesses that own MPP facilities. All small business owned facilities that EPA found to be affected by the rule are in Subcategories F-I, Subcategory J, and Subcategory L. Thus, the economic impact analysis for these facilities is based on screener survey data.

EPA projected no small business owned facility closures for the final rule. However, EPA cannot state that the probability of closure as a result of the rule is zero for those facilities, although it is small. In addition, of the 33 potentially small business owned facilities, two are estimated to incur annualized post-tax compliance costs greater than three percent of revenues; 5 are estimated to incur compliance costs composing more than one but less than three percent of revenues; and 24 small entities are estimated to incur compliance costs of less than one percent of revenues.

ES.6 ENVIRONMENTAL ASSESSMENT AND BENEFITS

EPA estimated the environmental and human health benefits, including pollutant reductions, that will occur from this rule. The total monetized benefits associated with the effluent limitation guideline requirements are estimated to approximate $2.6 million (2003$) with a range of approximately zero to $10 million annually. These values represent those benefits for which EPA was able to quantify and determine an economic value. The benefit value estimates reflect only those pollutant reductions and water quality improvements attributable to the MPP industry. As discussed later in this section, EPA identified additional environmental benefits that will result from this rule, but was unable to attribute a specific economic value to benefits that could not be monetized or quantified.

The rule is expected to reduce nitrogen discharges from MPP facilities from 48.5 to 20.0 million pounds and reduce sediment discharge by 2.4 million pounds, annually. 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 from $1,340.2 \times 10^{18}$ cfu to 240.2×10^{18} cfu due to disinfection requirements. Chapter 7 describes the environmental effects of this rule and details how they impact ecological systems and human health.

For this rule, EPA conducted five benefit studies to estimate the impacts of reductions in pollutant discharges from MPP facilities. The first study used the National Water Pollution Control Assessment Model (NWPCAM), which estimates pollutant discharge to rivers, streams, and, to a lesser extent, lakes in the United States, to estimate the value society places on improvements in surface water quality associated with today's rule. EPA used a newer version of the NWPCAM than was used for the proposal to estimate the value to society of improvements at a sample of MPP facilities. The new version enabled EPA to model nutrient loadings. EPA derived sample weights related to characteristics of the receiving water body and local population to extrapolate the sample results to a national estimate. EPA also derived confidence bounds for the estimates using Monte Carlo techniques. NWPCAM methods and results are discussed in Chapter 8.

In the second study, changes in the nutrient criteria exceedances due to reduced MPP facility loads were examined. When discharges from the MPP facilities are reduced in accordance with the requirements under this rule, under one baseline assumption 6 of the 45 excursions are projected to be eliminated under 7Q10 low flow stream conditions. Under different baseline assumptions, 4 of the 41 excursions are projected to be eliminated. When mean stream flow conditions are assumed, approximately one-half of the excursions are projected to be eliminated. Improvements in water quality are also predicted in receiving streams where in-stream nitrogen concentrations are not projected to exceed 304(a) nitrogen criteria. 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. The methods and results of the nutrient study are reported in Chapter 9.

EPA also assessed the possible impacts of ten toxic pollutants (i.e., ammonia, barium, chromium, copper, manganese, molybdenum, nickel, titanium, vanadium, and zinc) on aquatic life or human health by comparing the modeled instream pollutant concentrations under today's treatment levels to EPA's published guidance for aquatic life criteria or human health criteria. Toxics could be incidentally removed through the biological treatment and DAF system but EPA projects that there are no meaningful human health or aquatic life benefits to be obtained from this action.

Reductions in sediment in drinking water supplies are expected to reduce public water treatment costs. An estimate of the changes in these costs is described in Chapter 11. The results suggest that the cost savings from the reduction in TSS is very small. Even under the most stringent option, the estimated savings amount to $1,500 nationwide annually.

Finally, EPA conducted site-specific analyses of 62 watersheds, which compared the background concentrations of nitrogen (N) with the facility-generated loads. The analyses, discussed in Chapter 12, identified 30 facility locations where background non-point source nitrogen loads are less than 1 percent of facility loads. Implementing the rule at these sites would reduce 20 facility N loads. A second group of 19 locations has background N loads between 1 percent and 25 percent of facility N loads. Implementing the rule at these sites would reduce 12 facility N loads. A companion analysis identified facilities with loads that exceed established nutrient criteria levels with high and low instream decay rates. EPA then determined which facilities' loads would allow instream decay processes to keep stream nutrient levels below established nutrient criteria after implementation of the rule. While instream processing reduced N levels to some extent, phosphorous levels remained high.

ES.7 REFERENCES

U.S. EPA. 2002. 2001 Meat Products Industry Survey. Washington, DC: OMB Control No. 2040-0225. Expiration Date February 29, 2004.

U.S. EPA. 2004. *Development Document for the Final Revisions to the Effluent Limitations Guidelines for the Meat Products Industry.* EPA-xxx-x-xx-xxx. Washington, D.C.: U.S. Environmental Protection Agency, Office of Water.

CHAPTER 1

INTRODUCTION

1.1 SCOPE AND PURPOSE

The U.S. Environmental Protection Agency (EPA) proposes and promulgates water effluent discharge limits (effluent limitations guidelines and standards) for industrial sectors. This Economic and Environmental Benefit Analysis (EEBA) summarizes the costs and economic impacts of technologies that form the bases for setting limits and standards for the meat products industry.[1]

The Federal Water Pollution Control Act (commonly known as the Clean Water Act [CWA, 33 U.S.C. §1251 et seq.]) establishes a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (section 101(a)). EPA is authorized under sections 301, 304, 306, and 307 of the CWA to establish effluent limitations guidelines and standards of performance for industrial dischargers. The standards EPA establishes include:

- Best Practicable Control Technology Currently Available (BPT). Required under section 304(b)(1), these rules apply to existing industrial direct dischargers. BPT limitations are generally based on the average of the best existing performances by plants of various sizes, ages, and unit processes within a point source category or subcategory.
- Best Available Technology Economically Achievable (BAT). Required under section 304(b)(2), these rules control the discharge of toxic and nonconventional pollutants and apply to existing industrial direct dischargers.
- Best Conventional Pollutant Control Technology (BCT). Required under section 304(b)(4), these rules control the discharge of conventional pollutants from existing industrial direct dischargers.[2] BCT limitations must be established in light of a two-part cost-reasonableness test. BCT replaces BAT for control of conventional pollutants.
- Pretreatment Standards for Existing Sources (PSES). Required under section 307. Analogous to BAT controls, these rules apply to existing indirect dischargers (whose discharges flow to publicly owned treatment works [POTWs]).

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[1] The industry, however, is free to use whatever technology it chooses in order to meet the limit.

[2] Conventional pollutants include biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, pH, and oil and grease.

- New Source Performance Standards (NSPS). Required under section 306(b), these rules control the discharge of toxic and nonconventional pollutants and apply to new source industrial direct dischargers.

- Pretreatment Standards for New Sources (PSNS). Required under section 307. Analogous to NSPS controls, these rules apply to new source indirect dischargers (whose discharges flow to POTWs).

The current meat products rule, 40 CFR Part 432, set effluent guidelines and limitations for the beef and pork sectors of the meat products industry. These standards were set and revised over a number of years, most recently in 1995. Table 1-1 presents a listing of the standards set for each of the 10 current subcategories in the meat products industry along with the relevant Federal Register citation. This final rule revises the existing subcategories in the industry, and proposes new standards for facilities that perform poultry slaughter and processing operations. Prior to this rule, EPA has set no national effluent limitations guidelines or standards for poultry slaughterers or processors.

1.2 REPORT ORGANIZATION

This Economic Analysis (EA) is organized as follows:

- Chapter 2—Industry Profile

  Provides background information on the industry affected by this regulation.

- Chapter 3—Economic Impact Analysis Methodology Overview

  Summarizes the economic methodology by which EPA examines incremental pollution control costs and their associated impacts on the industry.

- Chapter 4—Pollution Control Options

  Presents short descriptions of the regulatory options considered by EPA. More detail is given in the Development Document (U.S. EPA, 2004).

Table 1-1
EPA Effluent Limitations Guidelines for Meat Products Industry

Subcategory	Standard	Federal Register Notice
Simple Slaughterhouses (Subpart A)	BPT	39 FR 7897, February 28, 1974; amended at 60 FR 33964, June 29, 1995
	BAT	Reserved
	PSES	40 FR 6446, February 11, 1975; amended at 60 FR 33964, June 29, 1995
	NSPS	39 FR 7897, February 28, 1974; 39 FR 26423, July 19, 1974
	PSNS	60 FR 33964, June 29, 1995
	BCT	51 FR 25001, July 9, 1986
Complex Slaughterhouses (Subpart B)	BPT	39 FR 7897, February 29, 1974; 39 FR 26423, July 19, 1974; amended at 45 FR 82254, December 15, 1980; 60 FR 33964, June 29, 1995
	BAT	Reserved
	PSES	40 FR 6446, February 11, 1975; amended at 60 FR 33965, June 29, 1995
	NSPS	39 FR 7897, February 28, 1974; 39 FR 26423, July 19, 1974
	PSNS	60 FR 33965, June 29, 1995
	BCT	51 FR 25001, July 9, 1986
Low-Processing Packinghouse (Subpart C)	BPT	39 FR 7897, February 28, 1974; amended at 60 FR 33965, June 29, 1995
	BAT	Reserved
	PSES	40 FR 6446, February 11, 1975; amended at 60 FR 33965, June 29, 1995
	NSPS	39 FR 7897, February 28, 1974; 39 FR 26423, July 19, 1974
	PSNS	60 FR 33965, June 29, 1995

Table 1-1 (cont.)
EPA Effluent Limitations Guidelines for Meat Products Industry

Subcategory	Standard	Federal Register Notice
	BCT	51 FR 25001, July 9, 1986
High-Processing Packinghouse (Subpart D)	BPT	39 FR 7897, February 28, 1974; amended at 60 FR 33965, June 29, 1995
	BAT	Reserved
	PSES	40 FR 6446, February 11, 1975; amended at 60 FR 33965, June 29, 1995
	NSPS	39 FR 7897, February 28, 1974; 39 FR 26423, July 19, 1974
	PSNS	60 FR 33965, June 29, 1995
	BCT	51 FR 25001, July 9, 1986
Small-Processor (Subpart E)	BPT	40 FR 905, January 3, 1975; amended at 60 FR 33965, June 29, 1995
	BAT	Reserved
	PSES	Reserved
	NSPS	40 FR 905, January 3, 1975
	PSNS	40 FR 905, January 3, 1975; amended at 60 FR 33965, June 29, 1995
	BCT	51 FR 25001, July 9, 1986
Meat Cutter (Subpart F)	BPT	40 FR 906, January 3, 1975; amended at 60 FR 33965, June 29, 1995
	BAT	44 FR 50748, August 29, 1979
	PSES	Reserved
	NSPS	40 FR 906, January 3, 1975
	PSNS	40 FR 906, January 3, 1975; amended at 60 FR 33965, June 29, 1995
	BCT	51 FR 25001, July 9, 1986

Table 1-1 (cont.)
EPA Effluent Limitations Guidelines for Meat Products Industry

Subcategory	**Standard**	**Federal Register Notice**
Sausage and Luncheon Meats Processor (Subpart G)	BPT	40 FR 907, January 3, 1975; amended at 60 FR 33966, June 29, 1995
	BAT	40 FR 50748, August 29, 1979
	PSES	Reserved
	NSPS	40 FR 907, January 3, 1975
	PSNS	40 FR 907, January 3, 1975; amended at 60 FR 33966, June 29, 1995
	BCT	51 FR 25001, July 9, 1986
Ham Processor (Subpart H)	BPT	40 FR 908, January 3, 1975; amended at 60 FR 33966, June 29, 1995
	BAT	44 FR 50748, August 29, 1979
	PSES	Reserved
	NSPS	40 FR 908, January 3, 1975
	PSNS	40 FR 908, January 3, 1975; amended at 60 FR 33966, June 29, 1995
	BCT	51 FR 25001, July 9, 1986
Canned Meats Processor (Subpart I)	BPT	40 FR 909, January 3, 1975; amended at 60 FR 33966, June 29, 1995
	BAT	44 FR 50748, August 29, 1979
	PSES	Reserved
	NSPS	40 FR 909, January 3, 1975
	PSNS	40 FR 909, January 3, 1975; amended at 60 FR 33966, June 29, 1995
	BCT	51 FR 25001, July 9, 1986
Renderer (Subpart J)	BPT	40 FR 910, January 3, 1975; 40 FR 11874, March 14, 1975; amended at 60 FR 33966, June 29, 1995
	BAT	44 FR 50748, August 29, 1979
	PSES	Reserved

Subcategory	Standard	Federal Register Notice
	NSPS	42 FR 54419, October 6, 1977
	PSNS	40 FR 910, January 3, 1975; amended at 60 FR 33966, June 29, 1995
	BCT	51 FR 25001, July 9, 1986

- Chapter 5—Economic Impacts

  Using the methodology presented in Chapter 3, EPA presents the annualized costs reflecting both the capital and annual operating and maintenance costs that are associated with more stringent pollution control. EPA then presents the economic impacts associated with the regulatory costs, including impacts on facilities, companies, industry output, prices, international trade, and employment. In other words, this chapter presents the findings on which EPA based its determination of economic achievability under the CWA.

- Chapter 6—Regulatory Flexibility Analysis

  Pursuant to the Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act, EPA examines whether the regulatory options have a significant adverse impact on a substantial number of small entities.

- Chapter 7—Environmental Impacts and Potential Benefits

  Describes the environmental effects of this rule and details the impact of wastewater on ecological systems and human health. EPA also discusses the water quality improvements realized by the rule.

- Chapter 8—Water Quality Benefits Measured Using NWPCAM

  Using the National Water Pollution Control Assessment Model (NWPCAM), which estimates pollutant discharge to rivers, streams, and, to a lesser extent, lakes in the United States, EPA estimates the value society places on improvements in surface water quality associated with the rule.

- Chapter 9—Changes in Water Quality Measured Using Nutrient Criteria

  Examines changes in the nutrient criteria exceedances due to reduced facility loads and presents the results of such changes.

- Chapter 10—Toxicity Assessment of Changes in Water Quality

  Discusses the assessment of the possible impacts of ten pollutants on aquatic life or human health by comparing the modeled instream pollutant concentrations under today's treatment levels to EPA's published guidance for aquatic life criteria or human health criteria.

- Chapter 11—Benefits from Reduced Drinking Water Treatment Costs

  Estimates changes in public water treatment costs due to reductions in sediment in drinking water supplies.

- Chapter 12—Benefits to New Technology for Reducing Nitrogen Loadings to Streams

  Presents EPA's site-specific analyses of 62 watersheds comparing background concentrations of nitrogen with facility-generated loads.

- Chapter 13—Cost-Benefit Comparison and Unfunded Mandates Reform Act Analysis

  Using the benefits described in Chapters 7 through 12, EPA presents an assessment of the nationwide costs and benefits of the regulation pursuant to Executive Order 12866 and the Unfunded Mandates Reform Act (UMRA).

1.3 REFERENCES

U.S. EPA. 2004. Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat Products Point Source Category. EPA-821-R-04-011. Washington, DC: U.S. Environmental Protection Agency, Office of Water.

CHAPTER 2

INDUSTRY PROFILE

For the proposed rule, EPA's industry profile was based on publicly available information about the meat and poultry products industry. This information was drawn from a number of sources including USDA's Food Safety and Inspection Service (FSIS), USDA's Economic Research Service (ERS), professional journals, trade publications, corporate publications and websites, but primarily the *1997 Economic Census* (U.S. Census Bureau, 1999a through 1999d).

For the final rule, EPA used its authority under Section 308 of the Clean Water Act to collect information not otherwise available to supplement this publicly available information. This included:

- site-specific data
- financial information for privately-held firms.

EPA sent out two surveys: a "detailed" survey and a "screener" survey (so-called because of their relative lengths and complexity). The screener survey was sent to 1,500 facilities. Of these, 1,254 were returned and usable. The detailed survey was sent to 350 facilities, with 328 returned. Numbers presented in the following profile are based on information collected in both surveys. Specifically, facility counts and financial information for Subcategories A - D and K are based on data collected in the detailed survey, while facility counts for Subcategories F - I, J, and K are based on the screener survey and supplemented with Census data. National estimates were calculated by weighting results based on the sampling frame (see the Technical Development Document for details).

Sections 2.1 and 2.2 lay out definitions for facilities affected by this effluent guideline by detailing the subcategory and size definitions used to classify facilities. Section 2.3 summarizes the site-level information, while Section 2.4 reviews the company-level information. This chapter concludes with a discussion in Section 2.5 of possible impacts of the recent discovery of BSE in the U.S. Further background on the MPP industry is contained in the Industry Profile (Chapter 2) from the Proposal EA.

All site and company level information collected was from the 1997-1999 period. Company ownership information presented in this profile is based on this time period and does not include changes in ownership that occurred after 1999.

2.1 SUBCATEGORIZATION

The subcategories developed for this rule modify and extend EPA's existing industry subcategories. Prior to promulgation of this rule, EPA subcategorized the industry as follows:

- Subcategory A — Simple Slaughterhouse
- Subcategory B — Complex Slaughterhouse
- Subcategory C — Low-Processing Packinghouse
- Subcategory D — High- Processing Packinghouse
- Subcategory E — Small Processor
- Subcategory F — Meat Cutter
- Subcategory G — Sausage and Luncheon Meats Processor
- Subcategory H — Ham Processor
- Subcategory I — Canned Meats Processor
- Subcategory J — Renderer

For this final rule, EPA regrouped these 10 subcategories. The first four subcategories are combined to form Subcategories A - D, and the next four are combined to form Subcategories E - I. Subcategory J remains unchanged. Additionally, this rule creates two new subcategories for poultry facilities that were not regulated under the prior effluent guidelines. Thus, the final rule sets effluent guidelines and limitations for five subcategories:

- Subcategory A - D: Meat first processing
- Subcategory E - I: Meat further processing

- Subcategory J: Rendering
- Subcategory K: Poultry first processing
- Subcategory L: Poultry further processing

The first three of these subcategories are already regulated under existing effluent guidelines. The last two subcategories are new and apply to facilities that are not regulated under existing effluent guidelines.

The structure of the subcategorization for the rule is as follows:

- meat facilities that perform first processing (i.e., slaughter) alone or in combination with further processing and/or rendering are assigned to Subcategories A - D.
- meat facilities that perform further processing alone or in combination with rendering, but no first processing, are assigned to Subcategories E - I.
- facilities that perform rendering but no other processes are assigned to Subcategory J.
- poultry facilities that perform first processing alone or in combination with further processing and/or rendering are assigned to Subcategory K.
- poultry facilities that perform further processing alone or in combination with rendering, but no first processing, are assigned to Subcategory L.
- mixed facilities — those that process both meat and poultry — may be subject to guidelines in two subcategories. EPA found that all mixed facilities in its survey database were further processors and thus would be subject to guidelines for Subcategories E - I and Subcategory L.

2.2 CLASSIFICATION OF FACILITIES BY SIZE

2.2.1 Production Thresholds Defining Small and Nonsmall Facilities

In addition to categorizing facilities by meat type and processes performed, EPA also classified facilities by their level of production. Table 2-1 presents the production thresholds EPA set to distinguish small and nonsmall facilities.[1]

Table 2-1
Size Classifications for Meat Products Industry Subcategories

Subcategory	Classification	Definition
A - D	Small	< 50 million pounds live weight kill per year
	Nonsmall	≥ 50 million pounds live weight kill per year
E	NA	≥ 1.56 million pounds of finished product per year
F - I	Small	> 1.56 million pounds of finished product per year < 50 million pounds of finished product per year
	Nonsmall	≥ 50 million pounds of finished product per year
J	NA	≥ 10 million pounds of raw product per year
K	Small	< 100 million pounds live weight kill per year
	Nonsmall	≥ 100 million pounds live weight kill per year
L	Small	< 7 million pounds of finished product per year
	Nonsmall	≥ 7 million pounds of finished product per year

NA: no distinction is made between small and nonsmall facilities in this subcategory.

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[1] EPA uses two different size classifications to analyze and present the economic impact analysis for the promulgated rule. The production level classification in Table 2-1 above determines the effluent guidelines and standards the facility must meet; within a subcategory, different guidelines may be set for small and nonsmall facilities. However, for the purposes of the regulatory flexibility analysis (Chapter 6), EPA must also distinguish between facilities that are owned by small business and those that are owned by large businesses. In the MPP industry, a facility is defined as small business owned if its parent company employs less than 500 workers. There is no necessary relationship between these two definitions of small; a facility that is defined as small based on its level of production may be owned by a large business. Similarly, a facility that is defined as nonsmall based on its level of production may be owned by a small business.

2.2.2 Revised Production Threshold in Subcategory K

For the proposed rule, EPA defined small processors in Subcategory K as those facilities that slaughter less than 10 million pounds of poultry per year. For the final rule, EPA has redefined this threshold as 100 million pounds per year. EPA modified the threshold because it found the lower threshold figure could create a potentially substantial competitive disadvantage for small poultry slaughter facilities with respect to both larger poultry facilities and with meat facilities. Major factors contributing to this conclusion were the effects of economies of scale, and the nature of competition between the meat and poultry sectors.

2.2.2.1 Economies of Scale

Based on the most reliable studies performed to date, significant economies of scale exist in poultry slaughter. Extrapolating from Ollinger et al. (2000), a 50 million pounds per year (lbs/yr) poultry plant has about a 3 percent cost advantage over a 10 million lbs/yr plant. For a 100 million lbs/yr plant, the cost advantage is probably in the 7 to 10 percent range, and for a 150 million lbs/yr plant, the advantage is about 15 percent.[2]

Economies of scale in meat slaughter plants are not as significant as in poultry slaughter. Extrapolating from MacDonald et al. (2000), a 150 million lbs/yr meat slaughter plant might have a 5 percent cost advantage over a 10 million lbs/yr plant.

The relative importance of economies of scale in the two sectors is consistent with detailed survey data. In the detailed survey database, only about 1 percent of poultry slaughter plants produce less than 10 million lbs/yr. In the meat sector, about 12 percent of slaughter plants are below that threshold.

[2] The economies of scale in poultry slaughter are so significant, that Ollinger suggests that smaller poultry slaughter plants stay in business primarily because of special circumstances. Plants might be constrained by poultry supply, environmental conditions, labor force, or other facility-specific factors. Industry also suggests that some of these small producers survive because of niche markets.

Further, in both the meat and poultry sectors, slaughter plants that produce less than 100 million lbs/yr are projected to incur compliance costs per pound of output that are substantially larger than slaughter plants with output greater than 100 million lbs/yr. This exacerbates the competitive disadvantage under which the smaller plants already operate.

2.2.2.2 Competition Between Poultry and Meat Sectors

Consumers consider meat and poultry to be substitutes. That is, if the price of poultry increases relative to that of meat, consumers will increase purchases of meat and decrease purchases of poultry. This effect is not large, but it is statistically significant. In the MPP market model, EPA used a cross-price elasticity of demand between poultry and beef of approximately 0.1; this means a 1 percent increase in the price of poultry is expected to increase the demand for beef by 0.1 percent (holding all other things constant). The cross-price elasticity of demand between pork and poultry is smaller, about 0.05 (i.e., a 1 percent increase in the price of poultry is expected to increase the demand for pork by 0.05 percent, holding all other things constant).

EPA found that compliance costs per pound of poultry were projected to exceed the compliance costs per pound of meat by almost 60 percent under the selected option. (In all cases, the costs per pound were considerably less than $0.01 per pound.) This suggests that the price of poultry will rise relative to the price of meat, and a small shift from poultry to meat consumption can be expected to result from the effluent guideline.

In summary, EPA determined that:

- poultry will be somewhat disadvantaged by the rule relative to meat, and
- within the poultry sector, small slaughter facilities will be disadvantaged by the rule relative to large slaughter facilities.

Therefore, EPA increased the production threshold that defines a small poultry slaughter facility from 10 million lbs/yr to 100 million lbs/yr.

2.3 FACILITY LEVEL INFORMATION

2.3.1 National Facility Counts

Based on the results of its screener survey, EPA estimates there are:

- 6,619 meat and poultry sites,
- 288 direct dischargers, and
- 6,331 non-direct dischargers (including indirect and zero dischargers)

in the MPP industry. Table 2-2 details national estimates by subcategory, discharge type, and size classification.

EPA is only promulgating new effluent guidelines for nonsmall direct dischargers. Thus, based on the results of the screener survey, EPA projects the promulgated rule will apply to 154 out of 6,619 facilities, approximately 2.3 percent of all meat and poultry facilities.

EPA used the economic section of the detailed survey to collect financial data in order to perform its economic impact analysis. In some subcategories, EPA did not receive detailed surveys from direct discharging facilities. On the basis of the screener survey, however, EPA believes that direct discharging facilities, although few, do exist in those subcategories. Therefore, EPA used both types of surveys for its economic impact analysis (see Chapter 3 for details).

Table 2-3 presents the number of direct discharger facilities estimated in each subcategory and size class using both screener and detailed survey facility counts. The last two columns provide the facility counts that EPA used to project the economic impacts of the MPP rule, and whether they were based on the screener or the detailed survey. Because the detailed survey provided much more facility level financial information, EPA selected the detailed survey, and its facility counts, to perform that subcategory's economic impact analysis whenever possible.

Table 2-2
National Estimates of Meat and Poultry Facilities by Subcategory and Size
(Screener Survey Database)

Subcategory	Production Size	Direct Dischargers	Non-direct Dischargers	Total	Percent of Facilities Facing Regulation
Total	NA	**288**	**6,331**	**6,619**	**2.3** [1]
Subtotal	Small	**134**	**5,670**	**5,804**	**0.0**
	Nonsmall	**154**	**661**	**815**	**18.9** [2]
A - D	Small	63	1,668	1,731	NA
	Nonsmall	47	92	139	33.8
E	Small	25	2,395	2,420	NA
F - I	Small	22	838	860	NA
	Nonsmall	4	146	150	2.7
J	Small	0	14	14	NA
	Nonsmall	19	98	117	16.2
K	Small	17	129	146	NA
	Nonsmall	79	127	206	38.4
L	Small	7	626	633	NA
	Nonsmall	5	198	203	2.5

Source: U.S. EPA MPP Screener Survey Database.
[1] Calculated as 154 nonsmall direct dischargers divided by 6,619 total MPP facilities.
[2] Calculated as 154 nonsmall direct dischargers divided by 815 total MPP direct discharging facilities.

Table 2-3
Direct Discharging Meat and Poultry Facilities
Analyzed for Economic Impacts by Subcategory and Size
(Screener and Detailed Survey Databases)

Subcategory	Production Size	Direct Discharging Facilities: Screener Survey	Detailed Survey	Facility Counts for Impact Analysis[1]	Source
Total	NA	**288**	**195**	**234**	**NA**
Subtotal	Small	**134**	**51**	**65**	**NA**
	Nonsmall	**154**	**144**	**169**	**NA**
A - D	Small	63	15	15	Detailed Survey
	Nonsmall	47	31	31	Detailed Survey
E	Small	25	0	NA	NA
F - I	Small[2]	22	0	11	Screener Survey
	Nonsmall	4	0	4	Screener Survey
J	Small	0	0	NA	NA
	Nonsmall	19	7	19	Screener Survey
K	Small	17	36	36	Detailed Survey
	Nonsmall	79	105	105	Detailed Survey
L	Small[3]	7	0	0	Screener Survey
	Nonsmall[4]	5	1	3	Screener Survey
Mixed Processors[5]	Small[6]	NA	NA	3	Screener Survey
	Nonsmall[7]	NA	NA	7	Screener Survey

Source: U.S. EPA MPP Screener Survey and Detailed Survey Databases.
NA: No distinction between small and non small is made for this subcategory.
[1] Facility counts for the impact analysis differs from facility counts by survey type in that subcategory for two reasons: (1) facility counts for the impact analysis only include facilities for which costs were estimated, and (2) mixed processing facilities that have some production in this subcategory are listed separately below.
[2] With mixed processors included, 21 facilities are analyzed for impacts in this subcategory and size classification.
[3] With mixed processors included, 3 facilities are analyzed for impacts in this subcategory and size classification.
[4] With mixed processors included, 10 facilities are analyzed for impacts in this subcategory and size classification.

[5] To avoid double-counting in the national estimates (Table 2-2), mixed processors were allocated to only one subcategory in which they produced. For analyzing facility level impacts, mixed processors were included in both subcategories in which they produced, leading to the double-counting of 10 facilities.
[6] For 3 small mixed processors, 18 percent of production is subject to guidelines and limitations for small processors in Subcategories F - I, and 82 percent of production is subject to small Subcategory L guidelines and limitations.
[7] For 7 nonsmall mixed processors, 39 percent of production in s subject to guidelines and limitations for small facilities in Subcategories F-I, and 61 percent of production is subject to nonsmall Subcategory L guidelines and limitations.

The number of facilities analyzed for the rule (Table 2-3) may differ from the number of facilities in the national estimates (Table 2-2) for three reasons. First, the national estimates are completely based on screener survey weights, while in the impact analysis, EPA used a mix of detailed and screener survey facility weights. The screener survey was sent to 1,650 facilities, while the detailed survey only went to 350. Thus, the responses from the screener surveys are from over four times as many facilities, yielding survey estimates with twice the precision of those based on the detailed survey responses (standard errors are inversely proportional to the square root of the sample size).[3] Therefore, EPA used the screener survey weights, not the detailed survey weights, to estimate national level facility counts.

Second, EPA did not have sufficient data to estimate costs for some surveyed facilities. These direct dischargers with lack of sufficient cost data were not included in the facility counts for the economic impact analysis.

Third, for the national level facility counts, EPA allocated mixed processing facilities (i.e., facilities with less than 85 percent of total production in one subcategory) exclusively between subcategories. For example, assume that 33 percent of a screener survey facility's total production is further processed poultry, and 67 percent is further processed meat. If that screener survey facility has a weight of 3, then in the national estimates EPA would count it as two Subcategory F - I facilities and one Subcategory L facility. To project economic impacts, EPA analyzed such a facility in both Subcategory F - I and Subcategory L because it could potentially incur compliance costs in both subcategories. Thus, the total number of facilities analyzed for economic impacts includes double-counting of mixed processor facilities.

In Table 2-3, a total of 169 nonsmall direct discharging facilities are analyzed for the rule. Of these, 136 are in Subcategories A - D and K, and have their economic impact analysis based on detailed survey data. The remaining 33 nonsmall direct dischargers in Subcategories F - I, J, and L have their impact analysis based on screener survey data. Economic impacts are also projected for 65 small direct

[3] The screener survey weights and detailed survey weights were constructed to give the same estimates of the number of facilities in each subcategory. Any other estimates calculated using the two sets of weights are likely to produce different estimates. For example, the estimates of number of direct dischargers produced from the two sets of weights will be different.

dischargers, 51 of which are in Subcategories A - D and K and have detailed survey data available, while the remaining 14 are in Subcategories F - I, J, and L and are analyzed using screener survey data.

The rest of the discussion in this chapter deals only with the direct discharging facilities, and the companies that own them. For this profile, EPA focuses primarily on Subcategories A - D and K, which contain 80 percent of facilities within the scope of this regulation, and account for over 90 percent of estimated revenue and employment for facilities affected by this effluent guideline. The profile data for facilities in Subcategories F - I, J, and L were derived from Census data.

2.3.2 Profile of Direct Discharging Facilities

2.3.2.1 Data Sources

The EPA surveys collected information on site-level and company-level bases for a sample of the meat industry. The site-level information forms the basis for the economic impact analysis for the site closure and direct impact analysis. The detailed and screener surveys are the only source for this information. The company information forms the basis of the corporate financial distress analysis. The detailed survey is the only source of information for privately-held firms. (See Chapter 3 for more details on the economic impact methodology.)

The detailed survey collected site and company level financial information. The screener survey primarily focused on production and wastewater treatment characteristics. Financial information presented for Subcategories A - D and K is based on detailed survey data. Facilities in these subcategories represent approximately 71 percent of facilities affected by the promulgated effluent guidelines.

The small number of direct discharging facilities in Subcategories F - I, J, and K meant that almost none of these facilities received a detailed survey. EPA therefore based its analysis of these facilities on screener survey data. Since the screener survey did not collect site or company level financial data, revenue and employment numbers for these subcategories are estimated from surveyed facilities that were matched to model facilities derived from the *1997 Economic Census* data (see Proposal EA Chapter 3 and Appendix B, and Final EEBA Chapter 3).

2.3.2.2 Revenues

Revenues for the direct discharging facilities in all subcategories are $32 billion. Subcategories A - D and K represent the largest individual components at $17 billion and $13 billion respectively. Combined these two subcategories represent about 94 percent of revenues generated by facilities affected by this regulation.

Facilities in Subcategory A - D have the highest average revenue at $564 million per year. The next two largest Subcategories are K at $124 million per facility and Subcategory F - I at $112 per facility. Table 2-4 presents revenue data for all subcategories.

2.3.2.3 Employment

As with revenues, Subcategories A - D and K employ the vast majority of people at facilities within the scope of this effluent guideline. Combined, they represent about 96 percent of employment. In gross terms, large facilities in Subcategory K employ the most people at 107,096. However, on average, facilities in subcategory A - D employ more people than facilities in Subcategory K at 1,601 and 1,020 workers respectively. Table 2-4 presents employment data for all facilities within scope of this regulation.

Table 2-4
Employment and Revenues by Subcategory for Facilities Facing Regulation

Subcategory	Business Size	Number of Facilities	Employment	Average Facility Employment	Revenues (000)	Average Facility Revenue (000)
A - D	Small	15	615	41	$185,760	$12,384
	Nonsmall	31	49,630	1,601	$17,492,882	$564,287
F - I	Small	14	832	59	$237,465	$16,962
	Nonsmall	4	1,506	377	$448,654	$112,164
J	NA	19	1,123	59	$274,270	$14,435
K	Small	36	2,271	63	$276,287	$7,675
	Nonsmall	105	107,096	1,020	$13,022,059	$124,020
L	Small	3	97	32	$22,712	$7,571
	Nonsmall	10	974	97	$223,663	$22,366
Totals		**237**	**164,144**	**NA**	**$32,183,752**	**NA**

Sources: Subcategories A - D and K: U.S. EPA MPP Detailed Survey Database. Subcategories F - I, J, and K: U.S. EPA MPP Screener Survey Database; screener survey facilities matched to model facilities based on U.S. Census Bureau, 1999a - 1999d.

2.4 COMPANY LEVEL INFORMATION

As described above, only the detailed survey collected company level financial data. Information presented in this section is for those companies who reported operating a direct discharging facility in Subcategories A - D or K. These facilities represent 80 percent of the facilities affected under this regulation. Additionally, screener survey data indicate that 11 facilities in Subcategories F - I, J, and K are owned by companies that also own facilities in Subcategories A - D and K.

EPA reviewed the 56 direct discharging facilities in Subcategories A - D and K that received a detailed survey to determine their corporate parent, then compiled a list of all other meat processing facilities owned by each of those corporate parents. Of the 56 surveys, 4 are small producers, and are not within the scope of this effluent guideline. The rest of this section contains information for the 52 surveyed facilities within the scope of this guideline.

EPA used the detailed survey database, the screener survey database and EPA's Water Permit Compliance database to estimate the number of direct discharging facilities owned by these corporate parents that were not represented in the detailed survey database. EPA determined that the 52 surveyed direct dischargers are owned by 25 corporate parents; these companies owned a total of 323 MPP facilities in 1999. EPA then examined the discharge status of these 323 facilities because indirect and zero discharging facilities will not incur costs under this regulation. EPA estimates that of the 323 facilities owned by these corporate parents, approximately 117 were direct dischargers. Of these 117 direct dischargers, 52 received detailed surveys, and 65 required analysis based on non-survey data.

2.4.1 Type of Ownership

The 25 companies owning direct discharging sites in Subcategories A - D and K are primarily organized as corporations:

- 22 C corporations
- 2 S or limited liability corporations
- 1 agricultural cooperative

Almost half of these companies are privately owned; the detailed survey is EPA's only source of financial information for these privately-held firms.

2.4.2 Number of Sites per Company

The majority of the direct dischargers in Subcategories A - D and K (21 out of 25) are multi-site firms. The three companies that each operate 30 or more sites skews the average number of facilities per company upwards. On average, each company owns 13 facilities; however, 44 percent of these companies own 5 facilities or fewer. On average, companies owning 5 facilities or fewer have 1.25 direct dischargers. Companies that own more than 5, but fewer than 30 total facilities each own about 4 direct dischargers. However, the three largest companies own almost 20 direct discharging facilities each.

Table 2-5
Total Number of Facilities Operated by Companies that Own Direct Discharging Facilities

Range of Facilities per Company	Total Facilities Owned	Number Direct Discharging Facilities Owned	Number of Companies
1	4	4	4
2 to 5	25	10	7
6 to 10	44	19	6
11 to 15	51	20	4
16 to 20	0	0	0
21 to 25	21	6	1
26 to 30	0	0	0
More than 30	178	58	3

Source: U.S. EPA MPP Detailed Survey Database.

2.4.3 Company Level Employment and Revenues

Meat products represent the primary source of revenue for a majority of the companies in the survey. However, a significant minority of companies are diversified into other businesses. Based on the information gathered by EPA it was not always possible to separate meat and non-meat business segments for these companies. Therefore, the data presented in Table 2-6 includes revenue and employment for non-meat business segments. Companies that operate facilities processing both meat and poultry were more likely to be diversified into other businesses. Employment and revenue for this category contain the majority of the non-meat related data.

Table 2-6
Employment and Revenue at Companies Owning Meat and Poultry Facilities

Meat Type	Number of Companies	Employment	Revenues (000)
Primarily Owning Meat Processing Facilities	9	80,775	$29,949,011
Primarily Owning Poultry Processing Facilities	12	135,850	$15,441,204
Owning Both Meat and Poultry Processing Facilities	4	184,834	$89,439,473
Totals		**401,459**	**$134,829,688**

Source: U.S. EPA MPP Detailed Survey Database.

2.5 BSE AND EPA'S REGULATION OF THE MPP INDUSTRY

2.5.1 Background

In late December 2003 USDA reported the first BSE cow discovered in the U.S. BSE (bovine spongiform encephalopathy) or "mad cow disease" is a chronic, degenerative disorder affecting the central nervous system of cattle. BSE has been linked with the fatal variant Creutzfeldt-Jacob disease (vCJD) in humans; since 1995, approximately 140 deaths world-wide have resulted from vCJD, probably as a result of eating BSE-infected beef products. In addition, in early February 2004 avian flu was discovered on two Delaware poultry farms. Avian influenza is an extremely infectious and fatal form of avian flu for chickens. U.S. public health officials claim that the flu strain discovered in Delaware is not fatal to humans, unlike the strain in Asia.

2.5.2 Expected Impact on the MPP Industries

2.5.2.1 Short-run Market Effect

The short-run effect of BSE and avian flu have been severe. Immediately following the BSE discovery, cattle feedlot prices dropped sharply from about $92 per hundredweight (cwt) to about $75/cwt during the last week of December, 2003. After the announcements, many U.S. trading partners banned imports of U.S. beef and poultry products, causing some export companies to consider worker layoffs (U.S. exports account for roughly 10 percent of total U.S. beef production and about 15 percent of the nation's broiler production.) Following the avian flu discovery, poultry prices actually rose sharply in response to decreases in overall supplies because of the slaughter of millions of birds worldwide in an effort to contain the virus and the increased demand for U.S. poultry products. However, some USDA economists predict the trade ban may lower the price of frozen leg cuts, which make up roughly two-thirds of U.S. poultry exports.

It is too early, however, to predict the long-run impact of BSE case on the MPP industry. Only a single case of BSE has been reported to date, and much will depend on whether additional cases are reported. USDA has appeared to respond to the case relatively quickly and decisively to reassure the public of the safety of the food system, and surveys show U.S. consumer confidence in that safety remains strong (Food Policy Institute, 2004; Gallup, 2004; Harvard School of Public Health, 2004). The impact of BSE on the U.S. beef industry may also be mitigated by the fact that the infected cow was imported from Canada, and was old enough to have contracted BSE prior to 1997 regulations designed to eliminate BSE in the U.S. These regulations have been further strengthened since the case was reported.

Although cattle prices have fallen sharply since the reported case of BSE, prices are still higher now than in 2002: beef prices were $69/hundredweight (cwt) at year-end 2002 compared to $75/cwt at year-end 2003. By mid-February, 2004, prices had rebounded to the $77/cwt to $79/cwt range, less than 2 percent lower than mid-February, 2003. Further, weekly slaughter in mid-February was about 5 percent below the same period in 2003; in January 2004 slaughter had been 15 to 20 percent below the previous year. In 2003, cattle prices were unusually high due to: (1) lower cattle supplies due to a drought in prime cattle producing regions, (2) a ban on Canadian beef imports because of a single reported case of BSE in Canada on May 20, 2003, and (3) increased consumer demand attributable to the popularity of "low-carb" diets. Land grant universities are forecasting that further cattle price decreases as a result of BSE will be modest and prices will eventually improve over time. For example, while cattle futures prices for 2004 have not rebounded to the high levels reached prior to the reported case in December, they have returned to the neighborhood of the current spot market price of $75/cwt (Barchart.com, 2004).

Although the cattle industry and the MPP industry are very closely related, they are not identical, and the impact of BSE on each sector of the system that processes beef for final consumption will differ.

Prices for cattle and for processed beef do not move in lockstep. There is a negative correlation between the farm price for cattle and the farm–to-wholesale price spread (the difference between the price per pound paid for cattle, and the price per pound at which the processed meat is sold on the wholesale market). That is, when the price of cattle decreases, the farm–to-wholesale price spread tends to increase, or at least remain stable (EPA analysis of USDA price spread data). Thus, it is possible that the decrease in cattle prices will increase the margin earned by processors on each pound of meat sold.

An improved price spread per pound of beef could be offset if the number of pounds sold declines significantly. Here, survey evidence on domestic consumer confidence is reassuring that — barring further findings of BSE — there will not be a long-term shift in consumer preferences away from beef. Some evidence from Great Britain and Canada seems to support this conclusion. In Britain, beef consumption (and the proportion of meat consumed out of total meat), after falling by 26 percent in 1996, returned to its long term trend by 1997, and remained stable in 1998 (Atkinson, 1999); this is in a country that had experienced over 174,000 cases of BSE and 41 deaths from vCJD between 1966 and 1998 (UKDH, 2004; WOAH, 2004). In Canada, domestic consumption of beef actually increased after the report of BSE as a result of aggressive marketing and an apparent show of consumer support for the industry; Canada is the only country in which domestic consumption of beef has increased after a report of BSE (CAHC, 2003).

The long-term effects of the reported case of BSE on export markets is less easy to determine. U.S. officials have aggressively tried to convince trading partners such as Japan to reopen their markets to U.S. beef. While the U.S. continues to trade boneless beef from cattle under 30 months old (the beef considered least susceptible to BSE) with Canada, that is the only major export market open to the U.S. Both the U.S. and Canada appear confident that trade with Mexico will reopen, but as of February 2004 that had not yet occurred. The international trade ban on Canadian beef, with the limited exception of the U.S., has continued, even though the first and only Canadian case of BSE was reported 6 months before the U.S. case. The European Union waited three years before lifting its ban on British beef in mid-1999. While, British exports of beef remain at a fraction of their pre-BSE level, the data is probably confounded by the outbreak of hoof-and-mouth disease in 2001.

USDA does point out that despite the unknown prognosis for beef exports, the current U.S. market conditions will at least somewhat cushion the industry from the shock of having to absorb 10 percent of its overall meat production in its domestic markets (USDA, 2004). Cattle supply was unusually low in 2003 due to the effects of the drought on cattle grazing areas, lack of imports from Canada, and unusually high demand for beef attributable to the popularity of “low-carb” diets. This was reflected in the extremely high cattle prices observed in 2003. With beef supply so tight, the excess production due to the ban on exports can be more easily absorbed in the domestic market as long as domestic demand remains robust.

While the reported case of BSE will undoubtedly have a negative impact on the beef component of the MPP industry, the pork and poultry components of the industry could benefit from it. Pork and poultry are substitutes for beef. Even if consumers reduce their beef purchases in response to the BSE report, it is highly likely that they will purchase more pork and poultry rather than forgo all meat and poultry products as a source of protein. This will tend to increase both the price and sales of those products. Thus, while the beef sector of the industry is worse off as a result of BSE, other industry sectors may well benefit from the report of BSE. This effect was clearly observed in Great Britain (Atkinson, 1999). This effect was not observed in Canada, but that is because of the unusual increase in domestic purchases of beef after the report of BSE.

2.5.2.2 Longer-run Production Cost Effect

The collective response by USDA, FDA, and the industry has been relatively quick and decisive, resulting in production level changes that should help prevent cases of BSE and avian flu. These production level changes will likely result in changes in industry cost structures as new food safety rules are implemented by all meat packing and poultry processing facilities. The cost of these new procedures will depend on implementation details which are currently being determined and are not available for inclusion in the final MPP rule.

Prior to last year's BSE discovery, in November 2003, USDA's Animal and Plant Health Inspection Service proposed to amend regulations on the importation of animals and animal products to recognize a category of regions that present a minimal risk of introducing BSE into the U.S. via live ruminants and ruminant products. See "Bovine Spongiform Encephalopathy; Minimal Risk Regions and Importation of Commodities" (USDA, 2003) published in the Federal Register on November 4, 2003 (Volume 68, Number 213:62386-62405).

Following the December BSE discovery, USDA's Food Safety and Inspection Service issued four new rules in January 2004 to further enhance safeguards against BSE. The following four emergency actions went into effect on January 12, 2004. First, one action will establish "product holding" standards requiring that cattle test negative for BSE before FSIS inspectors considered them as "inspected and passed" (DCN 329501). A second action will require all federally inspected slaughter establishments remove, segregate and dispose of all "specified risk material" (e.g., skull, brain, trigeminal ganglia, eyes, vertebral column, spinal cord and dorsal root ganglia, etc.) and ensure these do not enter the food chain (DCN 329502). A third action will expand current prohibitions on what may be labeled as "meat" from "advanced meat recovery" to include dorsal root ganglia, clusters of nerve cells connected to the spinal cord along the vertebral column, along with spinal cord tissue (DCN 329503). Finally, a fourth action will ban the practice of "air-injection stunning" so that portions of the brain are not dislocated into the tissues of the carcass as a consequence of stunning cattle during the slaughter process (DCN 329504).

To date, EPA is not aware of any proposed or enacted USDA or FDA regulations or emergency actions to prevent further cases of avian flu that could affect poultry growers and processors.

2.5.3 Combined Effect of BSE and EPA's Rule on the MPP Industry

Chapter 5 of this report outlines EPA's reasons for its preliminary assessment that its determination of economic achievability for the final MPP rule would not change if the Agency were able to take into account recent events attributable to BSE and other related events, such as avian influenza. These reasons center on the ability of the Agency's financial models, based on information obtained through its detailed survey of the MPP industry and the conservative assumptions in the model facilities, which provide substantial margin for these models to be able to absorb additional costs and/or additional decreases in net income before showing additional facility closures. More information is provided in Chapter 5.

In addition, the overwhelming majority of the meat and poultry processing facilities in the U.S. will, however, not be subject to the final MPP rule. The MPP regulation affects 35 meat packing plants and about 110 poultry processing facilities. Department of Commerce's latest Census of Manufacturers reports that there were about 1,400 meat packing plants and about 500 poultry processing facilities in 1997 (U.S. Census Bureau, 1999a through 1999d). Thus, a very small percentage of the entire MPP industry is affected by both the effluent guideline and the potential impacts of BSE.

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CHAPTER 3

ECONOMIC IMPACT METHODOLOGY

3.1 BACKGROUND

EPA tailored its economic analysis to the Meat and Poultry Products industry and the data available. The data gathering effort is outlined in Figure 3-1. EPA selected a sample of 2,000 MPP facilities from a list of approximately 8,200 facilities. The set of 2,000 facilities was divided into those that were sent a screener survey (1,650 facilities) and those that were a detailed survey (350 facilities). From these data, EPA identified direct discharging facilities for further investigation.[1] Due to the longer amount of time required to complete and process the detailed survey compared to the screener survey, EPA had the screener survey data at proposal and knew the detailed survey data would be available for final promulgation. EPA therefore presented two methodologies in the Economic Analysis document accompanying the proposed rule. The first methodology was based on public and screener survey data and intended for use in the proposed rule while the second was based on detailed survey data and intended for use in the final rule.

As the results of the detailed survey data were analyzed, it became clear that few—if any—direct discharging further processors or renderers (Subcategories E - I, Subcategory J, and Subcategory L) had received a detailed survey. On the basis of the screener survey, EPA believes that a small number of direct discharging facilities do exist in these subcategories. Therefore, for the final rule EPA used detailed survey data and the associated methodologies to project economic impacts on direct discharging slaughter facilities (Subcategories A - D and Subcategory K), but continued to use the proposal methodology and screener survey data to project economic impacts on direct discharging facilities in Subcategories E - I, Subcategory J, and Subcategory L.

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[1] See preamble to the final rule for EPA's decision to exclude indirect discharging facilities in the MPP industry from the scope of this rule.

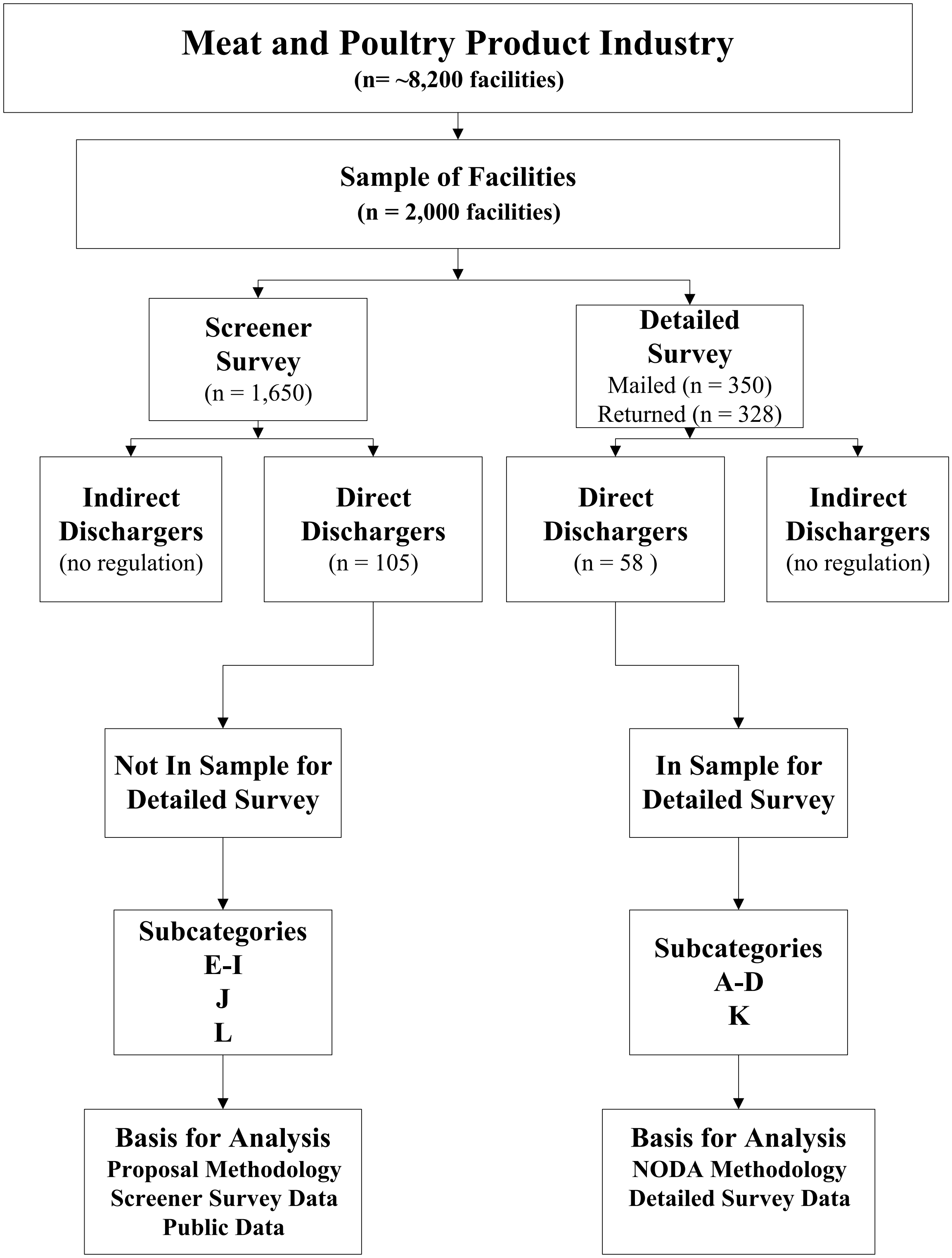

Figure 3-1

Road Map to Methodology by Subcategory

The rest of this chapter is predominantly a road map that explains which method was used to evaluate impacts by level and subcategory. It is organized by level: cost annualization, facility, company, market, and national. All methodologies were presented in detail in the proposal EA (hereafter "proposal EA," U.S. EPA, 2002) and Notice of Data Availability (FR, 2003). This chapter provides a brief overview and describes any modifications that EPA made in response to comments.

3.2 COST ANNUALIZATION

The beginning point for any analysis is the cost annualization model (see Figure 3-2). Annualized costs are calculated as the equal annual payments of an annuity that has the same present value as the stream of cash outflow over the project life and includes the opportunity cost of money or interest. An annualized cost is analogous to a mortgage payment that spreads the one-time investment of a home over a series of constant monthly payments. There are two reasons to annualize capital and O&M costs. First, the capital cost is incurred only once in the equipment's lifetime; therefore, initial investment should be expended over the life of the equipment. Second, money has a time-based value, so expenditures incurred at the end of the equipment's lifetime or O&M expenses in the future are not the same as expenses paid today.

Inputs to the cost annualization model come from EPA's engineering staff, secondary data, and detailed survey data. EPA's engineering staff developed capital and operating and maintenance (O&M) costs for incremental pollution control. The capital cost, a one-time cost, is the initial investment needed to purchase and install equipment involved in pollution control.[2] The O&M cost is the annual cost of operating and maintaining that equipment; a site incurs its O&M cost each year.

Secondary data sources provide the depreciation method, federal and state tax rates, and deflator indices. The depreciation method used in the cost annualization model is the Modified Accelerated Cost Recovery System (MACRS). MACRS can model businesses as depreciating a higher percentage of an investment in the early years and a lower percentage in the later years. The Internal Revenue Code Section 168 classifies an investment with a lifetime of at least 20 years but less than 25 years as 15-year

[2] One-time costs are included in capital costs.

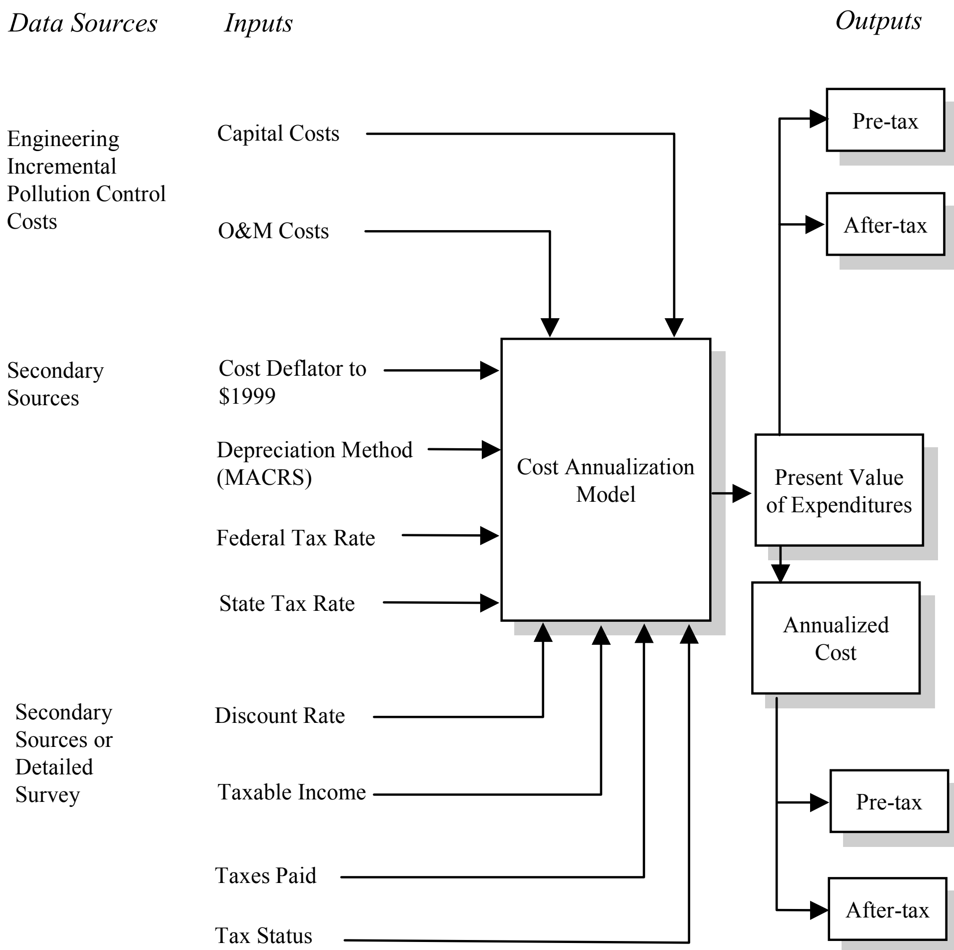

Figure 3-2

Cost Annualization Model

property. Therefore, the cost annualization model uses a 15-year depreciable lifetime for the capital cost. A mid-year depreciation convention is used; that is, EPA assumes that a 6-month period elapses between purchase of equipment and time of operation. As such, the model covers a 16-year period, with a 6-month period in the first year and a 6-month period in the sixteenth year (RIA, 1999).

Tax rates are determined by the national average state tax rate plus the federal tax rate. The model uses flags to identify whether a facility pays taxes at corporate rate, personal rate, or is an S/limited liability corporation which distributes earnings to its shareholders prior to taxation (CCH, 1999a and 1999b). The tax shield on compliance costs is limited to the average annual tax paid by the facility over the survey period.[3]

The Consumer Price Index (CPI) is used to estimate the average inflation rate for the 1987 to 1999 time period (CEA, 2002). Costs are deflated to $1999 values with the Engineering News Record Construction Cost Index to use with the 1999 data collected in the detailed questionnaire (ENR, 2000).

Several inputs to the cost annualization model vary depending on whether detailed survey data are available or not. For facilities with survey data, the discount rate reported in the detailed questionnaire adjusted for inflation by the CPI, taxable income is calculated as earnings before taxes (EBT),[4] and taxes paid are reported in the survey as tax status (corporate or personal). For facilities without detailed survey data, EPA used a real discount rate of 6.7 percent, which is the average real discount rate for detailed survey facilities. Taxable income and taxes paid are calculated from Census data and corporate tax rates as described in the proposal EA, Section 3.1.2.2[3] and Appendix B. Appendix A of the proposal EA provides a sample cost annualization spreadsheet and detailed descriptions of the calculations.

[3] For screener survey facilities, EPA assumed the tax shield was equal to zero to avoid underestimating facility costs and impacts.

[4] Taxable income was originally calculated on EBIT; this modification was made in response to a comment.

3.3 FACILITY ANALYSIS

The facility-level analysis is a closure analysis that examines whether an otherwise profitable site closes in response to the additional costs of increased pollution control. Direct impacts, such as closures and losses in employment and revenue are calculated based on the survey data for the facilities projected to close as a result of the regulation.

As indicated in Figure 3-1, EPA developed two methods of evaluating facility closure. The first method, described in Section 3.3.1, is based on detailed questionnaire data and is therefore used for Subcategories A - D and Subcategory K. Facilities in Subcategories E - I, Subcategory J, and Subcategory L are not represented in the returned detailed questionnaires. EPA used a combination of data from the screener survey and public sources to analyze these facilities, see discussion in Section 3.3.2.

3.3.1 Sites with Detailed Questionnaire Data

The closure analysis is a discounted cash flow analysis that compares the costs incurred during the 2005 to 2020 time period to the earnings accumulated during the same period. Both costs and earnings are discounted with the same value to put both time series on a comparable basis. To be considered a closure as a result of the rule, a facility has to show (1) positive long-term earnings without the rule and (2) negative long-term earnings as a result of the rule in the majority of the forecasts.

3.3.1.1 Forecasting Methods and Assumptions

While the analysis may be described simply, there are many complexities to address in building the model, such as what to consider as earnings, what costs are considered, and the number and type of forecasting methods used. As mentioned, the facility closure analysis was discussed in the Proposal EA, Section 3.2 and a revised forecasting method based on U.S. Department of Agriculture's Economic Research Service time series on the farm-to-wholesale price spread to develop an index that reflects the industry's cyclicality (FR, 2003).

For the purposes of this analysis, EPA used net income as an estimate of earnings even though it contains the non-cash cost of depreciation.[5] EPA developed several forecasting methods to account for uncertainty in both the forecast future facility net income, and the appropriate start point of the forecast. EPA has the 1997-1999 net income data as reported in the detailed survey and the indices developed from USDA ERS data from 1970 to 2002. The rule was promulgated in 2004, so costs to respond to the rule could be incurred as early as 2005. EPA first uses the indices to project the survey data from 2000 to 2005, the time period between the most recent data collected in the survey and promulgation. The earnings for 1997 and 1998 are re-calculated based on the ratio of the actual to forecast values for 1999. The year 2005 becomes the new starting point for the earnings forecast. That is, the time period over which to calculate the present value of earnings is 2005-2020; the same period over which the costs are projected. From these combinations, EPA selected the following three projection methods for net income:

- using a simple average of 1997, 1998, and 1999 net income projected over the 15 year project life to provide an unsophisticated baseline;
- using 2005 net income as the start point for projections using Cycle 1 in Table 3-1 (index initial value is 2005);
- using the three years average of each facility's net income (from the detailed survey) as the start point for projections using Cycle 2 in Table 3-1 (index initial value is the largest margin in the 1995 and 2001 period).

EPA used a "weight of evidence" approach to determine if a facility is projected to close. That is, a facility is projected to close if the PV of future compliance costs exceeds the forecast PV of net income under two of the three forecasting methods.

[5] In theory, depreciation is supposed to reflect wear and tear over the useful life of the asset, it does not necessarily do so for tax purposes due to the accelerated cost system.

Table 3-1
Business Cycle Indices for Forecasting Net Income

	Cycle 1 Year 1 of Cycle Equals 2005			Cycle 2 Year 1 of Cycle Equals High Point of 1995 - 2001		
Year	Beef	Pork	Broilers	Beef	Pork	Broilers
1	1.00	1.00	1.00	1.00	1.00	1.00
2	0.97	0.99	0.86	0.95	0.84	0.81
3	1.00	1.19	1.34	0.94	0.84	0.63
4	1.05	1.16	1.00	0.98	0.83	0.95
5	0.93	0.97	0.86	0.86	0.87	0.61
6	0.89	0.91	1.34	0.83	0.79	0.48
7	0.90	1.06	1.00	0.86	0.67	0.99
8	0.96	1.13	0.86	0.91	0.66	0.70
9	0.87	0.95	1.34	0.80	0.79	0.63
10	0.81	0.84	1.00	0.76	0.77	0.97
11	0.81	0.92	0.86	0.78	0.65	0.73
12	0.87	1.08	1.34	0.83	0.60	0.63
13	0.80	0.92	1.00	0.75	0.70	0.97
14	0.73	0.79	0.86	0.70	0.75	0.73
15	0.73	0.82	1.34	0.70	0.63	0.63
16	0.76	0.99	1.00	0.75	0.56	0.97

3.3.1.2 Baseline Conditions

The focus of the analysis is to evaluate impacts that result from the rule. A facility might be projected to close without any compliance costs. This will occur if: (1) the company does not record sufficient information at the site level for the closure analysis to be performed, (2) the company does not assign costs and revenues that reflect the site's true financial health (e.g., the facility is a cost center or a captive site), or (3) the site is already in financial trouble.

Under the first two conditions, EPA does not have sufficient information to evaluate impacts at the site level *as a result of the rule.* In the case of the MPP industry, many companies do not maintain financial records at the facility level. Instead they maintain their financial records at, for example, the company level, division level or product line level. EPA found that less than 40 percent of direct discharging facilities provided facility level financial data in the detailed survey. EPA did collect company level financial data in the detailed survey. Therefore, EPA performed a closure analysis at the company level in addition to the facility level analysis, see Section 3.4. In the third case, the facility is unprofitable prior to the regulation, and the company may decide to close the site even in the absence of the rule. The projected closure of a site that is unprofitable prior to a regulatory action is not attributed to the regulation.

3.3.1.3 Adjustment of Facility Weights to Account for Detailed Survey Nonresponse

As previously noted, EPA did not receive facility level financial data from a significant portion of respondents in response to the Agency's detailed survey. In particular, 10 facilities (18 weighted) in Subcategories A - D (both small and nonsmall) and 27 facilities (97 weighted) in Subcategory K facilities (both small and nonsmall) did not provide sufficient financial information for use in EPA's closure analysis. This was generally because the companies do not maintain the type of information about each facility that EPA requested. Instead, the information is consolidated at the company level.

To account for the lack of facility level data in the facility closure analysis for Subcategories A - D and Subcategory K, EPA conducted its facility level closure analysis on the 10 facilities (28 weighted) in Subcategory A - D (both small and nonsmall) and 9 facilities (45 weighted) in Subcategory K (both small and nonsmall) that provided sufficient data about each facility. EPA then incorporated additional adjustments to the survey weights to account for the facilities without the financial information, but that had otherwise responded to the questionnaire. By adjusting in this manner, EPA is assuming that the facilities that provided facility-level information are similar to those that did not. EPA only uses these adjusted weights for the facility level closure analysis in Subcategories A - D and Subcategory K.

Table 3-2 lists the number of facilities by subcategory and production size, as well as the numbers of facilities that did and did not provide financial information for the closure analysis (see the TDD and the rulemaking docket for further details on survey stratification and facility counts).

Table 3-2
Facility Counts

Subcategory	Production Size	Facility Counts: Eligible (N)	Facility Counts: With Data (n_1)	Facility Counts: Without Data (n_2)	"Economic Analysis" Adjustment Factor (N/n_1)
A - D	nonsmall	31	13	18	2.38
	small	15	15	0	1.00
K	nonsmall	105	36	69	2.92
	small	36	9	27	4.15

The final weight w_{hi} for a facility i in stratum h can be written as follows:

$$w_{h,i} = (\text{base weight})_{h,i} \times (\text{economic analysis adjustment factor})_h$$

$$w_{h,i} = (\text{base weight})_{h,i} \times (N / n_1)_h$$

In other words, the 13 non-small facilities that provided facility level financial data in Subcategories A - D, for example, would have its detailed survey weight multiplied by 2.38 (13 × 2.38 = 31), and so forth for the remaining subcategories and size classes.

3.3.2 Sites without Detailed Questionnaire Data

3.3.2.1 Economic Impact Analysis Using Model Facilities

Facilities in Subcategories E - I, Subcategory J, and Subcategory L, were not represented in the detailed questionnaire data. However, these facilities were represented in the screener survey database. EPA therefore used the methodology for the proposed rule based primarily on Census data to project impacts for these facilities (see Proposal EA, Section 3.1.2 for details).

EPA developed economic model facilities based on the U.S. Census Bureau's 1997 Economic Census of the four NAICS codes for meat and poultry product industries (NAICS 311611, 311612, 311613, and 311615; see U.S. Census Bureau, 1999a through d). EPA used Census revenue and cost information at both the industry level and disaggregated into size groupings based on the number of employees at the establishment ("employment class"). At the employment class level, EPA used the Census' value of total shipments, payroll, and material costs data. (Total shipments serves as a proxy for total revenues.) EPA used industry level data on benefits, depreciation, rent, and purchased services and attributed it to the employment class level using a small number of reasonable assumptions (e.g., employment benefits are proportionate to payroll, refuse removal costs are proportionate to material costs). EPA divided each component of facility income by the number of establishments in the employment class to calculate the average for that class. EPA then estimated model facility earnings before interest and taxes (EBIT) in each class as the average value of shipments minus payroll, material costs, benefits, depreciation, rent, and purchased services. Because revenues, payroll and cost of materials are the most significant components of EBIT, the relative error introduced by attributing industry level data to the employment class level should be small.

EPA used data from Census' Annual Survey of Manufactures (ASM, 2000), 1997 Economic Census, and the Internal Revenue Service code combined with additional assumptions to estimate model facility net income from EBIT. EPA estimated industry level interest payments using a combination of ASM data on past investment by industry, Census data on relative investment in buildings and equipment, and assumptions about investment behavior (e.g., all investment in each year was funded through bank loans, the interest rate on those loans was equal to the nominal prime rate for that year plus 1 percent). Interest payments were then attributed to each employment class based on the percentage of industry investment accounted for by that employment class in the 1997 Census. EPA assumed model facility EBIT less interest (EBT) is equal to business entity taxable income as the basis for calculating tax payments; EPA then applied 1999 federal and an average of state corporate tax rates to EBT. EPA estimated net income as EBIT less estimated tax and interest payments for each model facility. EPA inflated all model income measures from the Census year, 1997, to the baseline year, 1999, using the implicit price deflator for the meat and poultry products industry (U.S. DOC, 2000 and U.S. DOC, 2001).

However, the model facility in reality represents a distribution of facility incomes around the mean. Therefore, EPA estimated this distribution of income around the model facility mean by obtaining from Census a special tabulation of the variances and covariances for value of shipments, material costs, and payroll in each employment class (U.S. DOC, 2001). EPA assumed that the distribution of each variable is normal; given the relatively large number of observations within each employment class, this assumption is reasonable. Because model facility EBIT is calculated as a linear function of the means of its components, the variance of EBIT for each employment class can be calculated as a linear function of the variances and covariances of the components using well established formulae. Because the actual income measures differed from the approximate income measure (EBIT) on which variance was estimated, EPA adjusted the variance of each income measure using standard rules concerning the expected value of mean and variance.

In order to perform the economic impact analysis, EPA matched its economic model facilities to the screener survey facilities that were costed. All meat facilities that perform animal slaughter, whether alone or in combination with other processes, were assigned economic model facilities from NAICS 311611. Meat facilities that perform further processing but no slaughtering activities processes were assigned economic model facilities from NAICS 311612, as were facilities that process a mix of both meat and poultry (approximately 70 percent of their production is meat). Facilities that process poultry, with or without slaughter, were assigned economic model facilities from NAICS 311615. Finally, facilities that only perform rendering operations were classified as NAICS 311613. The model economic facilities were further matched to the screener survey facilities by size. EPA used facility production from the screener survey, combined with representative meat product prices for 1999, to estimate facility revenues. The screener survey facility was then assigned an economic model that most closely matched its estimated revenues.

EPA chose the ratio of cost/net income as its preferred (central) measure of economic achievability. EPA also estimated the probability that a facility would close because the cost of compliance exceeded net income. EPA estimated these probabilities by using the variance and covariance information provided by the Census Bureau to derive the variance of net income. The probability that annualized compliance costs are greater than net income provides a rough estimate of the probability of that facility closing.

EPA is cognizant that the use of average ratios could mask considerable variability in economic impacts. This is a shortcoming of the use of model facilities. EPA took several steps to minimize this effect by: (1) using multiple model facilities within each subcategory, (2) being relatively conservative in its choice of average ratios that are deemed economically achievable, and (3) estimating the probabilities of closure (i.e., the likelihood of closure given the uncertainty around the estimated average income for the model facility).

3.3.2.2 Combining Detailed Survey Facility and Screener Survey Facility Costs

In Subcategories F - I, J, and L, EPA found that it had only two detailed surveys from direct discharger facilities, and, as explained in Section 2.3.1, chose to use direct discharging screener survey facilities to estimate costs and project economic impacts. Restricting the analysis in these subcategories to detailed survey facilities only would result in very unstable estimates because of the small number of direct dischargers found through the detailed survey.

However, rather than restrict the analysis in these subcategories to only screener survey facilities, and thus ignoring the information provided by the detailed survey facilities, EPA chose to use both data sources. The cost estimates are improved by determining an average cost per direct discharging facility, regardless of survey source, then multiplying that average cost by the weights from the larger screener survey. Detailed survey weights and screener survey weights are non-additive, thus only one set of weights can be applied. Because the screener survey weights are more precise (see Section 2.3.1), the screener survey weights are used.

For example, assume that compliance costs are estimated from a matched set of three screener survey facilities, S_1, S_2, and S_3, and one detailed survey facility, D_1 (i.e., based on production data, all four facilities would use the same model facility for projecting economic impacts). The facilities' corresponding weights are SS_1, SS_2, SS_3, and DS_1. The average cost for this group of facilities is calculated as:

$$\text{Average Cost} = (COST_{S1} + COST_{S2} + COST_{S3} + COST_{D1})/(4)$$

Total costs for this group of facilities are estimated as:

$$\text{Total Cost} = (\text{Average Cost})*(SS_1 + SS_2 + SS_3)$$

To project facility level impacts, EPA uses the average cost to the model facility to project impacts, and applies the sum of screener survey weights ($SS_1 + SS_2 + SS_3$) to the model facility to scale the results of that analysis. For national level costs, EPA uses the total cost as estimated above.

3.4 COMPANY ANALYSIS

EPA used three methods to examine impacts on companies: closure, Altman's Z′, and a financial ratio analysis. As with the facility analysis, the method used depend on whether the subcategory is represented in the detailed questionnaire data. EPA developed the company-level closure analysis because a substantial portion of the industry does not maintain financial records at the company level. The Altman's Z analysis was described in the proposal EA (Section 3.1.3.2). The financial ratio analysis is for that part of the industry not represented in the detailed questionnaire.

3.4.1 Companies with Detailed Survey Data

3.4.1.1 Estimation of Company Costs

For companies represented in the detailed survey, EPA constructed total company costs from costs for direct discharge facilities represented in the detailed survey data base, and estimated costs for other facilities owned by the same company that did not receive a detailed survey. EPA focused on estimating company costs for those within the scope of the final rule. EPA determined production thresholds below which a facility would not be within scope of the regulation (see Chapter 2, Industry Profile and Chapter 4, Options). Facilities that produce above the threshold and are within the scope of the regulated community are termed "nonsmall" facilities. That is, EPA developed company costs only for companies that owned at least one nonsmall, direct discharging facility and received a detailed survey.

EPA's steps in identifying the number of companies, the facilities they owned in 1999, and the number of facilities for which costs were needed were:

- review the 53 nonsmall detailed survey direct discharging facilities in Subcategories A - D and Subcategory K to determine their corporate parent.
- compile a list of companies/corporate parents. There are 25 companies on this list.
- for each company, identify all other meat processing facilities owned by that company. EPA used screener survey, PCS, and public data to do this. EPA estimates that the 25 corporate parents of the 53 nonsmall direct dischargers owned about 323 MPP facilities in 1999.
- determine the discharge status of these 323 facilities because indirect discharging facilities will not incur costs under this regulation. EPA estimated that approximately 117 of the 323 facilities owned by these corporate parents were direct dischargers.

Of these 117 direct dischargers, 53 received detailed surveys, and 64 required analysis based on non-survey data. EPA estimated costs for the 53 facilities on the basis of their detailed survey data.

To estimate compliance costs attributable to the 64 non-surveyed facilities, EPA applied average compliance costs by meat type (meat or poultry) to each facility. EPA examined alternative means of allocating compliance costs to these facilities, such as matching costs from detailed survey facilities based on meat type and processes performed. EPA determined that applying average costs by meat type to non-surveyed facilities resulted in more conservative (i.e., higher) cost estimates. See Franz, 2003a (DCN 125501), for additional information on the estimation of non-surveyed direct discharge facilities.

3.4.1.2 Closure Analysis

The company level closure analysis is identical to the facility level closure analysis with company earnings and costs replacing facility earnings and costs in the discounted cash flow calculations. If a company is projected to close, company output and employment are considered lost.

EPA did not attempt to scale up the projected company closures to correspond to a national estimate because EPA lacks data on which to base sample weights for the 25 companies. Thus, the company level analysis reflects closures only among the 25 companies analyzed. EPA made an effort to determine whether there are additional companies that own direct discharging MPP facilities and found three additional companies based on the screener survey results that may own direct discharging MPP facilities. Therefore, the company level analysis could underestimate the number of company closures nationally.

3.4.1.3 Altman's Z′-score

There is no change from EPA's proposed methodology on using an Altman Z′-score to assess the financial health of a company before and after incremental pollution control costs (see Proposal EA, Section 3.1.3.2; Altman, 1993). Altman Z′-score analysis uses on a statistical technique called multiple discriminant analysis calculate a weighted combination of financial ratios. The Altman Z′-score is a widely-used tool used to predict firm "financial distress" or bankruptcy. It takes into account a company's total assets, total liabilities and earnings, which are influenced by total compliance capital costs incurred by a company because of the proposal as well as pre-tax annualized compliance costs.

The score places firms into three categories of financial health *if no corrective action is taken by the company*: (1) financial distress is unlikely, (2) financial distress is indeterminate, and (3) financial distress is likely. EPA considered firms that move from an indeterminate or unlikely distress category to a likely distress category to be at risk of bankruptcy or other serious financial disruption. The actual effects of financial distress are inherently unpredictable and a firm may avoid legal bankruptcy by taking other measures such as laying off employees, closing facilities, or selling assets. These firms still may incur very significant impacts even if they do not file for bankruptcy.

EPA used the Altman Z′-score to assess the baseline financial condition of MPP firms and the incremental impacts of the rule on their financial health. This analysis includes the same 26 companies analyzed for company closure analysis.

3.4.2 Companies Without Detailed Survey Data

For companies and sites without detailed survey data, EPA assumed the facility and company are the same. EPA combined Census data (via the model facilities developed for the closure analysis) with Dun & Bradstreet financial ratio data (D&B, 1998). For each model facility, EPA divided net income by the median value for return on assets reported by Dun & Bradstreet for the relevant industry to estimate the model facility's total assets. Given the model facility's net income and total assets, EPA calculated the post-regulatory return on assets as: (net income - posttax annualized costs)/(total assets + capital costs).

3.5 MARKET MODEL

3.5.1 Overview

EPA developed a market model to examine the impacts of the proposal on the price and output of various meat and poultry products. The market model was described in the Proposal EA, Section 3.1.4, Appendix C (Market Model Methodology), and Appendix D (Summary of Supply and Demand Elasticity Literature).

The market analysis for each product depends not only on the compliance costs for that product but also on the impact of costs on the prices of the other three meat and poultry products because as prices for one product rise, consumers will purchase less of that product and more of the other three products. EPA selected a perfectly competitive structure for the meat and poultry products market model after performing an extensive literature search. EPA developed standard domestic supply, domestic demand, import supply, and export demand equations for each meat and poultry product. Domestic demand for each meat and poultry product is specified as a function of the price of the other three meat and poultry products in addition to its own price. EPA used USDA data to determine baseline market prices and quantities. Key model parameters (*e.g.*, price elasticities) were selected from existing published sources after an extensive search. For each meat and poultry product market to be in equilibrium, that is, U.S. domestic demand plus foreign demand (exports) must equal U.S. domestic supply plus foreign sales (imports) at its current market price.

Compliance costs shift the supply curve for each meat and poultry product by the pre-tax annualized compliance costs per pound of carcass weight for each of the four meat types. The most appropriate measure of the shift in supply is the cost per pound of total industry production because: (1) the majority of facilities incur no costs, and (2) the competition from facilities that do not incur costs will discourage affected facilities from increasing price by the full cost per pound of the ELG.

Given the supply shift for each product, EPA solves for the post-regulatory set of meat prices that results in equilibrium in all four markets. This solution provides estimates of post-regulatory impacts. Finally, the post-regulatory prices are substituted back into the individual component equations to estimate post-regulatory domestic supply, domestic demand, import supply, and export demand for each meat and poultry product. Changes in prices and these quantities for each meat and poultry product measure the market-level impacts of the final rule.

3.5.2 Revision to Trade Elasticities

The primary factor in determining trade impacts are the trade elasticities specified in the model. EPA received comments that it did not adequately address trade impacts on the poultry sector. In response, EPA reviewed the two frameworks for deriving the trade elasticities. The first assumes that one country's meats are an imperfect substitute for those of other countries (i.e., Armington's framework). The second assumes that each country's meat products are perfect substitutes for those of any other country (i.e., Orcutt's framework).

EPA found sufficient evidence in the published literature to retain the Armington framework it had proposed. However, EPA decided to revise how it estimated the trade elasticities. EPA now believes it is more appropriate to use the U.S. own price elasticity of mead demand as a direct proxy for the price elasticity of U.S. demand for meat products regardless of the country of origin. This is because econometric studies measure the responsiveness of meat purchases by consumers regardless of the country of origin of those meat products. This modification was presented in the NODA and the detailed discussion and equations are in the rulemaking docket (Franz, 2003b; DCN 125503). Table 3-3 summarizes the two sets of estimates.

Table 3-3
Estimates of Armington Trade Elasticities for the MPP Market Model

	Import Elasticities[a]		Export Elasticities[b]	
Meat Type	**Proposal**	**Revised**	**Proposal**	**Revised**
Beef	0.0968	1.9994	-1.5584	-1.5316
Pork	0.0346	1.3337	-1.5745	-1.5711
Broilers	0.0002	1.1458	-1.2017	-1.1903
Turkeys	0.0002	1.1600	-1.1865	-1.1557

[a] The percent change in U.S. demand for rest of the world (ROW) meat products resulting from a one percent change in U.S. price.
[b] The percent change in ROW demand for U.S. meat products resulting from a one percent change in U.S. price.

3.6 DIRECT IMPACTS

Direct impacts are calculated from facility closures estimated from the detailed survey data and the probablistic method based on public data and model facilities (Sections 3.3.1 and 3.3.2, respectively). All employment, production, exports, and revenue associated with the closed sites are considered lost when the sites close.[6]

3.7 NATIONAL DIRECT AND INDIRECT IMPACTS

Impacts on the meat product industry are known as direct effects, impacts that continue to resonate through the economy are known as indirect effects (effects on input industries), and effects on consumer demand are known as induced effects. The U.S. Department of Commerce's Bureau of

[6] This approach projects the severest effects because it does not account for other sites increasing production or hiring workers in response to the site closure. The market model, however, accounts for this effect.

Economic Analysis (BEA) tracks these effects both nationally and regionally in massive "input-output" tables, published as the Regional Input-Output Model (RIMS II) multipliers. For every dollar in a "spending" industry, these tables identify the portion spent in contributing, or "vendor," industries.

For this analysis, EPA calculated direct and indirect impacts using the national-level final-demand multipliers for BEA industries 14.0103 (meat packing plants, sausages, and other prepared meats):

- Output: 4.9661 dollars of total output per dollar of meat products
- Employment: 46.9297 FTEs per $1 million in output in 1992 dollars

and these multipliers for BEA 14.0105, poultry slaughtering and processing:

- Output: 4.3518 dollars of total output per dollar of meat products
- Employment: 45.1800 FTEs per $1 million in output in 1992 dollars

Because employment multipliers are based on 1992 data, the value of lost output needs to be deflated to 1992 dollars before estimating employment impacts. (U.S. DOC, 1996). EPA used Gross Domestic Product (GDP) data by industry for the years 1947 to 2000, compiled by the Bureau of Economic Analysis (BEA), to calculate the implicit price deflator for the Food and Kindred Products industry in the period 1992 to 1999 (U.S. DOC, 2001).

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CHAPTER 4

POLLUTION CONTROL OPTIONS

4.1 EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS

The Federal Water Pollution Control Act (commonly known as the Clean Water Act [CWA, 33 U.S.C. §1251 et seq.]) establishes a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (§101(a)). EPA is authorized under sections 301, 304, 306, and 307 of the CWA to establish effluent limitations guidelines and pretreatment standards of performance for industrial dischargers. The standards EPA establishes include:

- Best Practicable Control Technology Currently Available (BPT) . Required under section 304(b)(1), these rules apply to existing industrial direct dischargers. BPT limitations are generally based on the average of the best existing performances by plants of various sizes, ages, and unit processes within a point source category or subcategory.

- Best Available Technology Economically Achievable (BAT). Required under section 304(b)(2), these rules control the discharge of toxic and nonconventional pollutants and apply to existing industrial direct dischargers.

- Best Conventional Pollutant Control Technology (BCT). Required under section 304(b)(4), these rules control the discharge of conventional pollutants from existing industrial direct dischargers.[1] BCT limitations must be established in light of a two-part cost-reasonableness test. BCT replaces BAT for control of conventional pollutants.

- Pretreatment Standards for Existing Sources (PSES). Required under section 307. Analogous to BAT controls, these rules apply to existing indirect dischargers (whose discharges flow to publicly owned treatment works (POTWs).

- New Source Performance Standards (NSPS). Required under section 306(b), these rules control the discharge of toxic and nonconventional pollutants and apply to new source industrial direct dischargers.

- Pretreatment Standards for New Sources (PSNS). Required under section 307. Analogous to NSPS controls, these rules apply to new source indirect dischargers (whose discharges flow to [POTWs]).

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[1] Conventional pollutants include biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, pH, and oil and grease.

EPA is promulgating final effluent limitations guidelines for the meat products industry in this rulemaking effort.

4.2 TECHNOLOGY OPTIONS

EPA does not mandate technologies when establishing effluent limitations guidelines and pretreatment standards. However, EPA evaluates various technology options in order to base the limitations on demonstrated technologies and to evaluate the economic impact of the cost of those technologies on the regulated industry. This section briefly describes the pollution control options evaluated for each subcategory within the meat products industry. The Development Document (U.S. EPA, 2004) provides a detailed description of the meat products industry subcategories and pollution control options for each subcategory.

Table 4-1 summarizes the technology options considered for each meat products industry subcategory. The first column indicates the option number that appears in the cost and impact tables in Chapters 5 through 8. The second column contains a brief description of the technology option. For the proposed rule, EPA examined costs and impacts of guidelines and standards to both direct and indirect discharging facilities. The rule as promulgated only sets effluent limitations for direct dischargers.

Table 4-1
Meat Products Industry Treatment Technology Options
Direct Dischargers

Option	Treatment Unit
1	Biological Treatment, Partial Nitrification, Disinfection
2	Biological Treatment, *More Complete Nitrification*, Disinfection
2.5	Biological Treatment, More Complete Nitrification, Disinfection, *Partial Denitrification*
2.5 + P	Biological Treatment, More Complete Nitrification, Disinfection, Partial Denitrification, *Chemical Phosphorus Removal*
4	Biological Treatment, More Complete Nitrification, Disinfection, *More Complete Denitrification*, Chemical Phosphorus Removal

Changes between technology options indicated by italics.

As can be observed in Table 4-1, the treatment trains costed in the higher numbered options build upon the set of technologies costed for the first option. Thus, under Option 1, direct dischargers were costed for: biological treatment, partial nitrification, and disinfection. These components are also included in Options 2 through 4. Option 2 increases the degree of nitrification, while Options 2.5, 2.5 + P, and 4 add denitrification. Chemical phosphorus removal is added to Option 2.5 + P and Option 4.

EPA examined the costs and economic impacts of Options 1 and 2 on small processors; nonsmall processors were not costed for Option 1, but were costed for all higher options. The levels of production that EPA used to define small facilities are presented in Table 4-2. For the proposed rule, EPA defined small processors in Subcategory K as those facilities that slaughter less than 10 million pounds of poultry per year. For the final rule, EPA has redefined this threshold as 100 million pounds per year. EPA modified the threshold because it found significant economies of scale for poultry slaughter facilities. This results in relatively little production (and pollutant loads in the wastewater) from facilities that produce below this threshold. Further details of the analysis of this threshold may be found in docket item DCN 321001.

Table 4-2

Size Classifications for Meat Products Industry Subcategories

Subcategory	Classification	Definition
A - D	Small	< 50 million pounds live weight kill per year
	Nonsmall	≥ 50 million pounds live weight kill per year
E	NA	≥ 1.56 million pounds of finished product per year
F - I	Small	> 1.56 million pounds of finished product per year < 50 million pounds of finished product per year
	Nonsmall	≥ 50 million pounds of finished product per year
J	NA	≥ 10 million pounds of raw product per year
K	Small	< 100 million pounds live weight kill per year
	Nonsmall	≥ 100 million pounds live weight kill per year
L	Small	< 7 million pounds of finished product per year
	Nonsmall	≥ 7 million pounds of finished product per year

NA: no distinction is made between small and nonsmall facilities in this subcategory.

Table 4-3 summarizes the technology options selected for direct discharging facilities in each meat products industry subcategory. EPA is excluding small facilities in Subcategories A though J from the revised limitations, and is only setting new source standards for small facilities in Subcategory K and Subcategory L. EPA is not revising pretreatment standards for indirect dischargers in any subcategory.

Table 4-3
Technology Options for Meat Products Industry Subcategories
Direct Dischargers

Subcategory		Selected Option for Final Rule				
		1	2	2.5	2.5 + P	4
A - D[1]	Nonsmall		BPT	BAT, NSPS		
F - I[2]	Nonsmall			BAT, NSPS		
J[3]	NA			BAT, NSPS		
K[4]	Small		NSPS			
	Nonsmall		BPT, BCT	BAT, NSPS		
L[5]	Small		NSPS			
	Nonsmall		BPT, BCT	BAT, NSPS		

NA: no distinction is made between small and nonsmall facilities in this subcategory.
[1] Guidelines for small facilities are not revised under this rulemaking. BCT for nonsmall facilities is not revised under this rulemaking.
[2] Guidelines for subcategory E and for small processors in subcategory F - I are not revised under this rulemaking. BPT and BCT for nonsmall processors are not revised under this rulemaking.
[3] BPT and BCT are not revised under this rulemaking.
[4] EPA chose not to set BPT, BCT, and BAT for small facilities in Subcategory K.
[5] EPA chose not to set BPT, BCT, and BAT for small facilities in Subcategory L.

4.3 REFERENCES

U.S. EPA. 2004. Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat Products Point Source Category. EPA-821-R-04-011. Washington, DC: U.S. Environmental Protection Agency, Office of Water.

CHAPTER 5

COSTS AND ECONOMIC IMPACTS

The national costs for the options described in Chapter 4 are presented in Section 5.1. Section 5.2 presents the estimated impacts on existing facilities while Section 5.3 discusses barriers to entry for new facilities. Section 5.4 is a summary of the impacts under the final rule.

EPA exercised its authority for regulatory flexibility and evaluated several production thresholds below which a facility was excluded from the scope of this rule, see Chapter 2 (Industry Profile) and Chapter 4 (Options). Facilities that produce more than the threshold amount, and are therefore subject to the rule, are called "nonsmall" facilities. Facilities that produce below that threshold, and are not subject to the rule, are called "small" facilities.

5.1 NATIONAL COSTS

All costs are presented in 1999 dollars unless otherwise identified.

5.1.1 Costs for Nonsmall Facilities

Table 5-1 presents the pre-tax and post-tax annualized costs for nonsmall facilities. The costs are reported by subcategory and option. Pre-tax annualized costs are the most complete estimates of annualized control costs, but the post-tax costs more accurately reflect the costs businesses will incur because they net out tax savings. For that reason, both pre-tax and post-tax costs are used in the economic impact analysis. Pre-tax costs, however, more accurately reflect the total cost to society of the rule and are used in the E.O. 13258 analysis, the cost-effectiveness analysis, and elsewhere.

EPA calculated two cost estimates for the selected option: the "low" costs are based on EPA's selection of input parameters for the cost model, while the "high" cost estimate includes industry's input parameters, with the exception of a few values where EPA disagreed with industry's comments.

Table 5-1
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 (29 facilities)						
Option 2	$24,588	$4,687	$7,288	$793	$151	$235
Option 2.5 (Low)	**$55,801**	**$8,886**	**$13,242**	**$1,800**	**$287**	**$427**
Option 2.5 (High)	**$67,940**	**$11,219**	**$16,686**	**$2,192**	**$362**	**$538**
Option 2.5 + P	$88,398	$27,873	$42,914	$2,852	$899	$1,384
Option 4	$110,203	$33,836	$52,001	$3,555	$1,091	$1,677
Subcategory F-I (4 facilities)[1]						
Option 2	$1,001	$266	$266	$250	$66	$66
Option 2.5 (Low)	**$717**	**$289**	**$289**	**$179**	**$72**	**$72**
Option 2.5 (High)	**$1,017**	**$329**	**$329**	**$254**	**$82**	**$82**
Option 2.5 + P	$1,101	$359	$359	$275	$90	$90
Option 4	$2,127	$798	$798	$532	$200	$200
Subcategory J (19 facilities)[1]						
Option 2	$1,294	$627	$627	$68	$33	$33
Option 2.5 (Low)	**$5,960**	**$1,919**	**$1,919**	**$314**	**$101**	**$101**
Option 2.5 (High)	**$7,019**	**$2,826**	**$2,826**	**$369**	**$149**	**$149**
Option 2.5 + P	$9,031	$7,433	$7,433	$475	$391	$391
Option 4	$11,610	$10,171	$10,171	$611	$535	$535
Subcategory K (96 facilities)						
Option 2	$63,948	$13,600	$17,739	$608	$130	$169
Option 2.5 (Low)	**$103,751**	**$17,700**	**$21,906**	**$988**	**$169**	**$209**
Option 2.5 (High)	**$133,591**	**$25,404**	**$31,817**	**$1,272**	**$242**	**$303**
Option 2.5 + P	$160,601	$48,308	$63,384	$1,530	$460	$604
Option 4	$331,343	$84,547	$109,077	$3,156	$805	$1,039
Subcategory L (10 facilities)[1, 2]						
Option 2	$1,353	$557	$557	$135	$56	$56
Option 2.5 (Low)	**$2,229**	**$747**	**$747**	**$223**	**$75**	**$75**
Option 2.5 (High)	**$2,367**	**$983**	**$983**	**$237**	**$98**	**$98**
Option 2.5 + P	$3,808	$1,475	$1,475	$381	$148	$148
Option 4	$7,822	$3,269	$3,269	$782	$327	$327

[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.

Total pre-tax annualized costs of the rule under the selected Option 2.5 range from $38.1 million to $52.6 million. Capital costs are projected to total from $168.5 to $211.9 million under the selected option. Pre-tax annualized costs per facility are consistently largest in Subcategories A - D ($0.4 to $0.5 million), and smallest in Subcategories F - I ($72,000 to $82,000).

5.1.2 Costs for Small Facilities

Table 5-2 presents estimated total and average compliance costs for small facilities. These costs are reported for completeness; EPA chose not to set new effluent limitations and guidelines for small processors under this rule.

Table 5-1 includes only that percentage of costs for mixed processors that is attributable to nonsmall levels of production of further processed poultry (Subcategory L). Similarly, Table 5-2 includes costs for mixed processors that are attributable to small levels of production of further processed meat (Subcategories F - I) and poultry (Subcategory L). Therefore, the facility counts presented in these tables include the double counting of 7 facilities with nonsmall levels of production in Subcategory L and small levels of production in Subcategories F - I, and 3 facilities with small levels of production in both Subcategory L and Subcategories F - I.

Table 5-2
Total and Average Compliance Costs for Small Processors by Subcategory and Option

Option	Total Costs (000) Capital	Total Costs (000) Post-tax Annualized[1]	Total Costs (000) Pre-tax Annualized[1]	Average Costs (000) Capital	Average Costs (000) Post-tax Annualized[1]	Average Costs (000) Pre-tax Annualized[1]
Subcategory A-D (14 facilities)[2, 3]						
Option 1	$1,000-$3,000	$1,000-$2,500	$1,000-$2,500	$150 - $175	$80 - $120	$80 - $120
Option 2	NA	NA	NA	NA	NA	NA
Subcategory F-I (21 facilities)[4]						
Option 1	$2,308	$1,108	$1,108	$110	$53	$53
Option 2	$2,308	$1,116	$1,116	$110	$53	$53
Subcategory K (36 facilities)[2]						
Option 1	$7,000-$10,000	$2,000-$4,000	$2,000-$4,000	$200 - $275	$50 - $120	$50 - $120
Option 2	$7,000-$10,000	$2,000-$4,000	$2,000-$4,000	$200 - $275	$50 - $120	$50 - $120
Subcategory L (3 facilities)[5]						
Option 1	$17	$13	$13	$6	$4	$4
Option 2	$17	$13	$13	$6	$4	$4

[1] For small facilities, post-tax annualized costs are equal to pre-tax annualized costs because: (1) the facility is an S corporation or LLC (Subcategories A - D and K), so taxes are paid on the income of the owning partners, or (2) the analysis is based on model facilities (Subcategories F - I and L), and EPA assumed a tax shield of $0 to avoid underestimating impacts.
[2] Estimated costs are presented as a range to prevent the disclosure of confidential business information.
[3] Option 2 was not costed for small facilities in this subcategory, because EPA did not propose further regulations.
[4] Subcategory includes 7 mixed processor facilities with small levels of production in Subcategory F - I and nonsmall levels of production in Subcategory L. This subcategory also includes 3 mixed processor facilities with small levels of production in Subcategory F - I and small levels of production in Subcategory L. Compliance costs for mixed processor facilities are distributed between subcategories based on their percentage of production in each.
[5] Subcategory includes 3 mixed processor facilities with small levels of production in Subcategory L and small levels of production in Subcategory F - I. Compliance costs for mixed processor facilities are distributed between subcategories based on their percentage of production in each.

5.1.3 National Costs for Rule

The national cost for the rule depends on the option selected for each of the subcategories, see Table 5-3. The subcategory costs correspond to those shown in Table 5-1 because EPA chose not the regulate small facilities under this rule. The national cost of the rule is $52.6 million dollars (1999 dollars), less than the $100 million threshold to be considered a "major" rule under E.O. 13258 and the Unfunded Mandates Reform Act.

Table 5-3
Total Cost of the Rule by Subcategory

Subcategory	Promulgated Option	Pre-tax Annualized Cost (Thousands)			
		Low Estimate		High Estimate	
		1999 Dollars	2003 Dollars	1999 Dollars	2003 Dollars
A - D	2.5	13,242	14,629	16,686	18,435
F - I	2.5	289	319	329	363
J	2.5	1,919	2,120	2,826	3,123
K	2.5	21,906	24,201	31,817	35,151
L	2.5	747	825	983	1,086
Total		**38,103**	**42,095**	**52,641**	**58,158**

5.2 ECONOMIC IMPACTS ON EXISTING FACILITIES (BAT)

5.2.1 Facility Analysis

5.2.1.1 Nonsmall Facilities

Subcategories A - D. Facilities in Subcategories A - D were represented in the detailed survey. The closure analysis therefore follows the methodology described in Section 3.3.1. The results are reported in Table 5-4.

Eighteen of the 31 facilities did not report site-level financial data. To account for this the remaining facilities were reweighted. This methodology is described in Section 3.3.1.3.

Of the 31 facilities, 5 were forecast to have negative earnings (i.e., net present value of net income) prior to imposition of regulatory costs under at least 2 of the 3 forecasting methods described in Section 3.3.1.1. The economic impact of the rule on "baseline closures" cannot be assessed using the closure model. **No closures** are projected as a result of the rule.

Table 5-4
Summary of Projected Nonsmall Facility Closure Impacts by Subcategory and 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 (Low)	0	$0	0
Option 2.5 Closures (High)	0	$0	0
Option 2.5 + P Closures	0	$0	0
Option 4 Closures	0	$0	0

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

The Potential Effects of BSE on the Facility Closure Analysis for Subcategories A - D

EPA believes the closure analysis for facilities in Subcategories A - D, and its determination of economic achievability would not change if the Agency were able to take into account recent events attributable to BSE and other related events, such as avian influenza.

Despite the recent market changes attributable to these events, there are encouraging signs that U.S. markets in these sectors will recover, as described in Chapter 2 of this report. In the beef sector, only a single BSE case has been reported and the infected cow was imported from Canada and was old enough to have contracted BSE prior to 1997 regulations designed to eliminate BSE. Price decreases have been severe on the cattle feeding sectors with relatively less effect on packers and processors: there is often a negative correlation between farm and wholesale level prices, such that when farm prices drop, wholesale prices rise or remain stable. Land grant universities are forecasting that further cattle price decreases will be modest and prices will eventually improve over time. Gallup polls immediately following the BSE discovery showed that confidence among U.S. consumers remains strong, with only one in three Americans viewing BSE in the U.S. as a major problem or crisis. Confidence among our trading partners also appears to be improving. These encouraging signs are partly attributable to the relatively quick and decisive response by USDA, FDA, and the industry, resulting in production level changes that should help prevent additional major outbreaks.

EPA expects that recent market changes attributable to BSE and avian flu would not alter the conclusions of its economic impact analysis of MPP facilities in the beef and poultry sectors that are affected by these final regulations. The basis for this determination is as follows. First, the results of EPA's analysis are mostly cost-driven such that projected facility closures are consistent across different cost options, affecting only those regulated facilities that either incur high costs because they do not have existing treatment technologies in place or affecting those facilities that are financially vulnerable prior to regulation. Second, EPA's financial models use a conservative projection of future net income streams. This can be observed by the overall long-term downward in the forecast cycle presented in Table 3-1. Third, financial data suggest that the farm to wholesale margin for beef appears adequate to absorb short-term market changes, whether caused by increased production costs or lowered sales income. EPA used data through 2002 to estimate economic effects and did not include record high meat prices in 2003 which could tend to improve the overall livestock industry profit picture and make new regulations appear more affordable. USDA data indicate that the farm-to-wholesale price spread for beef averaged \$0.42/lb in 2003, compared to \$0.35/lb in 2002 and \$0.38/lb in 2001. Therefore, while EPA's forecast of future facility net income, which is based on the farm-to-wholesale price spread, does not incorporate the effects of a potentially bad year (2004), neither does it incorporate an unusually good year (2003).

Finally, EPA's conclusions are supported by its examination of the projected discounted flow of net income for facilities in Subcategories A - D. Even after accounting for compliance costs under the selected option, the majority of facilities in these subcategories have sufficient margin to absorb impacts of BSE and remain open. In general, the distribution of facility net income tends to be bimodal: facilities are either in poor financial condition (either baseline closures, or at best show borderline viability) or are in fairly robust financial health. Thus, in Subcategories A - D, the majority of facilities that are not baseline closures could absorb an additional 90 percent decrease in net income before risking potential closure. Even those facilities that are in worse financial condition could absorb an additional 65 percent decrease in net income before closing. (For the poultry sector net income would also have to decrease dramatically, from 50 percent to 90 percent, before additional facility closures would occur.) Hence, unless the outbreak of BSE becomes more severe and prolonged than currently seems probable, EPA believes that this margin is sufficient to absorb these market impacts without changing the Agency's determination of economic achievability for the MPP regulation.

In addition, EPA believes that its determination of economic achievability for the final MPP regulation would not change even considering the combined effects with changes in cost structures due to other food safety and inspection regulations that may be implemented USDA, FDA, and the industry to prevent future outbreaks. These production level changes will likely result in changes in industry cost structures as new food safety rules are implemented by all meat packing and poultry processing facilities. The cost of these new procedures will depend on implementation details which are currently being determined and are not available for inclusion in the final rule.

Despite these expected production cost increases from the USDA food safety and inspections actions, EPA expects these cost changes would likely not alter the conclusions of its economic impact analysis of MPP facilities for the following reasons. First, the results of EPA's analysis are mostly cost-driven such that projected facility closures are consistent across different cost options, affecting only those regulated facilities that either incur high costs because they do not have existing treatment technologies in place or affecting those facilities that are financially vulnerable prior to regulation. As demonstrated for the proposed rulemaking, even the significantly higher-cost technology options that EPA evaluated for the beef sector showed no additional closures despite higher costs in the range of 40 percent to 700 percent. Second, EPA's financial models are conservative and use data through 2002 to estimate economic effects and did not include record high meat prices in 2003 which could tend to improve the overall livestock industry profit picture and make new regulations appear more affordable. Financial data used by EPA to model industry impacts from today's rule suggest that net income would have to decrease dramatically (i.e., in the range of 50 to 90 percent) before additional facility closures would occur. Expressed in terms of baseline production costs, baseline costs could increase by between 2 times to more than 100 times greater than the selected technology option before EPA's analysis would show additional facility closures. EPA believes that this margin is sufficient to absorb the combined effect of the MPP regulation along with other food safety and inspection regulations that may be implemented to prevent future outbreaks.

Finally, the overwhelming majority of the meat and poultry processing facilities in the U.S. will, however, not be subject to the final MPP rule. The MPP regulation affects 35 meat packing plants and about 110 poultry processing facilities. Department of Commerce's latest Census of Manufacturers reports that there were about 1,400 meat packing plants and about 500 poultry processing facilities in 1997 (U.S. Census Bureau, 1999a through 1999d). Thus, a very small percentage of the entire MPP industry is affected by both the effluent guideline and the potential impacts of BSE.

Subcategory K. Facilities in Subcategory K were represented in the detailed survey. The closure analysis therefore follows the methodology described in Section 3.3.1. The results are reported in Table 5-5. As with facilities in Subcategories A - D, not all facilities in Subcategory K keep site-level financial data. To account for this results are reweighted as described in Section 3.3.1.3.

Thirty facilities were forecast to have negative earnings (i.e., net present value of net income) before inclusion of regulatory costs under 2 or more of the 3 forecasting methods described in Section 3.3.1.1. The economic impact of the rule on these "baseline closures" cannot be assessed using the closure model. Of the 105 facilities, no closures are projected under either variant of Option 2.5. Twenty-two are projected to close under Option 4.

Table 5-5
Summary of Projected Nonsmall Facility Closure Impacts by Subcategory and 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 (Low)	0	$0	0
Option 2.5 Closures (High)	0	$0	0
Option 2.5 + P Closures	0	$0	0
Option 4 Closures	22	$800,000 - $1,000,000	10,000 - 14,000

Subcategories F - I, Subcategory J, and Subcategory L. Facilities in Subcategories F - I, Subcategory J, and Subcategory L were not represented in the detailed survey. The closure analysis therefore follows the methodology used to evaluate screener survey facilities. The methodology is described in the Proposal EA in detail and summarized in Section 3.3.2.

Table 5-6 shows that fractions of facilities are projected to close under each option. This result is attributable to the methodology used to estimate the probability of closure due to the rule. The probability of closure is estimated using a continuous distribution function. The number of closures is then calculated by multiplying the probability of closure by the number of facilities represented by that model facility. Because relatively few facilities are in each subcategory, and because the incremental probabilities of closure are relatively small, the projected number of closures in each subcategory is less than one. However, to report that no closures are projected is not accurate since the probability of closure, while small, is clearly greater than zero.

Under Option 2.5, facilities in Subcategories F - I are projected to incur compliance costs that are 1.1 to 1.2 percent of net income; facilities in these subcategories are expected to have about a 0.2 percent probability of closure due to the rule. Facilities in Subcategory J are projected to incur compliance costs of 4.6 to 6.7 percent of net income under Option 2.5. Probability of closure due to the rule ranges from 0.9 percent to 1.3 percent for these facilities under the selected option. In Subcategory L, facilities are expected to incur compliance costs ranging from 3.9 to 5.1 percent of net income under the selected option. The probability of closure due to the rule for these facilities is about 0.7 to 0.9 percent.

Table 5-6
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	1.0	0.2%	0.01	$751	3
Option 2.5 (Low)	1.1	0.2%	0.01	$816	3
Option 2.5 (High)	1.2	0.2%	0.01	$930	3
Option 2.5+P	1.3	0.2%	0.01	$1,014	3
Option 4	3.0	0.5%	0.02	$2,259	8
Subcategory J					
Baseline	NA	NA	19	$274,270	1,123
Option 2	1.5	0.3%	0.06	$809	3
Option 2.5 (Low)	4.6	0.9%	0.17	$2,493	11
Option 2.5 (High)	6.7	1.3%	0.25	$3,687	16
Option 2.5+P	17.1	3.3%	0.63	$9,986	45
Option 4	24.2	4.8%	0.91	$13,591	58
Subcategory L					
Baseline	NA	NA	10	$223,663	974
Option 2	2.8	0.5%	0.05	$1,135	5
Option 2.5 (Low)	3.9	0.7%	0.07	$1,477	6
Option 2.5 (High)	5.1	0.9%	0.09	$1,941	8
Option 2.5+P	7.7	1.4%	0.14	$2,937	12
Option 4	16.8	3.0%	0.30	$6,689	29

[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.

5.2.1.2 Small Facilities

Subcategories A - D and Subcategory K. As with the nonsmall facilities in these subcategories, the facility analysis is based on detailed survey data and the methodology described in Section 3.3.1. They are also reweighted to account for sites not reporting financial data as described Section 3.3.1.3. Table 5-7 presents the facility impact analysis for small facilities in Subcategories A - D and Subcategory K. For Subcategories A - D, there are 15 facilities, no baseline closures, and no closures under Option 1. Of the 36 facilities in Subcategory K, there were no baseline closures, and **all 36 facilities are projected to close under both options examined**.

Table 5-7
Summary of Projected Small Facility Closure Impacts by Subcategory and Option
Subcategories A - D and Subcategory K

Option	Baseline Conditions and Projected Incremental Closure Impacts[1]		
	Number of Facilities	**Total Revenues (000)**	**Employees**
Subcategories A - D			
Total Facilities Analyzed	15	$150,000 - $200,000	500 - 750
Baseline Closures	0	$0	0
Option 1 Closures	0	$0	0
Option 2 Closures[2]	NA	NA	NA
Subcategory K			
Total Facilities Analyzed	36	$250,000 - $280,000	2,000 - 2,500
Baseline Closures	0	$0	0
Option 1 Closures	36	$250,000 - $280,000	2,000 - 2,500
Option 2 Closures	36	$250,000 - $280,000	2,000 - 2,500

[1] Projected revenue and employment impacts are presented as a range to prevent the disclosure of confidential business information.
[2] Option 2 was not costed for small facilities in this subcategory.

Subcategory J. EPA found no small direct discharging facilities in these subcategory J.

Subcategories F - I and L. The facility analysis for small facilities in these categories rests on screener survey data and the methodology presented in Section 3.3.2. The results are presented in Table 5-8. Small facilities in Subcategories F - I are projected to incur compliance costs that are 9.4 percent of net income, resulting in a probability of closure due to the rule of 1.5 percent, while small facilities in Subcategory L are projected to bear cost that are 1.0 percent of net income and have a 0.15 percent probability of closure.

These results include facilities that operate in more than one subcategory. For these facilities, costs are attributed to each subcategory based on the percentage of production in that subcategory. The portion of the facility that operates in a different subcategory is assumed to be uncosted. While this is the best way to present subcategory closures accurately it may undercount potential impacts on these facilities. Section 5.2.1.3 will examine impacts more fully.

Table 5-8
Summary of Projected Small Facility Closure Impacts by Subcategory and Option
Screener Survey Facility Analysis

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]
Subcategories F - I[3]					
Baseline	NA	NA	21	$369,692	1,316
Option 1	9.4	1.49%	0.31	$2,632	11
Option 2	9.4	1.51%	0.31	$2,633	11
Subcategory L[4]					
Baseline	NA	NA	3	$22,712	97
Option 1	0.9	0.15%	0	$33	0
Option 2	1.0	0.15%	0	$33	0

[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.
[3] Includes costs and impacts on the portion of production that falls under small processor Subcategories F - I guidelines for 7 mixed processors, assuming no costs for that portion of their output that falls under nonsmall processor Subcategory L guidelines, and for 3 mixed processors, assuming no costs for that portion of their output that falls under small processor Subcategory L guidelines. Costs and impacts if guidelines for both types of production are promulgated are covered in Section 5.2.1.3 below.
[4] Includes costs and impacts on the portion of production that falls under small processor Subcategory L guidelines for 3 mixed processors, assuming no costs for that portion of their output that falls under small processor Subcategories F - I guidelines. Costs and impacts if guidelines for both types of production are promulgated are covered in Section 5.2.1.3 below.

5.2.1.3 Mixed Processors

For mixed processors, the results of the closure model are presented as a matrix. This is because a mixed processing facility might be subject to two different regulatory options depending on the type of meat, type of production processes, and quantity of production in different parts of the plant. Table 5-9 presents the average annualized costs as a percent of net income and the probability of closure due to the rule for 7 facilities that are **nonsmall** poultry further processors (and are therefore subject to Subcategory L guidelines and limitations on that portion of their output) and small meat further processors (Subcategories F - I). Under the combination of Option 2.5 selected for nonsmall poultry further processing, and no option selected for small meat further processing, these facilities are expected to incur compliance costs ranging from 4.5 to 5.9 percent of net income. These costs result in a 0.8 to 1.0 percent probability of closure due to the rule.

Table 5-9
Summary of Projected Mixed Processor Facility Closure Impacts

Options for Nonsmall Facilities in Subcategory L[1]	Variable	Options for Small Facilities in Subcategories F - I[1]		
		None	Option 1	Option 2
None	Average Annualized Costs as Percent of Net Income	NA	1.4%	1.4%
	Probability of Closure Due to Rule	NA	0.2%	0.2%
Option 2	Average Annualized Costs as Percent of Net Income	2.9%	4.4%	4.4%
	Probability of Closure Due to Rule	0.5%	0.7%	0.7%
Option 2.5 (Low)	Average Annualized Costs as Percent of Net Income	4.5%	5.9%	5.9%
	Probability of Closure Due to Rule	0.8%	1.0%	1.0%
Option 2.5 (High)	Average Annualized Costs as Percent of Net Income	5.9%	7.4%	7.4%
	Probability of Closure Due to Rule	1.0%	1.3%	1.3%
Option 2.5 + P	Average Annualized Costs as Percent of Net Income	8.7%	10.1%	10.1%
	Probability of Closure Due to Rule	1.5%	1.7%	1.7%
Option 4	Average Annualized Costs as Percent of Net Income	18.2%	19.6%	19.6%
	Probability of Closure Due to Rule	3.1%	3.4%	3.4%

[1] This group contains 7 facilities, with estimated revenues of $132 million and 484 employees. On average, 39 percent of production is subject to guidelines and limitations for small processors in Subcategories F - I, and 61 percent of production is subject to nonsmall Subcategory L guidelines and limitations.

Three mixed processors were found to be **small** further processors in both the poultry (Subcategory L) and meat (Subcategories F - I) sectors. EPA chose not to select a regulatory option for small processors of either meat type. Therefore, no impacts are projected for these facilities. Table 5-10 presents the results of the impact analysis under all possible combinations of regulatory options to which these facilities might have been subject.

Table 5-10
Summary of Projected Small Mixed Processor Facility Closure Impacts

Options for Small Facilities in Subcategory L[1]	Variable	Options for Small Facilities in Subcategories F - I[1]		
		None	Option 1	Option 2
None	Average Annualized Costs as Percent of Net Income	NA	4.3%	4.4%
	Probability of Closure Due to Rule	NA	0.9%	0.7%
Option 1	Average Annualized Costs as Percent of Net Income	1.0%	5.2%	5.2%
	Probability of Closure Due to Rule	0.2%	0.8%	0.8%
Option 2	Average Annualized Costs as Percent of Net Income	1.0%	5.3%	5.3%
	Probability of Closure Due to Rule	0.2%	0.8%	0.8%

[1] This group contains 3 facilities, with estimated revenues of $22.7 million and 97 employees. On average, 18 percent of production is subject to guidelines and limitations for small processors in Subcategories F - I, and 82 percent of production is subject to small Subcategory L guidelines and limitations.

To present results concisely, the number of projected closures, revenue and employment losses were not included in the two mixed processor closure impact tables. However, all information necessary to make those calculations is provided in the tables, and the complete results are included in the docket (DCN 324001).

5.2.2 Company Analysis

For the company analyses, EPA estimated compliance costs for each company that owned a direct discharging facility that submitted a detailed survey. The estimated costs for each company included all facilities that EPA was able to identify as a direct discharger, regardless of whether the facility completed a detailed survey, a screener survey, or neither; see Section 3.4.1.1 for details.

Company level results are unweighted because the survey sampling frame was stratified on the basis of facility level data. Therefore, the facility level and company level results are not additive.

5.2.2.1 Closure Analysis

Subcategories A - D and Subcategory K. For these subcategories, EPA had detailed survey data at the company level. As discussed in the facility level closure analysis (Section 5.2.1), companies did not record financial information at the facility level for between 50 to 70 percent of the facilities in Subcategories A - D and Subcategory K. EPA therefore analyzed the impact of the aggregate costs on the company's net income, see Section 3.4.1.2. EPA estimated that the 25 companies in the company level analysis own at least 117 of the 136 in-scope facilities in Subcategories A - D and K that EPA projects will be subject to regulation. In the company level closure analysis, one poultry company is projected to close under Option 2.5 + P, and Option 4 (see Table 5-11). This company employs between 2,500 and 5,000 workers. The poultry company that is projected to close did not provide facility level financial information, therefore the facilities owned by this company could not be analyzed.

5.2.2.2 Altman's Z′-Score Analysis

Subcategories A - D and Subcategory K. As mentioned above, EPA had detailed survey data at the company level for facilities in these subcategories. The data availability permitted EPA to examine corporate financial health by a weighted average of financial ratios called Altman's Z′- score (see Section 3.4.1.3).

EPA classified the 25 companies that held **nonsmall** facilities into three groups, depending on whether they predominantly owned meat processing facilities, poultry processing facilities, or a mix of meat and poultry facilities. Table 5-12 summarizes the changes in financial health as a result of incurring incremental pollution control costs. Prior to incurring any incremental costs, the Altman Z′- score analysis shows that 7 meat companies and 8 poultry companies are considered financially healthy in the baseline. One meat company, 4 poultry companies, and 3 mixed meat companies have Altman Z′- scores in the indeterminate range for financial health; 1 meat company and 1 mixed meat company are considered financially stressed.

No impacts are seen under either variant of Option 2.5. Under Option 4, the Altman Z′- score for one poultry company changed from the financially healthy to the indeterminate range (represented by the +1 and -1 on Table 5-12).

Table 5-11

Summary of Projected Company Closure Impacts by Subcategory and Option

Option	Baseline Conditions and Projected Incremental Closure Impacts[1]		
	Number of Companies	**Total Revenues (Millions)**	**Employees**
Meat (Predominantly Own Facilities in Subcategories A - I)			
Total Companies Analyzed	9	$29,949	80,755
Baseline Closures	1	$250-$500	1,000 - 4,000
Option 2 Closures	0	$0	0
Option 2.5 Closures (Low)	0	$0	0
Option 2.5 Closures (High)	0	$0	0
Option 2.5 + P Closures	0	$0	0
Option 4 Closures	0	$0	0
Poultry (Predominantly Own Facilities in Subcategories K and L)			
Total Companies Analyzed	12	$15,441	135,850
Baseline Closures	5	$3,384	31,042
Option 2 Closures	0	$0	0
Option 2.5 Closures (Low)	0	$0	0
Option 2.5 Closures (High)	0	$0	0
Option 2.5 + P Closures	1	$100 - $150	2,500 - 5,000
Option 4 Closures	1	$100 - $150	2,500 - 5,000
Mixed (Own facilities in both meat and poultry subcategories)			
Total Companies Analyzed	4	$89,439	184,834
Baseline Closures	0	N/A	N/A
Option 2 Closures	0	$0	0
Option 2.5 Closures (Low)	0	$0	0
Option 2.5 Closures (High)	0	$0	0
Option 2.5 + P Closures	0	$0	0
Option 4 Closures	0	$0	0

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

Table 5-12
Projected Impacts on Companies with Nonsmall Facilities
Subcategories A-I, Subcategory K, Subcategory L, and Mixed
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 (Low)	0	0	0
Option 2.5 (High)	0	0	0
Option 2.5 + P	0	0	0
Option 4	0	0	0
Poultry (predominantly own facilities in Subcategories K and L)			
Baseline	8	4	0
Option 2	0	0	0
Option 2.5 (Low)	0	0	0
Option 2.5 (High)	0	0	0
Option 2.5 + P	0	0	0
Option 4	-1	+1	0
Mixed (own facilities in both meat and poultry subcategories)			
Baseline	0	3	1
Option 2	0	0	0
Option 2.5 (Low)	0	0	0
Option 2.5 (High)	0	0	0
Option 2.5 + P	0	0	0
Option 4	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”.

Two companies that own **small** facilities in Subcategories A - D and Subcategory K provided sufficient financial data to analyze using the Altman Z′-score. Both of these companies were determined to be financially healthy in the baseline, and did not incur financial distress under any of the potential regulatory options examined.

5.2.2.3 Financial Ratio Analysis

Subcategories F - I, Subcategory J, and Subcategory L

Because facilities in these subcategories are not represented in the detailed survey data, neither are their corporate parents. The analysis for these companies, then, rests on screener survey and public data (see Section 3.4.2). EPA calculated the post-regulatory median return on assets ratio to project impacts to the balance sheet of companies in Subcategories F - I, Subcategory J, and Subcategory L.

The results for **nonsmall** companies are presented in Table 5-13. For nonsmall companies in Subcategories F - I, the selected option is projected to decrease return on assets by 1.2 to 1.4 percent. In Subcategory J, return on assets is projected to decrease by 4.8 to 7.0 percent, while in Subcategory L, it declines by 4.9 to 6.2 percent.

The results for **small** companies in Subcategories F - I are in Table 5-14. Option 1 results in an estimated 10.2 percent decrease on return to assets, while in Subcategory L it declines by 1 percent. EPA found no small direct discharging facilities in Subcategory J. Some mixed processing facilities are covered by the guidelines for Subcategory L; impacts on those facilities are examined separately in Tables 5-15 and 5-16.

Table 5-13
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	5.43	-1.2
Option 2.5 (Low)	5.43	-1.2
Option 2.5 (High)	5.42	-1.4
Option 2.5+P	5.41	-1.6
Option 4	5.31	-3.4
Subcategory J (19 Companies)[1]		
Baseline	2.00	NA
Option 2	1.97	-1.6
Option 2.5 (Low)	1.90	-4.8
Option 2.5 (High)	1.86	-7.0
Option 2.5+P	1.65	-17.4
Option 4	1.51	-24.6
Subcategory L (3 Companies)[1]		
Baseline	4.43	NA
Option 2	4.29	-3.3
Option 2.5 (Low)	4.22	-4.9
Option 2.5 (High)	4.16	-6.2
Option 2.5+P	4.02	-9.4
Option 4	3.58	-19.3

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

Table 5-14
Projected Impacts to Return on Assets Ratio by Subcategory and Option
Companies with Small Facilities in Subcategories F - I, Subcategory J, and Subcategory L

Option	Median Return on Assets (percent)	Percent Change in Return on Assets
Subcategory F-I (21 Companies)[1]		
Baseline	5.50	NA
Option 1	4.94	-10.2
Option 2	4.94	-10.2
Subcategory L (3 Companies)[1]		
Baseline	5.50	NA
Option 1	5.44	-1.0
Option 2	5.44	-1.0

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

Mixed Processors

For mixed processors, the results of the financial ratio analysis are presented as a matrix. This is because a mixed processing facility might be subject to two different regulatory options depending on the type of meat, type of production processes, and quantity of production in different parts of the plant. Table 5-15 presents the projected post-regulatory return on assets and the percent change from the baseline value for 7 facilities that are **nonsmall** poultry further processors (and are therefore subject to Subcategory L guidelines and limitations on that portion of their output) and small meat further processors (Subcategories F - I). Under the combination of Option 2.5 selected for nonsmall poultry further processing, and no option selected for small meat further processing, these facilities' compliance costs decrease median return on assets (the baseline value) from 5.50 to 5.13.

Table 5-15
Projected Impacts to Return on Assets Ratio for Mixed Processors by Subcategory and Option
Companies with Small Production in Subcategories F - I, Nonsmall Production in Subcategory L

Options for Nonsmall Facilities in Subcategory L[1]	**Variable**	**Options for Small Facilities in Subcategories F - I**[1]		
		None	**Option 1**	**Option 2**
None	Median return on assets (percent)	5.50	5.41	5.41
	Percent change in return on assets	NA	-1.6	-1.6
Option 2	Median return on assets (percent)	5.31	5.23	5.23
	Percent change in return on assets	-3.4	-5.0	-5.0
Option 2.5 (Low)	Median return on assets (percent)	5.21	5.13	5.13
	Percent change in return on assets	-5.2	-6.8	-6.8
Option 2.5 (High)	Median return on assets (percent)	5.13	5.04	5.04
	Percent change in return on assets	-6.7	-8.3	-8.3
Option 2.5 + P	Median return on assets (percent)	4.95	4.86	4.86
	Percent change in return on assets	-10.0	-11.6	-11.6
Option 4	Median return on assets (percent)	4.40	4.31	4.31
	Percent change in return on assets	-20.1	-21.6	-22.6

[1] This group contains 7 facilities, with estimated revenues of $132 million and 484 employees. On average, 39 percent of production is subject to guidelines and limitations for small processors in Subcategories F - I, and 61 percent of production is subject to nonsmall Subcategory L guidelines and limitations.

Three mixed processors were found to be **small** further processors in both the poultry (Subcategory L) and meat (Subcategories F - I) sectors. Table 5-16 presents the results of the financial ratio analysis under all possible combinations of regulatory options to which these facilities might have been subject had EPA chosen to regulate small processors.

Table 5-16
Projected Impacts to Return on Assets Ratio for Mixed Processors by Subcategory and Option Companies with Small Production in Subcategories F - I and Subcategory L

Options for Small Facilities in Subcategory L[1]	Variable	Options for Small Facilities in Subcategories F - I[1]		
		None	Option 1	Option 2
None	Median return on assets (percent)	5.50	5.25	5.24
	Percent change in return on assets	NA	-4.6	-4.6
Option 1	Median return on assets (percent)	5.44	5.19	5.19
	Percent change in return on assets	-1.0	-5.6	-5.7
Option 2	Median return on assets (percent)	5.44	5.19	5.19
	Percent change in return on assets	-1.0	-5.6	-5.7

[1] This group contains 3 facilities, with estimated revenues of $22.7 million and 97 employees. On average, 18 percent of production is subject to guidelines and limitations for small processors in Subcategories F - I, and 82 percent of production is subject to small Subcategory L guidelines and limitations.

5.2.3 Market Level Impacts

5.2.3.1 Impacts on Domestic Prices and Quantities

Table 5-17 summarizes the results from the market model analysis on domestic prices and quantities. The market model analysis show that the decrease in supply will be smallest for pork under the selected option, where the costs per pound of total production are estimated at approximately $0.00014, and largest for chicken with costs per pound of total production ranging of about $0.00079. The maximum projected price increase is less than 0.05 percent of baseline price for all products under Option 2.5.

The domestic production of meat products, and therefore industry employment, is projected to decrease by about 0.02 percent under Option 2.5. In general, impacts to domestic consumption of meat products are somewhat smaller than impacts to domestic supply due to partially offsetting increases in meat imports.

Table 5-17
Projected Impacts on Meat Product Markets

Option	Price (cost/lb.)	Domestic Supply (lbs. x 1 mil.)	Domestic Demand (lbs. x 1 mil.)	Quantity Imported (lbs. x 1 mil.)	Quantity Exported (lbs. x 1 mil.)	Compliance Costs per Pound
Beef						
Baseline	$1.1105	26,386.0	26,843.0	2,874.0	2,417.0	NA
Option 2	$1.1106	26,383.2	26,841.3	2,874.7	2,416.6	$0.00025
Option 2.5 (Low)	$1.1107	26,381.3	26,840.1	2,875.1	2,416.3	$0.00041
Option 2.5 (High)	$1.1108	26,380.3	26,839.6	2,875.4	2,416.1	$0.00050
Option 2.5 + P	$1.1110	26,375.3	26,836.6	2,876.6	2,415.3	$0.00095
Option 4	$1.1111	26,373.3	26,835.5	2,877.2	2,415.0	$0.00113
Pork						
Baseline	$1.0038	19,278.0	18,827.0	827.0	1,278.0	NA
Option 2	$1.0038	19,278.0	18,827.1	827.0	1,277.9	$0.00003
Option 2.5 (Low)	$1.0039	19,277.6	18,826.8	827.1	1,277.9	$0.00010
Option 2.5 (High)	$1.0039	19,277.5	18,826.7	827.1	1,277.8	$0.00014
Option 2.5 + P	$1.0040	19,276.0	18,825.7	827.3	1,277.5	$0.00040
Option 4	$1.0041	19,275.4	18,825.3	827.3	1,277.4	$0.00051
Chicken						
Baseline	$0.5807	29,741.0	24,826.0	5.000	4,920.0	NA
Option 2	$0.5808	29,737.8	24,824.2	5.001	4,918.7	$0.00044
Option 2.5 (Low)	$0.5809	29,737.1	24,823.8	5.002	4,918.3	$0.00055
Option 2.5 (High)	$0.5809	29,735.4	24,822.8	5.002	4,917.6	$0.00079
Option 2.5 + P	$0.5812	29,729.7	24,819.6	5.005	4,915.1	$0.00159
Option 4	$0.5815	29,721.6	24,814.7	5.008	4,911.9	$0.00270
Turkey						
Baseline	$0.6898	5,297.0	4,919.3	1.2500	379.0	NA
Option 2	$0.6899	5,296.7	4,919.0	1.2501	379.0	$0.00026
Option 2.5 (Low)	$0.6899	5,296.6	4,919.0	1.2502	378.9	$0.00032
Option 2.5 (High)	$0.6899	5,296.5	4,918.8	1.2503	378.9	$0.00046
Option 2.5 + P	$0.6900	5,296.3	4,918.7	1.2500	378.9	$0.00066
Option 4	$0.6902	5,295.5	4,918.0	1.2510	378.8	$0.00132

5.2.3.2 Foreign Trade Impacts

Despite its position as one of the largest agricultural producers in the world, historically the U.S. has not been a major player in world markets for meat products. In fact, until recently, the U.S. was a net importer of these products. The presence of a large domestic market for meat has limited U.S. reliance on developing export markets for its products. As the U.S. has taken steps to expand export markets for meat, one major obstacle has been that it remains a relatively high cost producer of these products compared to other net exporters, such as New Zealand, Australia, Brazil, and other Latin American countries, as well as other more established and government-subsidized exporting countries, including Canada and the countries in the European Union. Increasingly, however, continued efficiency gains and low-cost feed are making the U.S. more competitive in world markets for meat.

In contrast, U.S. poultry products account for a significant share of world trade and exports account for a sizable share of annual U.S. production. One factor suggests that trade impacts may be smaller than projected using the market model, at least for poultry products. It has been noted above that the U.S. primarily exports dark poultry meat, considered inferior by U.S. consumers, while the U.S. domestic market is dominated by sales of white poultry meat (Aylward, 2002; Salin et al., 2002; Standard & Poor's, 2000). However, dark meat and white meat are joint products of the poultry industry — obviously, one cannot be produced without simultaneously producing the other. Under conditions of joint production, the price of each product will tend towards its marginal cost of production (in the absence of market power; Layard and Walters, 1978).

In the case of the U.S. poultry industry, the dominant market is the U.S. domestic market — the market for white meat. Although export sales are very important, they still compose less than 17 percent of U.S. production. The market for dark meat, whether domestic or foreign, is secondary. This suggests that the marginal cost of producing dark meat is relatively low. Chickens are bred, raised, slaughtered and processed primarily for their white meat, thus the marginal cost of producing white poultry meat is composed of the variable costs of these activities. Given that the chicken has already been bred, raised, slaughtered and processed for its white meat, the marginal cost of producing dark meat would be relatively low — the incremental cost of processing the dark meat given that the white meat has been processed (part of this incremental cost could include greater care needed to process white meat without damaging the dark meat). Because dark meat is a secondary product, its marginal cost, and therefore its price, are relatively low.

It has been estimated that U.S. production costs per pound of broiler meat exceeds those of Brazil by almost 50 percent. However, while the U.S. export price for both boneless breast meat and whole broilers substantially exceeds the Brazilian export price, the U.S. export price for chicken leg quarters is less than the Brazilian export price (Joiner, 2003). This evidence is consistent with the discussion above of joint production.

For the same reason, there should be little increase in the marginal cost of processing dark meat due to the effluent guideline and therefore little increase in its price. The impact on the marginal cost of producing dark meat given that white meat is already produced (and wastewater treatment already purchased for its processing) should be relatively small: primarily the higher cost of treating the incremental water used to process dark meat. Therefore, the increase in the marginal cost of producing dark meat should be smaller than the increase in the marginal cost of producing white meat. The increase in price necessary to earn an adequate rate of return can be smaller for exports than for domestic sales, and therefore the decrease in exports of dark meat should be smaller than projected by the market model, which is based on the change in domestic price.

As part of its market analysis, EPA evaluated the potential for changes in traded volumes, such as increases in imports and decreases in exports. In addition, EPA performed a sensitivity analysis to ensure that trade impacts were not underestimated under the selected option (Table 5-18). In the standard analysis, the decrease in supply (compliance costs per pound) is calculated as a weighted average of compliance costs per pound of production for direct dischargers and compliance costs per pound for indirect dischargers (which are zero), where the weights are the relative share of total production. The sensitivity analysis assumes the decrease in supply is equal to the average compliance costs per pound of production to direct dischargers only. The standard assumption is more appropriate because the competition of indirect dischargers with zero compliance costs will discourage direct dischargers from raising their price in response to their increased costs.

Under the sensitivity analysis, compliance costs per pound are 2.0 (chicken) to 6.3 (turkey) times larger than the standard analysis. The largest impact under the sensitivity analysis is observed in the beef market, where exports are projected to decrease by 0.11 percent per year, and overall domestic production is projected to decrease by 0.06 percent per year. Under the more realistic standard analysis, the largest decrease in exports occurs in the chicken market (0.05 percent per year) with an overall decrease in domestic production of 0.02 percent per year.

Table 5-18
Projected Impacts on Foreign Trade in Meat and Poultry Products under the Selected Option

Option	Price (cost/lb.)	Domestic Supply (lbs. x 1 mil.)	Domestic Demand (lbs. x 1 mil.)	Quantity Imported (lbs. x 1 mil.)	Quantity Exported (lbs. x 1 mil.)	Compliance Costs per Pound
Beef						
Baseline	$1.1105	26,386.0	26,843.0	2,874.0	2,417.0	
Option 2.5[1]	$1.1108	26,380.3	26,839.6	2,875.4	2,416.3	$0.00050
Sensitivity Analysis[2]	$1.1113	26,369.1	26,832.6	2,878.0	2,414.4	$0.00147
Pork						
Baseline	$1.0038	19,278.0	18,827.0	827.0	1,278.0	
Option 2.5[1]	$1.0039	19,277.5	18,826.7	827.1	1,277.8	$0.00014
Sensitivity Analysis[2]	$1.0040	19,276.8	18,826.6	827.3	1,277.5	$0.00034
Chicken						
Baseline	$0.5807	29,741.0	24,826.0	5.0	4,920.0	
Option 2.5[1]	$0.5809	29,735.4	24,822.8	5.0	4,917.6	$0.00079
Sensitivity Analysis[2]	$0.5812	29,730.0	24,819.9	5.0	4,915.1	$0.00156
Turkey						
Baseline	$0.6898	5,297.0	4,919.3	1.3	379.0	
Option 2.5[1]	$0.6899	5,296.7	4,919.0	1.3	379.0	$0.00030
Sensitivity Analysis[2]	$0.6903	5,294.9	4,917.5	1.3	378.7	$0.00189

[1] Compliance costs per pound (shift in supply) are equal to the weighted average of compliance costs per pound of production for direct dischargers and compliance costs per pound for indirect dischargers (which are zero), where the weights are the relative share of total production.
[2] Compliance costs per pound (shift in supply) are equal to the average compliance costs per pound of production to direct dischargers.

The projected trade impacts presented in Table 5-18 incorporate only the impacts of the MPP effluent guideline on U.S. trade in meat and poultry products. Many nonprice events, such as the political decision by Russia to set poultry import quotas (April 2003), or the closing of export markets to

U.S. beef following the discovery of BSE in Washington state (December 2003), can play a very significant role in determining trade volumes in meat and poultry products. What Table 5-18 demonstrates is that the MPP effluent guideline will have a very marginal effect on trade volumes.

5.2.4 Community Impacts

The communities where the meat products facilities are located may be affected by the final regulation if facilities cut back operations; local employment and income may fall, sending ripple effects throughout the local community. Under the option selected for this rule, no facilities are projected to close, hence no community impacts are estimated for the rule.

The facility closure analysis and the company closure analysis show impacts under Option 2.5 + P and Option 4. Twenty-two facilities are projected to close under Option 4. The community impact analysis is not presented for these facilities, however, due to CBI concerns. The company projected to close is a poultry processor with approximately 2,500 to 5,000 employees. All facilities owned by this company are located in the same state. Based on detailed survey employment data, and Census' *County Business Patterns* data, EPA estimated that the company projected to close represents the following percentage of total employment in the specified regions:

- 0.13 percent of state level employment;
- from 5.7 percent to 7.6 percent of county level employment.

The details of this analysis can be found in the docket (DCN 328003).

5.2.5 National Direct, Indirect, and Induced Impacts

Changes in output and employment are directly proportional to costs of compliance, that is, higher costs lead to lower output and employment. The impacts resonate through the economy causing a "ripple" effect. EPA used the Department of Commerce's national final demand multipliers from the Regional Input-Output Modeling System to estimate these effects (RIMS II; U.S. DOC, 1996).

The methodology used for the input-output analysis is explained in Section 3.7. The final demand output multipliers used here are 4.96 for meat and 4.35 for poultry, which means that for every $1 million of output lost in the meat and poultry industry, an additional $3.96 million and $3.35 million respectively is lost throughout the U.S. economy. The employment multipliers are 46.93 for meat and 45.18 for poultry. That is, for every $1 million in output loss in the meat industry, 46.93 full-time equivalent (FTEs: 1 FTE equals 2,080 hours and can be equated with one full-time job) jobs are lost in the U.S. economy (see Section 3.7 for more detail).

The larger the compliance costs, the greater the output and employment impacts. This is the reason why the subcategories with the largest impacts will be the same as those with the largest costs presented in Section 5.1.1. Table 5-19 presents the output and employment impacts stemming from compliance costs in each subcategory. These losses are spread over a wide variety of industries in addition to the meat products industry. Also note that the input-output methodology used for this analysis overestimates changes in output and employment because it does not allow for impact reducing substitutions between final products by consumers or inputs by producers.

Total direct, indirect, and induced output and employment losses under Option 2.5 are as follows:

- Subcategory A - D: $68 million 644 FTEs
- Subcategory E - I: $1 million 13 FTEs
- Subcategory J: $12 million 109 FTEs
- Subcategory K: $114 million 1,183 FTEs
- Subcategory L: $4 million 37 FTEs

Table 5-19

National Direct and Indirect Output and Employment Impacts

Subcategory and Option	Pretax Annualized Costs (Millions)	Total Change in Output [1] (Millions)	Total Change in Employment [2] (Millions)
Subcategory A - D			
Option 2	$6	($30)	(281)
Option 2.5 (High)	$14	($68)	(641)
Option 2.5+P	$35	($175)	(1,657)
Option 4	$43	($212)	(2,008)
Subcategory E - I			
Option 2	$0	($1)	(10)
Option 2.5 (High)	$0	($1)	(13)
Option 2.5+P	$0	($1)	(14)
Option 4	$1	($3)	(31)
Subcategory J			
Option 2	$1	($3)	(24)
Option 2.5 (High)	$2	($12)	(109)
Option 2.5+P	$6	($30)	(287)
Option 4	$8	($42)	(393)
Subcategory K			
Option 2	$15	($63)	(659)
Option 2.5 (High)	$26	($114)	(1,183)
Option 2.5+P	$52	($227)	(2,356)
Option 4	$90	($390)	(4,055)
Subcategory L			
Option 2	$0	($2)	(21)
Option 2.5 (High)	$1	($4)	(37)
Option 2.5+P	$1	($5)	(55)
Option 4	$3	($12)	(122)

Source: U.S. DOC, 1996 and U.S. DOC, 2001

[1] Based on a total loss of $4.96 million for the meat industry and $4.35 million for the poultry industry for each $1 million loss in output in the affected industry.

[2] Based on 47 jobs lost in the meat industry and 45 in the poultry industry per $1 million change in output.

5.3 ECONOMIC IMPACTS ON NEW SOURCES (NSPS)

When establishing the NSPS level of control, EPA considers the barrier that compliance costs due to the effluent guidelines regulation pose to entry into the industry for a new facility. In general, it is less costly to incorporate waste water treatment technologies as a facility is built than it is to retrofit existing facilities. Therefore, because the rule is economically achievable for existing facilities, it will also be economically achievable for new facilities that can meet the same guidelines at lower cost. However, it is possible that if the upfront costs of building a new facility are significantly increased as a result of the rule, prospective builders may face difficulties in raising additional capital. This could present a barrier to entry. Therefore, as part of its barrier to entry analysis, EPA compares estimated average incremental facility or company capital costs incurred to meet the effluent guidelines to average total assets of existing facilities to ensure that additional capital requirements are relatively small.

Tables 5-20 and 5-21, provide the results of the nonsmall facility level and company level analysis. Average capital costs of $1.9 million per facility under the selected Option 2.5 comprise 1.6 percent of average facility assets in Subcategories A - D. In Subcategory K, average capital costs of $1.1 million per facility are 4.0 percent of average facility assets under the selected option. The company level ratio of capital costs to total assets under Option 2.5 is 2.6 percent for meat companies, and 1.6 percent for poultry companies. For companies that own both meat and poultry facilities, the analysis projects that capital costs will comprise about 0.1 percent of company total assets under the selected option. Based on the results of this analysis, EPA concludes that this rule should not present barriers to entry for new businesses.

Table 5-20
Summary of Nonsmall Facility Level Ratio of Capital Costs to Assets (Barrier to Entry)[1]

Subcategory	Option 2	Option 2.5 (Low)	Option 2.5 (High)	Option 2.5 + P	Option 4
A - D	0.6%	1.3%	1.6%	2.6%	3.3%
K	2.1%	3.2%	4.0%	4.2%	12.3%

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

Table 5-21
Summary of Nonsmall Company Level Ratio of Capital Costs to Assets (Barrier to Entry)[1]

Subcategory	Option 2	Options 2.5 (Low)	Option 2.5 (High)	Option 2.5 + P	Option 4
Meat	0.8%	2.1%	2.6%	3.5%	4.4%
Poultry	1.0%	1.3%	1.6%	2.1%	4.6%
Mixed Meat	0.1%	0.1%	0.1%	0.2%	0.3%

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

Table 5-22 provides the small facility level ratios. In Subcategories A - D, average capital costs comprise between 15 and 20 percent of average facility assets. Average capital costs are 12.9 percent of average facility assets in Subcategory K.

Table 5-22
Summary of Small Facility Level Ratio of Capital Costs to Assets (Barrier to Entry)[1]

Subcategory	Option 1	Option 2
A - D[2]	15% - 20%	NA
K	12.9%	12.9%

[1] Percentages are based on those facilities for which EPA had asset data and compliance costs.
[2] Ratio of capital costs to total assets presented as a range to prevent the disclosure of confidential business information.

EPA also compared projected capital costs with estimated total assets for the model facilities used to analyze impacts in Subcategories F - I, J, and L. EPA estimated model facility total assets from model facility income (based on Census data) combined with the median return on assets for the appropriate NAICS code as reported in Dun and Bradstreet (see Proposal EA, Chapter 3 for more details). Thus, the analysis presented below incorporates a greater degree of uncertainty than the results based on detailed survey data for Subcategories A - D and K.

Tables 5-23 and 5-24 present the results of this analysis to nonsmall and small facilities respectively. These tables only include facilities with production that is classified solely in the indicated subcategories; the results for mixed processors, with production that is classified in more than one subcategory, are presented in Table 5-25 below. In general, the model facility analysis suggests that capital costs are not expected to exceed 2 percent of facility assets.

Table 5-23
Summary of Nonsmall Facility Level Ratio of Capital Costs to Assets (Barrier to Entry)
Screener Survey Facility Analysis

Subcategory	Option 2	Option 2.5	Option 2.5 + P	Option 4
F - I	0.2%	0.2%	0.2%	0.4%
J	0.1%	0.3%	0.4%	0.5%
L[1]	0.1%	0.1%	0.1%	0.6%

[1] Results do not include mixed processor facilities.

Table 5-24
Summary of Small Facility Level Ratio of Capital Costs to Assets (Barrier to Entry)
Screener Survey Facility Analysis

Subcategory	Option 1	Option 2
F - I[1]	1.7%	1.7%

[1] Results do not include mixed processor facilities.

Table 5-25
Summary of Mixed Processor Facility Ratio of Capital Costs to Assets (Barrier to Entry)
Screener Survey Facility Analysis

Subcategory Combination and Option	Ratio of Capital Costs to Assets
Nonsmall L (Option 2.5), Small F - I (Option 2)	1.1%
Small L (Option 2), Small F - I (Option 2)	0.4%

The results for mixed processors include capital costs for both subcategories in which they operate, even though NSPS was not set for small facilities in Subcategories F - I. Comparing capital costs for only a percentage of production (i.e., small or nonsmall levels of production in Subcategory L) with a facility's total assets for all production could result in a misleadingly small ratio of capital costs to total assets. Even with this more costly estimate, the ratio of capital costs to total assets does not exceed 1.1 percent for mixed processors.

5.4 SUMMARY OF FINAL OPTION

Under the promulgated rule, EPA estimates that there will be:

- **No** facility closures in Subcategories A - D and Subcategory K.
  Less than one facility closure (0.24 to 0.34 facility) in Subcategories F - I, Subcategory J, and Subcategory L combined.

- **No** company closures in Subcategories A - D and Subcategory K.
  No changes in company financial health in Subcategories A - D
  and Subcategory K.
  ROA decreases by less than 1.5 percent for companies in Subcategories F - I.
  ROA decreases by less than 7.5 percent for companies in Subcategory J.
  ROA decreases by less than 6.5 percent for companies in Subcategory L

- The maximum projected price increase is less than 0.05 percent of baseline price for all products.

- The domestic production of meat products, and therefore industry employment, is projected to decrease by about 0.02 percent.

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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

[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.

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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) 50^{th} 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.

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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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9.6 REFERENCES

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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).

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

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

EPA. U.S. Environmental Protection Agency, Office of Water, Engineering and Analysis Division. *Detailed Questionnaire for the Meat and Poultry Products Point Source Category*. Washington, DC.

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Versar, 1992. Versar, Inc. *Upgrade of Flow Statistics Used to Estimate Surface Water Chemical Concentrations for Aquatic and Human Exposure Assessment*. Prepared for the EPA, Office of Pollution Prevention and Toxics.

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.

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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.

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[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);

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[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 ($ per pound removed)	High Estimate	Treatment Type	Literature Sources
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