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Technical Development Document for Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category

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Acronyms & Abbreviations

BAT	Best Available Technology Economically Achievable
BADCT	Best Available Demonstrated Control Technology
BCT	Best Conventional Pollutant Control Technology
BOD	Biochemical Oxygen Demand
BPT	Best Practicable Control Technology Currently Available
CBI	Confidential Business Information
cBOD	Carbonaceous Biochemical Oxygen Demand
CFR	Code of Federal Regulations
COD	Chemical Oxygen Demand
CWA	Clean Water Act
DAF	Dissolved Air Flotation
DCN	Document Control Number
DMR	Discharge Monitoring Reports
DO	Dissolved Oxygen
E. Coli	Escherichia coli
ELGs	Effluent Limitation Guidelines and Standards
EPA	Environmental Protection Agency
FC	Fecal coliform
FRN	Federal Register Notice
FSIS	Food Safety Inspection Service
GPD	Gallons Per Day
GPY	Gallons Per Year
GSAP	Generic Sampling and Analysis Plan
HRSD	Hampton Roads Sanitation District
ICIS	Integrated Compliance Information System
LTA	Long-Term Average
LWK	Live Weight Killed
MBR	Membrane Bioreactor
MDL	Method Detection Limit
MGD	Millions of Gallons per Day
MGY	Millions of Gallons per Year
MLE	Modified Ludzack-Ettinger
MPI	Meat, Poultry and Egg Product Inspection
MPN	Most Probable Number
MPP	Meat and Poultry Products
MWh	Megawatt Hour
NAICS	North American Industry Classification System
ND	Non-Detect
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
NWQEI	Non-Water Quality Environmental Impacts
O&G	Oil and grease
O&M	Operation and Maintenance
PM2.5	Particulate Matter 2.5 Microns
POC	Pollutants of Concern
PSES	Pretreatment Standards for Existing Sources
PSNS	Pretreatment Standards for New Sources
POTW	Publicly Owned Treatment Works
SAP	Sampling and Analysis Plan
SBR	Sequencing Batch Reactors
SBREFA	Small Business Regulatory Enforcement Fairness Act

SER	Sampling Episode Reports
SRT	Sludge Retention Time
TDD	Technical Development Document
TDS	Total Dissolved Solids
TIP	Treatment In Place
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TOC	Total Organic Carbon
TSS	Total Suspended Solids
U.S.	United States
USDA	United States Department of Agriculture
UV	Ultraviolet
VF	Variability Factor

Glossary

Biological Treatment: Wastewater treatment intended to degrade and reduce organic matter in wastewater, primarily in the form of soluble organic compounds.

Canned Meat Processor: An operation that prepares and cans meats (such as stew, sandwich spreads, or similar products) alone or in combination with other finished products.

Complex Slaughterhouse: A slaughterhouse that accomplishes extensive by-product processing, usually at least three such operations as rendering, paunch and viscera handling, blood processing, hide processing, or hair processing.

Confidential Business Information: Privileged information, classified information, or specific information (e.g., trade secrets) of a type for which there is a clear and compelling need to withhold from disclosure.

Conventional Pollutants: Constituents of wastewater as determined by Clean Water Act (CWA) Section 304(a)(4) and the U.S. Environmental Protection Agency regulations (i.e., pollutants classified as biochemical oxygen demand, total suspended solids, oil and grease, fecal coliform, and pH).

Deepwell Injection: Long-term or permanent disposal of untreated, partially treated, or treated wastewaters by pumping them into underground formations of suitable character through a bored, drilled, or driven well.

Denitrification: A microbial process in which nitrite and nitrate are reduced by heterotrophic bacteria into gaseous nitrous oxide and nitrogen gas under anoxic conditions without the presence of molecular oxygen. A carbon source, such as methanol, may need to be added to keep the microbes healthy.

Direct Discharger: A facility that discharges or may discharge treated or untreated wastewaters into waters of the United States.

Disinfection: Destruction of pathogenic microorganisms in wastewater, typically achieved through chemical and/or physical treatment.

Effluent Limitations Guidelines and Standards: Regulations promulgated by the U.S. EPA under authority of CWA Sections 301, 304, 306, and 307 that set out minimum, national technology-based standards of performance for point source wastewater discharges from specific industrial categories (e.g., meat and poultry products). Effluent limitations guidelines and standards regulations are implemented through the National Pollutant Discharge Elimination System (NPDES) permit and national pretreatment programs.

Finished Product: The final fresh or frozen products resulting from the further processing of either whole or cut-up meat or poultry carcasses.

First Processing: Operations that receive live meat animals and produce a raw, dressed meat product, either whole or in parts.

Further Processing: Operations that use whole carcasses or cut-up meat or poultry products for the production of fresh or frozen products. These operations may include the following types of processing: cutting and deboning, cooking, seasoning, smoking, canning, grinding, chopping, dicing, forming, breading, breaking, trimming, skinning, tenderizing, marinating, curing, pickling, extruding, and/or linking.

Ham Processor: An operation that manufactures hams alone or in combination with other finished products.

Hide Processing: Wet or dry hide processing. Includes demanuring, washing, and defleshing, followed by curing.

High Chlorides Wastewater: A specific type of meat and poultry products (MPP) process wastewater generated from hide processing, kosher slaughter, curing, smoking, pickling, and marinating.

High-Processing Packinghouse: A packinghouse that processes both animals slaughtered onsite and additional carcasses from outside sources.

Indirect Discharger: A facility that discharges or may discharge treated or untreated wastewaters into a Publicly Owned Treatment Works (POTW).

Live Weight Killed: The total weight of the total number of animals slaughtered during the time to which the effluent limitations apply (i.e., during any one day or any period of 30 consecutive days).

Low-Processing Packinghouse: A packinghouse that processes no more than the total animals killed at that facility, normally processing less than the total kill.

Meat: Includes all animal products from cattle, calves, hogs, sheep, and lambs, etc., except those defined as Poultry.

Meat and Poultry Products: Include meat and poultry from cattle, hogs, sheep, chickens, turkeys, ducks and other fowl. Also includes sausages; luncheon meats; and cured, smoked, canned, or other prepared meat and poultry products from purchased carcasses and other materials intended for human consumption. Meat and poultry products for animal food and feeds include animal oils, meat meal, and grease and tallow rendered from animal fat, bones, and meat scraps.

Meat and Poultry Products Process Wastewater: Commingled wastewater from the MPP facility, including any water which, during processing, comes into direct contact with any raw material, intermediate product, finished product, byproduct, or waste product. This includes meat and poultry product processing areas and animal holding areas.

Meat Cutter: An operation that fabricates, cuts, or otherwise produces fresh meat cuts and related finished products from livestock carcasses.

Meat Operations/Meat Product Operations: Includes meat slaughtering operations, by-product operations, rendering, and further processing.

National Pollutant Discharge Elimination System: The national program authorized by CWA Sections 307, 318, 402, and 405 for issuing, modifying, revoking and reissuing, and terminating, monitoring and enforcing permits, and for imposing and enforcing pretreatment requirements under the CWA. The

NPDES permit number is assigned by the relative state or EPA Region and typically includes the state abbreviation in the number.

Nitrification: A two-step aerobic process. First, ammonia is oxidized into nitrite by *Nitrosomonas* bacteria. Then, nitrite is oxidized into nitrate by *Nitrobacter* bacteria. Nitrification only occurs when there is enough biomass and residence time to fully convert ammonia to nitrite, and then convert nitrite to nitrate.

Nitrogen Removal: The removal of nitrogen, through nitrification and denitrification, from wastewater through either biological or physical/chemical means or a combination thereof.

Non-Conventional Pollutants: Pollutants that are neither conventional pollutants nor priority pollutants listed at 40 CFR 401.15 and 423 Appendix A.

Non-Water Quality Environmental Impacts: Deleterious aspects of control and treatment technologies applicable to point source category wastes, including, but not limited to air pollution, noise, radiation, sludge and solid waste generation, and energy used.

North American Industry Classification System: The standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. Each facility is categorized within a NAICS code based on the type of operations conducted at the facility (e.g., NAICS code 311611 is for Animal (except Poultry) Slaughtering).

Nutrient Removal: Wastewater treatment that is engineered or operated to remove the nutrients nitrogen and phosphorus in amounts greater than the basic metabolic needs of the biological treatment system. Nutrient removal may be accomplished through biological or physical/chemical means or a combination thereof.

Offsite/Off Site: Outside the boundaries of a facility.

Onsite/On Site: The same or geographically contiguous property, which may be divided by a public or private right-of-way, provided the entrance and exit between the properties is at a crossroads intersection, and access is by crossing as opposed to going along the right-of-way. Noncontiguous properties owned by the same company or locality but connected by a right-of-way, which it controls, and to which the public does not have access, is also considered on-site property.

Outfall: Pipelines or tunnels that discharge municipal or industrial wastewater, storm water, combined sewer overflows, cooling water, or brine effluents to a receiving water body.

Packinghouse: A facility that both slaughters animals and subsequently processes carcasses into cured, smoked, canned, or other prepared meat products.

Passthrough: A pollutant is determined to passthrough POTWs when the median percentage removed nationwide by well-operated POTWs is less than the median percentage removed by the Best Available Technology Economically Achievable/New Source Performance Standards (BAT/NSPS) technology basis.

Phosphorus Removal: The removal of phosphorus from wastewater through either biological or chemical means or a combination thereof.

Point Source: Any discernable, confined, and discrete conveyance from which pollutants are or may be discharged. See CWA Section 502(14).

Pollutants of Concern: Pollutants commonly found in meat and poultry processing wastewaters. Typically, a pollutant is considered as a pollutant of concern (POC) if it is detected in untreated process wastewater at five times a baseline value in more than 10 percent of the samples.

Poultry: Products derived from the slaughter and processing of broilers, other young chickens, mature chickens, hens, turkeys, capons, geese, ducks, small game fowl such as quail or pheasants, and small game such as rabbits.

Poultry Operations: Includes poultry slaughtering operations, by-product operations, rendering, and further processing.

Primary Treatment: An initial wastewater treatment stage intended to remove floating and settleable solids.

Priority Pollutants: 126 compounds that are a subset of the 65 toxic pollutants and classes of pollutants outlined, pursuant to CWA Section 307.

Process Wastewater: Any water which, during meat or poultry operations, comes into direct contact with or results from the storage, production, or use of any raw material, intermediate product, finished product, by-product, or waste product. Wastewater from equipment cleaning, direct-contact air pollution control devices, rinse water, storm water associated with industrial activity, and contaminated cooling water are considered process wastewater. Process wastewater may also include wastewater that is contract hauled for offsite disposal. Sanitary wastewater, uncontaminated noncontact cooling water, and storm water not associated with industrial activity are not considered process wastewater.

Publicly Owned Treatment Works: Any device or system owned and operated by a public entity and used in the storage, treatment, recycling, or reclamation of liquid municipal sewage and/or liquid industrial wastes. The sewerage system that conveys wastewaters to treatment works is considered part of the POTW.

Raw Material: The basic input materials to a renderer composed of animal and poultry trimmings, bones, meat scraps, dead animals, feathers, and related usable by-products.

Renderer: An independent or offsite rendering operation, conducted separate from a slaughterhouse, packinghouse, or poultry dressing or processing plant, that manufactures meat meal, tankage, animal fats or oils, grease, and tallow and may cure cattle hides. Excludesg marine oils, fish meal, and fish oils.

Rendering: An operation, conducted separate from a slaughterhouse, packinghouse or poultry dressing or processing operation that uses raw material, produces meat meal, tankage, animal fats or oils, grease, and tallow and may cure cattle hides. Excludes marine oils, fish meal, and fish oils.

Sausage and Luncheon Meat Processor: An operation that cuts fresh meats, grinds, mixes, seasons, smokes, or otherwise produces finished products such as sausage, bologna, and luncheon meats.

Simple Slaughterhouse: A slaughterhouse that does very limited by-product processing, if any, usually no more than two operations such as rendering, paunch and viscera handling, blood processing, hide processing, or hair processing.

Slaughterhouse: A facility that slaughters animals and has as its main product fresh meat as whole, half, or quarter carcasses or smaller meat cuts.

Slaughtering: Operations that kill animals for human consumption and/or animal food and feeds.

Small Business: The definitions of small business for the meat products industries are in the Small Business Administration (SBA) regulations at 13 CFR 121.201. These size standards were updated effective October 1, 2000. SBA size standards for the meat and poultry products industry (i.e., for NAICS codes 311611, 311612, 311613, and 311615) define a “small business” as one with 500 or fewer employees.

Small Processor: An operation that produces up to 2,730 kilograms (6,000 pounds) per day of any type or combination of finished products.

Solids (Biosolids) Handling: Disposal or destruction of biosolids generated during the treatment of wastewater.

Standard Industrial Classification: A numerical categorization system used by the U.S. Department of Commerce to catalogue economic activity. SIC codes refer to the products, or group of products, produced or distributed, or to services rendered by an operating establishment. SIC codes are used to group establishments by the economic activities in which they are engaged. They often denote a facility's primary, secondary, tertiary, etc. economic activities.

Surface Water: Waters of the United States as is consistent with the pre-2015 regulatory regime. Refer to the *Current Implementation of Waters of the United States* for details and definitions of terms: https://www.epa.gov/wotus/current-implementation-waters-united-states#Pre-2015.

Wastewater Treatment: The processing of wastewater by physical, chemical, biological, or other means to remove specific pollutants from the wastewater stream or to alter the physical or chemical state of specific pollutants in the wastewater stream. Treatment is performed for discharge of treated wastewater, recycling of treated wastewater to the same process that generated the wastewater, or for reuse of the treated wastewater in another process.

Zero Discharge: Disposal of process and/or nonprocess wastewaters other than by direct discharge to a surface water or by indirect discharge to a POTW. Examples include land application, deep well injection, and contract hauling.

1. Background

The U.S. Environmental Protection Agency is proposing revisions to the effluent limitations guidelines and standards (ELGs) for the meat and poultry products (MPP) point source category (40 CFR 432). These revisions are based on a review of available and collected data.

This Technical Development Document (TDD) presents information on the proposed revisions, including details on the EPA's data collection activities; industry background and profile (e.g., types of processing facilities, details on wastewater treatment); identification and evaluation of wastewater treatment technology systems; limitations and standards development; and methodologies for estimating compliance costs, pollutant removals, and non-water quality impacts. In addition to this TDD, the following reports support the proposed MPP ELGs:

- *Environmental Assessment for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category*, Document No. EPA-821-R-23-012. This report summarizes the environmental and human health improvements that result from implementation of the proposed ELGs.
- *Benefits and Cost Analysis for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category*, Document No. EPA-821-R-23-013. This report summarizes the monetary benefits and societal costs that result from implementation of the proposed ELGs.
- *Regulatory Impact Analysis for Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (RIA)*, Document No. EPA-821-R-23-014. This report presents a profile of the MPP industry, a summary of the costs and impacts associated with the regulatory options, and an assessment of the proposed ELGs impact on employment and small businesses.

The rest of this section describes background information for the EPA's proposed rulemaking. Section 1.1 summarizes the EPA's legal authority to propose changes to the MPP ELGs. Section 1.2 presents the regulatory history of the MPP ELGs.

All environmental information used is in accordance with the EPA's *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency* (the Guidelines), which contains the EPA's policy and procedural guidance for ensuring and maximizing the quality of information disseminated (U.S. EPA, 2002a). The EPA's quality assurance (QA) and quality control activities for this rulemaking include developing, approving, and implementing QA project plans for the use of environmental data generated or collected from sampling and analyses, existing databases, and literature searches, and for developing any models that use environmental data.

1.1 Legal Authority

The EPA is proposing to revise the ELGs for MPP under the authority of Clean Water Act (CWA) Sections 301, 304, 306, 307, 308, 402, and 501, 33 U.S.C. 1311, 1314, 1316–1318, 1342, and 1361.

Congress passed the Federal Water Pollution Control Act Amendments of 1972, also known as the CWA, to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," per 33 U.S.C. 1251(a). The CWA establishes a comprehensive program for protecting the nation's waters. Among its core provisions, the CWA prohibits the discharge of pollutants from a point source directly to waters of the United States or indirectly through discharge to Publicly Owned Treatment Works (POTWs), except as authorized under the CWA. Under section 402 of the CWA, direct discharges may be authorized through a National Pollutant Discharge Elimination System (NPDES) permit and national pretreatment standards for pollutants that passthrough, interfere with, or are otherwise incompatible with POTW operations apply to indirect discharges. The CWA also authorizes the EPA to establish national technology-based effluent limitations guidelines, new source performance standards, and pretreatment standards for discharges from categories of point sources.[1]

1.2 Regulatory History of the MPP Point Source Category

The EPA promulgated MPP ELGs in 1974 for meat slaughterhouses and packinghouse facilities (40 CFR 432, Subcategories A through D), and in 1975 for meat further processing facilities (40 CFR 432, Subcategories E through I) and independent rendering facilities (40 CFR 432 Subcategory J). Although the Agency proposed ELGs for the poultry industry in 1974, these ELGs were not finalized at that time.

In 2002, the EPA proposed revisions to the meat processing ELGs and proposed new ELGs for poultry processing. These proposed revisions and new ELGs included new or updated limitations on total nitrogen (TN), total phosphorus (TP), and ammonia on direct discharges for most subcategories. No pretreatment standards were proposed at that time (U.S. EPA, 2002b). The Agency intended to promulgate ELGs based on advanced biological treatment that would achieve higher levels of nutrient removal by facilitating the conversion of harmful forms of nutrients to less harmful ones (e.g., ammonia to nitrate, nitrate to nitrogen) prior to discharge. Public comments submitted for the proposal and a Notice of Data Availability (NODA) expressed concerns about seasonal changes affecting biological nitrification and the disparity of influent nitrogen concentrations among meat and poultry facilities. The EPA also noted at the time that the treatment technologies selected as the bases for the proposed limitations did not remove phosphorus from wastewater (U.S. EPA, 2004a). Following the proposal and NODA, the EPA promulgated final ELGs with limitations for ammonia and TN for all subcategories except Small Meat Further Processors (Subcategory E). The EPA did not establish pretreatment standards in the final rule because there was insufficient evidence of passthrough or interference at POTWs from meat and poultry facilities to warrant establishing national pretreatment standards for these facilities (U.S. EPA, 2004a).

During the 2017 annual review of ELGs, the EPA evaluated nutrient discharges from industrial point source categories based on the median facility load and number of facilities reporting discharges in each industrial category. The EPA found that the MPP point source category contributed some of the highest nutrient loadings across the nutrient discharge rankings for both TN and TP (U.S. EPA, 2019). Based on these findings, the EPA pursued a detailed study of the MPP category to gather more information and evaluate if a rulemaking to revise the ELG is appropriate (announced in *Effluent Guidelines Program Plan 14*; U.S. EPA, 2021a).

During this study, the EPA evaluated publicly available data for direct discharging facilities as well as POTWs' annual reports and available indirect discharge inspection reports from significant industrial users (U.S. EPA, 2021a). The EPA found that the existing ELGs only applied to around 300 of the estimated 7,000 MPP facilities nationwide and do not apply to indirect dischargers. The EPA also found that the MPP industry discharges the highest phosphorus levels and second highest nitrogen levels of all industrial categories from facilities across the country. During the study, the EPA identified facilities that were already removing nutrients and achieving effluent concentrations well below the limitations in the existing MPP ELGs, using available and affordable wastewater treatment technologies.

As the majority of MPP facilities are indirect dischargers, the EPA analyzed available data on MPP indirect facilities and POTWs that receive MPP wastewater. The EPA also discussed POTW noncompliance issues with the regions, states, and stakeholders and analyzed POTW reports, violation and noncompliance notices, and other correspondence between MPP indirect dischargers and their receiving POTWs. Some of these examples and case studies include:

[1] https://www.ecfr.gov/current/title-40/chapter-I; the CWA can be found at 33 U.S.C. § 1251 et seq. The CWA regulations are in 40 CFR 104–108, 110–117, 122–140, 230–233, 401–471, and 501–503.

- In 2021, the EPA reviewed 220 indirect discharging MPP facilities. Of the 112 POTWs that received MPP process wastewater from these facilities, the EPA found that 73 percent had violation(s) of permit limitations for pollutants found in MPP wastewater, including nitrogen, phosphorus, total suspended solids (TSS), biochemical oxygen demand (BOD), oil and grease (O&G), chloride, total residual chlorine, fecal coliform bacteria (e.g., *E. coli*), and metals. Of the more than 100 POTW discharge permits reviewed, the EPA found the majority did not have limitations for nitrogen or phosphorus. Thus, many POTWs may not be removing much of the nutrient load discharged by MPP industrial users because many POTWs do not have treatment designed to remove nutrients (U.S. EPA, 2021b).
- Region 8 visited POTWs that do not have approved pretreatment programs and compiled case studies. In one case study, a POTW was found to receive more flow and BOD that it was designed for, and as a result the POTW consistently failed to meet its BOD and flow limitations in 2017 and 2018. The EPA found that a slaughterhouse was discharging process wastewater to the POTW and causing the POTW to violate its permit limitations. The POTW has since been required to develop and submit a pretreatment program, according to the requirements of 40 CFR 403 (U.S. EPA, 2018, 2020).
- Region 1 provided information on a poultry slaughterhouse that caused reported issues at its receiving POTW with respect to ammonia, carbonaceous biochemical oxygen demand (cBOD), fats, O&G, ferric sulfate, flow, salt, TSS, and untreated wastewater. Reports also stated that the poultry facility discharges caused operational difficulties and premature fouling and also "interfered with the POTW's ability to function" (U.S. DOJ, 2014).
- Between 2006 and 2011, an MPP facility in Nebraska discharged pollutants at levels that exceeded the permitted limitations, causing interference with the receiving POTW's treatment process. In 2008, one of the violations resulted in a fish kill in nearby rivers. Estimates were that 10,000 fish were killed in the episode (U.S. DOJ, 2011).
- The EPA estimates that there are 23,000 to 75,000 Sanitary Sewer Overflows (SSOs) each year in the United States. SSOs involve raw sewage overflowing from municipal sewer systems and can cause public health issues. SSOs can be caused by blockages from fats, oils, and grease. The EPA's 2004 Report to Congress, *Impacts and Controls of CSOs and SSOs* found that 47 percent of reported blockages were due to "grease from restaurants, homes, and industrial sources" and that grease "solidifies, reduces conveyance capacity, and blocks flows," leading to blockages (U.S. EPA, 2004b). MPP facilities often discharge high amounts of fats, oils, and grease.

The results of the detailed study indicated a revision to the MPP ELGs may be appropriate (U.S. EPA, 2021c). Accordingly, in *Preliminary Effluent Guidelines Program Plan 15*, the EPA identified the MPP category for rulemaking (U.S. EPA, 2021c).

1.3 References

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2. Summary of the Proposed Rulemaking

This section presents a summary of the changes the U.S. Environmental Protection Agency is proposing to make to the meat and poultry products (MPP) effluent limitations guidelines and standards (ELGs), including a summary of the discharge requirements and a description of the scope and applicability provisions for the proposed MPP regulatory options.

2.1 Summary of Proposed Discharge Requirements

The proposed rule would revise the technology-based ELGs at 40 CFR 432 for certain wastewater discharges associated with the production of MPP. The EPA is proposing to revise or establish effluent limitations and standards for the MPP industry based on Best Practicable Control Technology Currently Available (BPT), Best Conventional Pollutant Control Technology (BCT), Best Available Technology Economically Achievable (BAT), Best Available Demonstrated Control Technology (BADCT) for New Source Performance Standards (NSPS), Pretreatment Standards for Existing Sources (PSES), and Pretreatment Standards for New Sources (PSNS). BPT, BCT, and BAT would apply to existing facilities that directly discharge to waters of the United States. BADCT/NSPS would apply to new sources that directly discharge to waters of the United States. PSES and PSNS would apply to existing and new sources, respectively, that discharge indirectly via Publicly Owned Treatment Works (POTWs). Section 9 includes a detailed discussion of the technology systems and regulatory options evaluated by the EPA.

Section 2.1.1 describes proposed requirements for direct dischargers, while Section 2.1.2 describes proposed requirements for indirect dischargers.

2.1.1 Proposed Requirements for Direct Dischargers

Under the preferred option in the proposed rule (Regulatory Option 1), the EPA proposes BPT/BAT effluent limitations for nitrogen based on biological removal to achieve full denitrification and BPT/BAT effluent limitations for phosphorus based on biological treatment with chemical precipitation with filtration. These limitations would apply to direct discharging facilities based on the same production thresholds as the existing rule: 50 million pounds per year of finished product produced for meat further processors (Subcategories F–I), 50 million pounds per year of live weight killed (LWK) for meat slaughtering (Subcategories A–D), 100 million pounds per year of LWK for poultry slaughtering (Subcategory K), 7 million pounds of finished product per year for poultry further processors (Subcategory L), and 10 million pounds per year of raw material processed for renderers (Subcategory J). The limitations for facilities in Subcategory E would not be changed. See Preamble Section VII.C.1 for the EPA's proposed rationale on these technologies as available, economically achievable, and have acceptable non-water quality environmental impacts.

The EPA evaluated three regulatory options. For a description of the proposed requirements for direct dischargers under these options, see Preamble Section I.B.

2.1.2 Requirements for Indirect Dischargers

Under the preferred option in the proposed rule (Regulatory Option 1), the EPA proposes to establish PSES based on the BPT and BCT limitations for biochemical oxygen demand (BOD), total suspended solids (TSS), and oil and grease (O&G) based on screening and dissolved air floatation (DAF) technology. Pretreatment standards would apply to facilities producing more than: 50 million pounds per year of finished product for meat further processors (Subcategories F–I), 50 million pounds per year of LWK for meat slaughtering (Subcategories A–D), 100 million pounds per year of LWK for poultry slaughtering (Subcategory K), 7 million pounds per year of finished product for poultry further processors (Subcategory L), and 10 million pounds per year of raw material processed by renderers (Subcategory J). No new PSES for Subcategory E would be established. No new PSES for nitrogen and phosphorus would be established. See Preamble Section VII.C.2 for the EPA's proposed rationale for indirect dischargers.

The EPA evaluated three regulatory options. For a description of the proposed requirements for indirect dischargers under these options, see Preamble Section I.B.

2.2 Scope and Applicability of Proposed Regulation

Facilities engaged in first processing, further processing, or rendering of MPP may be subject to the proposed regulatory options. Table 2-1 shows entities that would be potentially regulated by any final rule following this action, based on industry type and North American Industry Classification System (NAICS) code. Table 2-2 shows the applicable MPP subcategories included in this proposed rule to show further examples of the types of MPP facilities that may be subject to the proposed regulatory options. The scope of the proposed rule does not include any small governmental jurisdictions or not-for-profit organizations. Other types of entities not included in this table could also be regulated. To determine whether an entity would be regulated by this action, see the applicability criteria in 40 CFR 432.1, 432.10, 431.20, 432.30, 432.40, 432.50, 432.60, 432.70, 432.80, 432.90, 432.100, 432.110, and 432.120, with definitions in 40 CFR 432.2.

Table 2-1. MPP Industry Entities Potentially Regulated by the Proposed Rule

Example of Regulated Entity	NAICS Code
Meat Packing Plants	31161
Animal (Except Poultry) Slaughtering	311611
Meat Processed from Carcasses	311612
Sausages and Other Prepared Meat Products	311612
Poultry Slaughtering and Processing	311615
Meat & Meat Product Wholesalers	422470
Poultry Processing	311615
Rendering and Meat Byproduct Processing	311613
Support Activities for Animal Production	11521
Prepared Feed and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	311119
Dog and Cat Food Manufacturing	311111
Other Animal Food Manufacturing	311119
All Other Miscellaneous Food Manufacturing	311999
Animal and Marine Fats and Oils	311613
Livestock Services, Except Veterinary	311611

Table 2-2. MPP ELG Subcategories

Type of Processing	Subcategory	Description
Meat First	A	Simple Slaughterhouses
	B	Complex Slaughterhouse
	C	Low-Processing Packinghouses
	D	High-Processing Packinghouses
Any	E	Small Processors[a]

Table 2-2. MPP ELG Subcategories

Type of Processing	Subcategory	Description
Meat Further	F	Meat Cutters
	G	Sausage and Luncheon Meats Processors
	H	Ham Processors
	I	Canned Meat Processors
Render	J	Rendering
Poultry First	K	Poultry First Processing
Poultry Further	L	Poultry Further Processing

a — Producing less than 6,000 pounds of product per day or 2.2 million pounds per year.

3. Data Collection Activities

The U.S. Environmental Protection Agency conducted several data collection activities in support of developing the proposed rule for the meat and poultry products (MPP) effluent limitations guidelines and standards (ELGs). The EPA used these data to develop an MPP industry profile, determine wastewater characteristics and potential pollution control technologies, review potential pollutant load reductions and costs associated with certain wastewater treatment technology systems, review environmental impacts associated with discharges from this industry, and develop pollutant limitations. This section discusses the EPA's data collection activities as they relate to the technical aspects of the proposed rulemaking:

- Site visits (Section 3.1).
- Sampling program (Section 3.2).
- Industry questionnaires (Section 3.3).
- Other information collection activities (Section 3.4).
- Outreach activities (Section 3.5).

The final subsection (Section 3.6) presents the EPA's approach to protect confidential business information (CBI), which ensures that the data in the public docket explain the basis for the rule and that the docket provides the opportunity for informed public comment without compromising data confidentiality.

3.1 Site Visits

During 2022, the EPA conducted site visits at nine different MPP facilities: three meat facilities, five poultry facilities, and one independent rendering facility. In selecting candidates for site visits, the EPA attempted to identify facilities with advanced wastewater treatment technologies across the different types of MPP operations that were achieving low levels of nitrogen and/or phosphorus in their effluent. In addition, the EPA considered the type of meat and/or poultry processing operation, age of the facility, size of the facility (in terms of production), wastewater treatment processes employed, and best management practices and pollution prevention techniques used. During each visit, the EPA collected information on facility process operations including recent changes and upgrades, wastewater treatment operations, water usage, and waste management operations. More information can be found in the site visit notes attached to the administrative record and identified in Table 3-1.

Table 3-1. List of Site Visits

Facility Name	Type of Operation	Location	Reference to Site Visit Notes
Abbyland Foods Inc. Plant and Abbyland Foods Inc. Pork Pack Plant[a]	Beef slaughterhouse and sausage processing facility; pork slaughterhouse and further processing facility	Abbotsford, WI and Curtiss, WI	DCN MP00276
Darling Ingredients Hamilton Plant	Independent rendering facility	Hamilton, MI	DCN MP00135
Swift Beef Company Hyrum Plant	Beef slaughterhouse and further processing facility	Hyrum, UT	DCN MP00138
Smithfield Fresh Meats	Pork further processing and rendering facility	Smithfield, VA	DCN MP00123

Table 3-1. List of Site Visits

Facility Name	Type of Operation	Location	Reference to Site Visit Notes
Tyson Chicken, Inc. Albertville Facility	Poultry slaughterhouse and further processing facility	Albertville, AL	DCN MP00144
Tyson Farms, Inc Blountsville Facility	Poultry slaughterhouse and further processing facility	Blountsville, AL	DCN MP00142
Tyson Foods Inc. Glen Allen Facility	Poultry slaughterhouse and further processing facility	Glen Allen, VA	DCN MP00139
Tyson Fresh Meats Inc. Perry Facility	Pork slaughterhouse, further processing, and rendering facility	Perry, IA	DCN MP00143
Tyson Foods Inc. Temperanceville Facility	Poultry slaughterhouse, further processing, and rendering facility	Temperanceville, VA	DCN MP00140

Abbreviations: DCN = document control number.

a — Abbyland Food Inc. operates three facilities (Abbyland Foods Plant, Specialty Sausage Plant, and Abbyland Pork Pack Plant) as distinct facilities, but wastewater from all facilities is comingled for treatment in a combined wastewater treatment system.

3.2 Sampling Program

Between August and November 2022, the EPA conducted sampling at six MPP facilities throughout the United States to collect wastewater characterization data and treatment performance data.

The EPA selected facilities with low nitrogen and phosphorus discharges based on Discharge Monitoring Reports (DMRs) data, wastewater treatment information obtained from permits, permit application data, and site visits. The EPA selected three meat facilities, two poultry facilities, and one independent rendering facility. All of the sampled facilities were direct discharge facilities. However, since the wastewater characteristics are the same at direct and indirect facilities, the same wastewater treatment technology can be used at both types of facilities.

The EPA identified pollutants of interest in MPP wastewater based on data from the previous MPP rulemaking (U.S. EPA, 2004), discussions with the EPA regions and state environmental agencies, facility permit limitations, total maximum daily loads (TMDLs) and water quality standards, and literature searches. Below is a list of pollutant or pollutant groups chosen by the EPA for the MPP sampling program. The EPA chose not to sample for per-and polyfluoroalkyl substances (PFAS) as the EPA found no evidence that MPP processes produce PFAS or use it to produce finished products.

- Biochemical oxygen demand (BOD) and carbonaceous biochemical oxygen demand (cBOD).
- Chemical oxygen demand (COD).
- Inorganic anions.
- Oil and grease (O&G).
- Nitrogen compounds.
- Total phosphorus (TP) and ortho-phosphorus.
- Total suspended solids (TSS) and total dissolved solids (TDS).
- Total organic carbon (TOC).
- Fecal Coliform (including *E. coli*).
- Enterococci.
- Metals.

See the *Pollutants of Concern (POC) Analysis for the Meat and Poultry Products (MPP) Proposed Rule* memorandum, which presents a table of the pollutants by analytical method and corresponding baseline values (U.S. EPA, 2023a).

During each sampling episode, the EPA collected wastewater samples for five consecutive days. Sampling points varied by facility and wastewater treatment system, but in general, the EPA collected the following samples at all selected facilities:

- Treatment system influent (untreated wastewater). Samples were collected downstream of screening (if present) to ensure large solids were removed to facilitate sampling.
- Effluent from primary treatment (or influent to biological treatment). Primary treatment typically included a dissolved air flotation unit or anaerobic basin/lagoon.
- Effluent from biological treatment (or influent to tertiary treatment). Biological treatment typically included complete nitrification/denitrification.
- Effluent from tertiary treatment (e.g., filters, disinfection, and/or chlorination/dechlorination), if tertiary treatment was in place.
- Final effluent from the treatment system, if different from the effluent from the last level of treatment (e.g., reaeration basin).

Data collected from the treatment system influent (i.e., untreated wastewater) helped the EPA characterize the industry, develop the list of pollutants of concern to be evaluated for regulation, and determine raw wastewater pollutant concentrations. The EPA used the data collected from the influent, intermediate, and effluent points to analyze the efficacy of treatment at the facilities and to develop current discharge concentrations and loadings as well as the treatment technology systems for the MPP industry. The EPA used selected effluent data to estimate the potential long-term averages and numeric limitations for each regulatory option considered for the proposed rule (see Section 13 for a description of the data the EPA used for effluent limitation development). During each sampling episode, the EPA also collected flow rate data for each sample, when possible, as well as production information from each associated manufacturing operation for use in calculating pollutant loadings and production-normalized flow rates.

Based on conversations with industry, most MPP facilities use drinking water sources (public water supplies or well water) for all source water. Because the facilities are generating food-grade products, facilities may treat their source water with sodium hypochlorite or water softeners before use (U.S. EPA, 2022a, 2022b, 2022c, 2022d). Therefore, the EPA was not concerned about source water contamination for MPP pollutants of interest and did not collect source water samples.

The EPA also collected operations data during the sampling episode to allow for an engineering assessment of the design, operation, and performance of treatment systems at MPP facilities. Specifically, the EPA collected system design information, as well as daily operations data (e.g., production, wastewater flow, chemical additions, sludge generation).

The Agency (or facilities directed by the Agency) collected, preserved, and transported all samples according to the EPA protocols, as specified in:

- The EPA's *Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants* (U.S. EPA, 1977).
- Facility-specific sampling and analysis plan (SAPs).
- *Generic Sampling and Analysis Plan* (GSAP; U.S. EPA, 2022e).

The EPA collected composite samples for most parameters because it expected wastewater compositions to vary over the course of a day. The EPA collected composite samples manually or using automated samplers. The Agency collected individual aliquots for the composite samples at least once every 4 hours over each 24-hour period. The Agency took grab samples from unit operations for O&G and microbiologicals. O&G samples were collected every 6 hours, and microbiologicals were collected once a day.

The EPA contract laboratories completed all wastewater sample analyses except the field measurements of temperature, dissolved oxygen (DO), and pH. The EPA or facility staff collected field measurements of temperature, DO, and pH at the sampling site. The analytical chemistry methods used, as well as the sample volume requirements, detection limits, and holding times, were consistent with the laboratories' quality assurance and quality control plans. Laboratories contracted for MPP sample analysis followed EPA-approved analysis methods for all parameters. The EPA contract laboratories reported data on their standard report sheets and submitted the sheets to the EPA's sample control center (SCC), which reviewed them for completeness and reasonableness. The EPA reviewed all reports from the laboratories to verify that the data were consistent with requirements, reported in the proper units, and in compliance with the applicable protocol. Quality control measures used in performing all analyses complied with the guidelines specified in the analytical methods. The EPA reviewed all analytical data to ensure that these measures had been followed and that the resulting data were within the acceptance criteria for accuracy and precision.

See the *GSAP* (U.S. EPA, 2022e) and the facility-specific SAPs for more information on sampling procedures; see the facility-specific sampling episode reports (SERs) for details on the sampling points selected for each facility and the operational data collected. The facility-specific SAPs and facility-specific SERs are summarized in Table 3-2.

Table 3-2. List of Facility-Specific SAPs and SERs

Facility Name and Location	Reference to SAP	Reference to SER
Abbyland Foods, Abbotsford, WI	DCN MP00149	DCN MP00326
Darling Ingredients, Hamilton, MI	DCN MP00137	DCN MP00333
Swift Beef Company, Hyrum, UT	DCN MP00150	DCN MP00332
Tyson Fresh Meats, Perry, IA	DCN MP00151	DCN MP00317
Tyson Foods, Inc., Glen Allen, VA	DCN MP00152	DCN MP00315
Tyson Foods, Inc., Temperanceville, VA	DCN MP00153	DCN MP00311

Abbreviations: DCN = document control number.

3.3 MPP Industry Questionnaire

The EPA concurrently administered the *Census Questionnaire for the Meat and Poultry Products Effluent Guidelines* (Census Questionnaire) and the *Detailed Questionnaire for the Meat and Poultry Products Effluent Guidelines* (Detailed Questionnaire) under the authority of Section 308 of the Clean Water Act (CWA; Federal Water Pollution Control Act, 33 U.S.C. 1318) to facilities engaging in meat and poultry processing, including direct and indirect dischargers as well as facilities that do not discharge wastewater. The Census Questionnaire and Detailed Questionnaire are referred to collectively as the "MPP Questionnaires" and were approved by the Office of Management and Budget (OMB) in June 2022 (OMB Control No. 2040-0306). The EPA designed the MPP Questionnaires to obtain technical and financial information in support of developing the proposed rule for the MPP ELGs. The EPA made every reasonable attempt to ensure that data and information collected in the questionnaires were not currently available through less burdensome mechanisms.

The Detailed Questionnaire targeted a subset of all identified MPP facilities, distributed across the industry based on a stratification scheme that considered facility operation(s) (slaughtering, processing, rendering), meat type (meat, poultry), and production volume. Using these characteristics, the EPA grouped identified MPP facilities into 27 strata, each encompassing facilities with similar operations.

Stratification increases precision (reducing one source of uncertainty) for estimates of costs, benefits, and other quantities. The EPA deliberately selected approximately 50 “certainty” facilities to obtain site-specific information needed for evaluating facility operations and best technology systems. The Census Questionnaire was distributed to all additional MPP facilities (those that were not selected for the Detailed Questionnaire). Details on the stratification scheme are provided in the *Supporting Statement: US Environmental Protection Agency Meat and Poultry Products Industry Data Collection* (U.S. EPA, 2022f).

The Detailed Questionnaire was administered to 1,565 facilities, selected to ensure statistical representation across all processing operations, production sizes, and discharge types; provide information on the wastewater treatment technologies currently employed by industry; and assess the financial impacts of any regulation revisions or additions. The Detailed Questionnaire included all questions in the Census Questionnaire and additional questions on specific wastewater characterization information (e.g., pollutants discharged, wastewater flows), pollutant control technologies (e.g., pollution prevention techniques, pretreatment systems, end-of-pipe treatment systems), and financial information on facilities and ultimate parent companies. The EPA used the responses to characterize the pollution discharged from MPP facilities and to determine if pollutant discharges can be controlled beyond current requirements for any set or subset of MPP facilities. The Detailed Questionnaire consisted of 85 questions organized into 11 sections.

The Census Questionnaire was administered to 6,127 facilities—i.e., all the MPP facilities not chosen for the Detailed Questionnaire. It confirmed whether these facilities engaged in meat and/or poultry slaughtering, further processing, and/or rendering; confirmed where they fall under the applicability of 40 CFR 432; and collected updated identification information. The EPA used this information to verify the industry population and confirm general information on production details (including type of meat or poultry and type of processing); the type and size (both production and employees) of facilities; and wastewater generation, treatment, and discharge. The Census Questionnaire consisted of 32 questions organized into three sections.

The EPA included a helpline e-mail address and phone numbers in the instructions and on the EPA’s MPP Questionnaires webpage that respondents could use to request assistance in completing the MPP Questionnaires. Using these assistance methods enabled respondents to receive a response to any inquiries they had.

The EPA conducted outreach to maximize facility response. The EPA mailed postcards to facilities that had not begun their questionnaires to encourage them to respond and remind them of the legal requirement to submit responses. Twice during the response period, the EPA emailed respondents with incomplete Qualtrics questionnaires (initiated but not submitted) to remind them to complete and submit their questionnaires. The EPA also reviewed submitted questionnaires to identify incomplete responses, both in hardcopy and Qualtrics, and followed up with some respondents through phone calls and emails to obtain missing information. The EPA also followed up with specific facilities to request additional monitoring data and wastewater treatment details. The EPA used all questionnaire responses in all analyses supporting the proposed ELGs. See subsequent sections of this TDD for discussions of how the EPA used questionnaire data.

Table 3-3 presents the number of questionnaire responses received by April 2023. The EPA received a total of 3,657 responses. Of these, 2,281 responses were from facilities that met the eligibility requirements for the questionnaire. All remaining responses were screen outs (facilities that did not meet the eligibility requirements to complete the full questionnaire because they either do not process MPP or had closed prior to January 1, 2021).

Table 3-3. Summary of MPP Questionnaires Responses

Questionnaire Version	Number of Responses Received from Eligible Facilities	Number of Screen Out Responses	Total Responses Received
Census	1,621	1,208	2,829
Detailed	660	168	828
Total	**2,281**	**1,376**	**3,657**

Source: U.S. EPA, 2023b.

More details on the MPP Questionnaires, their administration, additional respondent support provided by the EPA, and a summary of responses can be found in the *MPP Questionnaires Memorandum* (U.S. EPA, 2023b).

3.4 Other Existing Data Sources

The EPA collected existing data to inform various portions of the analyses supporting the proposed ELGs and to fill data gaps for facilities that did not respond to the MPP Questionnaires. Table 3-4 summarizes the existing data sources, including a description of the data source. The EPA also obtained information on MPP facilities directly from industry, using sources other than the MPP Questionnaires. Table 3-5 summarizes the additional data obtained from industry.

Table 3-4. Existing Data Collection Sources Used by the EPA

Source of Data	Description	Year of Data
U.S. Department of Agriculture (USDA) Food Safety Inspection Service (FSIS)	In October 2019, the EPA downloaded the Meat, Poultry and Egg Product Inspection (MPI) Directory data compiled by the USDA. The MPI Directory is a list of establishments that produce meat, poultry, and/or egg products regulated by FSIS. The EPA also downloaded the USDA's Establishment Demographic Data (a supplement to the MPI directory), which provided information on the type of operations and products for each facility.	2018–2019
Integrated Compliance Information System National Pollutant Discharge Elimination System (ICIS-NPDES)	The EPA downloaded 2018 facility data (e.g., facility name, location, permit limitations, pollutant loadings) from the EPA's ICIS-NPDES for facilities classified by a Standard Industrial Classification (SIC) code listed under 40 CFR 432.1 (*General Applicability of the MPP ELGs*). The EPA also downloaded 2019 facility data from the EPA's ICIS-NPDES for facilities under Part 432 with individual NPDES permits.	2018–2019
Publicly Owned Treatment Works (POTWs) Annual Reports	POTWs with pretreatment programs are required to submit annual reports on their programs. These reports typically list their significant industrial users and their applicable point source categories. ERG collected publicly available online POTW Annual Reports from seven states (CA, TN, TX, WA, IN, MI, NH). The EPA reviewed the collected reports to identify MPP indirect dischargers.	Various

Table 3-4. Existing Data Collection Sources Used by the EPA

Source of Data	Description	Year of Data
National Pollutant Discharge Elimination System (NPDES) Permits, Permit Applications, and Fact Sheets	The CWA requires direct dischargers to control their discharges according to effluent guidelines and water quality-based effluent limitations included in NPDES permits. The EPA contacted all the EPA regions and searched online to find NPDES permits and fact sheets.	Various
U.S. Food and Drug Administration (FDA) Data	The EPA contacted the FDA's Center for Veterinary Medicine and received a list of MPP facilities.	2020
Toxics Release Inventory (TRI)	Section 313 of the Emergency Planning and Community Right-to-Know Act requires facilities meeting specified thresholds to report their annual releases and other waste management activities for listed toxic chemicals to TRI. This data set includes direct and indirect dischargers. The EPA downloaded 2017 data (the most recent data available) for North American Industry Classification System (NAICS) codes listed under 40 CFR 432.1 (*General Applicability of the MPP ELGs*).	2017
Discharge Monitoring Reports (DMRs)	Direct dischargers submit discharge monitoring data to their permitting authority using DMRs as required by their NPDES permits. The data are then uploaded into ICIS-NPDES. The EPA downloaded 2021 DMR data for MPP facilities.	2021
Hampton Roads Sanitation District (HRSD)	HRSD sets industrial wastewater discharge regulations for industrial users based on stepwise flow categories. In accordance with these regulations, Smithfield Fresh Meats collected effluent data and flow data. HRSD provided the EPA with effluent and flow data for Smithfield Fresh Meats for five years.	2016–2020
Virginia Department of Environmental Quality (VDEQ)	VDEQ provided the EPA with effluent data for four facilities that process poultry. These facilities perform advanced nutrient removal to meet the Chesapeake Bay TMDL requirement.	2015–2023
Scientific Literature and Journal Articles	The EPA conducted a literature search for information on various aspects of the animal processing industry, including documented environmental impacts, wastewater treatment technologies, waste generation and facility management, and pollution prevention.	Various

Table 3-5. Data Submitted by Industry

Source of Data	Description	Year of Data
National Renderers Association	The EPA received a list of members from this MPP trade association. From this list, the EPA collected facility names, addresses, contact information, list of products, and other notes.	2018
308 Letter for Data on High Chlorides Wastestreams and Treatment	Under the authority of CWA Section 308, the EPA collected wastewater characterization and treatment information from MPP facilities with potentially high chlorides wastestreams resulting from activities such as meat or poultry koshering and hides processing.	2022–2023

3.5 Outreach Activities

The EPA encouraged all interested parties to participate throughout the development of the MPP rule. The Agency conducted outreach to trade associations that represent most of the facilities that the rule will affect. The EPA met with various stakeholders to discuss aspects of the regulation development. The EPA also participated in industry meetings and gave presentations on the status of the regulation development. Table 3-6 lists stakeholder meetings conducted by the EPA. Summaries of these meetings are in the MPP Rulemaking Record.

Table 3-6. Summary of the EPA's Stakeholder Meetings

Meeting Participants	Date of Meeting	Summary of Discussion
U.S. Poultry and Egg Association Environmental Management Seminar	September 21, 2022; September 28, 2023	Discussed the EPA's ongoing information collection efforts, potential revisions to the MPP ELGs, and rulemaking timeline.
North American Meat Institute	October 12, 2022	Discussed the EPA's ongoing information collection efforts, potential revisions to the MPP ELGs, and rulemaking timeline.
Joint Poultry Environmental Committee	January 25, 2023	Discussed ongoing analyses, information collection activities, potential revisions to the MPP ELGs, and rulemaking timeline.
Consultation and Coordination with Indian Tribes: MPP ELG Webinars	February 6 and 13, 2023	Discussed current MPP ELGs, potential revisions to the MPP ELGs, possible interest to Tribes, opportunities for Tribal involvement, and rulemaking timeline.
North American Meat Institute	April 18, 2023	Discussed ongoing analyses, information collection activities, potential revisions to the MPP ELGs, and rulemaking timeline.
Joint Poultry Environmental Committee, North American Meat Institute, North American Renderers Association	May 18, 2023	Discussed the EPA's data analysis methodologies, potential ELG revisions and considerations, rulemaking timeline, and opportunities for future engagement.
Small Business Regulatory Enforcement Fairness Act (SBREFA) Pre-Panel and Formal-Panel Meeting	May 2 and July 17, 2023	Discussed potential regulatory operations and alternatives with industry small entity representatives and requested feedback.

Table 3-6. Summary of the EPA's Stakeholder Meetings

Meeting Participants	Date of Meeting	Summary of Discussion
Environmental Integrity Project, Earthjustice, and partners	September 15, 2023	Discussed ongoing analyses, information collection activities, potential revisions to the MPP ELGs, and rulemaking timeline.
Southwest Meat Association	September 26, 2023	Discussed ongoing analyses, information collection activities, potential revisions to the MPP ELGs, and rulemaking timeline.

The EPA also met with environmental groups and Tribal communities and conducted environmental justice outreach. For details on these meeting, see the *Environmental Assessment for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category* (U.S. EPA, 2023c).

3.6 Protection of Confidential Business Information

Certain data in the rulemaking record have been claimed as CBI. As required by federal regulations at 40 CFR 2, the EPA has taken precautions to prevent the inadvertent disclosure of this CBI. The Agency has withheld CBI from the public docket in the Federal Docket Management System; it has also found it necessary to withhold some data not directly claimed as CBI because releasing them could indirectly reveal CBI. Where necessary, the EPA has aggregated certain data in the public docket, masked facility identities, or used other strategies to prevent the disclosure of CBI. The Agency's approach to protecting CBI ensures that the data in the public docket explain the basis for the rule and that the docket provides the opportunity for informed public comment without compromising data confidentiality.

3.7 References

1. U.S. EPA. 1977. *Sampling and Analysis of Procedures for Screening of Industrial Effluents for Priority Pollutants* (April). 600R77006. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi/91004V4G.PDF?Dockey=91004V4G.PDF.
2. U.S. EPA. 2004. *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432)* (September). EPA-821-R-04-011. Available online at: https://www.epa.gov/sites/default/files/2015-11/documents/meat-poultry-products_tdd_2004_0.pdf.
3. U.S. EPA. 2022a. *Smithfield Fresh Meats Site Visit Report* (May). DCN MP00123.
4. U.S. EPA. 2022b. *Abbyland Foods Abbotsford, WI Site Visit Report* (July). DCN MP00276.
5. U.S. EPA. 2022c. *Swift Beef Company, Hyrum Plant Site Visit Report* (August). DCN MP00138.
6. U.S. EPA. 2022d. *Tyson Farms, Inc., Blountsville Site Visit Report* (October). DCN MP00142.
7. U.S. EPA. 2022e. *Generic Sampling and Analysis Plan for Meat and Poultry Products (MPP) Point Source Category* (August). DCN MP00136.
8. U.S. EPA. 2022f. *Supporting Statement: US Environmental Protection Agency Meat and Poultry Products Industry Data Collection* (February). EPA-HQ-OW-2021-0736. Available online at: https://www.epa.gov/system/files/documents/2022-03/mpp-icr-supporting-statement_feb-2022.pdf.
9. U.S. EPA. 2023a. *Pollutants of Concern (POC) Analysis for the Meat and Poultry Products (MPP) Proposed Rule* (November). DCN MP00190.
10. U.S. EPA. 2023b. *U.S. EPA MPP Questionnaires Memorandum* (November). DCN MP00234.
11. U.S. EPA. 2023c. *Environmental Assessment for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category* (November). EPA-821-R-23-012.

4. Meat and Poultry Products Industry Operations and Wastewater Generation

The meat and poultry products (MPP) industry comprises facilities that perform one or more of the following operations:

- Slaughter livestock (e.g., cattle, calves, hogs, sheep, and lambs), poultry (e.g., chickens, turkeys, and small game such as rabbits), or both.
- Further process meat, poultry, or both.
- Render waste from slaughter and further processing operations (e.g., bones, feathers, fat).

Wastewater generated from these operations is regulated by the MPP effluent limitations guidelines and standards (ELGs).

Slaughtering facilities, also called first processing or harvesting facilities, receive and hold live animals, slaughter them, and produce a raw dressed product, either whole or in parts. These products are then further processed (either onsite or after transfer to further processing facilities) or sold to distributors, retailers, or consumers. Some slaughtering operations may receive carcasses from off-site slaughter for initial first processing. Cutting whole carcasses into halves, quarters, or smaller pieces (including pieces with or without bone or which are ground) is considered part of first processing operations when done at first processing facilities. Companies that own slaughtering facilities might also own the facilities that raise the animals; however, wastewater generated by the raising of animals is not covered by the MPP ELGs.

Further processing facilities use whole carcasses or cut-up meat or poultry parts to produce consumable products. Further processing facilities may receive carcasses or parts from one or more first processing facilities. A facility that performs both first processing and further processing activities as a single operation is referred to as an integrated facility. Cutting, boning, and grinding operations are considered further processing operations when done at facilities not also engaged in first processing activities (U.S. EPA, 2004).

Further processing facilities process raw meat and/or poultry products to produce finished products,[2] such as those that use raw chicken to produce frozen chicken nuggets or fresh seasoned chicken wings. Food manufacturing facilities typically receive finished products to produce food items for consumption, such as facilities that use ground sausage to produce frozen pizzas or fresh or frozen stuffed pastas. Based on information from previous Technical Development Documents (TDDs) and regulatory text, and through follow up with facilities as part of administering the MPP Questionnaires, the U.S. Environmental Protection Agency found that there is confusion over how food manufacturing operations are classified under the existing MPP ELGs. Previous iterations of the MPP ELGs did not clearly define which food manufacturing operations are considered further processing operations. The “small processors” subcategory (40 CFR 432.50 and 432.51) does apply to certain operations that involve cooking and seasoning to produce a final product, including “stews.” The ELGs for “canned meats” (40 CFR 432.90 and 432.91) similarly apply to “stews, sandwich spreads or similar products.” In these examples, a regulated

[2] 40 CFR 432.2: “Finished product” means the final fresh or frozen products resulting from the further processing of either whole or cut-up meat or poultry carcasses. “Further processing” means operations that utilize whole carcasses or cut-up meat or poultry products for the production of fresh or frozen products and may include the following types of processing: Cutting and deboning, cooking, seasoning, smoking, canning, grinding, chopping, dicing, forming, breading, breaking, trimming, skinning, tenderizing, marinating, curing, pickling, extruding and/or linking.

facility would do more than simply add a purchased meat product into a stew or apply a meat spread processed elsewhere onto a sandwich.

Previously, the EPA specifically excluded "plants manufacturing products such as canned soups and TV dinners" (U.S. EPA, 1975). For the proposed rule, the EPA maintains this exclusion. For this proposal, the EPA considered only facilities that further process raw meat and/or poultry to produce finished products as covered by the MPP ELGs. Facilities that take a consumer product that has already been "processed" and use it as an ingredient in another consumer product are not covered. Similarly, the EPA excluded retail/wholesale distributors, grocery stores, and delis from the definition of meat processing as these facilities perform similar functions (e.g., slicing, grinding), but meat processing is not their primary function. For example, slicing pepperoni as a topping for pizza would not be covered. Likewise, adding ground meat into a lasagna, heating a lasagna, or packaging a prepared lasagna would not be covered. For additional questions, please contact the rule writer or Steve Whitlock, the contact on the EPA's webpage.[3]

Rendering operations convert byproducts from meat and poultry first and further processes into marketable edible and inedible products. Rendering operations are commonly integrated into first processing facilities but may take place at any type of MPP facility. Facilities that only engage in rendering processes are referred to as independent renderers.

The EPA compiled information from the existing data sources identified in Sections 3.4 and 3.5 to construct an initial list of facilities in the MPP industry, containing approximately 7,000 facilities. The EPA compiled data on facility location, MPP operations performed, and production volumes. The EPA suspected there were duplicate facilities as well as some out-of-date information (e.g., facilities that had since closed or changed operations) within this facility list. The EPA used response data from the MPP Questionnaires and industry communications through the Questionnaire Helpline to update the facility list. Updates included removing duplicates, removing closed facilities, removing facilities that did not process meat or poultry products, adding new facilities, and updating information such as facility names, locations, and processing operations. The EPA then developed the current MPP industry profile, primarily based on MPP Questionnaire responses but supplemented with existing data where MPP Questionnaire responses were not available. As a result, the current industry profile contains 5,055 facilities. See the *Meat and Poultry Products (MPP) Profile Methodology Memorandum* (MPP Profile Memo; U.S. EPA, 2023a) for details on how data from multiple sources were combined to identify MPP facilities, operations, production levels, and other details.

Throughout this section, the EPA describes MPP industry operations based on two main data sources, the MPP Questionnaire and the population of MPP facilities operating in the United States. The EPA received 2,248 MPP Questionnaire responses from MPP facilities.[4] Using additional publicly available data, the EPA identified additional MPP facilities operating in the United States to bring the total to 5,055 MPP facilities operating in the United States. Where information is based solely on a singular data source (e.g., data from the MPP Questionnaire), it is explicitly identified throughout this section. Table 4-1 identifies the number of MPP Questionnaire responses received and facilities identified in the U.S. by process type. See the MPP Profile Memo for details on how MPP Questionnaire data were used to identify processing type for each facility.

[3] https://www.epa.gov/eg/meat-and-poultry-products-effluent-guidelines

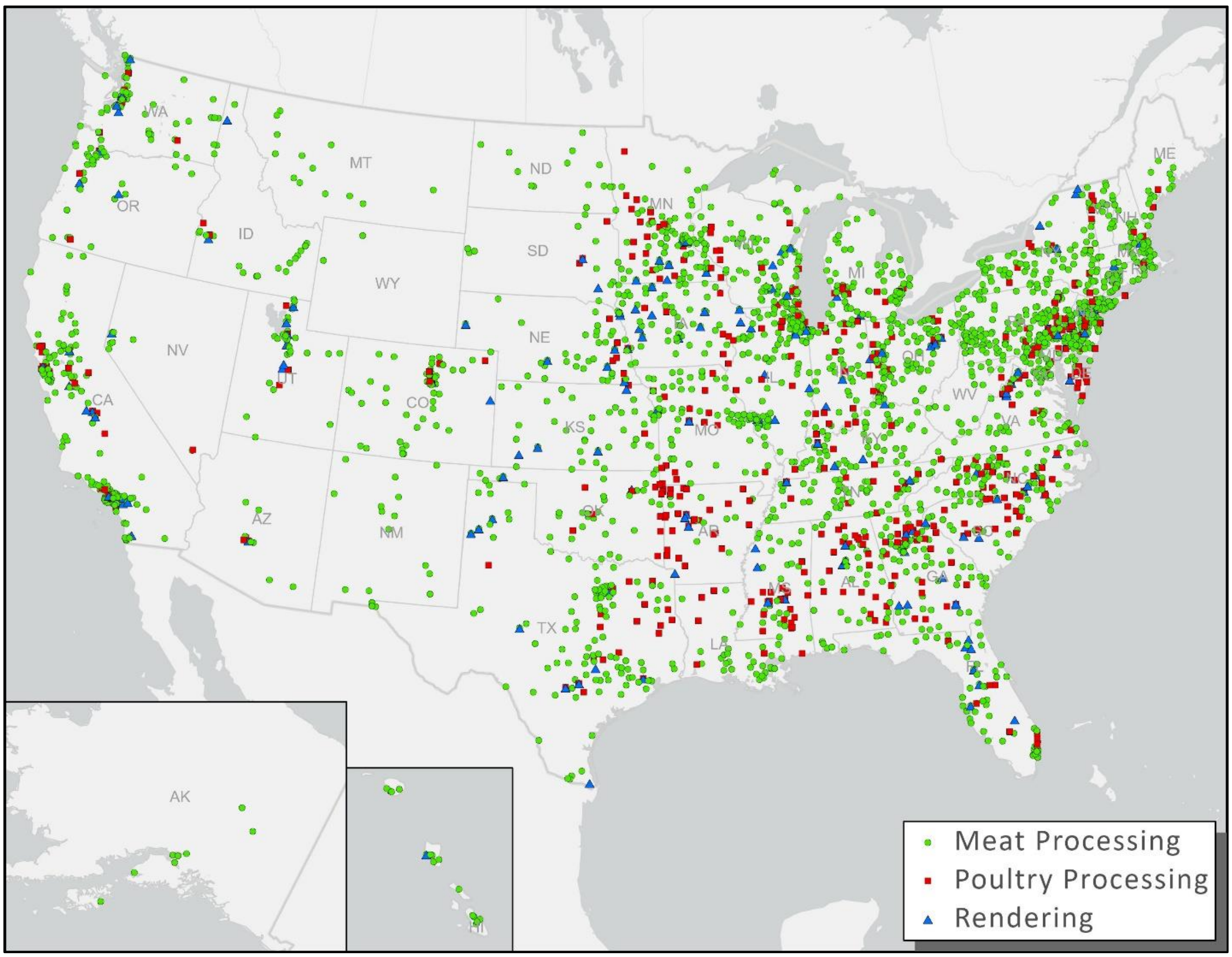
[4] The EPA received 3,657 individual responses, but 1,409 of those responses indicated no processing of meat or poultry products or that the business was closed. These facilities screened out of the MPP Questionnaire.

Table 4-1. MPP Facilities from MPP Questionnaires and Industry Profile

Process Type	Number of Facilities Based on Questionnaire Responses	Number of Facilities Based on Industry Profile
Meat First Processing	417	826
Meat Further Processing	1,209	3,460
Poultry First Processing	217	290
Poultry Further Processing	293	294
Independent Rendering	112	185
Total	**2,248**	**5,055**

Source: U.S. EPA, 2023a, 2023b.

MPP facilities are located across the United States. Figure 4-1 illustrates the distribution of 4,988 MPP facilities identified by the EPA in the United States and included in Table 4-1; 67 MPP facilities located in United States territories are not included.



Source: U.S. EPA, 2023a.

Figure 4-1. MPP Facilities in the United States (Excluding Territories)

This section provides an overview of MPP operations and wastewater generated during those operations. The subsections are separated into general categories of industry operation and type of raw material:

- Meat first processing (Section 4.1).

- Meat further processing (Section 4.2).
- Poultry first processing (Section 0).
- Poultry further processing (Section 4.4).
- Independent rendering (Section 4.5).

4.1 Meat First Processing

Meat first processing facilities slaughter livestock but not poultry. First processing operations typically encompass the following steps:

1. Receiving and holding live animals for slaughter.
2. Stunning before slaughter.
3. Slaughter and bleeding.
4. Initial processing of animals (e.g., hide or hair removal, evisceration, washing).

Based on conversations with industry, most MPP facilities use drinking water sources (public water supplies or well water) for all source water. Facilities may treat their source water with water softeners before use within the facility to minimize scale build-up in equipment and because the facilities are generating food-grade products (U.S. EPA, 2022a, 2022b). The waste brine from water softening generates a high chlorides wastestream. Most or all of the waste brine is discharged or disposed of, as reuse of brine impacts performance of water softening systems (Liu et al., 2021).

Meat slaughtering operations use substantial amounts of water for initial processing, generating wastewaters from a variety of operations that include areas where animals are killed and bled, hides or hair are removed, animals are eviscerated, carcasses are washed and chilled, and carcasses are trimmed and cut to produce whole carcasses or carcass parts. Wastewaters generated from these operations can contain varying levels of blood, animal parts, viscera, fats, bones, and other animal waste. In addition, federal food safety guidelines require frequent and extensive cleanup of slaughtering operations, which also generates wastewater. These cleanup wastewaters contain not only slaughtering residues and particulate matter but also products used for cleaning and disinfection (e.g., detergents and sanitizing agents) (U.S. EPA, 2004). While individual operations may take place on separate production lines, in separate rooms, or in separate buildings, process wastewater is typically collected via floor drains that comingle streams for end-of-pipe treatment.

The processes employed by the industry are largely the same as they were when the 2004 MPP ELG was promulgated, although the mechanization of processes has increased. In general, smaller facilities tend to rely more on manual processing, while larger facilities use more automated and advanced processing technology. The *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432)* from 2004 (the 2004 TDD; U.S. EPA, 2004) describes in detail the operations involved in transforming live meat animals into carcasses. The operations that are sources of process wastewater and those that may generate high chlorides wastestreams include the following (U.S. EPA, 2004, unless otherwise cited):

- Hide processing: Hides are typically rinsed and washed in freshwater to remove mud, manure, and debris before being de-fleshed. They are then cured in salt for preservation, often by soaking in a brine solution for up to 24 hours. Soaked hides are then wrung out to remove brine and moisture and then dried (U.S. EPA, 2022b).
    - Hides curing generates a high chlorides wastestream through soaking and wringing. Hide curing is often performed in a separate room or separate building from other meat first operations. Brine soaking can occur in a raceway or tank specified for the purpose (U.S. EPA, 2022b).

- **Hair removal**: Carcasses are first scalded in hot water and rubbed with rubber fingers to draw hair out of the follicles, typically in a dehairing machine. Then, a constant flow of water washes away removed hair. Any remaining hair is removed either by scraping blades or by passing the carcass through a gas flame, followed by a water spray. After hair removal, carcasses are washed again to remove any remaining manure, soil, and hair and to retard microbial growth and spoilage prior to evisceration.
- **Meat Koshering**: After hide removal and evisceration, carcasses are soaked and then coated in dry coarse salt and left to rest for one hour to allow blood to drain from the meat. Meat is then dry tumbled and washed to remove the salt (Chabad-Lubavitch Media Center, 2023).
    - Wash water from meat koshering generates a high chlorides wastestream. Industrial or commercial meat koshering occurs in facilities specially certified to perform the process by specially trained staff (Orthodox Union, 2023).
- **Carcass Washing**: Carcass washing removes blood, bone dust, and any other foreign matter. Processors may add bactericides such as an organic acid, chlorine, potassium chloride, acetic and lactic acids (in dilute concentrations) to the wash water to reduce microbial populations and the potential for microbe growth and spoilage.
- **Cleaning Operations**: Facilities clean regularly to maintain sanitary conditions. Cleaning entails rinsing equipment, walls, holding pens, floors, flumes, and raceways, followed by scrubbing, chemical application, and a final rinse. For many facilities, cleaning operations produce the largest volumes of process wastewater.

Based on the 2,248 Questionnaire responses, in general, meat first processing operations specialize in processing only meat, not poultry. Of 418 facilities that reported performing meat slaughtering in the MPP Questionnaire, only 4 percent (18 facilities) also reported performing poultry slaughtering (U.S. EPA, 2023b). If a single facility does slaughter both, it typically uses separate lines, if not separate buildings (U.S. EPA, 2004). However, a very small meat first processing facility, such as a specialty butcher or a wild game processor, may process several types of animals in a single building primarily using manual operations.

Integrated first and further processing operations are common in the meat processing industry. Of the 418 facilities that reported performing meat slaughtering in the MPP Questionnaire, 81 percent (340 facilities) also reported performing meat further processing (U.S. EPA, 2023b). Where first and further processing occur at the same site, usually some fraction of the carcass produced is marketed as fresh meat and the remainder is transformed into processed products.

Based on the 5,055 MPP facilities identified in the United States, the EPA identified 826 meat first processing facilities (including integrated facilities that do both meat first and further processing) in operation in the U.S. This represents an overall decrease in facilities since the 2004 MPP ELGs, when 1,400 meat first processing facilities were identified. The 2004 TDD also reported meat first processing facilities were found in the highest numbers (more than 60 establishments in each state) in Texas, California, Illinois, Iowa, and Wisconsin (U.S. EPA, 2004). Table 4-2 lists the five states that now have the highest percentages of meat first processing facilities (U.S. EPA, 2023a).

Table 4-2. States with the Highest Percentages of Meat First Processing Facilities

State	Percent of Meat First Processing Facilities (826 Facilities)
Pennsylvania	10.1 (83 facilities)
Texas	4.8 (40 facilities)
New York	4.5 (37 facilities)
Missouri	4.2 (35 facilities)
Nebraska	4.0 (33 facilities)

Source: U.S. EPA, 2023a.

Of the 826 meat first processing facilities the EPA identified, 32 percent (261 facilities) conduct operations that could generate high chlorides wastestreams. Of these 261 facilities:

- 163 are integrated facilities that perform specific further processing operations known to be capable of generating high chlorides wastestreams (described in Section 4.2).
- 58 perform hide curing.
- 39 perform both hide curing and specific further processing operations known to be capable of generating high chlorides wastestreams.
- One performs meat koshering (U.S. EPA, 2023a).

Table 4-3 includes the number of meat first processing facilities by annual production volume. The table includes the average production and total production of all the facilities within each range, measured as million pounds live weight killed (LWK) per year. These data illustrate that 69 percent of all meat first processing facilities each produce less than 5 million pounds LWK annually and collectively only account for 0.4 percent of total meat first processing industry production volume. Conversely, 11 percent of all facilities produce 200 million pounds LWK annually or more and account for 97 percent of total industry production volume (U.S. EPA, 2023a).

Table 4-3. Meat First Processing Facilities by Annual Production

Range (M lbs. LWK/yr.)	Number of Facilities	Average Production (lbs. LWK/yr.)	Total Production (lbs. LWK/yr.)
<5	570	1,088,096	620,214,968
5 to <10	63	8,206,075	516,982,727
10 to <200	106	50,075,108	5,307,961,408
≥200	87	1,639,659,410	142,650,368,657
Total	**826**	**180,503,060**	**149,095,527,759**

Source: U.S. EPA, 2023a.

Abbreviations: M = million, lbs. = pounds, yr. = year.

4.2 Meat Further Processing

Meat further processing involves processing or preserving meat and meat byproducts (but not poultry) from dressed meats. Further processing operations include canning, cooking, cutting and/or deboning, curing, forming, grinding, linking, marinating, pickling, seasoning, smoking, tenderizing, and trimming. The operations most commonly produce ground meat, case-ready cuts with or without bone, and/or sausage. Stand-alone further processing operations receive carcasses, or more commonly carcass parts, from first processing operations (U.S. EPA, 2004).

Based on conversations with industry, most MPP facilities use drinking water sources (public water supplies or well water) for all source water. Facilities may treat their source water with water softeners before use within the facility to minimize scale build-up in equipment and because the facilities are generating food-grade products (U.S. EPA, 2022a, 2022b). The waste brine from water softening generates a high chlorides wastestream. Most or all of the waste brine is discharged or disposed of, as reuse of brine affects performance of water softening systems (Liu et al., 2021).

Wastewaters generated by meat further processing operations contain both soft and hard tissue (e.g., muscle, fat, and bone) and blood. Differences in further processing wastestreams are largely driven by the type of finished product produced, as wastewaters can contain substances used in final product preparation, such as additives, breading, and sauces. Meat further processing wastewaters will also contain products used for cleaning and disinfection (detergents and sanitizing agents) (U.S. EPA, 2004). While individual operations may take place on separate production lines, in separate rooms, or in separate buildings, process wastewater is typically collected via floor drains that comingle streams for end-of-pipe treatment.

As with meat first processing, operations used for meat further processing have not changed much since 2004. The 2004 TDD describes in detail the operations involved in meat further processing. The operations that are sources of process wastewater and those that may generate high chlorides wastestreams include the following (U.S. EPA, 2004, unless otherwise cited):

- Thawing: Meat products are submerged in tanks or vats of warm water until thawed.
- Tenderizing: Meat is marinated or injected with salt solutions, such as calcium chloride, or acids, such as vinegar, to break down the muscle structure.
    - Tenderizing with a brine solution could generate a high chlorides wastestream from spilled brine, waste brine, and wash water. The EPA did not include this operation in its analysis of high chlorides wastestreams, though, because tenderizing is not always performed with a salt solution and data were not available on different solutions used by facilities.
- Marinating: Meat may be immersed in brine, injected with brine, tumbled with brine, or a combination thereof. Marination extends shelf-life, seals in moisture, increases meat yield, and adds flavor and tenderness. Marinades typically contain phosphates and salt for meat preservation and water retention (Alvarado and McKee, 2007).
    - Marinating generates high chlorides wastestreams from dripped or spilled brine, waste brine, and wash water. Brines are applied on dedicated work lines or facility areas.
- Tempering: The temperature or moisture content of meat is adjusted, often by immersion or soaking in water.
- Curing: Immersion curing submerges meat into a brine or injects brine into the meat to preserve it and develop a characteristic appearance and flavor. In dry curing, solid salts are rubbed into the meat surface.
    - The immersion curing process generates high chlorides wastestreams, as do rinsing and washing from all curing processes. Curing brines are often reused but are eventually wasted. Pumps recirculate brine that spills from the product or injection needles (USDA, 2020), facilitating capture of waste brine for treatment and/or disposal.
- Pickling: Large amounts of spillage from this operation typically occur by runoff from pickle injection, pickle oozing out of the meat after injection, dumping of cover pickle, and dumping of residual pickling solution at the end operations.
    - Pickling generates high chlorides wastestreams through preparation of the pickling solutions, waste pickle, and the pickle application process through both spillage and cleanup. As with liquid curing processes, pickling solutions are often pumped through equipment during application (USDA, 2020), facilitating capture of waste pickle for treatment and/or disposal.
- Smoking: Water that overflows during quenching of burned wood to generate smoke generates wastewater. Some facilities use liquid smoke products transformed into a gas via direct heat for application (USDA, 2020). Any moisture dripping from products during smoking is also captured in wash water.
    - Smoking generates a high chlorides wastestream through spillage and cleanup of liquid smoke products and rinsing and washing smoking chambers. Smoking operations typically occur in smoking chambers or smokehouses with ducts and ventilation that enable smoke to be pumped into the chamber with the meat products.
- Cooking: Steam condensate or hot water is used as the cooking medium. For example, luncheon meats are cooked in stainless steel molds, which may leak.

- **Cooling**: Cooked and smoked products are showered in water immediately after cooking to cool. Sausage products may be cooled with a spray of cold water or brine solution. Canned meat and products prepared in stainless steel molds are usually cooled by submersion in cold water.
  - Sausage brine spraying may generate a high chlorides wastestream. The EPA did not include this operation in its analysis of high chlorides wastestreams, though, because data were not available to allow differentiation of brine cooling from water cooling at facilities.
- **Canning**: After meat is sealed in a container, it is heated using steam under pressure. These cans may leak during the sealing process.
- **Casing, linking, and casing peeling**: Water is used to prepare natural casings for stuffing and a small stream of water is used to lubricate the casing to avoid breakage or splitting during linking. Synthetic casings are not edible and must be removed after cooking and cooling. A small spray of steam parts the casing from the finished product so the casing can be peeled off; however, the amount of wastewater generated by this spray is typically minute.
- **Cleaning operations**: Facilities clean regularly to maintain sanitary conditions. Cleaning entails rinsing all equipment, walls, and floors followed by scrubbing, chemical application, and a final rinse. For many facilities, cleaning operations produce the largest volumes of process wastewater.

Based on the 2,248 Questionnaire responses, 1,646 facilities indicated they further process meat. Of these 1,646 facilities, 79 percent (1,306 facilities) indicated they perform stand-alone meat further processing, meaning they perform only meat further processing and not meat slaughtering. However, further processing facilities may process both meat and poultry products on site. Of these 1,306 facilities, 53 percent (691 facilities) indicated they also further process poultry (U.S. EPA, 2023b).

Based on the 5,055 MPP facilities identified in the U.S., the EPA identified 3,460 facilities performing primarily meat further processing operations in the United States; these are distinct from meat first processing facilities that may have integrated meat further processing operations. In 2004, the EPA identified only 1,300 meat further processors, showing a large increase. Table 4-4 lists the top five states with the most identified meat further processing facilities (U.S. EPA, 2023a). Facility geographic distribution remains relatively unchanged since 2004 (U.S. EPA, 2004). In the meat processing industry, the current data show a decrease in meat first processing facilities and an increase in meat further processing facilities. The 2004 TDD identified 52 percent of the meat processing industry as meat first processing facilities and 48 percent as meat further processing facilities (U.S. EPA, 2004). Currently, 19 percent of all identified meat processing facilities are meat first processors (826 facilities) and 81 percent are meat further processors (3,460 facilities) (U.S. EPA, 2023a).

Table 4-4. States with the Highest Percentages of Meat Further Processing Facilities

State	Percent of Meat Further Processing Facilities (3,460 Facilities)
California	13 (449 facilities)
New York	6.7 (230 facilities)
Illinois	6.5 (226 facilities)
Texas	6.2 (213 facilities)
Pennsylvania	5.1 (177 facilities)

Source: U.S. EPA, 2023a.

Of the 3,460 stand-alone meat further processing facilities identified by the EPA, 15 percent (509 facilities) conduct operations that could generate high chlorides wastestreams from specific further processing operations, such as marinating and pickling (U.S. EPA, 2023a).

Table 4-5 includes the number of meat further processing facilities by annual production volume. The table also includes the average production and total production of all the facilities within each range, measured as pounds of finished product per year. These data illustrate that 63 percent of all identified meat further processing facilities each produce less than 2 million pounds of finished product annually and collectively only account for 1.8 percent of the total meat further processing production volume. Conversely, 10 percent of all facilities produce more than 50 million pounds of finished product annually and account for 80 percent of total industry production volume (U.S. EPA, 2023a).

Table 4-5. Meat Further Processing Facilities by Annual Production

Range (M lbs. Finished Product/yr.)	Number of Facilities	Average Production (lbs. Finished Product/yr.)	Total Production (lbs. Finished Product/yr.)
<2	2,194	423,149	928,388,099
2 to <10	695	5,668,123	3,939,345,703
10 to 50	224	23,480,623	5,259,659,470
>50	347	118,891,109	41,255,214,541
Total	**3,460**	**14,850,465**	**51,382,607,813**

Source: U.S. EPA, 2023a.

Abbreviations: M = million, lbs. = pounds, yr. = year.

4.3 Poultry First Processing

Poultry first processing involves the slaughter of poultry and small game animals (e.g., rabbits). Poultry first processing operations typically encompass the following steps:

1. Receiving and holding of live animals.
2. Stunning before slaughter.
3. Slaughter and bleeding.
4. Initial processing of animals (defeathering, evisceration).

Based on conversations with industry, most MPP facilities use drinking water sources (public water supplies or well water) for all source water. Facilities may treat their source water with water softeners before use to minimize scale build-up in equipment and because the facilities are generating food-grade products (U.S. EPA, 2022a, 2022b). The waste brine from water softening generates a high chlorides wastestream. Most or all the waste brine is discharged or disposed of, as reuse of brine affects performance of water softening systems (Liu et al., 2021).

Like meat slaughtering, poultry slaughter operations use substantial amounts of water for initial processing, generating wastewaters from a variety of operations that include areas where animals are killed and bled; feathers are removed; animals are eviscerated; carcasses are washed and chilled; and carcasses are trimmed and cut to produce the whole carcasses or carcass parts. As a result of these operations, wastewaters can contain blood, animal parts, viscera, fats, bones, and other animal waste. In addition, federal food safety guidelines require frequent and extensive cleanup of slaughtering operations, which also contributes to wastewater generation. These cleanup wastewaters contain not only slaughtering residues and particulate matter but also products used for cleaning and disinfection (e.g., detergents and sanitizing agents) (U.S. EPA, 2004). While individual operations may take place on separate production lines, in separate rooms, or in separate buildings, process wastewater is typically collected via floor drains that comingle streams for end-of-pipe treatment.

Like meat processing, operations used for poultry first processing have not changed much since 2004.The 2004 TDD describes in detail the operations involved in further processing poultry. Operations that are sources of process wastewater and those that may generate high chlorides wastestreams include the following (U.S. EPA, 2004, unless otherwise cited):

- **Scalding and defeathering**: After killing and bleeding, birds are scalded by immersion in a scalding tank (the preferred method) or by spraying with scalding water. Defeathering is performed by machines with multiple rows of rubber fingers on cylinders that rotate quickly across the birds while a continuous spray of warm water flushes feathers away. The carcasses are then washed in enclosures using high-pressure cold-water sprays to sanitize their outsides and thus reduce microbial contamination of the body cavity during evisceration.
- **Poultry koshering**: After defeathering, for kosher poultry production, bird carcasses are packed with dry coarse salt inside and out and propped up for one hour to allow blood to drain before being dry tumbled and washed to remove the salt. (Chabad-Lubavitch Media Center, 2023).
    - Poultry koshering operations may generate wastestreams that contain high concentrations of chlorides. Industrial or commercial poultry koshering occurs in facilities certified to perform the process by specially trained staff (Orthodox Union, 2023).
- **Evisceration**: Depending on the facility, viscera are collected via a wet or dry system. Wet systems use water to transport the offal by fluming it to a screening area for dewatering before rendering. Dry systems are not common.
- **Edible viscera washing**: Hearts and livers are stripped of connective tissue and washed. Gizzards are split, their contents are washed away, the hard linings are peeled off, and they are given a final wash.
- **Bird washing**: High-pressure nozzles spray water both inside and outside the carcass. The water is often mixed with chlorine or other anti-microbiological chemicals.
- **Chilling**: Most poultry processing facilities use large chilling tanks containing ice water; very few use air chilling. Most poultry facilities use two chilling tanks in series, a pre-chiller and a main chiller, both containing cold water.
- **Cleaning Operations**: Facilities clean regularly to maintain sanitary conditions. Cleaning entails rinsing all equipment, walls, holding pens or cages, and floors followed by scrubbing, chemical application, and a final rinse. For many facilities, cleaning operations produce the largest volumes of process wastewater.

Poultry first processing operations are performed slightly differently based on the type of poultry being processed. For example, chickens are typically killed by mechanical means due to similarity in bird body size. Turkeys are killed manually because of the wider variety in body shape and size (U.S. EPA, 2004). In general, smaller facilities tend to rely more on manual processing throughout all operations, whereas larger facilities use more automated and advanced processing technology.

Based on the 2,248 Questionnaire responses, in general, poultry first processing operations slaughter only poultry and not meat animals. Of 231 facilities that reported performing poultry slaughtering in the MPP Questionnaire, only 8 percent (18 facilities) also reported performing meat slaughtering. However, integrated first and further poultry processing operations are fairly common; of the 231 facilities that reported performing poultry slaughtering in the MPP Questionnaire, 68 percent (157 facilities) also reported performing poultry further processing (U.S. EPA, 2023b). At integrated facilities, usually some fraction of the carcass produced is marketed as fresh meat and the remainder is transformed into processed products (U.S. EPA, 2004).

Based on the 5,055 MPP facilities identified in the United States, the EPA identified 290 poultry first processing facilities (including integrated facilities that do both poultry first and further processing) in operation in the United States. This represents an overall decrease in facilities since the 2004 MPP ELGs, when 470 poultry slaughter facilities were identified (U.S. EPA, 2004). Table 4-6 lists the top five states with the highest percentages of poultry first processing facilities (U.S. EPA, 2023a). Facility geographic distribution has remained largely unchanged since 2004. In addition, the ratio of meat to poultry first processing facilities in the MPP industry has remained almost unchanged in that time. In 2004, 25 percent of the first processing industry processed poultry and 75 percent processed meat (U.S. EPA, 2004). The current data collection found the split is now 26 percent poultry first processors (290 facilities) to 74 percent meat first processors (826 facilities) (U.S. EPA, 2023a).

Table 4-6. States with the Highest Percentages of Poultry First Processing Facilities

State	Percent of Poultry First Processing Facilities (290 Facilities)
Arkansas	9.3 (27 facilities)
Georgia	7.6 (22 facilities)
North Carolina	6.6 (19 facilities)
California	6.2 (18 facilities)
Alabama	6.2 (18 facilities)

Source: U.S. EPA, 2023a.

Of the 290 poultry first processing facilities identified by the EPA, 27 percent (77 facilities) conduct operations that could generate high chlorides wastestreams. Of these 77 facilities:

- 75 are integrated facilities that perform specific further processing operations known to be capable of generating high chlorides wastestreams (described in Section 4.4).
- One performs poultry koshering.
- One performs poultry koshering and specific further processing operations known to be capable of generating high chlorides wastestreams (U.S. EPA, 2023a).

Table 4-7 includes the number of poultry first processing facilities by annual production volume. The table also includes the average production and total production of all the facilities within each range, measured as pounds LWK per year. These data illustrate that 20 percent of all poultry first processing facilities each produce less than 5 million pounds LWK annually and collectively only account for 0.05 percent of total poultry first processing industry production volume. Meanwhile, 52 percent of all facilities produce 200 million pounds LWK annually or more and account for 93 percent of total industry production volume (U.S. EPA, 2023a).

Table 4-7. Poultry First Processing Facilities by Annual Production

Range (M lbs. LWK/yr.)	Number of Facilities	Average Production (lbs. LWK/yr.)	Total Production (lbs. LWK/yr.)
<5	57	978,592	55,779,726
5 to 30	19	9,952,568	189,098,791
>30 to <200	64	109,186,833	6,987,957,300
≥200	150	657,560,764	98,634,114,587
Total	**290**	**365,058,450**	**105,866,950,403**

Source: U.S. EPA, 2023a.

Abbreviations: M = million, lbs. = pounds, yr. = year.

4.4 Poultry Further Processing

Poultry further processing involves processing and preparing poultry and small game products and their byproducts from dressed poultry carcasses. Further processing can be as simple as splitting a carcass into two halves or as complex as producing a breaded, fully cooked product from a carcass. Poultry further processing operations include canning, cooking, cutting and/or deboning, extruding, forming, grinding, linking, marinating, pickling, seasoning, smoking, tenderizing, and trimming (U.S. EPA, 2004).

Based on conversations with industry, most MPP facilities use drinking water sources (public water supplies or well water) for all source water. Facilities may treat their source water with water softeners before use within the facility to minimize scale build-up in equipment and because the facilities are generating food-grade products (U.S. EPA, 2022a, 2022b). The waste brine from water softening generates a high chlorides wastestream. Most or all of the waste brine is discharged or disposed of, as reuse of brine affects performance of water softening systems (Liu et al., 2021).

The characteristics of wastewaters generated by further processing operations are similar to those generated by poultry first operations, such as containing soft and hard tissue (e.g., muscle, fat, and bone) and blood. Differences in these wastewater characteristics are largely driven by the type of finished product desired, as further processing wastewaters can contain substances used in final product preparation, such as breading, stuffing, and marinades. Poultry further processing wastewaters will contain products used for cleaning and disinfection (detergents and sanitizing agents) (U.S. EPA, 2004). While individual operations may take place on separate production lines, in separate rooms, or in separate buildings, process wastewater is typically collected via floor drains that comingle streams for end-of-pipe treatment.

Like meat processing, operations used for poultry further processing are largely the same as they were in 2004. The 2004 MPP TDD describes in detail the operations involved in further processing poultry. Operations that are sources of process wastewater and those that may generate high chlorides wastestreams include the following (U.S. EPA, 2004, unless otherwise cited):

- Thawing: Wet thawing submerges poultry products in tanks or vats containing warm water until thawed. Some facilities may spray frozen products with water.
- Carcass/poultry handling and preparation: Poultry carcasses may be cut, deboned, diced, or ground. Some facilities may use high powered water jets to assist in cutting and other operations. Facilities with manual operations (e.g., knives) typically provide a continuous stream of water on the work line to clean equipment. However, some carcass handling operations do not generate wastewater.
- Marinating: Poultry may be immersed in brine, injected with brine, tumbled with brine, or a combination thereof. Marination extends shelf-life, seals in moisture, increases meat yield, and adds flavor and tenderness. Marinades typically contain phosphates and salt for meat preservation and water retention (Alvarado and McKee, 2007).
    - Marinating generates high chlorides wastestreams from dripped or spilled brine, waste brine, and wash water. Brines are applied on dedicated work lines or facility areas.
- Curing: Immersion curing submerges poultry into a liquid brine or injects brine into the poultry to preserve it and develop a characteristic appearance and flavor. In dry curing, solid salts are rubbed into the poultry surface, which may be captured in wash water.
    - Curing generates high chlorides wastestreams through brine waste as well as rinse and wash water. Curing brines are often reused, and pumps recirculate brine that spills from the product or injection needles (USDA, 2020), facilitating capture of waste brine for treatment and/or disposal.
- Pickling: Large amounts of spillage from this operation typically occur by runoff from pickle injection, pickle oozing out of the meat after injection, dumping of cover pickle, and dumping of residual pickling solution at the end operations.
    - Pickling generates high chlorides wastestreams through spillage and cleanup from preparation of the pickling solutions, waste pickle, and spillage and cleanup from the pickle application process. As with liquid curing processes, pickling solutions are often pumped through equipment during application (USDA, 2020), facilitating capture of waste pickle for treatment and/or disposal.
- Smoking: Water that overflows during quenching of burned wood to generate dry smoke generates wastewater. Some facilities use liquid smoke products transformed into a gas via direct heat for application (USDA, 2020). Gas that condenses and drips off product or equipment is captured in wash water. Any moisture dripping from products during smoking is also captured in wash water.

- Smoking generates a high chlorides wastestream through spillage and cleanup of liquid smoke products and washing smoking chambers/smokehouses.

- **Cooking**: Poultry products are typically immersed in water in steam-jacketed open vats. Chicken parts, whole birds, and processed products may be immersed in hot water cookers. Cooking methods including microwaving and deep frying do not generate wastewater. However, all cooked products are cooled before any further processing; a common cooling technique is immersion in a cold-water tank with continuous overflow.
- **Casing/stuffing**: Water is used to lubricate casings for use in the stuffing operation.
- **Canning**: During preparation, filling, and can covering, water is used to remove any spilled product from equipment and outer can surfaces. Condensed steam during these operations is also a source of wastewater. Hand filling cans typically results in less wastewater than mechanical filling.
- **Cleaning operations**: Facilities clean regularly to maintain sanitary conditions. Cleaning entails rinsing all equipment, walls, and floors followed by scrubbing, chemical application, and a final rinse. For many facilities, cleaning operations produce the largest volumes of process wastewater.

Poultry further processing facilities are often highly automated or mechanized. Fully manual operations are more common in smaller facilities (U.S. EPA, 2004).

0Based on the 2,248 Questionnaire responses, 1,025 facilities indicated they further process poultry. Of these 1,025 facilities, 85 percent (868 facilities) indicated they perform stand-alone poultry further processing, meaning they perform only poultry further processing and not poultry slaughtering. Of these 868 facilities, 83 percent (720 facilities) indicated they also further process meat (U.S. EPA, 2023b).

Based on the 5,055 MPP facilities identified in the United States, the EPA identified 294 poultry further processing facilities in operation in the U.S.; these are distinct from poultry first processing operations that may have integrated poultry further processing operations. Table 4-8 lists the top five states with the highest percentages of poultry further processing facilities (U.S. EPA, 2023a). The 2004 TDD did not include demographic data on stand-alone poultry further processing facilities.

Table 4-8. States with the Highest Percentages of Poultry Further Processing Facilities

State	Percent of Poultry Further Processing Facilities (294 Facilities)
California	9.5 (28 facilities)
Georgia	7.1 (21 facilities)
Arkansas	6.8 (20 facilities)
Pennsylvania	5.4 (16 facilities)
New York	5.1 (15 facilities)

Source: U.S. EPA, 2023a.

Of the 294 poultry further processing facilities the EPA identified, 22 percent (64 facilities) conduct operations that could generate high chlorides wastestreams from specific further processing operations, such as marinating and pickling (U.S. EPA, 2023a).

Table 4-9 includes the number of poultry further processing facilities by annual production volume. The table also includes the average production and total production of all the facilities within each range, measured as pounds of finished product per year. These data illustrate that 37 percent of all poultry further processing facilities each produce less than 2 million pounds of finished product annually and collectively only account for 0.3 percent of total poultry further processing industry production volume. Another 37 percent of all facilities each produce more than 30 million pounds of finished product annually and account for 94 percent of total industry production volume (U.S. EPA, 2023a).

Table 4-9. Poultry Further Processing Facilities by Annual Production

Range (M lbs. Finished Product/yr.)	Number of Facilities	Average Production (lbs. Finished Product/yr.)	Total Production (lbs. Finished Product/yr.)
<2	110	374,738	41,221,200
2 to <10	50	5,417,051	270,852,547
10 to 30	25	19,011,483	475,287,078
>30	109	112,415,194	12,253,256,125
Total	**294**	**44,355,840**	**13,040,616,950**

Source: U.S. EPA, 2023a.

Abbreviations: M = million, lbs. = pounds, yr. = year.

4.5 Rendering

Rendering facilities convert byproducts of meat and poultry processing into marketable products. Rendering materials include viscera, meat scraps (e.g., fat, bone, blood, feathers), hatchery by-products (e.g., infertile eggs, dead embryos), and dead animals (U.S. EPA, 2004), as well as used cooking oil from restaurants (Wilkinson and Meeker, 2021) and other organic waste materials.

The characteristics of wastewater generated by rendering facilities depend on several factors, including the type of product produced (e.g., edible vs. inedible) and the type(s) of raw material rendered. Factors such as rate of cooking, speed of agitation, cooker overloading, foaming, and presence of grease traps can result in volume and composition differences among rendering facilities (U.S. EPA, 2004). While individual operations may take place on separate production lines, in separate rooms, or in separate buildings, process wastewater is typically collected via floor drains that comingle streams for end-of-pipe treatment.

In general, rendering involves cooking raw material to recover fats, oil, and grease; remaining residue is dried and then granulated or ground into a meal. The 2004 MPP TDD describes the operations involved in rendering. It also describes operations that are sources of process wastewater (U.S. EPA, 2004). The EPA did not identify any high chlorides wastestreams produced by rendering operations.

- **Cooking**: Condensed steam from cooking operations is a large portion of wastewater generated from rendering operations.
- **Blood processing**: The drying process generates wastewater.
- **Hydrolyzing (feather and hair processing)**: The drying process generates wastewater.
- **Boiler blowdown**: Blow-down to remove accumulated solids inside boilers generates wastewater.
- **Air scrubbing**: Water used in air scrubbers, commonly used to control odor, generates wastewater.
- **Cleaning operations**: Facilities clean regularly to maintain sanitary conditions. However, rendering cleanup operations are typically less rigorous than first and further processing operations, generating a smaller proportion of the total process wastewater flow.

Based on the 2,248 Questionnaire responses received, some MPP processing facilities have integrated rendering facilities. Data from the MPP Questionnaire show that, of 200 facilities that reported performing rendering operations, 43 percent (86 facilities) also reported performing first and/or further processing operations. These facilities typically process only one type of raw material, meat or poultry - whichever one they process onsite. Of the 86 facilities that reported integrated rendering operations, only 17 percent (15 facilities) processed both meat and poultry products (U.S. EPA, 2023b). Integrated rendering facilities typically perform edible rendering, which aims to separate fatty animal tissue into edible fats and proteins, such as lard and food-grade tallow, but they can also perform inedible rendering or produce both types of products (U.S. EPA, 2004).

Independent rendering operations are more common. Of 200 facilities that reported performing rendering on the MPP Questionnaire, 57 percent (114 facilities) reported performing independent rendering (U.S. EPA, 2023b). Independent rendering facilities most often produce inedible products (i.e., not suitable for human consumption), such as industrial and animal feed-grade fats, meat and poultry byproduct meals, feather meal, dried blood, hydrolyzed hair (U.S. EPA, 2004), and even refined oil for biofuel and renewable diesel (Wilkinson and Meeker, 2021). These facilities often process several types of raw material that require either multiple rendering systems or significant modifications in the operating conditions for a single system. Raw material is typically received from farms, animal feeding operations, first processors, further processors, and restaurants (e.g., grease from traps and oil from fryers), but sources can include a wide range of facilities from butcher shops to animal shelters. Rendering collection areas for raw material are limited by cost of transportation and travel time for the raw material to reach the rendering facility (U.S. EPA, 2004).

Based on the 5,055 MPP facilities identified in the U.S., the EPA identified 185 independent rendering facilities in operation in the U.S. Table 4-10 lists the top five states with the highest percentages of independent rendering facilities (U.S. EPA, 2023a). This represents a decrease in facilities since publication of the 2004 MPP ELGs, when 240 facilities were identified and California and Texas hosted the highest numbers of facilities (U.S. EPA, 2004).

Table 4-10. States with the Highest Percentages of Independent Rendering Facilities

State	Percent of Independent Rendering Facilities (185 Facilities)
California	8.1 (15 facilities)
Iowa	8.1 (15 facilities)
Illinois	7.0 (13 facilities)
Texas	6.5 (12 facilities)
Georgia	6.5 (12 facilities)

Source: U.S. EPA, 2023a.

Table 4-11 includes the number of independent rendering facilities by annual production volume. The table also includes the average production and total production of all the facilities within each range, measured as pounds of raw material rendered per year. These data illustrate that 12 percent of all independent rendering processing facilities each render less than 5 million pounds of raw material annually and collectively only account for 0.1 percent of total independent rendering processing industry production volume. Thirteen percent of all facilities render 350 million pounds of raw material or more annually and account for 46 percent of total industry production volume. However, the bulk of the industry is represented by the 66 percent of facilities that each render between 30 and 350 million pounds of raw material annually and account for 54 percent of total industry production volume (U.S. EPA, 2023a).

Table 4-11. Independent Rendering Facilities by Annual Production

Range (M lbs. Raw Material/yr.)	Number of Facilities	Average Production (lbs. Raw Material/yr.)	Total Production (lbs. Raw Material/yr.)
<5	23	1,504,083	34,593,920
5 - 30	16	13,340,427	213,446,838
>30 - <350	122	165,209,335	20,155,538,830
≥350	24	711,812,964	17,083,511,139
Total	**185**	**202,632,923**	**37,487,090,727**

Source: U.S. EPA, 2023a.

Abbreviations: M = million, lbs. = pounds, yr. = year.

4.6 References

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5. Industry Subcategorization

The Clean Water Act (CWA) requires the U.S. Environmental Protection Agency to consider several different factors when developing effluent limitations guidelines or standards (ELGs) for a particular industry category (Section 304(b)(2)(B), 33 U.S.C. § 1314(b)(2)(B)). For determining Best Available Technology Economically Available (BAT), these factors include the technological availability, the economic achievability, the age of the equipment and facilities, the process employed, the engineering aspects of the application of various types of control techniques, process changes, the cost of achieving such effluent reduction, non-water quality environmental impacts (including emissions from energy usage), and other factors the Administrator deems appropriate. One way the EPA may take these factors into account, where appropriate, is by dividing a point source category into groupings called "subcategories." Regulating an industry with subcategories, where determined to be warranted, ensures that each subcategory has a uniform set of ELGs that consider technological availability, economic achievability, and other relevant factors unique to that subcategory.

In establishing the original ELGs for the meat and poultry products (MPP) industry, and again in the 2004 revisions, the EPA broke the industry down into subcategories with similar characteristics. This breakdown recognized the major differences among companies within the industry, which might reflect, for example, different processes or economies of scale. Subdividing an industry into subcategories results in more tailored regulatory standards, thereby increasing regulatory predictability and diminishing the need to address variations among facilities through a variance process. See *Weyerhaeuser Co. v. Costle*, 590 F. 2d 1011, 1053 (D.C. Cir. 1978).

5.1 MPP Proposed Subcategorization

Currently, the point source category is divided into 12 subcategories based on operation and material processed (U.S. EPA, 2004). Discharge requirements within the subcategories vary depending on size, measured by production rates (e.g., facilities that slaughter more than 50 million pounds per year). The EPA proposes keeping the same 12 subcategories as they continue to reflect differences in processes and wastewater strength and composition. The EPA has not identified any additional processes or changes in processes since the 2004 rulemaking that would warrant revision of the existing subcategories or consideration of any additional subcategories. The current MPP subcategories are:

- Simple Slaughterhouse (Subcategory A).
- Complex Slaughterhouse (Subcategory B).
- Low Processing Packinghouse (Subcategory C).
- High-Processing Packinghouse (Subcategory D).
- Small Processor (Subcategory E).
- Meat Cutter (Subcategory F).
- Sausage and Luncheon Meats Processor (Subcategory G).
- Ham Processor (Subcategory H).
- Canned Meats Processor (Subcategory I).
- Renderer (Subcategory J).
- Poultry First Processing (Subcategory K).
- Poultry Further Processing (Subcategory L).

The Agency also believes that retaining the existing subcategorization scheme will simplify implementation for the permit writers, as well as provide a sound basis for limitations and standards for the facilities. The EPA is proposing revisions to applicable pollutant limitations and proposing the addition of new pretreatment standards for all subcategories except Subcategory E.

As part of the proposed rule, the EPA considered other regulatory options (Option 2 and Option 3) that retained the subcategories but factored in different technology bases by production thresholds (see Preamble Section VII.A). The EPA did not select these options as the preferred regulatory option in the proposed rule, although is soliciting comment on and may consider these and other options in finalizing the rule; see Section VII.F of the Preamble for details.

5.2 References

1. U.S. EPA. 2004. *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432)* (September). EPA-821-R-04-011. Available online at: https://www.epa.gov/sites/default/files/2015-11/documents/meat-poultry-products_tdd_2004_0.pdf.

6. Wastewater Characterization

This section describes the characteristics of wastewater generated and discharged by meat and poultry products (MPP) processing facilities. The information in this section is based on data from U.S. Environmental Protection Agency sampling events and facility-reported data. The EPA is proposing effluent limitations guidelines and standards (ELGs) for the MPP industry that include regulations on all sources of MPP process wastewater. Process wastewater from MPP facilities includes any water used during MPP processing activities that comes into direct contact with any raw material, intermediate product, finished product, byproduct, or waste product. The proposed pollutants for regulation in MPP wastestreams are consistent across the MPP industry's various processing operations. Wastewaters generated during meat processing, poultry processing, and rendering are discussed in Sections 6.1 through 6.3. Section 6.4 discusses the wastewater characteristics of segregated high chlorides wastestreams, a specific type of MPP process wastewater which may be generated by some MPP operations. Each section discusses wastewater flow rates and wastewater constituents present in raw MPP process wastewaters6.4.

6.1 Meat Processing

This section discusses wastewater generated from meat first and meat further processes. Most meat processing wastewater is generated from carcass washing after hide removal, hair removal (scalding), evisceration, and cleaning and sanitization of equipment and facilities. In general, meat first processing uses more water than further processing. Most meat processing facilities operate 5 to 6 days per week with the killing cycle followed by processing and cleaning operations. A processing shift is typically 8 to 10 hours in duration and a cleaning and sanitation shift is typically 6 to 8 hours. Since water use and wastewater generation essentially cease after cleanup and do not start again until the next processing cycle begins, the rate of water use and wastewater generation varies with both time of day and day of the week. During processing, wastewater generation volumes are relatively lower and more constant compared to the larger volumes required during cleanup. In addition, there is little water use or wastewater generation on nonprocessing days, which are usually Saturdays and Sundays (U.S. EPA, 2004). As described in Section 4, typically all process wastewater, including water used during cleanup and sanitation, is collected via floor drains and comingled for end-of-pipe treatment.

The EPA evaluated wastewater generation flow rates based on data reported in Question 36 of the *Detailed Questionnaire for the Meat and Poultry Products Effluent Guidelines* (Detailed Questionnaire). For facilities identified as meat first processors or meat further processors in the MPP industry profile, Table 6-1 includes the number of facilities by annual production volume. The table also includes the median, minimum, and maximum wastewater generation flow rates in millions of gallons per day (MGD) using data as reported in the Detailed Questionnaire.

Table 6-1. MPP Process Wastewater Generation Flow Rates for Meat Processing Facilities By Annual Production as Reported in the Detailed Questionnaire

Production Range	Number of Facilities	Median Wastewater Generation Flow Rate (MGD)	Range of Wastewater Generation Flow Rates (MGD)
Meat First Processing[a]			
<5M lbs. LWK/yr.	51	0.00196	9.22E-06—1.35
5 to <10M lbs. LWK/yr.	0	NA	NA
10 to <200M lbs. LWK/yr.	20	0.0484	0.00260—0.298
≥200M lbs. LWK/yr.	52	1.05	0.110—3.83
Total	**123**	**0.0814**	**9.22E-06—3.83**
Meat Further Processing[b]			
<2M lbs. Finished Product/yr.	21	0.00109	2.04E-06—2.41
2 to <10M lbs. Finished Product/yr.	10	0.00653	0.000356—1.62
10 to 50M lbs. Finished Product/yr.	17	0.0577	0.00178—2.00
>50M lbs. Finished Product/yr.	42	0.241	0.00791—2.66
Total	**90**	**0.0926**	**2.04E-06—2.66**

Source: U.S. EPA, 2023a, 2023b.

Abbreviations: M = million, lbs. = pounds, LWK = live weight killed, yr. = year.

Notes: Flow rates presented as three significant figures. Wastewater generation flow rates are based on data from Detailed Questionnaire responses to Question 36.

a — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 27 (11 producing <5M lbs. LWK/yr., two producing 5 to <10M lbs. LWK/yr., six producing 10 to <200M lbs. LWK/yr., and eight producing ≥200M lbs. LWK/yr.) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. These suspected outlier values were not included in this evaluation of wastewater generation flow rates.

b — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 35 (two producing <2M lbs. finished product/yr., five producing 2 to <10M lbs. finished product/yr., 14 producing 10 to 50M lbs. finished product/yr., and 15 producing >50M lbs. finished product/yr.) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. These suspected outlier values were not included in this evaluation of wastewater generation flow rates.

In general, production is directly correlated with the volume of process wastewater generated, higher production results in higher wastewater generation. In total, meat further processing facilities generate a slightly higher median volume of wastewater than meat first processing facilities. Meat first processing facilities generate 0.319 gallons per pound of LWK. Meat further processing facilities generate 0.970 gallons per pound of finished product, more than three times as much as meat first processing facilities (U.S. EPA, 2023a, 2023b). To get these average production flow rates, the EPA calculated the total pounds produced per year and total gallons of process wastewater generated per year by each process type, using data from the Detailed Questionnaire (excluding suspected wastewater generation flow rate reporting errors).

The EPA also evaluated wastewater generation flow rates by facility discharge type. For facilities identified as meat first processors or meat further processors and as direct, indirect, or zero dischargers in the MPP industry profile, Table 6-2 includes the median wastewater generation flow rates in MGD using data as reported in the Detailed Questionnaire.

Table 6-2. MPP Process Wastewater Generation Flow Rates for Meat Processing Facilities By Discharge Type as Reported in the Detailed Questionnaire

Type of Discharge	Number of Facilities	Median Wastewater Generation Flow Rate (MGD)
Meat First Processing[a]		
Direct	23	1.16
Indirect	62	0.0521
Zero Discharge	38	0.00215
Total	**123**	**0.0814**
Meat Further Processing[b]		
Direct	8	0.346
Indirect	67	0.109
Zero Discharge	15	0.00731
Total	**90**	**0.0926**

Source: U.S. EPA, 2023a,2023b.

Notes: Flow rates presented as three significant figures. Wastewater generation flow rates are based on data from Detailed Questionnaire responses to Question 36.

a — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 27 generation flow rates reported for these facilities (one direct discharger, 13 indirect dischargers, and 13 zero dischargers) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. Including flows greater than these values, the median generation flow rates are 1.17 MGD for direct dischargers, 0.280 MGD for indirect dischargers, and 0.0195 MGD for zero dischargers.

b — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 36 generation flow rates reported for these facilities (two direct dischargers, 31 indirect dischargers, and three zero dischargers) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. Including flows greater than these values, the median generation flow rates are 0.490 MGD for direct dischargers, 0.253 MGD for indirect dischargers, and 0.0210 MGD for zero dischargers.

The current MPP ELGs only include requirements for direct dischargers. 52 percent of meat first processing facilities and 74 percent of meat further processing facilities are indirect dischargers (U.S. EPA, 2023a). Thus, under the 2004 MPP ELGs, the majority of meat processing facilities are not regulated by the ELG. Of note, meat processing facilities operating to achieve zero discharge, which may not be covered by National Pollutant Discharge Elimination System (NPDES) requirements, generate the smallest quantities of wastewater of all meat processing facilities (U.S. EPA, 2023b).

The principal sources of wastes in meat processing are live animal holding, killing, hide or hair removal, eviscerating, carcass washing, trimming, and cleanup operations. Meat processing wastes include blood, viscera, soft tissue, bone, manure (urine and feces), soil from hides and hooves, and various cleaning and sanitizing compounds. Further processing and hide processing operations are a source of fat and other soft tissues, as well as substances such as brines, cooking oils, and tanning solutions. Pollutants found in untreated wastewater from meat processing operations include:

- Biochemical oxygen demand (BOD), total Kjeldahl nitrogen (TKN), ammonia nitrogen, and grease from blood, fat, and manure.
- Ammonia nitrogen from cleaning and sanitizing compounds.
- Nitrite and nitrate nitrogen from bacon and ham curing operations.
- Phosphorus from bone, soft tissue, blood, manure, and cleaning and sanitizing compounds.
- Total coliforms, fecal coliforms, and fecal streptococcus bacteria from manure.
- Chlorides from brines, meat koshering, hides processing, and water softening.

- Mineral elements introduced to wastewater from supply water.
- Metals from water supply systems and mechanical equipment. Hog manure may be a significant source of copper, arsenic, and zinc because these constituents are commonly added to hog feed (U.S. EPA, 2004).

As discussed in Section 3, the EPA reviewed analytical data gathered through the sampling program and the Detailed Questionnaire. Table 6-3 displays the average concentrations of pollutants in untreated MPP process wastewater at integrated meat first processing facilities (facilities that perform both meat first processing and meat further processing). The EPA did not receive adequate data with which to characterize wastewater from stand-alone meat first processing facilities. Lacking these data, the EPA used all available meat processing data to characterize all meat operations (first only, further only, and integrated meat operations). As described in Section 4.1, only a small portion of meat first processors are stand-alone facilities. The EPA received data from six integrated meat processing facilities.

Table 6-3. Average Pollutant Concentrations in Untreated MPP Wastewater at Integrated Meat Processing Facilities

Analyte	Unit	Integrated Meat Processing Average Concentration
Aluminum	mg/L	0.564
Ammonia	mg/L	61.7
Barium	mg/L	0.0984
Biochemical Oxygen Demand (BOD)	mg/L	3,870
Bromide	mg/L	1.99
Calcium	mg/L	87.9
Carbonaceous Biochemical Oxygen Demand (cBOD)	mg/L	3,620
Chemical Oxygen Demand (COD)	mg/L	5,720
Chloride	mg/L	675
Copper	mg/L	0.110
E. coli	MPN/100mL	9,540,000
Enterococci	MPN/100mL	6,260,000
Fecal Coliform	MPN/100mL	3,730,000
Fluoride	mg/L	23.9
Iron	mg/L	35.1
Magnesium	mg/L	36.4
Manganese	mg/L	0.257
Molybdenum	mg/L	0.0262
Nitrogen, Total	mg/L	195
Oil and Grease	mg/L	1,420
Phosphorus, Total	mg/L	36.1
Sodium	mg/L	512
Sulfate	mg/L	32.0
Titanium	mg/L	0.0831
Total Dissolved Solids (TDS)	mg/L	2,970
Total Organic Carbon	mg/L	545
Total Suspended Solids (TSS)	mg/L	2,160
Vanadium	mg/L	0.0738

Table 6-3. Average Pollutant Concentrations in Untreated MPP Wastewater at Integrated Meat Processing FacilitiesTable 6-2. MPP Process Wastewater Generation Flow Rates for Meat Processing Facilities By Discharge Type as Reported in the Detailed Questionnaire

Analyte	Unit	Integrated Meat Processing Average Concentration
Zinc	mg/L	0.504

Source: U.S. EPA, 2023c.

Abbreviations: mg/L = milligram per liter, MPN/100mL = most probable number per 100 milliliters.

Note: Results presented as three significant figures.

Data available to characterize stand-alone meat further processing operations are limited to data reported by one facility for four analytes: ammonia, BOD, total phosphorus, and total suspended solids (TSS). For all four analytes, the average concentrations from integrated meat processing facilities were at least four times higher than concentrations reported by the meat further processor (U.S. EPA, 2023c).

6.2 Poultry Processing

In poultry processing, most process wastewater is generated by scalding for feather removal, bird washing before and after evisceration, chilling, and cleaning and sanitizing of equipment and facilities. Rates of wastewater generation at poultry first processing facilities typically exceed those generated at meat first processing facilities, largely due to required continuous overflows from scalding tanks and carcass immersion in ice bath chillers. Rates of wastewater generation by poultry first processing is typically higher than poultry further processing. Most poultry processing facilities operate 5 to 6 days per week with the killing cycle followed by processing and cleaning operations. Water use and wastewater generation essentially cease after cleanup and do not start again until the next processing cycle begins. As a result, the rate of wastewater generation varies by both time of day and day of the week (U.S. EPA, 2004). As described in Section 4, typically all process wastewater, including water used during cleanup and sanitation, is collected via floor drains and comingled for end-of-pipe treatment.

The EPA evaluated wastewater generation flow rates based on data reported in Question 36 of the Detailed Questionnaire. For facilities identified as poultry first processors or poultry further processors in the MPP industry profile, Table 6-4 includes the number of facilities by annual production volume. The table also includes the median, minimum, and maximum wastewater generation flow rates in MGD using data as reported in the Detailed Questionnaire.

Table 6-4. MPP Process Wastewater Generation Flow Rates for Poultry Processing Facilities By Annual Production as Reported in the Detailed Questionnaire

Production Range	Number of Facilities	Median Wastewater Flow Rate (MGD)	Range of Wastewater Flow Rates (MGD)
Poultry First Processing[a]			
<5M lbs. LWK/yr.	8	0.0112	9.05E-05—0.0997
5 to 30M lbs. LWK/yr.	6	0.0463	0.000500—0.761
>30 to <200M lbs. LWK/yr.	14	0.689	0.120—2.04
≥200M lbs. LWK/yr.	75	1.21	0.00312—3.52
Total	**103**	**0.982**	**9.05E-05—3.52**
Poultry Further Processing[b]			
<2M lbs. Finished Product/yr.	2	0.0666	0.0261—0.107
2 to <10M lbs. Finished Product/yr.	5	0.0108	0.00350—0.0308
10 to 30M lbs. Finished Product/yr.	4	0.0346	0.00514—1.06
>30M lbs. Finished Product/yr.	16	0.234	0.0192—0.882
Total	**27**	**0.0996**	**0.00350—1.06**

Source: U.S. EPA, 2023a, 2023b.

Abbreviations: M = million, lbs. = pounds, LWK = live weight killed, yr. = year.

Notes: Flow rates presented as three significant figures. Wastewater generation flow rates are based on data from Detailed Questionnaire responses to Question 36.

a — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 39 generation flow rates reported for these facilities (four producing <5M lbs. LWK/yr., four producing 5 to 30M lbs. LWK/yr., four producing >30 to <200M lbs. LWK/yr., and 29 producing ≥200 M lbs. LWK/yr.) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. These suspected outlier values were not included in this evaluation of wastewater generation flow rates.

b — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 13 generation flow rates reported for these facilities (two producing <2M lbs. finished product/yr., two producing 2 to <10M lbs. finished product/yr., two producing 10 to 30M lbs. finished product/yr., and seven producing >30M lbs. finished product/yr.) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. These suspected outlier values were not included in this evaluation of wastewater generation flow rates.

In general, production is directly correlated with the volume of process wastewater generated, higher production results in higher wastewater generation. Poultry first processing facilities generate a higher median volume of wastewater than poultry further processing facilities. However, on average, poultry first processing facilities generate 0.645 gallons per pound of LWK. Poultry further processing facilities generate 1.05 gallons per pound of finished product, 1.6 times as much as poultry first processing facilities (U.S. EPA, 2023a, 2023b). To get these average production flow rates, the EPA calculated the total pounds produced per year and total gallons of process wastewater generated per year by each process type, using data from the Detailed Questionnaire (excluding suspected wastewater generation flow rate reporting errors).

When comparing gallons of process wastewater generated per pound at meat processing facilities to those at poultry processing facilities, poultry first processing facilities generate twice as many gallons per pound as meat first processing facilities. However, meat further processing facilities and poultry further processing facilities generated nearly equal rates of gallons per pound (U.S. EPA, 2023a, 2023b).

The EPA also evaluated wastewater generation flow rates by facility discharge type. For facilities identified as poultry first processors or poultry further processors and as direct, indirect, or zero dischargers in the MPP industry profile, Table 6-5 includes the median wastewater generation flow rates in MGD using data as reported in the Detailed Questionnaire.

Table 6-5. MPP Process Wastewater Generation Flow Rates for Poultry Processing Facilities By Discharge Type as Reported in the Detailed Questionnaire

Type of Discharge	Number of Facilities	Median Wastewater Generation Flow Rate (MGD)
Poultry First Processing[a]		
Direct	33	1.21
Indirect	52	0.970
Zero Discharge	18	0.0938
Total	**103**	**0.982**
Poultry Further Processing[b]		
Direct	2	0.926
Indirect	22	0.0861
Zero Discharge	3	0.0185
Total	**27**	**0.0996**

Source: U.S. EPA, 2023a, 2023b.

Notes: Flow rates presented as three significant figures. Wastewater generation flow rates are based on data from Detailed Questionnaire responses to Question 36.

a — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 41 generation flow rates reported for these facilities (14 direct dischargers, 13 indirect dischargers, and 14 zero dischargers) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. Including flows greater than these values, the median generation flow rates are 1.41 MGD for direct dischargers, 1.23 MGD for indirect dischargers, and 1.60 MGD for zero dischargers.

b — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 13 generation flow rates reported for these facilities (one direct discharger, nine indirect dischargers, and three zero dischargers) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. Including flows greater than these values, the median generation flow rates are 1.060 MGD for direct dischargers, 0.202 MGD for indirect dischargers, and 100.2 MGD for zero dischargers.

The current MPP ELGs only include requirements for direct dischargers. 51 percent of poultry first processing facilities and 81 percent of poultry further processing facilities are indirect dischargers (U.S. EPA, 2023a). Thus, under the 2004 MPP ELGs, the majority of poultry processing facilities are not regulated by the ELG. Of note, poultry processing facilities operating to achieve zero discharge, which may not be covered by National Pollutant Discharge Elimination System (NPDES) requirements, generate the smallest quantities of wastewater of all meat processing facilities (U.S. EPA, 2023b).

Waste from poultry processing includes blood, feathers, viscera, soft tissue, manure, bone, soil from feathers, and various cleaning and sanitizing compounds. Further processing operations can produce animal fat and other soft tissue, as well as other substances such as pickling brines and cooking oils. Pollutants found in untreated wastewater from poultry processing operations include:

- BOD, TKN, ammonia nitrogen, and grease from blood, fat, and manure. BOD is more significant in poultry processing wastewaters than in meat processing wastewaters because of fat transmission from immersion chilling and because of feather and skin oils desorbed during feather removal scalding.
- Ammonia nitrogen from cleaning chemicals.
- Phosphorus from bone, soft tissue, blood, manure, and cleaning and sanitizing compounds.
- Total coliforms, fecal coliforms, and fecal streptococcus bacteria from manure.
- Chlorides from brines, poultry koshering, and water softening.
- Mineral elements introduced to wastewater from supply water.

- Metals from water supply systems and mechanical equipment. Poultry manure is a significant source of arsenic and zinc (U.S. EPA, 2004).

As discussed in Section 3, the EPA reviewed analytical data gathered through the sampling program and the Detailed Questionnaire. Table 6-6 displays the average concentrations of pollutants in untreated MPP process wastewater at poultry first processing facilities and integrated poultry processing facilities (facilities that perform both poultry first and further processing). The EPA did not receive adequate data with which to characterize wastewater from stand-alone poultry further processing facilities. Lacking these data, the EPA used all available poultry processing data to characterize all poultry operations (first only, further only, and integrated poultry operations). The EPA received data from one poultry first processing facility and seven integrated poultry facilities.

Table 6-6. Average Pollutant Concentrations in Untreated MPP Wastewater at Poultry First and Integrated Poultry Processing Facilities

Analyte	Unit	Poultry First and Integrated Poultry Processing Average Concentration
Aluminum	mg/L	0.576
Ammonia	mg/L	88.1
Biochemical Oxygen Demand (BOD)	mg/L	4,660
Bromide	mg/L	0.0580
Calcium	mg/L	24.2
Carbonaceous Biochemical Oxygen Demand (cBOD)	mg/L	1,280
Chemical Oxygen Demand (COD)	mg/L	3,020
Chloride	mg/L	98.8
E. coli	MPN/100mL	396,000
Enterococci	MPN/100mL	319,000
Fecal Coliform	MPN/100mL	169,000
Fluoride	mg/L	15.8
Magnesium	mg/L	10.2
Nitrogen, Total	mg/L	122
Oil and Grease	mg/L	177
Phosphorus, Ortho-P	mg/L	14.5
Phosphorus, Total	mg/L	17.3
Sodium	mg/L	148
Sulfate	mg/L	56.6
Total Dissolved Solids (TDS)	mg/L	4,680
Total Organic Carbon	mg/L	406
Total Suspended Solids (TSS)	mg/L	6,520
Zinc	mg/L	0.156

Source: U.S. EPA, 2023c.

Abbreviations: mg/L = milligram per liter, MPN/100mL = most probable number per 100 milliliters.

Note: Results presented as three significant figures.

Data available to characterize stand-alone poultry first processing operations (not integrated) are limited to data reported by one facility for two analytes: ammonia and chemical oxygen demand (COD). The average ammonia concentration from integrated facilities was at least 10 times higher than concentrations reported by the poultry first processor. The COD concentration reported by the poultry first processor was less than half of the average concentration from the integrated facilities (U.S. EPA, 2023c).

6.3 Independent Rendering

Major sources of wastewater from rendering operations include raw material receiving operations, condensing cooking vapors, drying, facility cleanup, and truck and barrel washing. Variations in wastewater flow are largely attributable to the fact that different facilities use different types of condensers on cooking vapors. Inconsistencies in the initial moisture content of the raw material also contribute to variations in wastewater flow, but to a lesser extent. Rendering usually is a 24-hour operation and commonly occurs on a seven-days-per-week schedule. However, cleanup of rendering equipment and facilities is less intensive than that in processing facilities and usually occurs only once per day, after raw material is received and prepared for processing. Thus, despite consistent weekly production, wastewater generation flow rates vary throughout the operating day (U.S. EPA, 2004). As described in Section 4, typically all process wastewater, including water used during cleanup and sanitation, is collected via floor and ground drains and comingled for end-of-pipe treatment.

The EPA evaluated wastewater generation flow rates based on data reported in Question 36 of the Detailed Questionnaire. For facilities identified as independent renderers in the MPP industry profile, Table 6-7 includes the number of facilities by annual production volume. The table also includes the median, minimum, and maximum wastewater generation flow rates in MGD, using data as reported in the Detailed Questionnaire.

Table 6-7. MPP Process Wastewater Generation Flow Rates for Independent Rendering Facilities By Annual Production as Reported in the Detailed Questionnaire

Production Range (M lbs. Raw Material/yr.)	Number of Facilities[a]	Median Wastewater Flow Rate (MGD)	Range of Wastewater Flow Rates (MGD)
<5	0	NA	NA
5 to 30	1	0.107	0.107—0.107
>30 to <350	17	0.0971	0.0202—2.04
≥350	4	0.321	0.151—1.91
Total	**22**	**0.112**	**0.0202—2.04**

Source: U.S. EPA, 2023a, 2023b.

Abbreviations: M = million, lbs. = pounds, yr. = year.

Notes: Flow rates presented as three significant figures. Wastewater generation flow rates are based on data from Detailed Questionnaire responses to Question 36.

a — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 13 generation flow rates reported for these facilities (one processing <5M lbs. raw material/yr., one processing 5 to 30M lbs. raw material/yr., nine processing >30 to <350M lbs. raw material/yr., and two processing ≥350M lbs. raw material/yr.) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. These suspected outlier values were not included in this evaluation of flow rates.

In general, production is directly correlated with the volume of process wastewater generated, higher production results in higher wastewater generation. Independent rendering facilities, on average, generate 0.333 gallons per pound of raw material. This is most similar to the gallons of process wastewater generated per pound by meat first processing facilities (U.S. EPA, 2023a, 2023b). To get this average production flow rate, the EPA calculated the total pounds produced per year and total gallons of process wastewater generated per year, using data from the Detailed Questionnaire (excluding suspected wastewater generation flow rate reporting errors).

The EPA also evaluated wastewater discharge flow rates by facility discharge type. For facilities identified as independent renderers and as direct, indirect, or zero dischargers in the MPP industry profile, Table 6-8 includes the median wastewater generation flow rates in MGD, using data as reported in the Detailed Questionnaire.

Table 6-8. MPP Process Wastewater Generation Flow Rates for Independent Rendering Facilities By Discharge Type as Reported in the Detailed Questionnaire

Type of Discharge	Number of Facilities	Median Wastewater Generation Flow Rate (MGD)[a]
Direct[b]	3	0.209
Indirect	12	0.0986
Zero Discharge	6	0.133
Total	**22**	**0.112**

Source: U.S. EPA, 2023a, 2023b.

Notes: Flow rates presented as three significant figures. Wastewater generation flow rates are based on data from Detailed Questionnaire responses to Question 36.

a — Of the facilities that reported wastewater generation flow rates in response to the Detailed Questionnaire, the EPA suspects that as many as 13 generation flow rates reported for these facilities (three direct dischargers, seven indirect dischargers, and three zero dischargers) reported rates that include a unit of measurement error. Based on the distribution of flows reported in the MPP Questionnaires, the EPA suspects that flows reported above 4.4 MGD are reporting errors. Including flows greater than these values, the median generation flow rates are 85.02 MGD for direct dischargers, 0.1510 MGD for indirect dischargers, and 0.1711 MGD for zero dischargers.

b — Facilities with both direct and indirect discharges were classified as direct dischargers for this presentation.

The current MPP ELGs only include requirements for direct dischargers. 57 percent of independent rendering facilities are indirect dischargers, and therefore, are not nationally regulated under the ELG (U.S. EPA, 2023a).

The characteristics of wastewater generated by rendering facilities depend on several factors, including the type of product produced (e.g., edible vs. inedible) and the type of raw materials rendered. Factors such as rate of cooking, speed of agitation, cooker overloading, foaming, and presence of grease traps can result in volume and composition differences among rendering facilities. In some cases, wastewater treatment solids from dissolved air flotation (DAF) treatment units are recycled back to the rendering process. In processes that produce edible products, DAF solids are not recycled back to the rendering process. At facilities that use metal salts for flocculation/coagulation prior to or in DAF treatment, the DAF solids also cannot be recycled back to the rendering process.

The composition of rendering process wastewaters can be impacted by the degree of decomposition that occurs before rendering. The rate of decomposition accelerates in warm weather, leading to increased ammonia concentrations in untreated rendering process wastewater during summer months. Much of this decomposition occurs during transport of raw material, as raw material is not climate controlled. In many cases, the threat of decomposition can limit the maximum transport distance for raw materials that rendering facilities can accept (U.S. EPA, 2004). Pollutants found in untreated wastewater from rendering operations include:

- BOD resulting from the cooking and drying process.
- Phosphorus from bone, soft tissue, blood, and corrosion control additives in boiler water.
- COD, TKN, ammonia nitrogen, and grease from blood (U.S. EPA, 2004).

As discussed in Section 3, the EPA reviewed analytical data gathered through the sampling program and the Detailed Questionnaire. Table 6-9 displays the average concentrations of pollutants in untreated MPP process wastewaters at independent rendering facilities. While the pollutants are similar to those from meat and poultry processing, the pollutant concentrations tend to be much higher. Rendering facilities typically produce less wastewater than first and further processors, which can attribute to higher pollutant concentrations in the untreated wastewater. This is, in part, due to the less intensive cleanup and sanitation at rendering facilities compared to first and further processors. The EPA received data from three independent rendering facilities.

Table 6-9. Average Pollutant Concentrations in Untreated MPP Wastewater at Independent Rendering Facilities

Analyte	Unit	Independent Rendering Average Concentration
Aluminum	mg/L	2.35
Ammonia	mg/L	103
Barium	mg/L	0.0974
Biochemical Oxygen Demand (BOD)	mg/L	8,630
Calcium	mg/L	89.5
Carbonaceous Biochemical Oxygen Demand (cBOD)	mg/L	8,270
Chemical Oxygen Demand (COD)	mg/L	21,400
Chloride	mg/L	467
Copper	mg/L	0.225
E. coli	MPN/100mL	111,000,000
Enterococci	MPN/100mL	7,144,000
Fecal Coliform	MPN/100mL	29,900,000
Fluoride	mg/L	89.3
Iron	mg/L	7.73
Lead	mg/L	0.0164
Magnesium	mg/L	39.8
Manganese	mg/L	0.266
Nitrogen, Total	mg/L	257
Oil and Grease	mg/L	1,110
Phosphorus, Total	mg/L	93.3
Sodium	mg/L	365
Sulfate	mg/L	56.0
Titanium	mg/L	0.115
Total Dissolved Solids (TDS)	mg/L	4,530
Total Organic Carbon	mg/L	1,660
Total Suspended Solids (TSS)	mg/L	4,140
Zinc	mg/L	0.814

Source: U.S. EPA, 2023c.

Abbreviations: mg/L = milligram per liter, MPN/100mL = most probable number per 100 milliliters.

Note: Results presented as three significant figures.

6.4 High Chlorides Wastewater

Certain MPP wastewaters with high concentrations of chlorides can be segregated from MPP wastewater at the time they are generated. Too much salt can impair water use through unpleasant taste, high water-treatment costs, staining, corrosion, mineral accumulation in plumbing, and restricted use for irrigation are among the problems associated with elevated concentrations of dissolved solids. MPP operations generating high chlorides wastewater are described in Sections 4.1 through 4.4. This high chlorides wastewater, while considered an MPP process wastewater by definition, is of unique interest due to the high salt content resulting from these specific MPP operations. As a result, throughout the remainder of this TDD, the EPA discusses details for high chlorides wastewaters separate from all other MPP process wastewaters.

Traditional curing and brining recipes often use a ratio of 1 cup salt to 1 gallon water, yielding a concentration of 7 to 10 percent by weight (70,000 mg/L — 100,000 mg/L), which aligns with the maximum water uptake for myofibrillar proteins in meat. Reuse of brines is possible but results in more concentrated solutions (Du et al., 2010), which is not ideal for all processes. Used brine solutions are usually discharged.

Koshering of meat and poultry also uses chlorides, but there may be options to reduce the wastestream concentrations. A study on a kosher poultry processor found that dry tumbling the birds to segregate the high chlorides wastestream can reduce total dissolved solids (TDS) and chlorides concentrations in the discharged process wastewater by 80 to 85 percent. The high chlorides wastestream at this facility had a chlorides concentration around 24,000 mg/L (U.S. EPA, 2023d). Halacha rules do not permit surplus salt from the koshering process to be reused (Weber et al., 1996), but waste salt can be used in other industries, such as tanneries, if available.

Hide curing also uses large amounts of chlorides. Bovine raw hides are typically cured either in a high chlorides concentration about half the weight of the hide(s) or in a 95 percent saturated brine solution. Almost 75 percent of the salt used ends up in the effluent stream during soaking; one study found that salt can constitute up to 40 percent of total solids content in tannery effluent (Sarker et al., 2018). Some MPP facilities process and cure hides. Hides sent to tanneries that do not process meat and poultry products are regulated by 40 CFR 425 (Leather Tanning and Finishing ELG).

Based on conversations with industry, most MPP facilities use drinking water sources (public water supplies or well water) for all source water. Facilities may treat their source water with water softeners before use to minimize scale build-up in equipment and because the facilities are generating food-grade products (U.S. EPA, 2022a, 2022b). Water softening using ion exchange to remove water hardness often requires sodium chloride brine concentrations of 8 to 20 percent (80,000 mg/L — 200,000 mg/L). After softening, most or all of the brine is discharged or disposed of, as reuse of brine impacts performance of water softening systems (Liu et al., 2021).

As part of the *EPA's Clean Water Act (CWA) High Chlorides Treatment 308 Request*, the EPA requested information from MPP facilities on operations related to high chlorides wastewater generation, characterization, treatment, and discharge. All characterization data received demonstrated chlorides concentrations that were multiple orders of magnitude above the baseline value for chloride, which is 1,000 μg/l for EPA Method 300.0 (U.S. EPA, 1993). Four facilities provided concentration data for untreated high chlorides wastestreams from hides processing operations. The average concentration was 94,175.5 mg/L. Fifteen facilities provided flow data specific to high chlorides streams, 12 of which were from hides curing and tanning operations. The 15 reported flows ranged from 750 gallons per day (GPD) up to 25,000 GPD, with the average calculated as 9,451 GPD (U.S. EPA, 2023d).

6.5 References

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7. Selection of Pollutants and Pollutant Parameters for Regulation

This section describes the U.S. Environmental Protection Agency's process for identifying pollutants of concern (POCs) and selecting pollutants for the proposed meat and poultry products (MPP) effluent limitations guidelines and standards (ELGs). Section 7.1 discusses the pollutants in MPP wastewater that the EPA evaluated as potential POCs for the proposed ELGs. Section 7.2 presents the pollutants selected as POCs. Section 7.3 presents the subset of POCs for the proposed regulation under each specified level of technology-based controls under the Clean Water Act (CWA).

7.1 Pollutants Considered for Regulation

As discussed in Sections 4 and 6, the pollutants present in MPP process wastewater typically include organics, nutrients, microorganisms, salts, and metals. The EPA identified pollutants of interest in MPP wastewater based on data from the previous MPP rulemaking (U.S. EPA, 2004) and literature searches. The EPA included the pollutants listed below and others in its data collection and analysis supporting the proposed ELGs. See the *Generic Sampling and Analysis Plan* (U.S. EPA, 2022a) for more details.

- Biochemical oxygen demand (BOD) and carbonaceous biochemical oxygen demand (cBOD) are estimates of the oxygen-consuming requirements of organic matter decomposition. Severe reductions in dissolved oxygen (DO) concentrations in receiving waters can lead to fish kills and even moderate decreases can cause decreases in biodiversity.
- Chemical oxygen demand (COD) is an estimate of organic matter content. When the ratio of COD to BOD is consistent, COD can be used as a surrogate to estimate impacts of wastewater discharges on receiving waters. COD can be analyzed faster than BOD, making it more useful for real-time management of biological wastewater treatment systems.
- Total organic carbon (TOC) is a measure of total organic matter content from a variety of organic compounds, only some of which are captured in measurements of COD and BOD. When wastewater composition is relatively constant, TOC can be used to estimate BOD and COD. Like COD, TOC provides a relatively rapid measurement of organic content compared to BOD.
- Oil and grease (O&G) is an estimate of fats, greases, and oils present in wastewater. In MPP wastewaters, these are primarily biodegradable animal fats and oils, which are significant sources of BOD and thereby impact DO availability in ecosystems receiving MPP process wastewater discharges.
- Total suspended solids (TSS) and total dissolved solids (TDS) are measures of solids content in wastewater. Dissolved solids can upset receiving water ecosystems, impacting public and industrial water supplies. Suspended solids can impact turbidity and have severe impacts on fish and vegetation in receiving waters.
- Nitrogen is present as organic and inorganic nitrogen in MPP wastewaters and is measured as total Kjeldahl nitrogen (TKN; the sum of organic nitrogen and ammonia), ammonia nitrogen, and nitrate-nitrite nitrogen. Total nitrogen (TN) is the sum of TKN and nitrate-nitrite nitrogen. Ammonia is especially toxic to fish and can decrease DO concentrations in receiving waters. All forms of nitrogen can contribute to eutrophic conditions in surface waters, which frequently result in fish kills and loss of biodiversity. Nitrogen, especially nitrate, can also degrade the quality of drinking water supplies.
- Phosphorus is present in several forms in MPP wastewaters. Phosphorus is considered the limiting nutrient in freshwater ecosystems; excess phosphorus contributes to the growth of algae and aquatic plants (U.S. EPA, 2023a), making it a driving force of freshwater eutrophication in cases of excess phosphorus.

- Chlorides, as described in Section 4, can be found in high concentrations in wastestreams from specific MPP first and further processing operations. High chlorides concentrations in freshwater ecosystems can harm both plants and animals, increased TDS and salinity in receiving waters, and impair drinking water supplies due to taste issues. High chlorides concentrations in wastewater can also adversely affect biological wastewater treatment processes.
- Fecal coliform and fecal streptococcus bacteria, such as enterococci, can indicate the presence of fecal contamination and viruses, enteric pathogenic bacteria, and parasites of enteric origin in wastewater. Detection of these organisms may indicate inadequate disinfection of MPP wastewater and the presence of pathogens in discharged effluent. These organisms present potential human health impacts when receiving surface waters are used for recreational activities or as drinking water supplies. Pathogens can also be infectious to wildlife.
- *Escherichia coli*, commonly referred to as *E. coli*, is a single species and typically the principal component of the fecal coliform group whose presence is used as an indicator of fecal contamination (U.S. EPA, 2004). *E. coli* is potentially a more harmful pathogen than other total coliform bacteria (U.S. EPA, 2022b).
- Metals are potentially toxic to phytoplankton and zooplankton and to higher aquatic plant and animal species, including fish. They have potential for bioaccumulation and biomagnification in aquatic food chains and may be present in potable water supplies downstream from effluent receiving waters (U.S. EPA, 2004).

7.2 Selection of Pollutants of Concern

The EPA collected data on the pollutants described in Section 7.1. To identify POCs, the EPA reviewed data from the EPA sampling program, from the *Detailed Questionnaire for the Meat and Poultry Products Effluent Guidelines*, and from Discharge Monitoring Reports (DMRs) for treated and untreated wastewater samples. When developing proposed ELGs, the EPA first evaluates which pollutants are present in untreated wastewater and whether those pollutants are present at treatable levels. Those that meet these criteria are identified as POCs. More information on this POC analysis (such as the methodology, the baseline values the EPA used for identification of POCs, and the sensitivity analysis) can be found in *Pollutants of Concern (POCs) Analysis for the Meat and Poultry Products (MPP) Proposed Rule* (the POC Memo; U.S. EPA, 2023b).

To be identified as a POC, a pollutant must have been detected at levels that are 10 times its baseline value or higher in at least 10 percent of all untreated process wastewater samples. These criteria ensure that a pollutant was present with sufficient frequency and in sufficient concentrations for treatment. The EPA evaluated POCs for MPP process wastewater for the three main process types: meat processing, poultry processing, and independent rendering (U.S. EPA, 2023b). Table 7-1 presents the POCs identified for each type of process wastewater.

Table 7-1. POC Analysis Results for MPP Process Wastewaters

Pollutant Group	Pollutant	Meat Processing[a]	Poultry Processing[a]	Rendering[a]
Classicals/ Biologicals	BOD	POC	POC	POC
	Bromide	POC	POC	Never detected
	cBOD	POC	POC	POC
	COD	POC	POC	POC
	Fluoride	POC	POC	POC
	O&G	POC	POC	POC
	TOC	POC	POC	POC
	Sulfate	POC	POC	POC
	TDS	POC	POC	POC
	TSS	POC	POC	POC
Chlorides	Chloride	POC	POC	POC
Metals	Aluminum	POC	POC	POC
	Antimony	Never detected	Never detected	Never detected
	Arsenic	Not a POC	Not a POC	Not a POC
	Barium	POC	Not a POC	POC
	Beryllium	Never detected	Never detected	Never detected
	Boron	Not a POC	Not a POC	Not a POC
	Cadmium	Never detected	Never detected	Never detected
	Calcium	POC	POC	POC
	Chromium	Not a POC	Not a POC	Not a POC
	Cobalt	Not a POC	Never detected	Not a POC
	Copper	POC	Not a POC	POC
	Iron	POC	Not a POC	POC
	Lead	Not a POC	Not a POC	POC
	Magnesium	POC	POC	POC
	Manganese	POC	Not a POC	POC
	Molybdenum	POC	Not a POC	Not a POC
	Nickel	Not a POC	Never detected	Not a POC

Table 7-1. POC Analysis Results for MPP Process Wastewaters

Pollutant Group	Pollutant	Meat Processing[a]	Poultry Processing[a]	Rendering[a]
	Selenium	Not a POC	Never detected	Not a POC
	Silver	Not a POC	Never detected	Never detected
	Sodium	POC	POC	POC
	Thallium	Never detected	Never detected	Never detected
	Thorium	Never detected	Never detected	Never detected
	Tin	Never detected	Never detected	Never detected
	Titanium	POC	Not a POC	POC
	Uranium	Not a POC	Never detected	Never detected
	Vanadium	POC	Never detected	Never detected
	Zinc	POC	POC	POC
Nutrients	Ammonia	POC	POC	POC
	Nitrogen, Nitrate-Nitrite	Meets criteria	Meets criteria[b]	Never detected
	TKN	Meets criteria[b]	Meets criteria[b]	Meets criteria[b]
	TN	POC[b]	POC[b]	POC[b]
	Orthophosphate	No data	POC	No data
	Phosphorus, Total (TP)	POC	POC	POC
Microbiologicals	*E. coli*	POC	POC	POC
	Enterococci	POC	POC	POC
	Fecal Coliform	POC	POC	POC

Source: U.S. EPA, 2023b.

a — Pollutants identified as POCs for the processing area were present in 10 percent or more of untreated process wastewater samples at levels that are greater than 10 times the baseline value or higher. If a pollutant does not meet this criterium but was detected, it is listed as "Not a POC."

b — The EPA evaluated nitrate-nitrite nitrogen and TKN samples to determine whether TN is a POC. TN is identified as a POC if 10 percent or more of the TKN and/or nitrate-nitrite nitrogen samples are at levels greater than 10 times the baseline value or higher. "Meets criteria" indicates the pollutant met the present in 10 percent or more of untreated process wastewater samples at greater than 10 times the baseline value or higher.

7.3 Selection of Pollutants for Regulation

The EPA selects pollutants for regulation based on applicable CWA provisions regarding the pollutants subject to each statutory level. For each regulated subcategory within the MPP point source category, the EPA selected a subset of pollutants for which to establish numeric effluent limitations from the list of POCs presented in Section 7.2 (regulated subcategories are discussed in Section 5).

Regulating all POCs is not necessary to ensure that MPP wastewater pollution is adequately controlled, since many pollutants originate from similar sources, have similar treatability, and are removed by similar mechanisms. While the proposed rule establishes numeric effluent limitations or standards for some POCs, the EPA did not set limitations and standards for POCs that:

- Are associated with treatment system chemicals because regulating these pollutants could interfere with efforts to optimize treatment system operation.
- Are not demonstrated to be reliably treated by the Best Available Technology Economically Achievable (BAT) technology basis for MPP process wastewater effluent limitations and standards.
- Are adequately controlled through the regulation of another indicator pollutant because the two pollutants have similar properties and are treated by similar mechanisms.

7.3.1 Regulated Pollutants for Direct Dischargers

Direct dischargers are subject to the following four levels of controls:

- Best Practicable Control Technology Currently Available (BPT): Establishes effluent limitations based on the average of the best performance of facilities within the industry of various ages, sizes, processes, or other common characteristics. Priority, conventional, and non-conventional pollutants (as defined by the CWA) are regulated by BPT effluent limitations.
- Best Conventional Pollutant Control Technology (BCT): Addresses conventional pollutants from existing industrial point sources. In addition to considering other factors, the EPA establishes BCT limitations after consideration of a two-part cost-reasonableness test.
- Best Available Technology Economically Achievable (BAT): Represents the best available economically achievable performance of facilities in the industrial subcategory or category. Priority and non-conventional pollutants are regulated by BAT effluent limitations.
- New Source Performance Standards (NSPS): Reflects effluent reductions that are achievable based on the Best Available Demonstrated Control Technology (BADCT). New sources have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As such, NSPS should represent the most stringent controls attainable through the application of the BADCT for conventional, non-conventional, and priority pollutants.

The EPA is proposing new or revised BCT, BAT, or NSPS limitations and standards for:

- TN: The EPA is proposing to regulate total nitrogen more stringently and implement new limitations on most subcategories. New and revised limitations will ensure greater removals of all forms of nitrogen, including TKN and nitrate-nitrite nitrogen.
- TP: The EPA is proposing to regulate total phosphorus across most subcategories to ensure that treatment systems used by facilities are achieving meaningful reductions in discharges of all forms of phosphorus.
- Fecal coliform: The EPA is proposing to regulate fecal coliform more stringently to ensure that treatment systems used by facilities are achieving adequate disinfection and control of pathogens in discharged effluent.

The EPA is considering regulating *E. coli*, as it serves as an indicator of sufficient treatment for other microbiologicals, including fecal coliform and enterococci. The EPA is also considering establishing BAT zero discharge effluent limitations for chlorides in high chlorides wastestreams from direct discharging MPP facilities. As discussed in Section 4, high chlorides wastestreams typically can be segregated from MPP process wastewater, enabling separate treatment and/or disposal.

As noted above, the EPA decided to eliminate a number of POCs from consideration for regulation. The following paragraphs describe the EPA's rationale for some of those decisions.

- **Treatment chemicals**: The EPA identified and eliminated from consideration five POCs that are used as wastewater treatment chemicals as their regulation could interfere with efforts to optimize treatment system operation. The five POCs—aluminum, calcium, iron, magnesium, and sodium—may be introduced to the wastewater stream through pipes, mechanical equipment, and animal feed.
- **Pollutants not effectively treated by BAT technology**: The EPA identified and eliminated from consideration three POCs—bromide, fluoride, and sulfate—because the BAT technology basis for MPP process wastewater effluent limitations and standards is not demonstrated to reliably treat these pollutants. The EPA also eliminated from consideration barium, copper, lead, manganese, molybdenum, titanium, vanadium, and zinc. While the EPA observed via sampling data that some biological treatment systems used in the MPP processing industry provide reductions of metal concentrations, these systems are not specifically engineered to remove metals. Thus, the EPA believes that not all facilities will be able to manage biological treatment processes to consistently achieve effluent limitations for metals. Finally, the EPA eliminated TDS from consideration because organic matter decomposition during biological wastewater treatment may increase TDS concentrations.
- **Pollutants directly regulated or controlled by regulation of other pollutants**: The existing BPT, BCT, and NSPS limitations and standards adequately control BOD, TSS, and O&G in discharges of MPP process wastewater. These regulations also effectively control discharges of three other POCs: cBOD, COD, and TOC. The proposed BAT limitations for TN and TP will adequately control discharges of three other nutrient POCs in MPP process wastewater: nitrate-nitrite nitrogen, TKN, and orthophosphate. Finally, the proposed and existing BPT and BCT regulations for fecal coliform adequately control discharges of enterococci in MPP process wastewater.

Table 7-2 provides a summary of POCs eliminated from consideration and the rationale for each.

Table 7-2. POCs Eliminated from Consideration for Regulation for Direct Dischargers

Pollutant Group	Pollutant of Concern	Used As Treatment Chemical	Not Effectively Treated by the BAT Technology	Directly Regulated or Controlled by Regulation of Another Pollutant
Classicals/ Biologicals	Bromide[a]		X	
	cBOD			X
	COD			X
	Fluoride		X	
	TOC			X
	Sulfate		X	
	TDS		X	
Metals	Aluminum	X		
	Barium[b]		X	
	Calcium	X		
	Copper[b]		X	
	Iron[b]	X		
	Lead[c]		X	
	Magnesium	X		
	Manganese[b]		X	
	Molybdenum[d]		X	
	Sodium	X		
	Titanium[b]		X	
	Vanadium[d]		X	
	Zinc		X	
Nutrients	Nitrogen, Nitrate-Nitrite			X
	TKN			X
	Orthophosphate[e]			X
Microbiologicals	Enterococci			X

a — Identified as POC for only meat processing and poultry processing.

b — Identified as POC for only meat processing and rendering.

c — Identified as POC for rendering only.

d — Identified as POC for meat processing only.

e — Identified as POC for poultry processing only.

7.3.2 *Regulated Pollutants for Indirect Dischargers*

Indirect dischargers are subject to two levels of control under ELGs that are designed to prevent the discharges of pollutants that passthrough, interfere with, or are otherwise incompatible with the operation of Publicly Owned Treatment Works (POTWs). These controls include:

- Pretreatment Standards for New Sources (PSNS): PSNS are national, uniform, technology-based standards that apply to facilities within certain industrial categories that discharge to POTWs (i.e., indirect dischargers). New indirect dischargers have the opportunity to incorporate into their facilities the best available demonstrated technologies. The Agency typically considers the same factors in promulgating PSNS as it considers in promulgating NSPS.
- Pretreatment Standards for Existing Sources (PSES): Like PSNS, PSES are national, uniform, technology-based standards that apply to indirect dischargers. PSES apply by a specified date, typically no more than three years after the effective date of the categorical standard. The EPA typically considers the same factors in promulgating PSES as it considers in promulgating BPT/BAT.

The proposed rule establishes new PSES and PSNS for most subcategories. Before establishing PSES or PSNS limitations for a POC, the EPA examines whether the pollutant "passes through" a POTW to waters of the United States, interferes with, or is otherwise incompatible with POTW operations, within the meaning of CWA Section 307(b).

In establishing categorical pretreatment standards, the EPA determines whether a pollutant passes through a POTW by comparing the percentage of a pollutant removed by well-operated POTWs performing secondary treatment to the percentage removed by the BAT/NSPS technology basis. A pollutant is determined to passthrough POTWs when the median percentage removed nationwide by well-operated POTWs is less than the median percentage removed by the BAT/NSPS technology basis. Pretreatment standards are established for those pollutants regulated under BAT/NSPS that passthrough POTWs.

The EPA determined the percentage of pollutant removed by the proposed rule's technology basis for pollutants selected for regulation via BAT (PSES) controls or via NSPS (PSNS) controls. Table 7-3 summarizes the results of the POTW Passthrough Analysis for MPP process wastewater for PSES; determinations for PSNS are equal to PSES. For details on this analysis, see the *Meat and Poultry Products POTW Passthrough Analysis* memorandum (U.S. EPA, 2023c).

Table 7-3. POTW Passthrough Analysis for MPP Process Wastewater

Pollutant	Median BAT Percent Removal	Median POTW Percent Removal	Is BAT Percent Removal > POTW Percent Removal?	Does Pollutant Passthrough?
Meat Processing				
BOD	100%	90%	Yes	Yes
O&G	99.9%	87%	Yes	Yes
TSS	99.9%	90%	Yes	Yes
TN	84.5%	39%	Yes	Yes
TP	96.9%	30%	Yes	Yes
Poultry Processing				
BOD	99.9%	90%	Yes	Yes
O&G	99.6%	87%	Yes	Yes
TSS	99.6%	90%	Yes	No
TN	90.2%	39%	Yes	Yes
TP	99.5%	30%	Yes	Yes

Table 7-3. POTW Passthrough Analysis for MPP Process Wastewater

Pollutant	Median BAT Percent Removal	Median POTW Percent Removal	Is BAT Percent Removal > POTW Percent Removal?	Does Pollutant Passthrough?
Rendering				
BOD	100%	90%	Yes	Yes
O&G	99.5%	87%	Yes	Yes
TSS	99.9%	90%	Yes	Yes
TN	73.5%	39%	Yes	Yes
TP	99.7%	30%	Yes	Yes

Source: U.S. EPA, 2023c.

Because BOD, TSS, and O&G do passthrough POTWs, the EPA is proposing PSES and PSNS requirements for these pollutants. As described in Section 9, PSES and PSNS limitations for BOD, O&G, and TSS are based, for some facilities, on treatment that includes screening and a dissolved air flotation (DAF) treatment unit as the technology basis, referred to as the Indirect Wastewater Treatment Technology System Targeting Conventionals (BOD, O&G, and TSS).

- BOD: The EPA is proposing to regulate BOD because it serves as an indicator of the performance of treatment systems in removing oxygen-demanding pollutants. High amounts of BOD can cause interference in biological treatment at POTWs, and this interference could lead to pollutants passing through the POTW, which could result in violations.
- TSS: The EPA is proposing to regulate TSS because it serves as an indicator of the performance of treatment systems in removing solids. High levels of TSS can cause interference through clogging and fouling of pipes and pumps.
- O&G: The EPA is proposing to regulate O&G to ensure that treatment systems are effective in removing O&G. O&G can cause blockages in sewer systems and can negatively impact POTW performance.

The EPA is also concerned about discharges of chlorides from indirect facilities for the same reasons as discharges from direct facilities (see Section 7.17.3.1). The EPA is considering establishing PSES zero discharge effluent limitations for chlorides in high chlorides wastestream from indirect discharging MPP facilities. As such, the EPA did not conduct its traditional passthrough analysis for high chlorides wastestreams because these limitations and standards achieve 100 percent removal of chlorides.

7.4 References

1. U.S. EPA. 2004. *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432)* (September). EPA-821-R-04-011. Available online at: https://www.epa.gov/sites/default/files/2015-11/documents/meat-poultry-products_tdd_2004_0.pdf.
2. U.S. EPA. 2022a. *Generic Sampling and Analysis Plan for Meat and Poultry Products (MPP) Point Source Category* (August). DCN MP00136.
3. U.S. EPA. 2022b. *Addressing Total Coliform Positive or E. Coli Positive Sample Results in EPA Region 8* (September). DCN MP00328. Available online at: https://www.epa.gov/region8-waterops/addressing-total-coliform-positive-or-e-coli-positive-sample-results-epa-region-8.
4. U.S. EPA. 2023a. *Indicators: Phosphorus* (June). DCN MP00331. Available online at: www.epa.gov/national-aquatic-resource-surveys/indicators-phosphorus.
5. U.S. EPA. 2023b. *Pollutants of Concern (POC) Analysis for the Meat and Poultry Products (MPP) Proposed Rule* (November). DCN MP00190.

6. U.S. EPA. 2023c. *Meat and Poultry Products POTW Passthrough Analysis* (November). DCN MP00309.

8. Wastewater Treatment Technologies and Pollutant Prevention Practices

This section provides an overview of the treatment technologies and wastewater management practices currently in use at meat and poultry products (MPP) facilities. As described in Section 4 of this report, the U.S. Environmental Protection Agency's current MPP industry population contains 5,055 MPP facilities that were identified through the *Census Questionnaire for the Meat and Poultry Products Effluent Guidelines* (Census Questionnaire), *Detailed Questionnaire for the Meat and Poultry Products Effluent Guidelines* (Detailed Questionnaire), and publicly available data. The EPA compiled data on each facility, including type of operations, discharge status, and location. The *Meat and Poultry Products (MPP) Profile Methodology Memorandum* (U.S. EPA, 2023a) explains how data from these multiple sources were combined to develop this industry population.

The EPA reviewed information specific to treatment technologies and wastewater management practices from MPP facilities that responded to Section 7 of the Detailed Questionnaire (Wastewater Treatment Information). See Section 3.3 of this report for more information on the Detailed Questionnaire. Table 8-1 presents a breakdown by discharge type of the 5,055 facilities in the EPA's MPP industry population as well as the 510 MPP facilities that provided information on their wastewater treatment systems in response to the Detailed Questionnaire (10 percent of the industry population) (U.S. EPA, 2023b). Table 8-2 presents a breakdown of the same populations by process type and annual production volume.

The EPA identified four types of wastewater dischargers: direct dischargers (facilities discharging to a surface water), indirect dischargers (facilities discharging to a Publicly Owned Treatment Works [POTW], direct and indirect dischargers (facilities with both direct discharge and indirect discharge), and zero dischargers (facilities that generate wastewater but do not discharge any of it). The EPA identified one facility from the 510 Detailed Questionnaire respondents that is both a direct and indirect discharger. This facility discharges the majority of its wastewater directly; thus, this facility is classified as a direct discharger in the remainder of this section.

As described in Section 4, MPP facilities can be differentiated by operation and placed into one of five categories: meat first processors, meat further processors, poultry first processors, poultry further processors, and independent renderers. Meat first processors and poultry first processors include MPP facilities that slaughter meat or poultry (some may also perform further processing and/or rendering). Meat further processors and poultry further processors include MPP facilities that further process (some may also render). Independent rendering facilities only perform rendering operations. Some MPP facilities perform both meat and poultry processing. The EPA categorized each MPP facility in the industry population based on its dominant operation.

Table 8-1. MPP Facility Breakdown from Industry Profile and Detailed Questionnaire by Discharge Type

Type of Discharge	Number of Facilities, Based on Industry Profile	Number of Detailed Questionnaire Respondents
Indirect Dischargers	3,708	293
Direct Dischargers[a]	171	91
Zero Dischargers	1,176	126
Total	**5,055**	**510**

Source: U.S. EPA, 2023a, 2023b.

a — One facility discharging both to a receiving water (i.e., direct discharge) and to a POTW (i.e., indirect discharge) is classified here as a direct discharger.

Table 8-2. MPP Facility Breakdown from Industry Profile and Detailed Questionnaire by Production by Process Type and Annual Production

Type of Processing and Annual Production	Number of Facilities, Based on Industry Profile	Number of Detailed Questionnaire Respondents
Meat First Processors		
<5M lbs. LWK/yr.	570	65
5 to <10M lbs. LWK/yr.	63	2
10 to <200M lbs. LWK/yr.	106	25
≥200M lbs. LWK/yr.	87	60
Total Meat First	**826**	**152**
Meat Further Processors		
<2M lbs. Finished Product/yr.	2194	26
2 to <10M lbs. Finished Product/yr.	695	17
10 to 50M lbs. Finished Product/yr.	224	32
>50M lbs. Finished Product/yr.	347	59
Total Meat Further	**3,460**	**134**
Poultry First Processors		
<5M lbs. LWK/yr.	57	12
5 to 30M lbs. LWK/yr.	19	10
>30 to <200M lbs. LWK/yr.	64	18
≥200M lbs. LWK/yr.	150	104
Total Poultry First	**290**	**144**
Poultry Further Processors		
<2M lbs. Finished Product/yr.	110	4
2 to <10M lbs. Finished Product/yr.	50	8
10 to 30M lbs. Finished Product/yr.	25	6
>30M lbs. Finished Product/yr.	109	24
Total Poultry Further	**294**	**42**
Independent Renderers		
<5M lbs. Raw Material/yr.	23	1
5 to 30M lbs. Raw Material/yr.	16	4
>30 to <350M lbs. Raw Material/yr.	122	27
≥350M lbs. Raw Material/yr.	24	6
Total Renderers	**185**	**38**
Industry Total	**5,055**	**510**

Source: U.S. EPA, 2023a, U.S. EPA, 2023b.

Abbreviations: M = million, lbs. = pounds, LWK = live weight killed, yr. = year.

The EPA gathered information through the Detailed Questionnaire on whether respondents treat process wastewater on site prior to discharge. Table 8-3 presents a breakdown of facilities that treat process wastewater on site by facility discharge type, and Table 8-4 presents a breakdown of the same facilities by operation and annual production volume. Of the 510 Detailed Questionnaire respondents, 420 (over 80 percent) reported some level of wastewater treatment on site. All direct discharging respondents reported implementing wastewater treatment (U.S. EPA, 2023a, 2023b).

Table 8-3. Facilities that Treat MPP Process Wastewater on Site Based on Detailed Questionnaire by Discharge Type

Type of Discharge	Number of Respondents That Treat Process Wastewater On Site	Total Number of Detailed Questionnaire Respondents
Indirect Dischargers	255	293
Direct Dischargers[a]	91	91
Zero Dischargers	74	126
Total	**420**	**510**

Source: U.S. EPA, 2023a, 2023b.

a — One facility with multiple outfalls discharging both to a receiving water (i.e., direct discharge) and to a POTW (i.e., indirect discharge) is classified here as a direct discharger.

Table 8-4. Facilities that Treat MPP Process Wastewater on Site Based on Detailed Questionnaire by Process Type and Annual Production

Type of Processing and Annual Production	Number of Respondents That Treat Process Wastewater On Site	Total Number of Detailed Questionnaire Respondents
Meat First Processors		
<5M lbs. LWK/yr.	30	65
5 to <10M lbs. LWK/yr.	0	2
10 to <200M lbs. LWK/yr.	20	25
≥200M lbs. LWK/yr.	56	60
Total Meat First	**106**	**152**
Meat Further Processors		
<2M lbs. Finished Product/yr.	14	26
2 to <10M lbs. Finished Product/yr.	15	17
10 to 50M lbs. Finished Product/yr.	28	32
>50M lbs. Finished Product/yr.	54	59
Total Meat Further	**111**	**134**
Poultry First Processors		
<5M lbs. LWK/yr.	8	12
5 to 30M lbs. LWK/yr.	7	10
>30 to <200M lbs. LWK/yr.	17	18
≥200M lbs. LWK/yr.	102	104
Total Poultry First	**134**	**144**
Poultry Further Processors		
<2M lbs. Finished Product/yr.	2	4
2 to <10M lbs. Finished Product/yr.	5	8
10 to 30M lbs. Finished Product/yr.	4	6
>30M lbs. Finished Product/yr.	24	24
Total Poultry Further	**35**	**42**
Independent Renderers		
<5M lbs. Raw Material/yr.	0	1
5 to 30M lbs. Raw Material/yr.	2	4
>30 to <350M lbs. Raw Material/yr.	26	27
≥350M lbs. Raw Material/yr.	6	6

Table 8-4. Facilities that Treat MPP Process Wastewater on Site Based on Detailed Questionnaire by Process Type and Annual Production

Type of Processing and Annual Production	Number of Respondents That Treat Process Wastewater On Site	Total Number of Detailed Questionnaire Respondents
Total Renderers	34	38
Industry Total	420	510

Source: U.S. EPA, 2023a, U.S. EPA, 2023b.

Abbreviations: M = million, lbs. = pounds, LWK = live weight killed, yr. = year.

Sections 8.1 through 8.5 discuss end-of-pipe wastewater treatment practices and technologies for process wastewater present at the 384 direct and indirect discharging MPP facilities that reported treating wastewater on site in the Detailed Questionnaire. Section 8.6 describes wastewater treatment for high chlorides wastewater. Section 8.7 presents a summary of the 126 MPP facilities achieving zero discharge. Section 8.8 presents information on pollution prevention and wastewater reduction practices in the industry. All analyses and statistics presented in the following sections are based on responses to the Detailed Questionnaire.

8.1 Primary Treatment

Primary treatment typically targets removal of large particulates and floating or settleable solids. These treatment units are often operated as the initial stage of treatment and may be followed by additional treatment units. Some facilities that discharge to an outside treatment system, such as a POTW, operate only primary treatment units. Primary treatment units can be referred to as pretreatment since they may be physically located and operated in the processing area or otherwise apart from the rest of the wastewater treatment system. Primary treatment can include other units that provide flow control, aeration to prevent solids from settling, and/or odor control.

Table 8-5 presents a breakdown of indirect dischargers and direct dischargers that implement at least one treatment unit for primary treatment as part of their wastewater treatment system. Approximately 81 percent of direct dischargers (74 of 91 facilities) and 62 percent of indirect dischargers (181 of 293 facilities) implement some form of primary treatment (U.S. EPA, 2023a, 2023b).

When facilities are further broken down by process type, the majority of facilities in each category have some form of primary treatment in place. Table 8-6 presents a breakdown of facilities reporting primary treatment by process and annual production volume.

Table 8-5. Number of Detailed Questionnaire Respondents That Implement Primary Treatment by Discharge Type

Type of Discharge	Number of Respondents That Implement Primary Treatment	Total Number of Detailed Questionnaire Respondents[a]
Indirect Dischargers	181	293
Direct Dischargers[b]	74	91
Total	255	384

Source: U.S. EPA, 2023a, 2023b.

a — Facilities operating in a manner to achieve zero discharge are excluded from this presentation. See Section 8.7 for a discussion on zero discharge facilities.

b — One facility discharging both to a receiving water (i.e., direct discharge) and to a POTW (i.e., indirect discharge) is classified here as a direct discharger.

Table 8-6. Number of Detailed Questionnaire Respondents That Implement Primary Treatment by Process Type and Annual Production

Type of Processing and Annual Production	Number of Respondents That Implement Primary Treatment	Total Number of Detailed Questionnaire Respondents[a]
Meat First Processors		
<5M lbs. LWK/yr.	4	27
5 to <10M lbs. LWK/yr.	0	1
10 to <200M lbs. LWK/yr.	10	18
≥200M lbs. LWK/yr.	45	52
Total Meat First	**59**	**98**
Meat Further Processors		
<2M lbs. Finished Product/yr.	5	13
2 to <10M lbs. Finished Product/yr.	3	14
10 to 50M lbs. Finished Product/yr.	14	29
>50M lbs. Finished Product/yr.	41	56
Total Meat Further	**63**	**112**
Poultry First Processors		
<5M lbs. LWK/yr.	4	5
5 to 30M lbs. LWK/yr.	2	4
>30 to <200M lbs. LWK/yr.	8	13
≥200M lbs. LWK/yr.	75	90
Total Poultry First	**89**	**112**
Poultry Further Processors		
<2M lbs. Finished Product/yr.	0	2
2 to <10M lbs. Finished Product/yr.	2	6
10 to 30M lbs. Finished Product/yr.	2	4
>30M lbs. Finished Product/yr.	17	22
Total Poultry Further	**21**	**34**
Independent Renderers		
<5M lbs. Raw Material/yr.	0	0
5 to 30M lbs. Raw Material/yr.	0	3
>30 to <350M lbs. Raw Material/yr.	18	20
≥350M lbs. Raw Material/yr.	5	5
Total Renderers	**23**	**28**
Industry Total	**255**	**384**

Source: U.S. EPA, 2023a, 2023b.

Abbreviations: M = million, lbs. = pounds, LWK = live weight killed, yr. = year.

a — Facilities operating in a manner to achieve zero discharge are excluded from this presentation. See Section 8.7 for a discussion on zero discharge facilities.

Table 8-7 describes common primary treatment units used in the MPP industry. Removal of large particles (such as feathers, offal, bone trimmings, or cartilage) as well as oil and grease (O&G) is important for MPP wastewater treatment because these particles could damage or interfere with downstream equipment or disrupt treatment efficiency. Many MPP facilities use a treatment unit for O&G removal, such as a dissolved air flotation (DAF) unit, an American Petroleum Institute (API) separator, and/or a catch basin. The most commonly used O&G removal treatment unit, as reported in the Detailed Questionnaire, is a DAF (U.S. EPA, 2023b).

Table 8-7. Primary Treatment Units Used in the MPP Industry

Treatment Unit	Description
Screens	Screening removes large solid particles (0.01 to 0.06 inch in diameter) from wastewater. Different types of screens can be used in wastewater treatment, including static or stationary, rotary drum, brushed, and vibrating. Screens typically have stainless steel wedge wire that removes medium and coarse particles.
DAF	In a DAF unit, air is dissolved under pressure and then released at atmospheric pressure in a tank containing wastewater. The released air creates bubbles that adhere to suspended solids, causing the solids to float to the surface where they can be removed by skimming. DAF removes suspended solids (e.g., soil, sand), fatty tissue from meat and poultry, oils, grease, and metals. This treatment unit can also be used for biological treatment, as it can reduce biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Solids gathered from this treatment unit are often combined with sludge from other treatment units and moved to solids handling, discussed in Section 8.5.
API Separators	API separators remove oils, fatty grease from animals, and suspended solids by skimming and collecting the materials from the surface of the wastewater.
Catch Basin	Catch basins separate grease and finely suspended solids from wastewater by the process of gravity separation. Each basin is equipped with a skimmer and a scraper. The skimmer removes grease and scum on the surface, and the scraper removes sludge that collects at the bottom of the basin.
Flow Equalization	A flow equalization unit is any type of basin, lagoon, tank, or reactor that serves to control a variable flow of wastewater to achieve a near-constant flow into the treatment system. A separate unit for equalization may not be necessary as many treatment units (such as DAF, a catch basin, or an anaerobic lagoon) may provide flow equalization.
Chemical Addition	Facilities may add chemicals for settling, thickening, and/or pH control. These chemicals can be added in the DAF, flow equalization, or other units, or before the wastewater enters these units. Chemicals include polymers, coagulants, and flocculants.

8.2 Biological Treatment

Biological treatment typically occurs after primary treatment and uses microorganisms to reduce BOD and COD through the consumption of organic matter in wastewater via microbial respiration and synthesis. Biological treatment can also reduce the levels of nitrogen through nitrification and denitrification.

- **Nitrification** is a two-step aerobic process. First, ammonia is oxidized into nitrite by Nitrosomonas bacteria. Then, nitrite is oxidized into nitrate by Nitrobacter bacteria. Nitrification only occurs when there is sufficient biomass and residence time to fully convert ammonia to nitrite, and then convert nitrite to nitrate (Metcalf & Eddy, 2003).
- **Denitrification** is a microbial process in which nitrite and nitrate are reduced by heterotrophic bacteria into gaseous nitrous oxide and nitrogen gas under anoxic conditions without the presence of molecular oxygen. A carbon source, such as methanol, may need to be added to keep the microbes healthy.
    - Treatment systems may perform varying degrees of denitrification, depending on the solids retention time and the volume and location of the anoxic areas compared to the aerobic areas.

Partial denitrification indicates that nitrate-nitrite nitrogen has been partially broken down; full denitrification indicates a more complete breakdown of nitrate-nitrite nitrogen.

Biological treatment can use aerobic processes to achieve nitrification and anaerobic/anoxic processes to achieve denitrification in multiple units or within the same treatment unit using different zones.

Anaerobic lagoons pretreat high-strength wastewaters using microorganisms in the absence of dissolved oxygen to convert organic matter into carbon dioxide and methane. These deep earthen basins allow for sedimentation of settleable solids; a layer of sludge accumulates over time and eventually is removed. Anaerobic lagoons are used in biological treatment and often serve as BOD pretreatment.

Aerobic treatment processes use microorganisms to consume biodegradable organic compounds in aerated wastewater for nitrification. This process reduces BOD and suspended solids as well as ammonia. MPP facilities can use a variety of biological treatment systems for this, but the most common is a conventional activated sludge system. Activated sludge systems achieve biological nitrification using microorganisms to convert ammonia to nitrate in an aerobic envrionment. Wastewater and the microorganisms are aerated in a reactor for a specified period of time. This process creates a sludge that later separates from the water by settling in a clarification unit. A portion of the activated sludge is recirculated to the reactor, and a portion is wasted. The wasted portion is usually sent to the solids handling treatment units (discussed further in Section 8.5). The most important factor in controlling an activated sludge system is the sludge retention time (SRT). SRT is a design parameter that can control the efficacy of the system. See Figure 8-1 for a process flow diagram of a typical activated sludge system.

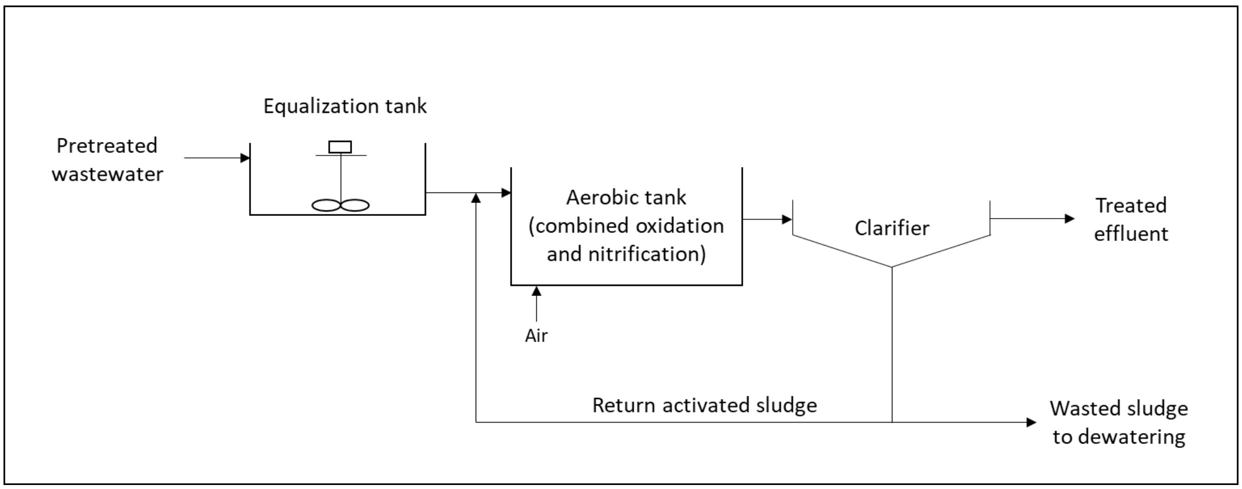

Figure 8-1. Process Flow Diagram of Conventional Activated Sludge System

Conventional activated sludge systems typically treat wastewater continuously through a series of separate tanks. An alternative approach is treating the wastewater in separate batches using a sequencing batch reactor (SBR) that carries out the activated sludge process sequentially in the same reactor tank. Attached growth/fixed film reactors are another alternative in which the microbes are attached to a rigid supporting media. Some MPP facilities use a moving bed biofilm reactor (MBBR), which is another type of aerobic treatment that uses activated sludge. Specifically, it is a hybrid suspended, growth-fixed film system in which a "biocarrier" media in the unit provides a place for the microorganisms to grow on. Another option is a membrane bioreactor (MBR) system, which combines filtration with a suspended growth bioreactor.

Anaerobic or anoxic wastewater treatment processes reduce complex organic compounds to methane and carbon dioxide. Anaerobic treatment can achieve partial to complete denitrification, converting nitrate to nitrogen gas. MPP facilities may use a Modified Ludzack-Ettinger (MLE) system to achieve denitrification, as shown in Figure 8-2. The MLE is a two-stage system with an anoxic zone followed by an aerobic zone. The nitrate produced by the aeration zone is recycled back to the anoxic zone and is used as an oxygen source for facultative bacteria in the anoxic zone. The MLE process removes most BOD and can achieve 80 percent nitrogen removal (U.S. EPA, 2009). The SRT and the size of the anoxic zone compared to the aerobic zone are important design parameters that help determine whether the system will achieve partial or full denitrification.

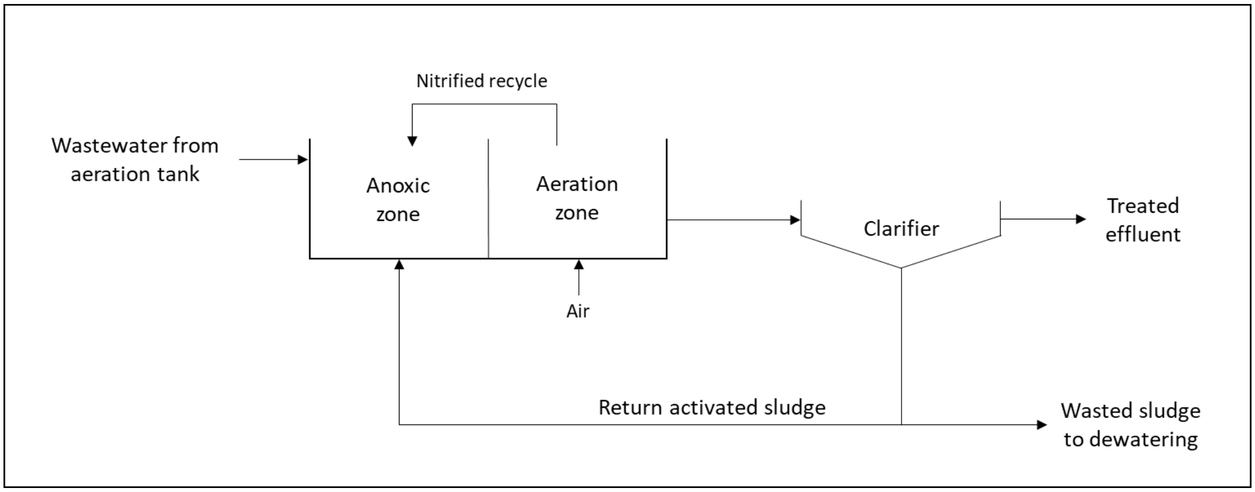

Figure 8-2. Process Flow Diagram of MLE System to Achieve Denitrification

Nitrification and denitrification can be achieved within a single multi-stage system where organic matter is the source for nitrification and organic carbon is the source for denitrification. For example, both the four-stage Bardenpho and the modified (five-stage) Bardenpho system achieve nitrification and denitrification through separate aerobic and anoxic zones.

- Four-stage Bardenpho: includes anoxic, aerobic, anoxic, and aerobic stages, followed by a secondary clarifier. Mixed liquor with high levels of nitrate is recycled from the first aerobic stage back to the first anoxic stage. Activated sludge from the clarifier is recycled back to the influent. Nitrification occurs primarily in the second stage (aerobic). Denitrification occurs in the first and third stages (anoxic). The final aeration stage removes nitrogen gas from the system and increases the concentration of dissolved oxygen. The four-stage Bardenpho process achieves higher rates of nitrogen removal compared to the two-stage MLE process.
- Modified Bardenpho (Five-Stage Bardenpho): includes anaerobic, anoxic, aerobic, anoxic, and aerobic stages, followed by a secondary clarifier. As in the four-stage Bardenpho process, mixed liquor with high levels of nitrate is recycled from the first aerobic stage back to the first anoxic stage and activated sludge from the clarifier is recycled back to the influent. The Five-Stage Bardenpho process can achieve high rates of denitrification. See Figure 8-3 for a process flow diagram of a typical Five-Stage Bardenpho.

Other systems, such as the SBR, can be configured to achieve nitrification as well as denitrification.

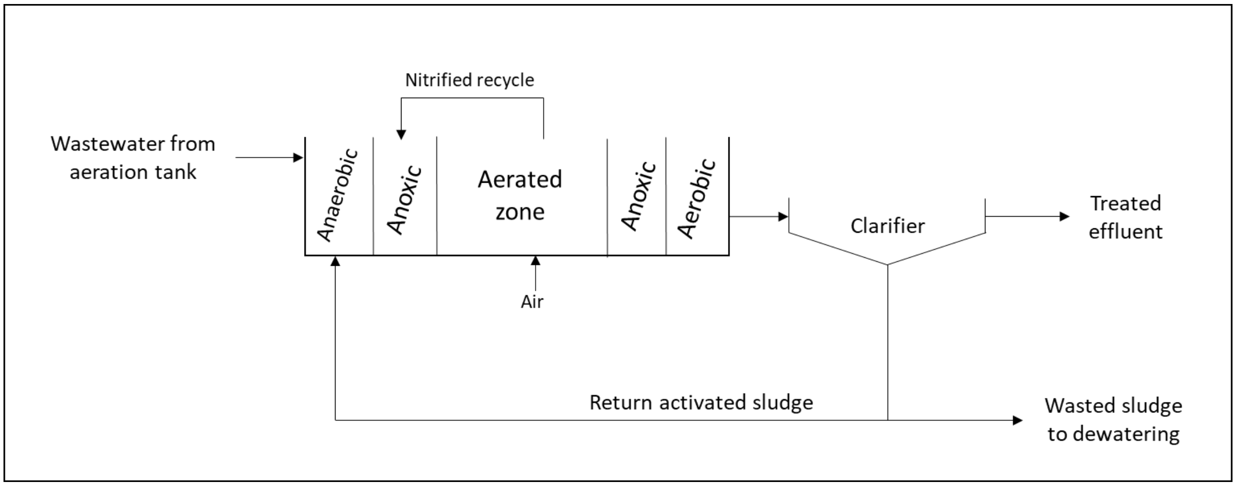

Figure 8-3. Process Flow Diagram of Modified Bardenpho (Five-Stage Bardenpho)

MPP facilities use a variety of biological treatment units, and some facilities may be implementing and reporting multiple types of biological treatment. Responses to the Detailed Questionnaire showed that:[5]

- 86 facilities reported using some type of anaerobic or anoxic treatment.
- 74 facilities reported using some type of aerobic treatment unit.
- 26 facilities reported using an activated sludge system.
- 13 facilities reported using some type of bioreactor (U.S. EPA, 2023b).

Table 8-8 presents a breakdown of the direct and indirect dischargers that implement at least one treatment unit for biological treatment as part of their wastewater treatment system based on the Detailed Questionnaire. MPP facilities can use certain biological treatment units, such as anaerobic lagoons, as primary treatment (i.e., BOD pretreatment). The data in the table exclude respondents who reported using biological treatment units only for purposes other than biological treatment (e.g., primary treatment).

In all, 18 percent of indirect dischargers (54 of 293 facilities) compared to 96 percent of direct dischargers (87 of 91 facilities) implement at least one a biological treatment unit (U.S. EPA, 2023a, 2023b). The low percentage for indirect dischargers is not unusual given that POTWs perform biological treatment. Likewise, the high percentage for direct dischargers is expected given that the current MPP ELGs regulate direct dischargers of a certain size (depending on their subcategory) for total nitrogen (TN) and ammonia.

Table 8-8 presents a breakdown of facilities reporting biological treatment by discharge type. Table 8-9 presents a breakdown of facilities reporting biological treatment by process type and annual production volume.

[5] In the Detailed Questionnaire, respondents reported the names used for treatment units implemented at their facilities. The EPA used keywords to categorize the type of treatment based on the reported name. Some facilities that responded with generic names may not be represented here.

Table 8-8. Number of Detailed Questionnaire Respondents That Implement Biological Treatment by Discharge Type

Type of Discharge	Number of Respondents That Implement Biological Treatment	Total Number of Detailed Questionnaire Respondents[a]
Indirect Dischargers	54	293
Direct Dischargers[b]	87	91
Total	**141**	**384**

Source: U.S. EPA, 2023a, 2023b.

Note: If a respondent reported using a biological treatment unit for purposes other than biological treatment (e.g., primary treatment), that facility is not included in this table for that treatment unit.

a — Facilities operating in a manner to achieve zero discharge are excluded from this presentation. See Section 8.7 for a discussion on zero discharge facilities.

b — One facility discharging both to a receiving water (i.e., direct discharge) and to a POTW (i.e., indirect discharge) is classified here as a direct discharger.

Table 8-9. Number of Detailed Questionnaire Respondents That Implement Biological Treatment by Process Type and Annual Production

Type of Processing and Annual Production	Number of Respondents That Implement Biological Treatment	Total Number of Detailed Questionnaire Respondents[a]
Meat First Processors		
<5M lbs. LWK/yr.	2	27
5 to <10M lbs. LWK/yr.	0	1
10 to <200M lbs. LWK/yr.	8	18
≥200M lbs. LWK/yr.	35	52
Total Meat First	**45**	**98**
Meat Further Processors		
<2M lbs. Finished Product/yr.	2	13
2 to <10M lbs. Finished Product/yr.	3	14
10 to 50M lbs. Finished Product/yr.	6	29
>50M lbs. Finished Product/yr.	7	56
Total Meat Further	**18**	**112**
Poultry First Processors		
<5M lbs. LWK/yr.	3	5
5 to 30M lbs. LWK/yr.	0	4
>30 to <200M lbs. LWK/yr.	6	13
≥200M lbs. LWK/yr.	50	90
Total Poultry First	**59**	**112**
Poultry Further Processors		
<2M lbs. Finished Product/yr.	0	2
2 to <10M lbs. Finished Product/yr.	0	6
10 to 30M lbs. Finished Product/yr.	1	4
>30M lbs. Finished Product/yr.	5	22
Total Poultry Further	**6**	**34**
Independent Renderers		
<5M lbs. Raw Material/yr.	0	0
5 to 30M lbs. Raw Material/yr.	1	3

Table 8-9. Number of Detailed Questionnaire Respondents That Implement Biological Treatment by Process Type and Annual Production

Type of Processing and Annual Production	Number of Respondents That Implement Biological Treatment	Total Number of Detailed Questionnaire Respondents[a]
>30 to <350M lbs. Raw Material/yr.	9	20
≥350M lbs. Raw Material/yr.	3	5
Total Renderers	**13**	**28**
Industry Total	**141**	**384**

Source: U.S. EPA, 2023a, 2023b.

Abbreviations: M = million, lbs. = pounds, LWK = live weight killed, yr. = year.

Note: If a respondent reported using a biological treatment unit for purposes other than biological treatment (e.g., primary treatment), that facility is not included in this table for that treatment unit.

a — Facilities operating in a manner to achieve zero discharge are excluded from this presentation. See Section 8.7 for a discussion on zero discharge facilities.

8.3 Phosphorus Removal

Some MPP facilities implement treatment technologies to achieve phosphorus removal. Table 8-10 provides brief descriptions of a few of these treatment technologies. Other treatment technologies, such as the DAF units described in Section 8.1, are also often used for phosphorus removal.

Biological treatment can also achieve phosphorus removal as microorganisms used in biological treatment require phosphorus for cell synthesis and energy transport. Certain biological systems (e.g., SBRs) can also be specifically designed and/or operated to remove phosphorus. Multi-stage biological treatment systems (e.g., Bardenpho, modified Bardenpho) are capable of targeting nitrogen and phosphorus. In the Modified Bardenpho process, the anaerobic stage at the beginning of the process results in biological phosphorus removal. Phosphate-accumulating organisms (PAOs) are recycled from the aerobic stage in the mixed liquor to the anaerobic stage. In the aerobic stages that follow, PAOs uptake large amounts of phosphorus (U.S. EPA, 2021). Biological phosphorus removal (BPR) and Enhanced BPR (EBPR) reduce phosphorus in the wastewater but often are not able to remove as much phosphorus as other treatment systems discussed in Table 8-10.

In all, 24 Detailed Questionnaire respondents (12 direct dischargers and 12 indirect dischargers) reported implementing a treatment unit specifically for the purpose of phosphorus removal (U.S. EPA, 2023a, 2023b).

Table 8-10. List of Phosphorus Removal Treatment Units

Treatment Unit	Description
Chemical Precipitation	Chemical precipitation involves adding chemicals that encourage coagulation and promote particle adhesion to form large, visible clumps (i.e., flocculation) which can then settle out of the wastewater. The sludge collected from the treatment unit is moved to solids handling treatment units. MPP facilities use chemical precipitation for phosphorus removal through the addition of metal salts, most commonly alum or ferric chloride. MPP facilities may add chemicals to primary treatment (e.g., DAF), biological treatment, or they may have a separate treatment unit.

Table 8-10. List of Phosphorus Removal Treatment Units

Treatment Unit	Description
Filtration	Filtration is the process of passing treated wastewater through a granular media, (e.g., sand, mixed-media, or a filter cloth). This treatment provides further clarification of wastewater by removing total suspended solids (TSS), nitrogen, and phosphorus. The sludge collected from the filter is moved to solids handling treatment units. Reverse osmosis is another type of filtration system, used to remove small ions from water.
Ion Exchange	Ion exchange is a physical-chemical process in which ions swap between a solution phase and a solid resin phase. Selective ion exchange targets specific charged particles. This treatment can be used for nutrient removal and/or disinfection.

8.4 Disinfection

MPP facilities implement additional treatment units beyond primary and biological treatment to achieve pathogenic microorganism removal (i.e., disinfection). These additional processes are typically performed after biological treatment. Table 8-11 presents a breakdown of the indirect dischargers and direct dischargers that implement at least one treatment unit for disinfection as part of their on-site wastewater treatment system. Table 8-12 includes counts by process type and annual production of facilities reporting use of disinfection. Given the nature of the raw material at MPP facilities, disinfection is widely used by direct dischargers and is more common at first processing facilities than at further processing facilities. Table 8-13 describes disinfection treatment units commonly used in the MPP industry. MPP facilities that reported performing disinfection typically use UV or chlorination/dechlorination.

Table 8-11. Number of Detailed Questionnaire Respondents That Implement a Disinfection Treatment Unit by Discharge Type

Type of Discharge	Number of Respondents That Implement Disinfection Treatment	Total Number of Detailed Questionnaire Respondents[a]
Indirect Dischargers	7	293
Direct Dischargers[b]	79	91
Total	**86**	**384**

Source: U.S. EPA, 2023a, 2023b.

a — Facilities operating in a manner to achieve zero discharge are excluded from this presentation. See Section 8.7 for a discussion on zero discharge facilities.

b — One facility discharging both to a receiving water (i.e., direct discharge) and to a POTW (i.e., indirect discharge) is classified here as a direct discharger.

Table 8-12. Number of Detailed Questionnaire Respondents That Implement a Disinfection Treatment Unit by Processing and Annual Production

Type of Processing and Annual Production	Number of Respondents That Implement Disinfection Treatment	Total Number of Detailed Questionnaire Respondents[a]
Meat First Processors		
<5M lbs. LWK/yr.	2	27
5 to <10M lbs. LWK/yr.	0	1
10 to <200M lbs. LWK/yr.	2	18
≥200M lbs. LWK/yr.	20	52
Total Meat First	**24**	**98**
Meat Further Processors		
<2M lbs. Finished Product/yr.	2	13
2 to <10M lbs. Finished Product/yr.	2	14
10 to 50M lbs. Finished Product/yr.	1	29
>50M lbs. Finished Product/yr.	4	56
Total Meat Further	**9**	**112**
Poultry First Processors		
<5M lbs. LWK/yr.	2	5
5 to 30M lbs. LWK/yr.	0	4
>30 to <200M lbs. LWK/yr.	4	13
≥200M lbs. LWK/yr.	39	90
Total Poultry First	**45**	**112**
Poultry Further Processors		
<2M lbs. Finished Product/yr.	0	2
2 to <10M lbs. Finished Product/yr.	0	6
10 to 30M lbs. Finished Product/yr.	1	4
>30M lbs. Finished Product/yr.	1	22
Total Poultry Further	**2**	**34**
Independent Renderers		
<5M lbs. Raw Material/yr.	0	0
5 to 30M lbs. Raw Material/yr.	0	3
>30 to <350M lbs. Raw Material/yr.	4	20
≥350M lbs. Raw Material/yr.	2	5
Total Renderers	**6**	**28**
Industry Total	**86**	**384**

Source: U.S. EPA, 2023a, 2023b.

Abbreviations: M = million, lbs. = pounds, LWK = live weight killed, yr. = year.

a — Facilities operating in a manner to achieve zero discharge are excluded from this presentation. See Section 8.7 for a discussion on zero discharge facilities.

Table 8-13. List of Disinfection Treatment Units

Treatment Unit	Description
Ion Exchange	Ion exchange is a physical-chemical process in which ions swap between a solution phase and a solid resin phase. Selective ion exchange targets specific charged particles. This treatment can be used for nutrient removal and/or disinfection within the MPP industry.
Chlorination/ Dechlorination	Chlorination is the process of adding chlorine to wastewater at a rate that results in residual chlorine, which kills pathogens. Dechlorination is the process of removing residual chlorine from disinfected wastewater prior to discharge into the environment. Dechlorination is achieved by adding sulfur dioxide which reacts with free chlorine.
Ultraviolet Light (UV)	Ultraviolet light units use a suspended or submerged lamp that produces ultraviolet light radiation. The radiation penetrates the wastewater to oxidize organics and/or disinfect by inactivating pathogenic microorganisms.
Filtration	Filtration is the process of passing treated wastewater through a granular media, (e.g., sand, mixed-media, or a filter cloth). Filtration methods that remove particles as small as 100 nanometers (microfiltration), 10 nanometers (ultrafiltration), or 1 nanometer (nanofiltration) can potentially perform disinfection by filtering pathogens that are too large to pass through, though Ultrafiltration and Nanofiltration are not typical in the MPP industry.

8.5 Solids Handling

Solids are typically generated from primary treatment (e.g., screens, DAF units, or other O&G separators) and from biological treatment systems. In responses to the Detailed Questionnaire, 208 indirect dischargers and 81 direct dischargers reported generating sludge from their wastewater treatment system (U.S. EPA, 2023a, 2023b).

As discussed in Sections 8.1 through 8.4, solids can either be recycled for additional processing (such as an activated sludge system) or wasted. Wasted solids removed by screens and the DAF may be rendered if there aren't added chemicals. Wasted solids can be further treated at the MPP facility prior to disposal. Table 8-14 lists treatment units typically used for solids handling. Detailed Questionnaire respondents reported using centrifugation and filter presses. MPP facilities typically return wastewater from these units either to the end-of-pipe treatment system or back into the solids handling treatment system.

Table 8-14. List of Solids Handling Treatment Units

Treatment Unit	Description
Gravity Thickening	Involves placing the sludge in a tank, often cylindrical, where gravity separates the solids from the liquid.
Air Flotation	Uses air to encourage solids to float to the top of the tank, where they are skimmed off the surface.
Anaerobic Digestion	Uses anaerobic bacteria to stabilize sludge, break down organic compounds into biogas, and reduce pathogens and nutrients in the sludge.
Aerobic Digestion	Uses aerobic bacteria to stabilize sludge, breakdown organic compounds into biogas, and reduce organic compounds and other nutrients in the sludge.

Table 8-14. List of Solids Handling Treatment Units

Treatment Unit	Description
Filter Press	Involves pushing sludge between two continuous belts set one above the other. The sludge passes through three process zones: the drainage zone (dewatering by gravity), the pressure zone (dewatering by pressure applied by rollers on the belts), and the shear zone (final dewatering through shear forces).
Centrifugation	Involves pumping sludge into a cone-shaped drum. The drum is rotated to generate centrifugal forces that concentrate solids and cause them to press to the walls of the drum. These solids are continuously removed by an auger, or screw conveyer.

Table 8-15 presents a breakdown of indirect dischargers and direct dischargers that implement treatment units for solids handling on site. Based on data reported in the Detailed Questionnaire, solids handling is common among indirect dischargers and direct dischargers across all types of operations (U.S. EPA, 2023a, 2023b). Table 8-16 lists facilities reporting solids handling by process type and annual production.

Table 8-15. Number of Detailed Questionnaire Respondents That Implement Treatment for Solids Handling by Discharge Type

Type of Discharge	Number of Respondents That Implement Solids Handling	Total Number of Detailed Questionnaire Respondents[a]
Indirect Dischargers	150	293
Direct Dischargers[b]	66	91
Total	**216**	**384**

Source: U.S. EPA, 2023a, 2023b.

a — Facilities operating in a manner to achieve zero discharge are excluded from this presentation. See Section 8.7 for a discussion on zero discharge facilities.

b — One facility discharging both to a receiving water (i.e., direct discharge) and to a POTW (i.e., indirect discharge) is classified here as a direct discharger.

Table 8-16. Number of Detailed Questionnaire Respondents That Implement Treatment for Solids Handling by Processing and Annual Production

Type of Processing and Annual Production	Number of Respondents That Implement Solids Handling	Total Number of Detailed Questionnaire Respondents[a]
Meat First Processors		
<5M lbs. LWK/yr.	9	27
5 to <10M lbs. LWK/yr.	0	1
10 to <200M lbs. LWK/yr.	11	18
≥200M lbs. LWK/yr.	37	52
Total Meat First	**57**	**98**
Meat Further Processors		
<2M lbs. Finished Product/yr.	7	13
2 to <10M lbs. Finished Product/yr.	7	14
10 to 50M lbs. Finished Product/yr.	12	29
>50M lbs. Finished Product/yr.	25	56
Total Meat Further	**51**	**112**
Poultry First Processors		
<5M lbs. LWK/yr.	4	5

Table 8-16. Number of Detailed Questionnaire Respondents That Implement Treatment for Solids Handling by Processing and Annual Production

Type of Processing and Annual Production	Number of Respondents That Implement Solids Handling	Total Number of Detailed Questionnaire Respondents[a]
5 to 30M lbs. LWK/yr.	2	4
>30 to <200M lbs. LWK/yr.	8	13
≥200M lbs. LWK/yr.	60	90
Total Poultry First	**74**	**112**
Poultry Further Processors		
<2M lbs. Finished Product/yr.	1	2
2 to <10M lbs. Finished Product/yr.	1	6
10 to 30M lbs. Finished Product/yr.	3	4
>30M lbs. Finished Product/yr.	15	22
Total Poultry Further	**20**	**34**
Independent Renderers		
<5M lbs. Raw Material/yr.	0	0
5 to 30M lbs. Raw Material/yr.	1	3
>30 to <350M lbs. Raw Material/yr.	9	20
≥350M lbs. Raw Material/yr.	4	5
Total Renderers	**14**	**28**
Industry Total	**216**	**384**

Source: U.S. EPA, 2023a, U.S. EPA, 2023b.

Abbreviations: M = million, lbs. = pounds, LWK = live weight killed, yr. = year.

a — Facilities operating in a manner to achieve zero discharge are excluded from this presentation. See Section 8.7 for a discussion on zero discharge facilities.

Dried or further reduced sludge streams from these solids handling treatment units are typically disposed of through land application, off-site landfilling, off-site composting, or incineration. Land application was the most common disposal method reported in the Detailed Questionnaire by both indirect and direct dischargers, followed by off-site landfilling.

8.6 High Chlorides Wastewater Treatment

As discussed in Section 3.4, under the authority of Clean Water Act (CWA) Section 308, the EPA collected treatment information from MPP facilities with potentially high chlorides wastestreams. The EPA's data, which are limited, demonstrate that most MPP facilities generating high chlorides wastestreams collect and commingle it with other process wastewaters. In these cases, the high chlorides wastewater is diluted, and the commingled wastewaters are then treated using the existing end-of-pipe wastewater treatment system prior to discharge. However, these treatment systems are not designed to remove chlorides, which passthrough the system and are ultimately discharged.

The EPA also found that some facilities are able to segregate their high chlorides wastewater using, for example, dedicated floor drains and/or separate process lines/buildings. This allows for separate handling of high-strength chlorides-laden wastewater.

Some MPP facilities operating high chlorides processes that have available space and are located in climates with net evaporation operate a brine evaporation lagoon, which uses an impoundment to allow the water to naturally evaporate while the solids precipitate. Periodically the solids in the lagoon are cleaned out to extend the lifetime of the system and the solids are disposed of. In other cases, the lagoon is allowed to completely fill with salt and is then capped and closed (U.S. EPA, 2023c).

Some facilities use various types of mechanical evaporation systems, which have smaller footprints and can be used in any type of climate. Submerged combustion evaporators, which use a heat exchanger to evaporate water by combusting fuel and releasing the heat directly into the water, have had limited success. More often, MPP facilities that use mechanical evaporation systems for chlorides use forced circulation evaporators, which use steam with a heat exchanger and condenser to evaporate water and recover solids (see Figure 8-4). The concentrated brine (condensate) is recirculated to the preheater and a portion of the brine is either disposed of or sent on to a crystallizer to create a solid salt wastestream.

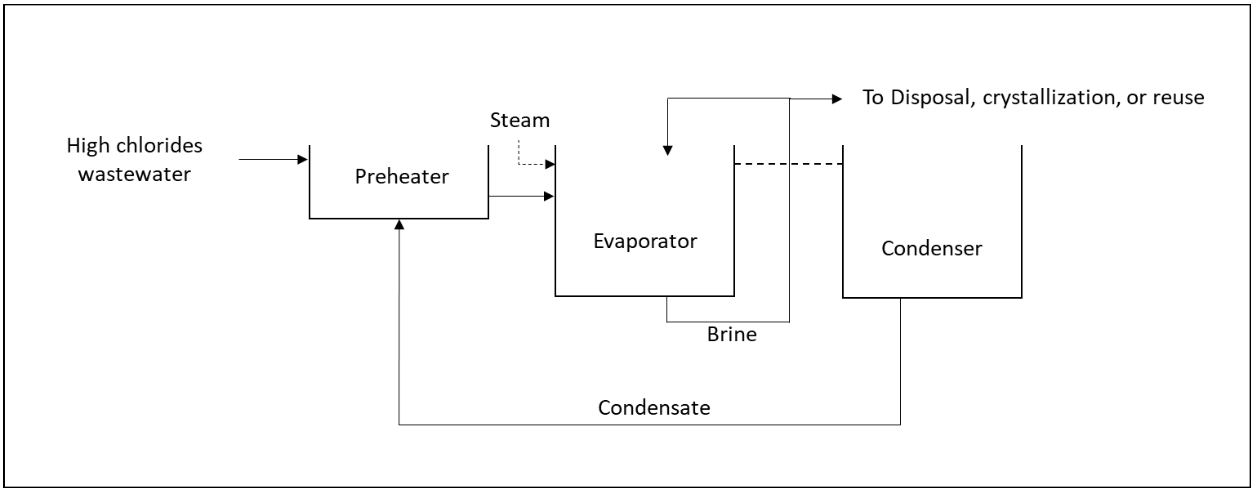

Figure 8-4. Process Flow Diagram of a Forced Circulation Evaporator System

Some MPP facilities dispose of their high chlorides wastewater using deepwell injection via Class I wells. Class I wells are used to inject hazardous and nonhazardous wastes into deep, confined rock formations, typically thousands of feet below the lowermost underground source of drinking water. However, deepwell injection is not allowed in some states and may not be an option for many facilities.

Lastly, some MPP facilities transfer their high chlorides wastewater to off-site wastewater treatment or to a renderer for treatment. See the *Summary of High Chlorides Wastewater Data* memorandum for more information on treatment technologies for this wastestream (U.S. EPA, 2023c).

8.7 Zero Discharge

A number of MPP facilities that generate wastewater are categorized as zero dischargers, meaning they operate in a manner that achieves zero discharge (e.g., the facility does not discharge directly to surface waters or to a POTW). MPP facilities that achieve zero discharge do so through land application of their treated wastewater, either on site or off site; the majority of these MPP facilities treat their wastewater before land application. Other facilities achieve zero discharge through complete reuse or by disposing of wastewater through subsurface injection or septic tanks. Of the 510 Detailed Questionnaire respondents, 126 operate in a manner that achieves zero discharge of MPP process wastewater. Of these, 74 facilities treat their wastewater prior to reuse or final disposal (U.S. EPA, 2023a, 2023b). Table 8-17 presents common treatment units implemented by these zero discharging MPP facilities.

Table 8-17. Common Treatment Units for Zero Discharging MPP Facilities

Purpose of Treatment Unit	Number of Facilities Implementing at Least One Treatment Unit	Common Treatment Units
Primary Treatment	41	Screens, DAF, equalization tank or pond
Biological Treatment	28	Anaerobic lagoon,[a] aerobic basin or lagoon, anoxic tank or basin, activated sludge, SBR, MBR

Table 8-17. Common Treatment Units for Zero Discharging MPP Facilities

Purpose of Treatment Unit	Number of Facilities Implementing at Least One Treatment Unit	Common Treatment Units
Nutrient Removal	7	Anoxic pond or lagoon, DAF, SBR
Phosphorus Removal	0	N/A
Disinfection	8	Chlorination, UV
Solids Handling	36	Biological system, DAF, O&G separation, screens

Source: U.S. EPA, 2023a, 2023b.

Note: Facilities may implement multiple treatment units for different purposes.

a — 12 facilities operate anaerobic lagoons, which is a biological treatment unit that may be used as a primary treatment unit for BOD pretreatment.

8.8 Pollution Prevention and Wastewater Reduction Practices

Process wastewater reuse can occur within the processing facility, prior to any wastewater treatment, or after treatment but prior to discharge. Based on responses to the Detailed Questionnaire and site visits, over 20 percent of the 510 MPP facilities that responded to the wastewater treatment section of the Detailed Questionnaire reported reusing or recycling a portion of the untreated wastewater within the facility. MPP facilities use screens in the processing area to treat wastewater from late-stage processing operations (e.g., rinsing or washing meat prior to packaging or chillers) so that it can be reused at initial-stage operations (e.g., bird washing after slaughter, gizzard machine, or neck breaker) (U.S. EPA, 2022a, 2022b, 2022c, 2023b). For example, the Tyson Foods Inc. Glen Allen facility reused over 40 percent of its treated wastewater in this way (U.S. EPA, 2022c). Other MPP facilities reported reusing wastewater for process operations, such as inside-outside bird washing, removing feathers and offal from poultry, or priming wastewater treatment systems. In the Detailed Questionnaire and during site visits, MPP facilities reported recycling treated effluent for cleaning slaughter equipment, trucks/trailers, cages, loading dock areas, and wastewater treatment equipment. Some MPP facilities also recycle a portion of their process wastewater for cooling towers and other forms of noncontact cooling water (U.S. EPA, 2022d, 2022e, 2022f, 2023b).

Many MPP facilities incorporate flow minimization and wasteload reduction practices to minimize the amount of process wastewater generated. In the Detailed Questionnaire, the most reported techniques to reduce wastewater generation are collecting solids or residual product prior to cleaning operations or performing dry clean up. Other common techniques include using flow-reduction nozzles, spray nozzles that are sized to control water use, high-pressure/low-volume nozzles, and/or controls that regulate supply line pressure. Many facilities also commonly shut off all unnecessary water flow during work breaks or use automatic flow shutoff valves. Some MPP facilities also reported implementing process changes and techniques to reduce wastewater generation and/or contain pollution. For example, facilities reported practices such as confining bleeding to reduce the amount of cleaning necessary, providing sufficient bleed time to reduce the level of pollutants in the wastewater, and/or transporting collectable blood to rendering tanks instead of commingling it with cleaning water (U.S. EPA, 2023b).

Based on responses to the Detailed Questionnaire, approximately half of the 510 MPP facilities implement water conservation, environmental management, monitoring, or pollutant prevention and wastewater management practices other than recycling or reuse of process wastewater. In the Detailed Questionnaire, the most reported pollution prevention techniques by these facilities were training employees on good water management practices; performing frequent, regular maintenance on equipment; and/or using dikes, curbs, and other control measures to contain leaks/spills. Over a third of MPP facilities that implement pollution prevention practices reported maintaining a water treatment and reuse system. A third of these facilities reported using smaller quantities of water in scalder/chillers (U.S. EPA, 2023b).

8.9 References

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9. Technology Systems and Regulatory Options

Using treatment technologies applicable to wastewater generated from meat and poultry products (MPP) process operations (see Section 8), the U.S. Environmental Protection Agency considered certain technology systems as the basis for the proposed MPP effluent limitations guidelines and standards (ELGs). The EPA then developed regulatory options (i.e., combinations of the technology systems and subcategories that were under consideration) for each level of control. This section describes the EPA's proposed technology systems and regulatory options for the proposed rulemaking.

The EPA is proposing ELGs based on six levels of control, as appropriate:

- Best Practicable Control Technology Currently Available (BPT).
- Best Conventional Pollutant Control Technology (BCT).
- Best Available Technology Economically Achievable (BAT).
- New Source Performance Standards (NSPS).
- Pretreatment Standards for Existing Sources (PSES).
- Pretreatment Standards for New Sources (PSNS).

BPT, BCT, BAT, and NSPS limitations regulate only those sources that discharge effluent directly into waters of the United States (i.e., direct dischargers). PSES and PSNS limitations regulate only those sources that discharge indirectly through discharge to Publicly Owned Treatment Works (POTWs) (i.e., indirect dischargers).

Section 9.1 presents the technology systems considered for MPP process wastewater treatment, and Section 9.2 summarizes the EPA's proposed regulatory options as well as the selected regulatory option. The EPA's technology systems incorporate pollutant control technologies that are used in the MPP industry, that minimize water use, and that result in minimal non-water quality environmental impacts. While the EPA establishes ELGs based on a particular set of in-process and/or end-of-pipe treatment technologies, the EPA does not require a discharger to use these technologies. Rather, the selection of technologies used to treat wastewater is left to the discretion of the individual facility operator, as long as the facility can achieve the numeric discharge limitations and standards, as required by Section 301(b) of the Clean Water Act (CWA). Direct and indirect dischargers can use any combination of process modifications, in-process technologies, and end-of-pipe wastewater treatment technologies to achieve the ELGs.

9.1 Wastewater Treatment Technology Systems

MPP process wastewater includes any water that, during processing, comes into direct contact with any raw material, intermediate product, finished product, byproduct, or waste product. MPP process wastewater includes wastewater generated in MPP processing areas and animal holding areas. This section presents the technology systems considered for direct dischargers (Section 9.1.1) and indirect dischargers (Section 9.1.2) of MPP process wastewater.

9.1.1 Direct Dischargers of MPP Process Wastewater

Table 9-1 presents two technology systems the EPA considered for MPP process wastewater treatment for direct dischargers. Direct Wastewater Treatment Technology System Targeting Phosphorus and Partial Denitrification (P with Partial N Treatment for Direct Dischargers) and Direct Wastewater Treatment Technology System Targeting Phosphorus and Full Denitrification (P with Full N Treatment for Direct Dischargers) use the same treatment units. However, P with Full N Treatment for Direct Dischargers is designed to achieve full denitrification in the biological treatment system, compared to partial denitrification in P with Partial N Treatment for Direct Dischargers, because of a longer solids retention time and larger anoxic zone. Therefore, P with Full N Treatment for Direct Dischargers achieves lower nitrogen levels compared to P with Partial N Treatment for Direct Dischargers. Both systems are similar to the current technology basis for direct dischargers, with the addition of phosphorus removal.

Table 9-1. Technology Systems Considered for Direct Dischargers

Treatment Process	Treatment Unit	P with Partial N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers
Primary Treatment for Solids Removal	Screen/Grit Removal	X	X
	Dissolved Air Flotation (DAF) for Oil and Grease (O&G) Removal	X	X
Biochemical Oxygen Demand (BOD) Pretreatment	Anaerobic Lagoon	X	X
Biological Treatment for Nitrification and Denitrification	Activated Sludge Biological Treatment	X - System has shorter retention time and smaller anoxic zone. Performs partial denitrification.	X - System has longer retention time and larger anoxic zone. Performs full denitrification.
	Secondary Clarifier	X	X
Phosphorus Removal	Chemical Phosphorus Removal Using Ferric Chloride	X	X
Filtration	Sand Filtration[a]	X	X
Disinfection	Chlorination/Dechlorination	X	X
Solids Handling	Gravity Thickener	X	X
	Filter Press	X	X
	Hauling and Landfill	X	X

a — Sand filtration is not part of the treatment system for rendering facilities.

9.1.2 Indirect Dischargers of MPP Process Wastewater

Table 9-2 presents two technology systems the EPA considered for indirect dischargers (i.e., PSES and PSNS) of MPP process wastewater. Indirect Wastewater Treatment Technology System Targeting Conventionals (BOD, O&G, and total suspended solids (TSS)) (BOD, O&G, and TSS Treatment for Indirect Dischargers) includes only primary treatment for solids removal and assumes other pollutants will be removed at a POTW. Indirect Wastewater Treatment Technology System Targeting Phosphorus and Full Denitrification (P with Full N Treatment for Indirect Dischargers) is similar to P with Full N Treatment for Direct Dischargers, presented in the previous section, as both systems include the same treatment units and are designed to achieve nitrification and full denitrification.

Table 9-2. Technology Systems Considered for Indirect Dischargers

Treatment Process	Treatment Unit	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers
Primary Treatment for Solids Removal	Screen/Grit Removal	X	X
	DAF for O&G Removal	X	X
BOD Pretreatment	Anaerobic Lagoon	NA	X
Biological Treatment for Nitrification and Denitrification	Activated Sludge Biological Treatment	NA	X
	Secondary Clarifier	NA	X
Phosphorus Removal	Chemical Phosphorus Removal using Ferric Chloride	NA	X
Filtration	Sand Filtration[a]	NA	X
Solids Handling	Gravity Thickener	X	X
	Filter Press	X	X
	Hauling and Landfill	X	X

Abbreviations: NA = not applicable.

a – Sand Filtration is not part of the treatment system for rendering facilities.

9.1.3 High Chlorides Wastewater Discharges

The EPA evaluated treatment for discharge of chlorides by two technologies, both achieving zero discharge of pollutants. The technology basis is segregation of high chlorides wastewaters from other process wastewater streams and treatment via either evaporation or disposal of the wastewater.

9.2 Regulatory Options

The EPA evaluated three regulatory options for the proposed rulemaking for MPP process wastewater. In developing these regulatory options, the EPA aimed to reduce pollutant discharges to surface waters, reduce and/or eliminate interference and passthrough at POTWs receiving MPP wastewater, and establish effluent limitations and pretreatment standards based on technologies that are available and affordable to the industry, while minimizing impacts to small businesses.

Table 9-3 and Table 9-4 summarize the technology systems that are the bases for the three regulatory options for direct dischargers and indirect dischargers, respectively. The regulatory options address each subcategory in the current ELGs as the EPA is not proposing any changes to the current subcategories. The EPA is proposing no new regulations for Subcategory E, Small Processors. The technology system for each regulatory option varies by the facility production volume. Each regulatory option incrementally increases the number of facilities impacted by the proposed ELG.

For direct dischargers, the EPA proposes to revise BAT limitations and NSPS for nitrogen and phosphorus. For indirect dischargers, under Regulatory Option 1, the EPA proposes to establish PSES and PSNS for BOD, O&G, and TSS. Under Regulatory Options 2 and 3, the EPA would include phosphorus and nitrogen removal for some indirect dischargers.

For high chlorides wastewater, the EPA evaluated requiring zero discharge via evaporation for all facilities with high chlorides processes producing more than 5 million pounds per year.

Table 9-3. Regulatory Options for Direct Dischargers (Level of Control includes BAT and NSPS) for MPP Process Wastewater

Subcategory	Units for Facility Production	Facility Production	Regulatory Option 1	Regulatory Option 2	Regulatory Option 3
Meat First Processors (Subcategories A through D)	M lbs. LWK/yr.	≥10 and <20	NA	NA	P with Partial N Treatment for Direct Dischargers
		≥20 and ≤50	NA	NA	P with Full N Treatment for Direct Dischargers
		>50	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers
Small Processors (Subcategory E)	M lbs. Finished Product/yr.	All	NA	NA	NA
Meat Further Processors (Subcategories F through I)	M lbs. Finished Product/yr.	≥10 and <20	NA	NA	P with Partial N Treatment for Direct Dischargers
		≥20 and ≤50	NA	NA	P with Full N Treatment for Direct Dischargers
		>50	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers
Renderers (Subcategory J)	M lbs. Raw Material/yr.	≥10 and <20	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	P with Partial N Treatment for Direct Dischargers
		≥20	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers

Table 9-3. Regulatory Options for Direct Dischargers (Level of Control includes BAT and NSPS) for MPP Process Wastewater

Subcategory	Units for Facility Production	Facility Production	Regulatory Option 1	Regulatory Option 2	Regulatory Option 3
Poultry First Processors (Subcategory K)	M lbs. LWK/yr.	≥10 and <20	NA	NA	P with Partial N Treatment for Direct Dischargers
		≥20 and ≤100	NA	NA	P with Full N Treatment for Direct Dischargers
		>100	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers
Poultry Further Processor (Subcategory L)	M lbs. Finished Product/yr.	≥7 and <10	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	NA
		≥10 and <20	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	P with Partial N Treatment for Direct Dischargers
		≥20	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers

Abbreviations: lbs. = pounds, LWK = live weight killed, M = million, NA = not applicable, yr. = year.

Table 9-4. Regulatory Options for Indirect Dischargers (Level of Control includes PSES and PSNS) for MPP Process Wastewater

Subcategory	Units for Facility Production	Facility Production	Regulatory Option 1	Regulatory Option 2	Regulatory Option 3
Meat First Processors (Subcategories A through D)	M lbs. LWK/yr.	>5 and ≤30	NA	NA	BOD, O&G, and TSS Treatment for Indirect Dischargers
		>30 and ≤50	NA	NA	P with Full N Treatment for Indirect Dischargers
		>50 and <200	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers
		≥200	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers
Small Processors (Subcategory E)	M lbs. Finished Product/yr.	All	NA	NA	NA
Meat Further Processors (Subcategories F through I)	M lbs. Finished Product/yr.	>5 and ≤30	NA	NA	BOD, O&G, and TSS Treatment for Indirect Dischargers
		>30 and ≤50	NA	NA	P with Full N Treatment for Indirect Dischargers
		>50	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers

Table 9-4. Regulatory Options for Indirect Dischargers (Level of Control includes PSES and PSNS) for MPP Process Wastewater

Subcategory	Units for Facility Production	Facility Production	Regulatory Option 1	Regulatory Option 2	Regulatory Option 3
Renderers (Subcategory J)	M lbs. Raw Material/yr.	>5 and ≤10	NA	NA	BOD, O&G, and TSS Treatment for Indirect Dischargers
		>10 and ≤30	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers
		>30 and <350	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers
		≥350	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers
Poultry First Processors (Subcategory K)	M lbs. LWK/yr.	>5 and ≤30	NA	NA	BOD, O&G, and TSS Treatment for Indirect Dischargers
		>30 and ≤100	NA	NA	P with Full N Treatment for Indirect Dischargers
		>100	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers
Poultry Further Processor (Subcategory L)	M lbs. finished product/yr.	>5 and ≤7	NA	NA	BOD, O&G, and TSS Treatment for Indirect Dischargers
		>7 and ≤30	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers
		>30	BOD, O&G, and TSS Treatment for Indirect Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers

Abbreviations: lbs. = pounds, LWK = live weight killed, M = million, NA = not applicable, yr. = year.

Table 9-5 presents the number of direct dischargers and indirect dischargers by regulatory option. Section 9.2.1 discusses the selected regulatory option in more detail.

Table 9-5. Number of MPP Facilities by Regulatory Option

Regulatory Option	Number of Direct Dischargers	Number of Indirect Dischargers
Option 1	125	719
Option 2	125	719 (conventional) 143 of 719 (TN and TP)
Option 3	133	1,485

9.2.1 Selected Regulatory Option

The EPA selected Regulatory Option 1 as the preferred option for the proposed rulemaking. For an explanation of the rationale for the preferred option, see Section VII.C of the Preamble. For an explanation of the rationale for rejecting Options 2 and 3 as the preferred option, see Section VII.E of the Preamble.

Under Regulatory Option 1, most facilities would face no new limitations because their production would fall below the proposed size thresholds. For details on the number of facilities and small businesses impacted by the preferred option, see Section VII.A of the Preamble. See Section XVI.C of the Preamble for EPA's discussion on impacts to small businesses. For more information on the costs and benefits associated with the preferred option, including pollutant discharge reductions, see Section I.A of the Preamble.

As described in Preamble Section VII.C.3, the EPA did not include any provisions for high chlorides wastewater treatment in the selected option. Instead, the EPA is soliciting comment on including requirements for chlorides in the final rule.

9.3 BPT Analysis for Conventional Pollutants

As part of the proposed rule, the EPA evaluated technologies to control conventional pollutants. CWA Section 304(b) defines two levels of control for conventional pollutants, BPT and BCT. CWA Section 304(a)(4) designates the following as conventional pollutants: BOD, TSS, fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated O&G as an additional conventional pollutant (44 FR 44501 (July 30, 1979) and 40 CFR 401.16).

The current MPP ELGs include BPT requirements for BOD, O&G, and TSS for direct discharging facilities. The EPA is proposing additional requirements for BOD, O&G, and TSS that would apply to indirect discharging facilities and be based on screening/grit removal and DAF treatment. The proposed rule would revise BPT limitations for conventional pollutants for indirect dischargers only and consider whether more stringent BCT limitations pass the two-part BCT cost test for indirect dischargers. A BPT Wholly Disproportionate Cost Test was performed for all direct and indirect facilities that would be required to control conventional pollutants under the three regulatory options.

The EPA estimated facility-specific costs and loadings for the use of DAF technology for BOD, O&G, and TSS Treatment for Indirect Dischargers. This level of technology is already in place for direct discharging facilities, reflecting the existing rule's BPT, BCT, and BAT requirements, but it would be a new requirement for indirect discharging facilities. The CWA requires that the EPA consider "the total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application," and these costs should not be wholly disproportionate to the corresponding effluent reduction benefits.

After reviewing the annualized after-tax technology costs and associated pollutant load reductions for individual subcategories of facilities and the industry, the EPA determined that, under BPT, there would be significant reductions in conventional pollutant loading for each subcategory and for the industry as a whole, across all three options. Based on these results, the EPA considers BPT costs to not be wholly disproportionate to the corresponding effluent reduction benefits.

9.4 BCT Analysis for Conventional Pollutants

As part of the proposed rule, the EPA also considered establishing BCT requirements for BOD, O&G, and TSS for indirect dischargers based on screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve nitrification and full denitrification, chemical phosphorus removal with ferric chloride, sand filtration, and solids handling (gravity thickener, filter press, hauling/landfilling).

The EPA evaluated the reasonableness of BCT candidate technologies (those that remove more conventional pollutants than BPT) by applying a two-part cost reasonableness test. The two-part test requires: (1) the cost per pound of conventional pollutant removed by dischargers in upgrading from BPT limitations to the candidate BCT option must be less than the cost per pound of conventional pollutant removed by upgrading POTWs from secondary treatment to advanced secondary treatment ("the POTW test"); and (2) an assessment of industry costs per pound removed in upgrading from BPT to BCT relative to the costs per pound removed in going from no treatment to BPT, followed by a comparison of that ratio to the analogous ratio for POTWs ("the industry cost effectiveness test").

9.4.1 Methodology

The CWA amendments that created BCT also specify that the cost associated with BCT limitations must be "reasonable" with respect to the effluent reductions. Accordingly, the EPA developed the "BCT Methodology" to answer the question of whether it is "cost-reasonable" for industry to control conventional pollutants at a level more stringent than already required by BPT effluent limitations guidelines. The BCT Methodology was originally published on August 29, 1979, at the same time that the EPA promulgated BCT effluent limitations guidelines for 41 industry subcategories (44 FR 50732). The methodology compares the costs of removing the conventional pollutants for a candidate BCT technology within a particular industry segment to the costs of removal for an average-sized POTW.

A number of industries and industry associations challenged the methodology, and, in 1981, the United States Court of Appeals for the Fourth Circuit remanded it to the Agency, directing the EPA to include an assessment of the cost-effectiveness of industry conventional pollutant removal as part of its evaluation of cost reasonableness, in addition to the POTW Test. The EPA proposed a revised BCT Methodology in 1982 (47 FR 49176) that addressed the industry cost effectiveness test (the Industry Cost Test, or "second" test), limiting it to the conventional pollutants BOD and TSS. The EPA proposed to base the POTW Benchmark on model facility costs in a 1984 notice (49 FR 37046).

The final BCT Methodology was published on July 9, 1986 (51 FR 24974). This methodology maintained the basic approach of the 1982 proposed BCT Methodology and adopted the use of the new model POTW data. The published guidelines state that the BCT cost analysis "...answers the question of whether it is 'cost reasonable' for industry to control conventional pollutants at a level more stringent than BPT effluent limitations already require."

The 1986 BCT Methodology uses both the POTW Test and the Industry Cost Test to establish cost-reasonableness.

If a candidate technology is feasible and passes both the POTW Test and the Industry Cost Test, then the technology system becomes the basis for setting BCT effluent limitations. Alternatively, if no candidate technology more stringent than BPT passes both tests, then BCT effluent limitations are set equal to BPT effluent limitations (51 FR 24,976).

The results from each of these tests are compared with established benchmarks. The POTW Benchmark used in the 1986 Federal Register Notice (FRN) is $0.25 per pound of BOD and TSS removed (in 1976 dollars) for industries where cost per pound is based on long-term performance data. The 1986 FRN Industry Cost Benchmark is 1.29 (a unitless ratio). These benchmarks were developed using only BOD and TSS pollutant removals (see 51 FR 24974 for more information on these two cost tests and benchmarks). The EPA assumes that O&G benchmarks (POTW and Industry Cost benchmarks) would be similar to those for BOD and TSS.

POTW Test

The POTW Test requires "a comparison of the cost of removing additional pounds of conventional pollutants by industrial dischargers to the cost of conventional pollutant removals by a POTW" (51 FR 24980). Specifically, the POTW Test compares two factors: (1) the incremental cost per pound of conventional pollutant removal for the industry to increase treatment from BPT to BCT; and (2) the incremental cost of conventional pollutant removal for a POTW to upgrade from secondary treatment to advanced secondary treatment (i.e., the POTW Benchmark, which the EPA estimated is $0.25 per pound in 1976 dollars). If the industrial incremental cost of removal exceeds the POTW Benchmark, the industrial treatment technology candidate fails the POTW cost test.

Industry Cost Test

The Industry Cost Test compares two calculated values: the Industry Cost Ratio and the Industry Cost Benchmark.

The EPA computes the Industry Cost Ratio using two incremental costs. The first incremental cost is the cost per pound of conventional pollutant removed by the candidate BCT relative to BPT. The second incremental cost is the cost per pound of conventional pollutant removed by BPT relative to no treatment (i.e., raw wasteload). Historically, this Industry Cost Ratio has been calculated using Equation 9-1:

$$\frac{(Cost\ of\ BCT - Cost\ of\ BPT) \div (Pollutant\ Removal\ of\ BCT - Pollutant\ Removal\ of\ BPT)}{Cost\ of\ BPT \div Pollutant\ Removal\ of\ BPT} \qquad \textit{Equation 9-1}$$

Next, the EPA calculates the Industry Cost Benchmark. The Industry Cost Benchmark is the ratio of two other incremental costs: the cost per pound to upgrade a POTW from secondary treatment to advanced secondary treatment (the POTW Benchmark) divided by the cost per pound to initially achieve secondary treatment. The Industry Cost Benchmark is calculated using Equation 9-2:

$$\frac{POTW\ Benchmark}{Cost\ of\ Secondary\ Treatment \div Pollutant\ Removal\ of\ Secondary\ Treatment} \qquad \textit{Equation 9-2}$$

The EPA calculated the Industry Cost Benchmark using the same model POTW data and flow-based weighting factors that were used to calculate the POTW Benchmark. The Industry Cost Benchmark established in the 1986 FRN for BOD and TSS is 1.29 (see 51 FR 24974).

To pass the Industry Cost Test, the Industry Cost Ratio for the subcategory must be lower than the Industry Cost Benchmark.

9.4.2 Analysis

POTW Test

To evaluate the POTW Test, the EPA converted the 1986 POTW Benchmark from 1976 dollars to 2022 dollars to be consistent with the cost basis supporting the proposed MPP ELGs. The EPA used the 2022 RSMeans Historical Cost Indices (Gordian, 2023) and Equation 9-3 to calculate the POTW Benchmark (in 2022$):

$$\frac{Index\ for\ 2022}{Index\ for\ 1976} x\ POTW\ Benchmark\ (in\ 1976\$) \qquad \textit{Equation 9-3}$$

Where:	POTW Benchmark	= $0.25 (1976$)
	Index for 2022	= 276.9
	Index for 1976	= 46.9
	In 2022 dollars, the POTW Benchmark	= $1.476

To estimate the Industry Incremental Removal Cost, the EPA considered the cost and pollutant removal for the candidate technologies considered. As described in the Preamble, the EPA is comparing the cost of upgrading from the candidate BPT (based on screening/grit removal followed by DAF treatment) to BCT based on biological removal including full denitrification and chemical precipitation with filtration as described for BAT. For all indirect discharging facilities, the EPA estimated BPT and BCT costs and pollutant removals as follows:

- **Cost of BPT:** Costs estimated for BOD, O&G, and TSS Treatment for Indirect Dischargers, which includes screening/grit removal, DAF, and solids handling. See *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023a).
- **Pollutant Removal of BPT:** Estimated as the BOD, O&G, and TSS removals for BOD, O&G, and TSS Treatment for Indirect Dischargers. See *Pollutant Loadings and Removals Methodology for Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023b).
- **Cost of BCT:** Costs estimated for P with Full N Treatment for Indirect Dischargers, which includes screening/grit removal, DAF, anaerobic lagoon, biological treatment with activated sludge to achieve nitrification and full denitrification, chemical phosphorus removal with ferric chloride, sand filtration, and solids handling (gravity thickener, filter press, hauling/landfilling). See *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023a).
- **Pollutant Removal of BCT:** Estimated as the BOD, O&G, and TSS removals for P with Full N Treatment for Indirect Dischargers. See *Pollutant Loadings and Removals Methodology for Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023b).

The EPA evaluated the Industry Incremental Removal Cost for each regulatory option and subcategory. For each regulatory option, the EPA calculated the total incremental removal cost based on the population of indirect discharging facilities anticipated to upgrade existing wastewater treatment. The EPA calculated the Industry Incremental Removal Cost to upgrade from BPT to BCT using Equation 9-4:

$$\frac{Cost\ of\ BCT - Cost\ of\ BPT}{Pollutant\ Removal\ of\ BCT - Pollutant\ Removal\ of\ BPT} \qquad \textit{Equation 9-4}$$

For each regulatory option and subcategory, the EPA compared the Industry Incremental Removal Cost to the POTW Benchmark. Any incremental removal cost greater than $1.476 per pound fails the POTW Test. Any regulatory option and subcategory with an incremental cost lower than the POTW Benchmark passes and is further evaluated using the Industry Cost Test.

Industry Cost Test

As noted in Section 9.4.1, the Industry Cost Benchmark is 1.29. This benchmark is unitless and not tied to a cost year. For all regulatory options and subcategories passing the POTW Test, the EPA calculated the Industry Cost Ratio using the Industry Cost Ratio equation (Equation 9-1):

$$\frac{(Cost\ of\ BCT - Cost\ of\ BPT) \div (Pollutant\ Removal\ of\ BCT - Pollutant\ Removal\ of\ BPT)}{Cost\ of\ BPT \div Pollutant\ Removal\ of\ BPT} \quad \text{Equation 9-1}$$

The Industry Cost Ratio is the Industry Incremental Removal Cost divided by the cost per pound removed of BPT. To pass the Industry Cost Test, the Industry Cost Ratio must be lower than 1.29.

Results

The EPA evaluated the results of both tests (POTW Test and Industry Cost Test) by regulatory option and subcategory, except Subcategory E, to determine if BCT requirements could be established. Table 9-6 presents the cost data and removals data for the population of facilities impacted by Regulatory Option 1 (the preferred option) for all subcategories considered. Table 9-7 presents the results of both BCT cost test components for Regulatory Option 1. See Appendix A for results based on the population of facilities impacted by Regulatory Options 2 and 3.

Table 9-6. Incremental Costs and Conventional Pollutant Removals—Regulatory Option 1

Level of Control	Annualized Costs (M 2022$, Post-Tax)	Total Incremental Removals (M lbs.)	Industry Incremental Removal Cost (2022$/lbs.)
Subcategories A–D			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$1.63	12.8	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$162	627	$0.26
Subcategories F–I			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$2.11	5.98	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$162	263	$0.62
Subcategory J			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$0.64	2.90	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$51.50	177	$0.29
Subcategory K			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$6.64	164	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$219	377	$1.00
Subcategory L			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$1.42	22.0	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$68.90	73.0	$1.32

Source: U.S. EPA, 2023b, 2023c.

Abbreviations: M = million, lbs. = pounds.

Note: Values presented as three significant figures.

Table 9-7. BCT Cost Test Results—Regulatory Option 1

Subcategory	Industry Incremental Removal Cost (2022$/lbs.)	POTW Benchmark (2022$/lbs.)	Industry Cost Ratio	Industry Cost Benchmark	Test 1 Results	Test 2 Results
A–D	$0.26	$1.476	2.04	1.29	Pass	Fail
F–I	$0.62	$1.476	1.76	1.29	Pass	Fail
J	$0.29	$1.476	1.33	1.29	Pass	Fail
K	$1.00	$1.476	24.5	1.29	Pass	Fail
L	$1.32	$1.476	20.5	1.29	Pass	Fail

Abbreviations: lbs. = pounds.

Note: Values presented as three significant figures.

When considering how to establish limitations for conventional pollutants for indirect dischargers, the EPA evaluated the BCT cost test by comparing the BOD, O&G, and TSS Treatment for Indirect Dischargers to the P with Full N Treatment for Indirect Dischargers. Both are pretreatment technologies. In both cases, wastewater from the MPP facilities will be further treated at a POTW (not directly discharged to surface water). Although the cost to upgrade MPP treatment from BOD, O&G, and TSS Treatment for Indirect Dischargers to the P with Full N Treatment for Indirect Dischargers is not directly comparable to the upgrade cost of a POTW, which discharges to a surface water, information from the comparison can be used to evaluate "the cost of removing additional pounds of conventional pollutants by industrial dischargers to the cost of conventional pollutant removals by a POTW" (51 FR 24980). All MPP subcategories evaluated did pass the POTW Test, but the EPA acknowledges that these treatment technology costs for indirect dischargers may not be directly comparable to what it would cost direct dischargers to perform the same or similar treatment. For example, a facility would need to install additional treatment beyond screening/grit removal and DAF to discharge to surface waters. Doing the analysis in this way may underestimate the upgrade costs compared to POTW upgrade costs; however, this would not change the result of the analysis as all categories evaluated failed the BCT test.

9.5 References

1. Gordian. 2023. *RS Means Historical Cost Indices* (January). DCN MP00707. Available online at: rsmeans.co.
2. U.S. EPA. 2023a. *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* (November). DCN MP00301.
3. U.S. EPA. 2023b. *Pollutant Loadings and Removals Methodology for the Meat and Poultry Products Proposed Rulemaking* (November). DCN MP00302.
4. U.S. EPA. 2023c. *Regulatory Impact Analysis for Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (RIA)* (November). EPA-821-R-23-014.

10. Incremental Capital, Operation, and Maintenance Costs for the Proposed Regulation

This section presents the U.S. Environmental Protection Agency's methodology for estimating the incremental capital and operation and maintenance (O&M) costs for the meat and poultry products (MPP) industry to meet the requirements of the technology systems the Agency considered as the basis for the proposed MPP regulatory options.

The sections that follow include a detailed description of the cost methodology, an example facility cost calculation, and a summary of total estimated compliance costs for the industry.

10.1 Introduction

Effluent limitations guidelines and standards (ELGs) are based on the performance of specific technology systems that the EPA evaluated for the regulatory options. Implementation of these specific technology systems is not required; regulated facilities can choose their own methods to meet the ELGs. However, the EPA calculates the cost for MPP facilities to implement these technologies in order to estimate the compliance costs for the industry to meet the ELGs. For existing sources, compliance costs are incremental, meaning that they represent the additional costs facilities are expected to incur as they revise their existing operations to meet the proposed requirements. For new sources, the EPA estimates the costs to install such technologies compared to what a typical source would do in the absence of the rule.

The EPA may estimate costs on a per-facility basis and then sum or otherwise escalate the facility-specific values to represent industry-wide compliance costs. Calculating costs on a per-facility basis allows the EPA to account for differences in facility characteristics such as types of processes used, types of wastewaters generated and their flows/volumes and characteristics, and categories of wastewater controls in place (e.g., best management practices and end-of-pipe treatment). The EPA took this approach in estimating the compliance costs associated with the proposed rule.

The EPA estimated compliance costs associated with each of the regulatory options using data collected through site visits, sampling episodes, and responses to the MPP Questionnaire. EPA also used data generated by CapdetWorks v.4 (Capdet), a cost modeling software (see Section 10.2.1 for more information on Capdet).

The EPA's cost estimates include capital costs (one-time costs) and annual O&M costs (which are incurred every year). Capital costs include costs associated with the purchase, delivery, and installation of pollution control technologies. Capital cost elements are specific to the industry and commonly include purchase and installation of equipment, construction and renovation of buildings, site preparation, engineering costs, construction expenses, contractors' fees, and contingency. Annual O&M costs include costs related to operating and maintaining the pollution control technologies for a period of one year. O&M costs are also specific to the industry and commonly include costs associated with operating labor, maintenance labor, maintenance materials (routine replacement of equipment due to wear and tear), chemical purchase, energy requirements, residual disposal, and compliance monitoring.

10.2 Methodology for Estimating Compliance Costs

For the proposed rule, the EPA developed compliance capital and annual O&M cost estimates based on the evaluation of six different technology systems. These technology systems were developed based on the wastewater and type of discharger.

MPP process wastewater includes any water that, during processing, comes into direct contact with any raw material, intermediate product, finished product, byproduct, or waste product. MPP process wastewater includes any wastewater generated in MPP processing areas and animal holding areas.

The following technology systems were evaluated for MPP process wastewater. More details on the specific treatment units included in each system are provided in Table 10-1.

- **Direct Wastewater Treatment Technology System Targeting Phosphorus and Partial Denitrification (P with Partial N Treatment for Direct Dischargers):** Screening/grit removal, dissolved air flotation (DAF) (for oil and grease [O&G] treatment), anaerobic lagoon (for biochemical oxygen demand [BOD] pretreatment), biological treatment with activated sludge to achieve nitrification and partial denitrification, chemical phosphorus removal with ferric chloride, sand filtration,[6] chlorination/dechlorination, solids handling (gravity thickener, filter press, hauling/landfilling).
- **Direct Wastewater Treatment Technology System Targeting Phosphorus and Full Denitrification (P with Full N Treatment for Direct Dischargers):** Screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve nitrification and full denitrification, chemical phosphorus removal with ferric chloride, sand filtration,[6] chlorination/dechlorination, solids handling (gravity thickener, filter press, hauling/landfilling).
- **Indirect Wastewater Treatment Technology System Targeting Conventionals (BOD, O&G, and total suspended solids [TSS]) (BOD, O&G, and TSS Treatment for Indirect Dischargers):** Screening/grit removal, DAF (for O&G treatment), solids handling.
- **Indirect Wastewater Treatment Technology System Targeting Phosphorus and Full Denitrification (P with Full N Treatment for Indirect Dischargers):** Screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve nitrification and full denitrification, chemical phosphorus removal with ferric chloride, sand filtration,[6] solids handling (gravity thickener, filter press, hauling/landfilling).

High chlorides wastewater is a specific type of MPP process wastewater that can contain high concentrations of salinity and dissolved solids. It is generated from certain MPP operations like hides processing, meat and poultry koshering, water softening, curing, smoking, pickling, and marinating.

The following technology systems were evaluated for high chlorides wastewater. More information on the treatment of high chlorides wastewater can be found in Section 10.2.2 and in the EPA's *Summary of High Chlorides Wastewater Data* (U.S. EPA, 2023a).

- **Zero Discharge Evaporation:** Utilizing a forced circulation evaporation system to evaporate the high chlorides wastewater and potentially save salt crystals for reuse.
- **Zero Discharge Disposal:** Disposal of high chlorides wastewater by deepwell injection.

The EPA used the following characteristics of MPP facilities as facility-specific inputs for the compliance cost methodologies:

- MPP facility processing type (i.e., meat first processing, meat further processing, poultry first processing, poultry further processing, and rendering).
- Size (i.e., amount of meat and/or poultry processed annually).
- Process wastewater discharge type (i.e., direct discharge, indirect discharge, zero discharge, or both direct and indirect discharge).
- Wastewater flow rate in millions of gallons per year (MGY).

[6] Sand filtration does not apply to rendering facilities.

- Population of facilities with high chlorides wastewater (i.e., facilities identified as having processes that generate a high chlorides wastestream).
- High chlorides wastewater flow rate in MGY.

Section 10.2.1 provides information about the costing of MPP process wastewater technology systems, and Section 10.2.2 details the methodology behind the costing of high chlorides wastewater technology systems.

10.2.1 MPP Process Wastewater

General Approach

Table 10-1 includes a list of the treatment units costed for each of the technology systems the EPA evaluated for MPP process wastewater. The EPA calculated facility-specific capital and annual O&M costs for each treatment unit of a proposed technology system. The EPA based calculations on a facility's reported wastewater flow rate and estimated pollutant concentrations in the untreated wastewater. Where data were not reported, the EPA estimated the flow rate and pollutant concentrations based on the amount of annual production and the type of facility processing operation (i.e., meat first processing, meat further processing, poultry first processing, poultry further processing, or rendering). Table 10-1 also includes the method(s) used to estimate those costs.

The EPA used Capdet software tool to design and cost many of the treatment units included in each of the technology systems evaluated for MPP process wastewater. Capdet is based on the process and cost estimating algorithms for the *Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment System*, originally developed by the U.S. Army Corps of Engineers. The EPA used the latest version (2018) of the software, which has kept pace with technology improvements and includes an extensive cost database (Hydromantis ESS Inc., 2018). The values and cost indices in the software were scaled and updated to costs in reflect 2022 dollars.

For this analysis, the EPA made modifications within the tool to better represent MPP process wastewater. Since MPP process wastewater has higher concentrations of nitrogen (i.e., ammonia, nitrate-nitrite nitrogen, and total Kjeldahl nitrogen [TKN]), BOD, TSS, O&G, and phosphorus compared to municipal wastewater. The Capdet default data on influent wastewater were updated to reflect those differences. Within the tool, modifications and assumptions were also made on the types of treatment units to represent appropriate wastewater treatment for the MPP industry. For example, anaerobic lagoons were adjusted to a depth of 15 feet (typical depth is between 12 and 15 feet) to minimize footprint; ferric chloride was assumed to be the chemical added to remove phosphorus; chlorination was assumed to be used for disinfection; and high-flow facilities (with wastewater flow rates greater than 10,000 gallons per day [GPD]) were costed for solids handling systems. The full list of modifications and assumptions made within Capdet to appropriately model MPP process wastewater can be found in Table 11 of the EPA's *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023b).

The EPA estimated some capital and O&M costs (described later in this section) using cost estimates developed outside of Capdet. These costs include:

- Capital costs for chemical phosphorus removal.
- Capital and O&M costs for coagulant addition for a sand filter.
- Annual O&M costs for compliance monitoring, based on the type of facility process operation and wastewater flow rate.

The EPA used the modified Capdet tool to generate costs for meat first, meat further, poultry first, poultry further, and rendering facilities. For each of these five facility types, the EPA generated costs for five different flow rate scenarios. The flow scenarios differ for each facility processing type and are based on the typical range of wastewater flows generated by these MPP facilities (see Table 10-2). Capdet provided cost elements for every treatment unit studied in these 25 scenarios. The cost elements included the capital cost of construction and the annual costs of operation, maintenance, materials, chemicals, and energy. See Table 8 in the EPA's *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023b) for more details.

For each treatment unit studied within one of 25 scenarios, the EPA summed the estimates for the individual costs components (both the estimates output from Capdet and those developed using an alternative method), to calculate the total capital and O&M costs for the treatment unit. The EPA then generated treatment unit cost curves for each processing type as (1) a relationship between flow and total capital cost and (2) a relationship between flow and total O&M cost. The EPA calculated the equation of each curve based on a linear relationship using slope and intercept formulas in Excel. See the EPA's *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023b) for more details.

The EPA calculated facility-specific capital and O&M costs using the following methodology:

- Calculated facility-specific capital and O&M costs using linear equations generated from the 25 Capdet modeling scenarios. These costs were calculated for each treatment unit within a technology system, for each type of processing facility (five), and for each wastewater flow rate (five) (Table 10-1 and Table 10-2).
- Calculated the sum of the capital costs and the sum of annual O&M costs for each treatment unit.
- Calculated other direct and indirect capital costs, like site preparation and engineering design, for each facility. Again, these calculations were based on the facility processing type and wastewater flow rate. The costs were based on the treatment technologies already in place at the facility.
- Calculated the total facility-specific capital costs by summing the capital cost elements for all applicable treatment units. Calculated the facility-specific O&M costs by summing O&M costs for all applicable treatment units.

Table 10-1. Cost Data Sources for Process Wastewater Technology Systems and Units

Treatment Unit	Technology System				Method for Cost Estimation	
	P with Partial N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers	Capdet Tool	Other Cost Estimates
Screening/Grit Removal	X	X	X	X	X	
DAF	X	X	X	X	X	
Anaerobic Lagoon	X	X		X	X	
Biological Treatment	X	X		X	X	
Chemical Phosphorus Removal	X	X		X	X (O&M)	X (Capital)

Table 10-1. Cost Data Sources for Process Wastewater Technology Systems and Units

Treatment Unit	Technology System				Method for Cost Estimation	
	P with Partial N Treatment for Direct Dischargers	P with Full N Treatment for Direct Dischargers	BOD, O&G, and TSS Treatment for Indirect Dischargers	P with Full N Treatment for Indirect Dischargers	Capdet Tool	Other Cost Estimates
Sand Filtration[a]	X	X		X	X	X (Capital and O&M for coagulant addition)
Chlorination/ Dechlorination	X	X			X	
Solids Handling	X	X	X	X	X	
Compliance Monitoring	X	X	X	X		X (O&M)

a — Not costed for rendering processing type.

Table 10-2. Flow Rates (MGD) Used to Generate MPP Operation Cost Curves

MPP Processing Type	Flow 1	Flow 2	Flow 3	Flow 4	Flow 5
Meat First	0.01	0.025	0.05	1	3.5
Meat Further	0.0001	0.0003	0.0005	0.25	1.4
Poultry First	0.01	0.1	0.2	1	2
Poultry Further	0.001	0.0025	0.005	0.3	0.9
Rendering	0.0001	0.05	0.5	0.75	1.1

Source: U.S. EPA, 2023b.

Abbreviations: MGD = millions of gallons per day.

Other Direct and Indirect Capital Costs

Other direct and indirect capital costs were estimated using the 1991 version of *Plant Design and Economics for Chemical Engineers* (Peters and Timmerhaus, 1991).[7] Capdet was not used to estimate other direct capital cost factors because the modeling software generates these costs only for greenfield construction (i.e., brand-new construction) and not for modifications to an existing facility. The indirect capital cost factors can apply to both new construction and retrofits.

For this costing analysis, other direct capital costs include instrumentation and controls, piping, electrical, and land. Indirect capital costs include the following:

- Engineering and supervision (engineering costs-administrative; process, design, and general engineering; drafting, cost engineering, procuring, expediting, reproduction, communications, scale models, consultant fees, travel, engineering supervision, and inspection).

[7] After finalizing cost estimates for the proposed rulemaking, the EPA identified a newer version of the *Plant Design and Economics for Chemical Engineers* by Peters et al. from 2003 (Peters et al., 2003). The EPA will update the values used to estimate direct capital costs for the final rulemaking.

- Construction expenses (construction and O&M of temporary facilities and infrastructure, including offices, roads, parking lots, railroads, electrical, piping, communications, fencing; construction tools and equipment; construction supervision, accounting, timekeeping, purchasing, expediting; warehouse personnel and expense, guards; safety, medical, fringe benefits; permits, field tests, special licenses; taxes, insurance, interest).
- Contractors' Fees.
- Contingency.

The EPA calculated that instrumentation and controls, piping, electrical, and land (other direct capital costs) account for approximately 26 percent of the direct capital costs (e.g., purchased equipment, installation, buildings, and service facilities). The EPA calculated that engineering and supervision, construction expenses, contractor's fees, and contingency account for 43 percent of the total direct capital costs (direct capital costs plus other direct capital costs) (U.S. EPA, 2023b).

Other Cost Estimates

As noted in Table 10-1 , other cost estimation methods were used instead of Capdet to calculate certain treatment unit costs. These include the capital costs associated with chemical phosphorus removal, the capital and O&M costs for coagulant addition at the sand filter,[8] and the O&M costs for compliance monitoring. Table 10-3 describes the cost data and the methodology behind the cost estimates for these treatment units.

Table 10-3. Other Cost Estimates for MPP Process Wastewater

Treatment Unit	Cost Data and Methodology
Chemical Phosphorus Removal	The EPA estimated capital costs associated with chemical addition equipment using existing EPA-cost data. The EPA used fiberglass reinforced plastic (FRP) tank costs, which factor in field-erected costs, auxiliary equipment, and freight costs. See Appendix 2 of the EPA's *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* for more information (U.S. EPA, 2023b).
Sand Filtration[a]	The EPA estimated costs for aluminum chloride coagulant solution using information from existing EPA-cost data, the MPP Questionnaires, the EPA's sampling data, and industry data. For chemical storage, the EPA estimated FRP tank costs, which factor in field-erected costs, auxiliary equipment, and freight costs. See Appendix 3 of the EPA's *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* for more information (U.S. EPA, 2023b).

[8] The costs for the filter itself are included in the Capdet output, but Capdet does not include chemical costs for filters.

Table 10-3. Other Cost Estimates for MPP Process Wastewater

Treatment Unit	Cost Data and Methodology
Compliance Monitoring	The EPA estimated annual O&M costs associated with monthly monitoring for the following: • P with Partial N Treatment for Direct Dischargers: total phosphorus (TP), total nitrogen (TN),[b] and *E. coli*. • P with Full N Treatment for Direct Dischargers: TP, TN,[b] and *E. coli*. • BOD, O&G, and TSS Treatment for Indirect Dischargers: O&G.[c] • P with Full N Treatment for Indirect Dischargers: TP, TN, and O&G.[c] • See Appendix 4 of the EPA's *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* for more information (U.S. EPA, 2023b).

a — Not costed for rendering processing type.

b — TN monitoring requirements are only applicable to facilities without TN limitations under the current ELG.

c — The EPA underestimated compliance monitoring costs for indirect treatment options by excluding monitoring costs for BOD and TSS. The EPA will update estimated compliance costs for the final rulemaking.

Facility Treatment in Place

For each facility, the EPA estimated costs for each treatment unit associated with each technology system. These costs assume greenfield installation of the entire technology system as described in Table 10-1. The EPA then used information on each facility's treatment in place to assess full or partial credit for the cost of individual treatment components that the facility has already in place. For facilities that responded to the MPP Questionnaires, the EPA used data from individual facility responses. The EPA evaluated the most common responses provided in the Detailed Questionnaire population to extrapolate treatment in place to other facilities without MPP Questionnaires response data based on discharge location and type of processing. See the *Treatment in Place (TIP) Analysis for the Meat and Poultry Products (MPP) Proposed Rule* for additional details on the EPA's methodology for determining treatment in place for each facility (U.S. EPA, 2023c).

Where the EPA identified a particular treatment unit in place, the EPA adjusted costs as described in Section 4.1.6 of the EPA's *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023b) in Table 13 (P with Partial N Treatment for Direct Dischargers), Table 14 (P with Full N Treatment for Direct Dischargers), Table 15 (BOD, O&G, and TSS Treatment for Indirect Dischargers), and Table 16 (P with Full N Treatment for Indirect Dischargers). Each table represents one of the four MPP process wastewater technology systems and describes how much cost credit was applied for each treatment unit within the technology system for both capital and O&M costs.

In addition to individual treatment unit costs, the EPA also adjusted the solids handling costs depending on whether a facility was already handling solids from a treatment unit in the technology basis. For example, where a facility currently operates a DAF, the EPA adjusted costs to reflect zero capital and O&M costs for this treatment unit. The EPA also assumed that the facility was handling solids generated by this unit; as such, the EPA adjusted the estimate of solids handling costs to cover only the equipment needed for additional (or incremental) solids handled. The EPA accounted for incremental solids handling costs where a facility had any of the following units in place: DAF, biological treatment, or phosphorus removal treatment. For more details, see Appendix 5 of the EPA's *Compliance Cost Methodology for the Meat and Poultry Products Proposed Rulemaking* (U.S. EPA, 2023b).

10.2.2 MPP High Chlorides Wastewater

The EPA estimated compliance costs associated with two zero discharge technology systems for the treatment of high chlorides wastewater: Zero Discharge Evaporation and Zero Discharge Disposal. This high chlorides and high salinity brine is generated from certain MPP operations, and, under the proposed rule, the EPA assumes that this wastestream would be treated separately from other MPP process wastewaters. Where the treatment in place evaluation indicated that facilities already handle all their high chlorides wastewater via zero discharge, the EPA did not estimate costs associated with either high chlorides technology system.

Zero Discharge Evaporation

For Zero Discharge Evaporation, the EPA estimated the costs of utilizing a forced circulation evaporation system. A forced circulation evaporation system uses steam with a heat exchanger and condenser, which causes the wastewater to evaporate and the salty brine to crystalize (see Figure 8-3 in Section 8). The salt crystals that are saved from this process can then be reused in a facility's MPP operations.

The EPA used facility-provided capital cost information for an evaporation system to develop a capital cost per GPD curve. The capital cost curve was used to estimate costs per facility for installing this treatment technology. Capital costs include costs for equipment, electrical, engineering, construction, and greenfield installation. The EPA also used facility-provided O&M cost information for an evaporation system to develop an O&M cost per GPD curve. The O&M cost curve was used to estimate costs per facility for operating and maintaining this treatment technology. O&M costs include labor, materials, energy (natural gas and electricity), and nonroutine chemicals. The EPA used the segregated, high chlorides brine flow rate and the capital and O&M cost curves to estimate zero discharge evaporation costs for each facility with high chlorides wastewater. In cases where a facility is already treating part, or all, of the high chlorides wastestream, the EPA adjusted the flow rate to estimate only costs associated with the untreated portion of the wastestream.

Zero Discharge Disposal

For Zero Discharge Disposal, the EPA estimated the costs to dispose of high chlorides wastewater using deepwell injection into Class I nonhazardous industrial well sites. Data from previous rulemakings and EPA Region 6 were used to estimate the annual O&M costs for the disposal of the segregated, high chlorides wastewater. The EPA estimated annual O&M costs based on the amount of high chlorides wastewater expected to be transported, the cost of transportation, and the disposal cost. In cases where a facility is already treating part, or all, of the high chlorides waste stream, the EPA adjusted the flow rate to estimate only costs associated with the untreated portion of the wastestream. Estimated compliance costs for this technology system include costs to haul the high chlorides wastewater off site via truck and disposal costs for utilizing the well site. The EPA assumed that facilities do not incur capital costs associated with the deepwell injection of high chlorides wastewater. Deepwell injection is not allowed in some states and may not be an option for many facilities.

10.3 Example Facility Cost

In this subsection, the EPA is presenting estimated compliance costs for an example MPP facility. The intent is to show how the Agency's cost methodology was applied to a specific facility based on its processing type, wastewater flow rate, and treatment in place. The example facility is a poultry first processing facility that also performs koshering (i.e., produces high chlorides wastewater). Table 10-4 presents the cost inputs associated with the example facility.

Table 10-4. Example Facility—Cost Inputs

Facility Characteristic	Assumption
Process Type	Poultry First
Process Flow	255 MGY
High Chlorides Flow	5.9 MGY

Abbreviations: MGY = millions of gallons per year.

Table 10-5 presents the treatment units already in place at the example facility prior to implementation of the proposed rule; the EPA will adjust compliance costs for this facility based on this treatment in place. Note that there is no treatment in place for the management of the high chlorides wastewater generated from the example facility's koshering operations.

Table 10-5. Example Facility—Treatment in Place

Treatment Unit	In Place?
MPP Process Wastewater Treatment	
Screening/Grit Removal	Yes
DAF	Yes
Anaerobic Lagoon	Yes
Biological Treatment	Yes
Chemical Phosphorus Removal	No
Sand Filtration	No
Chlorination/Dechlorination	Yes
Solids Handling	Yes
High Chlorides Wastewater Treatment	
Evaporation	No
Disposal	No

The example facility's total capital costs and annual O&M costs for treating MPP process wastewater were calculated by summing all estimated costs. These include the costs for each treatment unit generated from the Capdet modeling scenarios, the additional direct and indirect capital costs, and the calculated costs from other estimation methods. These costs were then adjusted based on the treatment already in place at the facility. Table 10-6 summarizes the estimated compliance costs for each technology system for the example facility's MPP process wastewater.

Table 10-6. Example Facility—Estimated Capital and O&M Costs for MPP Process Wastewater

Technology System	Capital Cost (2022$)	O&M Cost (2022$/yr.)
P with Partial N Treatment for Direct Dischargers	$6,540,000	$1,460,000
P with Full N Treatment for Direct Dischargers	$9,550,000	$1,670,000
BOD, O&G, and TSS Treatment for Indirect Dischargers	$0	$3,820
P with Full N Treatment for Indirect Dischargers	$10,100,000	$1,900,000

Abbreviations: yr. = year.

Note: Values presented as three significant figures.

The example facility's compliance costs for brine management were calculated for both high chlorides wastewater technology systems: Zero Discharge Evaporation (forced circulation evaporation system) and Zero Discharge Disposal (deepwell injection). Table 10-7 presents the estimated total capital costs and annual O&M costs for both high chlorides technology systems for the example facility.

Table 10-7. Example Facility—Estimated Capital and O&M Costs for High Chlorides Wastewater

Technology System	Capital Cost (2022$)	O&M Cost (2022$/yr.)
Zero Discharge Evaporation	$5,800,000	$1,360,000
Zero Discharge Disposal	$0	$2,680,000

Abbreviations: yr. = year.

Note: Values presented as three significant figures.

10.4 Summary of Total Estimated Compliance Costs

Table 10-8 presents a summary of the estimated compliance capital costs and annual O&M costs by technology system. As described in Section 9, the EPA considered different regulatory options based on various production thresholds across the ELG subcategories. Table 10-9 presents a summary of the estimated compliance capital costs and annual O&M costs by regulatory option.

Table 10-8. Industry Capital and O&M Costs by Technology System

Technology System	Number of Facilities	Total Capital Cost (2022$)	Total O&M Cost (2022$/yr.)
P with Partial N Treatment for Direct Dischargers	171	$451,000,000	$168,000,000
P with Full N Treatment for Direct Dischargers	171	$873,000,000	$220,000,000
BOD, O&G, and TSS Treatment for Indirect Dischargers	3,708	$339,000,000	$46,600,000
P with Full N Treatment for Indirect Dischargers	3,708	$8,770,000,000	$1,500,000,000
Zero Discharge Evaporation	470	$623,000,000	$146,000,000
Zero Discharge Disposal	470	$0	$287,000,000

Abbreviations: yr. = year.

Note: Costs presented as three significant figures.

Table 10-9. Industry Capital and O&M Costs by Regulatory Option

Regulatory Option	Number of Facilities	Total Capital Cost (2022$)	Total O&M Cost (2022$/yr.)
Option 1	845	$824,000,000	$210,000,000
Option 2	845	$2,510,000,000	$571,000,000
Option 3	1,620	$4,720,000,000	$928,000,000

Abbreviations: yr. = year.

Note: Values presented as three significant figures.

The EPA also estimated total capital costs and total O&M costs associated with 320 facilities that produce more than 5 million pounds per year and that generate high chlorides wastewaters, implementing evaporation for the treatment of the high chlorides wastewaters. For the 320 facilities, the EPA estimated a capital cost of $600,000,000 and an O&M cost of $141,000,000 per year in 2022 dollars.

10.5 References

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11. Pollutant Loadings

This section presents the methodology used to estimate annual pollutant loadings for the meat and poultry products (MPP) industry. The U.S. Environmental Protection Agency estimates pollutant loadings to evaluate the effectiveness of technology systems, to quantify the benefits gained from reducing the amounts of pollutants discharged, and to evaluate the cost in relation to the benefits achieved.

As discussed in Section 9, the EPA is evaluating technology systems for MPP process wastestreams. For each of these wastestreams, the EPA defines baseline loadings, technology system loadings, regulatory option pollutant loadings, and pollutant changes as follows:

- **Baseline loadings:** Pollutant loadings, in pounds per year, in MPP wastewater discharges to surface water before implementation of the proposed rule. For direct dischargers, baseline loadings were estimated at the discharge location leaving the MPP facility. For indirect dischargers, baseline loadings were estimated (1) at the location where discharge leaves the MPP facility, and (2) in the MPP contribution in the Publicly Owned Treatment Works (POTW) effluent (i.e., following treatment at the POTW).
- **Technology system loadings:** Estimated pollutant loadings, in pounds per year, in MPP process wastewater discharges based on the implementation of the technology systems considered as the basis for the proposed MPP effluent limitations guidelines and standards (ELGs). Target effluent concentrations for each technology system were calculated for the MPP pollutants of concern (POCs) to estimate annual discharges from all MPP facilities to which the proposed MPP ELGs apply. For direct dischargers, technology system loadings were estimated at the discharge location leaving the MPP facility. For indirect dischargers, technology system loadings were estimated (1) at the location where discharge leaves the MPP facility, and (2) in the MPP contribution in the POTW effluent (i.e., following treatment at the POTW).
- **Regulatory option loadings:** Estimated pollutant loadings, in pounds per year, in MPP process wastewater discharges after implementation of the proposed regulatory options. The EPA combined the wastestream-level POC loadings associated with the technology systems, processing type, and production threshold that reflect compliance with each regulatory option to determine post-compliance loadings for each regulatory option.
- **Pollutant changes (presented as removals):** The difference between the baseline loadings and the loadings for each technology system or each regulatory option. Note that the technology system operations may result in conversion of one pollutant form into another, resulting in an increase in pollutant loadings from baseline to the technology system or regulatory option loadings for specific pollutants. For direct dischargers, pollutant changes (removals) in wastewater discharges were estimated at the location where discharge leaves the MPP facility. For indirect dischargers, pollutant changes (removals) in wastewater discharges were estimated (1) at the location where discharge leaves the MPP facility, and (2) in the MPP contribution in the POTW effluent (i.e., following treatment at the POTW).

This section describes the detailed pollutant loadings evaluation that the EPA performed for facilities to which the proposed MPP ELGs will apply.

Section 11.1 presents background information and the EPA's general methodology for estimating pollutant loadings. Section 11.2 and Section 11.3 describe the baseline pollutant loadings and technology system loadings, respectively, for the MPP process wastewater and high chlorides wastewater streams. Section 11.4 presents the regulatory option loadings and pollutant removals.

11.1 General Methodology

To calculate pollutant loadings for an MPP facility, the EPA multiplied the pollutant concentration in the facility's wastewater discharge (effluent) by the wastewater flow rate, as shown in *Equation* ***9-1***Equation 11-1a and Equation 11-1a.

$$\boldsymbol{Load = C \times WW_{Flow} \times Factor}$$

Equation 11-1a — All pollutants except microbiologicals

Where: Load = Pollutant loading in the facility effluent (pounds per year [lbs./yr.])
C = Pollutant concentration (milligrams per liter [mg/L])
WW_{Flow} = Effluent flow rate (millions of gallons per year [MGY])
Factor = Conversion factor of 8.344 (derived from 3.785 liter per gallon [L/gal] × 2.2046 pounds per kilogram [lbs./kg] × 1 kilogram per million milligrams [kg/M mg])

$$\boldsymbol{Load_M = C_M \times WW_{Flow} \times Factor_M}$$

Equation 11-1b — Microbiologicals

Where: $Load_M$ = Pollutant loading in the facility effluent (MPN/yr.)
C_M = Pollutant concentration (MPN/100 mL)
WW_{Flow} = Effluent flow rate (MGY)
$Factor_M$ = Conversion factor of 37.85 (derived from 3,785 milliliter per gallon [mL/gal] × 1 MPN/100mL × 10^6 gallon per million gallon [gal/MG] × 1 million MPN/10^6 MPN)

Equation 11-1a and Equation 11-1a represent the pollutant loadings in the discharge from the facility, which are the same as the pollutant loadings entering the receiving water for direct dischargers. If the facility is an indirect discharger (i.e., discharges to a POTW), the EPA accounted for pollutant removal that occurs at the POTW using Equation 11-2 to calculate the baseline loadings to the receiving water.

$$\boldsymbol{POTW\ Load = Load \times (1 - POTW_{Removal})}$$

Equation 11-2

Where: POTW Load = Pollutant loading in the POTW discharge (lbs./yr. or million MPN/yr.)
Load = Pollutant loading in the facility effluent (lbs./yr. or million MPN/yr.)
$POTW_{Removal}$ = POTW percent removal for the pollutant (see Table 11-1)

Table 11-1 presents the POTW pollutant removals (percentages) that the EPA used to estimate the quantity of pollutant discharged to surface waters from POTWs.

Table 11-1. MPP POTW Pollutant Removals

Pollutant Group	Analyte	POTW Percent Removal	Reference
Classicals/ Biologicals	Biochemical Oxygen Demand (BOD)	90%	U.S. EPA, 1982
	Bromide	1.89%	U.S. EPA, 2018
	Carbonaceous Biochemical Oxygen Demand (cBOD)	90%	Transferred from BOD
	Chemical Oxygen Demand (COD)	81%	U.S. EPA, 1982
	Fluoride	54%	U.S. EPA, 2002
	Oil and Grease (O&G)	87%	U.S. EPA, 1982
	Organic Carbon, Total	70%	U.S. EPA, 1982
	Sulfate	85%	U.S. EPA, 2003
	Total Dissolved Solids	8%	U.S. EPA, 2003
	Total Suspended Solids (TSS)	90%	U.S. EPA, 1982
Chlorides	Chloride	57%	U.S. EPA, 2003
Metals	Aluminum	91%	U.S. EPA, 1982
	Antimony	67%	U.S. EPA, 1982
	Arsenic	66%	U.S. EPA, 1982
	Barium	55%	U.S. EPA, 1982
	Beryllium	61%	U.S. EPA, 2002
	Boron	24%	U.S. EPA, 1982
	Cadmium	90%	U.S. EPA, 1982
	Calcium	9%	U.S. EPA, 2003
	Chromium	80%	U.S. EPA, 1982
	Cobalt	10%	U.S. EPA, 1982
	Copper	84%	U.S. EPA, 1982
	Iron	82%	U.S. EPA, 1982
	Lead	77%	U.S. EPA, 1982
	Magnesium	14%	U.S. EPA, 1982
	Manganese	33%	U.S. EPA, 1982
	Molybdenum	19%	U.S. EPA, 1982
	Nickel	51%	U.S. EPA, 1982
	Selenium	34%	U.S. EPA, 2002
	Silver	88%	U.S. EPA, 1982
	Sodium	2.69%	U.S. EPA, 2003
	Thallium	54%	U.S. EPA, 2002
	Tin	43%	U.S. EPA, 1982
	Titanium	92%	U.S. EPA, 1982
	Vanadium	8%	U.S. EPA, 1982
	Zinc	79%	U.S. EPA, 1982

Table 11-1. MPP POTW Pollutant Removals

Pollutant Group	Analyte	POTW Percent Removal	Reference
Nutrients	Ammonia, as Nitrogen	39%	U.S. EPA, 1982
	Nitrogen, Total	39%	Transferred from ammonia
	Orthophosphate	Not analyzed	—
	Phosphorus, Total	30%	Ruzhitskaya & Gogina, 2017
Microbiologicals	*Escherichia coli* (*E. coli*)	Not analyzed	—
	Enterococci	Not analyzed	—
	Fecal Coliform	Not analyzed	—

Equation 11-3 represents the change in pollutant loadings following implementation of the technology system. A positive value represents pollutant removals, and a negative value represents an increase in the pollutant loading. This same equation can be used to determine loading change for both direct dischargers and indirect dischargers.

$$\boldsymbol{Load_{Change} = Load_{Base} - Load_{Option}} \qquad \textit{Equation 11-3}$$

Where: $Load_{Change}$ = Pollutant change for either direct or indirect discharges for a technology system (lbs./yr. or million MPN/yr.)

$Load_{Base}$ = Pollutant loading in the effluent at baseline (direct or indirect) (lbs./yr. or million MPN/yr.)

$Load_{Option}$ = Pollutant loading in the effluent following implementation of the technology system (direct or indirect) (lbs./yr. or million MPN/yr.)

The *Pollutant Loadings and Removals Methodology for the Meat and Poultry Products Proposed Rulemaking* memo (Loadings Methodology Memo; U.S. EPA, 2023a) includes brief descriptions of the supporting analyses and data sets for the MPP loadings calculations. Section 2 of the Loadings Methodology Memo includes a description of the input data used in the equations. Using data from the *Detailed Questionnaire for the Meat and Poultry Products Effluent Guidelines* (Detailed Questionnaire) and other existing data, the EPA identified facility-specific details on operations,[9] discharge status, and existing wastewater treatment in place (TIP). The EPA then used analytical data to calculate pollutant-level characterization data sets for wastewater being discharged by each facility under two scenarios: baseline conditions (using current TIP) and following implementation of each technology system. Section 2.2.1 of the Loadings Methodology Memo describes how the EPA characterized MPP process wastewater influent, Section 2.2.2 describes how the EPA characterized the wastewater discharges following implementation of each of the technology systems, and Section 2.2.3 describes how the EPA characterized other combinations of TIP at MPP facilities.

[9] Details on operations include type of processing, categorized as meat, poultry, or independent rendering and first or further processing. For facilities that process both meat and poultry, the EPA categorized each facility based on which meat type it processes in greatest quantities (e.g., the EPA assigned poultry if greater than 50 percent of material handled is poultry). If a facility processes equal amounts of meat and poultry, the facility was categorized as meat. See *the Meat and Poultry Products (MPP) Profile Methodology Memorandum* (U.S. EPA, 2023b) for additional details.

11.2 Baseline Pollutant Loadings

This section describes the analytical data sources and methodology that the EPA used to determine baseline pollutant loadings for the MPP process wastewater and high chlorides wastewater streams. Baseline loadings represent the current pollutant loadings in wastewater discharges before implementation of the proposed MPP ELGs. Section 11.2.1 presents the EPA's methodology for determining baseline pollutant loadings for all facilities discharging MPP process wastewater. Section 11.2.2 presents the EPA's methodology for determining baseline pollutant loadings for all facilities identified in the MPP Industry Profile as discharging high chlorides wastewater.

11.2.1 MPP Process Wastewater

As described in the *Treatment in Place (TIP) Analysis for the Meat and Poultry Products (MPP) Proposed Rule* (U.S. EPA, 2023c), for all facilities discharging MPP process wastewater, the EPA used data from the Detailed Questionnaire and engineering best judgment to identify existing treatment of MPP process wastewater.

The EPA used analytical data from the EPA sampling program, data from the Detailed Questionnaire, and other existing data to characterize wastewater discharged from each facility under baseline conditions, as described in Section 2.2 of the Loadings Methodology Memo (U.S. EPA, 2023a). In general, the EPA used the following steps to estimate the characteristics of discharges from facilities using the treatment combinations listed in Appendix B of the Loadings Methodology Memo:

- Where a facility does not treat wastewater, the EPA used the influent characterization data set described in Section 2.2.1 of the Loadings Methodology Memo to characterize the untreated MPP process wastewater discharged by the facility.
- Where a facility operates a technology consistent with one of the technology systems evaluated in this rulemaking, the EPA used the characterization data set corresponding with that technology system and with the type of processing conducted at the facility. The characterization data set is from Section 2.2.2 of the Loadings Methodology Memo.
- As described in Section 2.2.3 of the Loadings Methodology Memo, where a facility uses only select treatment units from one or more of the technology systems evaluated in this rulemaking, the EPA used the characterization data set for the technology system and adjusted based on what treatment units were or were not present, transferring concentrations for specific pollutants as appropriate. For example, for a facility with screening and disinfection, the EPA used the influent characterization data set. For this treatment train, the EPA expects additional treatment of microbiologicals beyond what is represented in the influent data set; therefore, the EPA adjusted the concentration of microbiologicals to reflect this treatment by transferring concentrations of *E. coli*, enterococci, and fecal coliform from the Direct Wastewater Treatment Technology System Targeting Phosphorus and Partial Denitrification (P with Partial N Treatment for Direct Dischargers) data set.

Table 4 within the Loadings Methodology Memo lists the TIP configurations identified at MPP facilities discharging wastewater, notes treatment assumptions for each TIP configuration, and includes details on the concentration data set used to estimate effluent concentrations for each TIP configuration. Appendix D of the Loadings Methodology Memo includes the average concentrations for POCs for all TIP combinations identified in Appendix B, organized by processing type (U.S. EPA, 2023a).

To estimate baseline loadings for each facility, the EPA used the facility-specific wastewater flow from the MPP Industry Profile and the concentration data set corresponding with the facility-specific TIP and type of processing conducted at the facility. For indirect dischargers, the EPA further estimated the POTW loadings using Equation 11-2.

11.2.2 High Chlorides Wastewater

MPP processes that are often salt intensive include hides processing, koshering meat, and brining processes. Many MPP facilities also use water softening for food safety. The EPA used data from the Detailed Questionnaire and publicly available information to create a list of facilities that may have processes that use high amounts of chlorides. Facilities that, when responding to the Detailed Questionnaire, selected hides processing, curing, pickling, marinating, or smoking were identified. Facilities that listed the amount of kosher meat products were also identified. The EPA recognizes that not all these facilities generate high chlorides.

Consistent with the approach used for the MPP process wastewater stream, for facilities discharging high chlorides wastewater directly, the EPA estimated baseline loadings based on existing treatment of this high chlorides wastewater and technology system loadings. For baseline loadings where facilities are discharging indirectly, the EPA estimated the loadings discharged by the facility and the loadings discharged by the POTW (after POTW removals) for the portion of the POTW discharge associated with the MPP facility.

For all facilities identified in the MPP Industry Profile as discharging high chlorides wastewater, baseline loadings were estimated using the facility-specific wastewater flow and the average chlorides baseline concentration (see Equation 11-1c).

$$\boldsymbol{Load_{Chloride}} = \boldsymbol{C_{Chloride}} \times \boldsymbol{WW_{Flow}} \times \boldsymbol{Factor} \qquad \textit{Equation 11-1c}$$

Where: $Load_{Chloride}$ = Pollutant loading in the facility effluent (lbs./yr.)
$C_{Chloride}$ = Pollutant concentration (mg/L)
WW_{Flow} = High chlorides wastewater flow rate (MGY)
Factor = Conversion factor of 8.344 (derived from 3.785 L/gal × 2.2046 lbs./kg × 1 kg/M mg)

The EPA estimated the untreated chlorides concentration using data obtained from the *EPA's Clean Water Act (CWA) High Chlorides Treatment 308 Request*. For baseline discharges, the EPA estimated the untreated concentration for chloride in this wastewater using data obtained from literature and the *EPA's CWA High Chlorides Treatment 308 Request*.

Basic curing/brining recipes often use a ratio of one cup salt to one gallon water. This gives a salt concentration between 7 and 10 percent by weight (70,000 to 100,000 mg/L) (Graiver et al., 2009). Hides are cured in a concentrated salt solution. Based on the *EPA's CWA High Chlorides Treatment 308 Request* data for hides processors, an average salt concentration of 94,200 mg/L was calculated. Exact brine concentrations vary by facility and process. The EPA is requesting comment on chlorides limitations in the proposed MPP ELGs. In preliminary calculations, the EPA used a salt concentration of 94,200 mg/L for high chlorides wastewater loadings calculations. This concentration is within the typical range of high chlorides MPP process wastewaters.

Section 2.4 of the Loadings Methodology Memo describes the EPA's methodology for determining baseline concentrations for the high chlorides wastewater in more detail. Where the EPA had data indicating that a facility is already achieving zero discharge, baseline loadings were calculated as zero. For facilities managing a portion of the wastewater as zero discharge, the EPA determined the percentage of the wastewater being discharged and estimated baseline loadings using this adjusted flow rate (U.S. EPA, 2023a).

11.3 Technology System Loadings

This section describes the analytical data sources and methodology that the EPA used to estimate pollutant loadings in MPP process wastewater and high chlorides wastewater discharges based on implementation of the technology systems considered as the basis for the proposed MPP ELGs. Section 11.3.1 presents the EPA's methodology for estimating pollutant loadings based on implementation of technology systems considered for direct dischargers and indirect dischargers of MPP process wastewater. Section 11.3.2 presents the EPA's methodology for determining pollutant loadings for all facilities identified in the MPP Industry Profile as discharging high chlorides wastewater based on implementation of two zero discharge technology systems.

11.3.1 MPP Process Wastewater

The EPA used analytical data from the EPA sampling program, data from the Detailed Questionnaire, and other existing data to calculate pollutant-level characterization data sets for each of the four MPP process wastewater technology systems considered for the proposed rule. The four technology systems are the P with Partial N Treatment for Direct Dischargers, the Direct Wastewater Treatment Technology System Targeting Phosphorus and Full Denitrification (P with Full N Treatment for Direct Dischargers), the Indirect Wastewater Treatment Technology System Targeting Conventionals (BOD, O&G, and TSS) (BOD, O&G, and TSS Treatment for Indirect Dischargers), and the Indirect Wastewater Treatment Technology System Targeting Phosphorus and Full Denitrification (P with Full N Treatment for Indirect Dischargers) technology systems (U.S. EPA, 2023a). Section 2.2.2 of the Loadings Methodology Memo describes the methodology that the EPA used to calculate the pollutant-level characterization data sets for these technology systems. Table 11-2 presents the pollutants treated and treatment description for each of the technology systems.

Table 11-2. Technology Systems for MPP Process Wastewater

Technology System Name	Pollutants Treated	Treatment Description
P with Partial N Treatment for Direct Dischargers	P removal and N removal (partial denitrification)	Screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve nitrification and partial denitrification, chemical phosphorus removal with ferric chloride, sand filtration,[a] chlorination/dechlorination, solids handling (gravity thickener, filter press, hauling/landfilling).
P with Full N Treatment for Direct Dischargers	P removal and increased N removal (full denitrification)	Screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve nitrification and full denitrification, chemical phosphorus removal with ferric chloride, sand filtration,[a] chlorination/dechlorination, solids handling (gravity thickener, filter press, hauling/landfilling).
BOD, O&G, and TSS Treatment for Indirect Dischargers	O&G removal	Screening/grit removal, DAF (for O&G treatment), solids handling.

Table 11-2. Technology Systems for MPP Process Wastewater

Technology System Name	Pollutants Treated	Treatment Description
P with Full N Treatment for Indirect Dischargers	P removal and N removal (full denitrification)	Screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve nitrification and full denitrification, chemical phosphorus removal with ferric chloride, sand filtration,[a] solids handling (gravity thickener, filter press, hauling/landfilling).

a — Sand filtration is not included in the technology basis for rendering facilities.

For each technology system, the EPA estimated the pollutant loadings that would result if all MPP facilities discharging MPP process wastewater would install the technology basis and achieve the effluent concentrations referenced in Section 2.2.2 and Appendix C of the Loadings Methodology Memo. Where a facility already has TIP to achieve these effluent concentrations, pollutant loadings are unchanged from baseline loadings. For example, for P with Partial N Treatment for Direct Dischargers, the EPA assumed that any facility that directly discharges MPP process wastewater and does not achieve the effluent quality associated with having partial denitrification and phosphorus removal treatment will install treatment. For these facilities, the EPA calculated their P with Partial N Treatment for Direct Dischargers technology system loadings to reflect this added treatment. The technology system loadings were estimated based on facility-specific wastewater flow and the P with Partial N Treatment for Direct Dischargers data set corresponding to each facility's type of processing, as presented in Table C-4 within the Loadings Methodology Memo (U.S. EPA, 2023a). For all other facilities (e.g., those with full denitrification and phosphorus removal or those with indirect discharges of wastewater), their P with Partial N Treatment for Direct Dischargers technology system loadings were set equal to their baseline loadings.

To calculate pollutant changes for each technology system, the EPA compared baseline loadings to the technology system loadings for each facility. Pollutant changes for each facility were calculated using Equation 11-3 (baseline minus technology system loadings).

Section 2.3 of the Loadings Methodology Memo presents the total industry-level estimated loadings and pollutant changes for direct discharge technology systems (Table 7 within the Loadings Methodology Memo) and indirect discharge technology systems and POTWs (Table 8 within the Loadings Methodology Memo) (U.S. EPA, 2023a).

11.3.2 High Chlorides Wastewater

As described in Section 738.6, the EPA evaluated two zero discharge technology systems for high chlorides wastewater. All technology system loadings for high chlorides wastewater are zero because the technology systems achieve zero discharge.

Section 2.5 of the Loadings Methodology Memo presents the total industry-level estimated loadings and pollutant changes for each technology system for high chlorides MPP process wastewater (U.S. EPA, 2023a).

11.4 Summary of Regulatory Option Loadings and Pollutant Removals

The EPA evaluated three regulatory options to control discharges of MPP process wastewater. See Section 9 for details on the regulatory options evaluated as part of the proposed ELG.

To calculate total regulatory option loadings for each regulatory option, the EPA combined the pollutant loadings associated with the technology systems, processing type, and production threshold that reflect compliance with the option. The EPA also calculated pollutant removals as the difference in loadings between baseline and each regulatory option. This section discusses the specific loadings and removals calculations for each pollutant group associated with each regulatory option evaluated by the EPA.

In calculating the pollutant loadings estimates for each regulatory option, the EPA considered the subcategorizations established by each option. The Preamble describes the applicable subcategories and requirements for each of the regulatory options evaluated by the EPA.

Table 11-3 presents the EPA's estimated total industry-level pollutant loadings and removals for baseline and for each regulatory option. Table 11-4 presents the EPA's estimated total industry-level chlorides loadings and removals for facilities that produce more than 5 million pounds per year and that could be impacted by potential requirements for high chlorides wastewater limitations. The EPA estimated the pollutant removals by subtracting the regulatory option loadings from the baseline loadings. Values presented in this document do not account for the timing or exact date of implementation (e.g., when technology systems are installed by the industry).

Table 11-3. Industry-Level Pollutant Loadings and Removals for MPP Process Wastewater by Regulatory Option

Regulatory Option	Number of Facilities	Pollutant Group [a]	Industry-Level Loadings	Removal
Baseline	3,879	Classicals/Biologicals (lbs./yr.)[b]	5,560,000,000	—
		Metals (lbs./yr.)	496,000,000	
		Nutrients (lbs./yr.)	112,000,000	
		Microbiologicals (MPN/yr.)	66,700,000,000,000	
Option 1	845	Classicals/Biologicals (lbs./yr.)[c]	4,600,000,000	965,000,000
		Metals (lbs./yr.)	491,000,000	4,150,000
		Nutrients (lbs./yr.)	95,500,000	16,500,000
		Microbiologicals (MPN/yr.)	66,700,000,000,000	0
Option 2	845	Classicals/Biologicals (lbs./yr.)[d]	3,320,000,000	2,250,000,000
		Metals (lbs./yr.)	490,000,000	5,470,000
		Nutrients (lbs./yr.)	51,100,000	60,900,000
		Microbiologicals (MPN/yr.)	66,700,000,000,000	0

Table 11-3. Industry-Level Pollutant Loadings and Removals for MPP Process Wastewater by Regulatory Option

Regulatory Option	Number of Facilities	Pollutant Group [a]	Industry-Level Loadings	Removal
Option 3	1,620	Classicals/Biologicals (lbs./yr.)[e]	2,530,000,000	3,030,000,000
		Metals (lbs./yr.)	488,000,000	7,470,000
		Nutrients (lbs./yr.)	16,300,000	95,700,000
		Microbiologicals (MPN/yr.)	66,700,000,000,000	0

Abbreviations: lbs. = pounds, yr. = year, MPN = most probable number.

Note: Loading and removal values presented as three significant figures.

a — Classicals/Biologicals include BOD, bromide, COD, chloride, fluoride, O&G, total organic carbon (TOC), sulfate, total dissolved solids (TDS), and TSS. Metals include aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, selenium, silver, sodium, thallium, tin, titanium, vanadium, and zinc. Nutrients include total nitrogen (TN) and total phosphorus (TP). Microbiologicals include *E. coli*, enterococci, and fecal coliform.

The EPA excluded cBOD, ammonia, and orthophosphate so as not to double-count loadings already included with BOD, TN, and TP.

b — Baseline BOD loadings are 102,000,000 lbs./yr. and TOC loadings are 298,000,000 lbs./yr.

c — Regulatory Option 1 BOD loadings are 92,700,000 lbs./yr. and TOC loadings are 150,000,000 lbs./yr.

d — Regulatory Option 2 BOD loadings are 45,100,000 lbs./yr. and TOC loadings are 83,400,000 lbs./yr.

e — Regulatory Option 3 BOD loadings are 12,300,000 lbs./yr. and TOD loadings are 29,600,000 lbs./yr.

Table 11-4. Industry-Level Pollutant Loadings and Removals for High Chlorides Wastewater for Facilities Producing More Than 5 Million Pounds per Year

Regulatory Option	Number of Facilities	Pollutant Group [a]	Industry-Level Loadings	Removal
Baseline	466	Chlorides (lbs./yr.)	489,000,000	--
Option	320		12,200,000	477,000,000

Abbreviations: lbs. = pounds, yr. = year.

Note: Loading and removal values presented as three significant figures.

a — Loadings are calculated only for pollutants identified as POCs. For high chlorides wastewater, this includes only chlorides.

11.5 References

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8. U.S. EPA. 2023b. *Meat and Poultry Products (MPP) Profile Methodology Memorandum* (November). DCN MP00306.
9. U.S. EPA. 2023c. *Treatment in Place (TIP) Analysis for the Meat and Poultry Products (MPP) Proposed Rule* (November). DCN MP00191.

12. Non-Water Quality Environmental Impacts

The elimination or reduction of one form of pollution has the potential to aggravate other environmental problems, an effect often referred to as cross-media impacts. Sections 304(b) and 306 of the Clean Water Act (CWA) require the EPA to consider non-water quality environmental impacts (NWQEI), including energy impacts, associated with effluent limitations guidelines and standards (ELGs). Accordingly, the U.S. Environmental Protection Agency has considered the potential impact of the proposed ELG revisions to the meat and poultry products (MPP) point source category on energy usage, air emissions, and solid waste generation.

The EPA estimated facility-specific NWQEI for each technology evaluated for the proposed ELG. See Section 8.6 for details on the technologies evaluated for treating both MPP process wastewater and high chlorides wastewater. Refer to *Non-Water Quality Environmental Impacts (NWQEI) for the Meat and Poultry Products (MPP) Proposed Rule—MPP Process Wastewater* (the NWQEI MPP Process Wastewater Memo; U.S. EPA, 2023a) and *Non-Water Quality Environmental Impacts (NWQEI) for the Meat and Poultry Products (MPP) Proposed Rule—High Chlorides Wastewater* (the NWQEI High Chlorides Wastewater Memo; U.S. EPA, 2023b) for details on the methodology used to estimate NWQEI from energy, air emissions, and solid waste generated by these technologies. As discussed in Section 9, regulatory options considered for the proposed rule require additional treatment for removal of conventional pollutants (e.g., biochemical oxygen demand [BOD], total suspended solids [TSS], oil and grease [O&G]) by screening and dissolved air flotation (DAF), phosphorus removal by chemical precipitation, and nitrogen removal by full denitrification in MPP process wastewater.

Section 12.1 discusses the energy requirements for implementing wastewater treatment technologies at MPP facilities. Section 12.2 and Section 12.3 discuss the impact of the treatment technologies on air emissions and wastewater treatment solid waste generation, respectively. Each section also includes estimates of each NWQEI element by regulatory option. Regulatory options are detailed in Section I of the Preamble.

12.1 Energy Requirements

Energy usage associated with the implementation of the proposed rule includes the use of electricity to operate wastewater treatment systems. Energy use rates vary depending on the treatment system evaluated and the current operations (i.e., treatment in place) of the MPP facility. The EPA calculated the incremental increases in energy usage for MPP facilities that would incur costs under the regulatory options evaluated. For facilities that discharge MPP process wastewater, the EPA estimated increases in electricity usage under each regulatory option, as shown in Table 12-1. Inputs, assumptions, and equations used to make these estimates are described in the NWQEI MPP Process Wastewater Memo (U.S. EPA, 2023a). See Preamble Section X.A for information on this increase in energy as a percentage of the total electricity generated in the United States in 2021.

Table 12-1. Net Incremental Increases in Annual Energy Usage for MPP Process Wastewater Regulatory Options

Regulatory Option	Increase in Energy (MWh/yr.)
Option 1	104,000
Option 2	385,000
Option 3	554,000

Source: U.S. EPA, 2023a.

Abbreviations: MWh = megawatt hours, yr. = year.

Note: Results presented as three significant figures.

Energy usage also includes fuel consumption associated with transport operations since the EPA's treatment systems for MPP process wastewater assume each facility's wastewater treatment solids will be hauled to an off-site landfill. The EPA estimated incremental solids generation requiring disposal for the treatment systems and calculated the increase in energy usage (in gallons of fuel) to transport the solid waste to the landfill; see Section 12.3 for details on solids generation. For facilities that discharge MPP process wastewater, the EPA estimated increases in fuel usage (in gallons per year [GPY]) under each regulatory option, as shown in Table 12-2. Inputs, assumptions, and equations used to make these estimates are described in the NWQEI MPP Process Wastewater Memo (U.S. EPA, 2023a). Responses to the *Detailed Questionnaire for the Meat and Poultry Products Effluent Guidelines* indicated other waste management techniques (e.g., land application, composting) may also be used (U.S. EPA, 2023c). Therefore, the estimated increase in fuel consumption for all facilities may overestimate the impacts for facilities managing solid waste on site.

Table 12-2. Net Incremental Increases in Annual Fuel Usage for MPP Process Wastewater Regulatory Options

Regulatory Option	Increase in Fuel Consumption (GPY)
Option 1	128,000
Option 2	331,000
Option 3	405,000

Source: U.S. EPA, 2023a.

Abbreviations: GPY = gallons per year.

Note: Results presented as three significant figures.

The EPA also calculated the incremental increase in energy usage for MPP facilities that generate high chlorides wastewater (through MPP operations described in Section 4). The EPA estimated the energy usage based on the high chlorides wastewater flow rate data developed as part of the industry profile (U.S. EPA, 2023d) and other publicly available data. Additional inputs, assumptions, and equations used to make these estimates are described in the NWQEI High Chlorides Wastewater Memo (U.S. EPA, 2023b).

The EPA estimated the following increases in energy usage for the high chlorides wastwater evaporation system for the 320 facilities producing more than 5 million pounds per year with high chlorides processes:

- Energy usage increased by less than 350,000 megawatt hours (MWh) per year.
- Natural gas usage increased by less than 30,000,000 million British thermal units (mmBTU) per year.

12.2 Air Emissions Impacts

The EPA estimated the increase in annual air emissions from the following sources:

- **Emissions from increased elecricity usage by MPP facilities to operate wastewater treatment systems:** Increased electricity generation from operation of additional treatment systems will result in increased air emissions of criteria air pollutants and greenhouse gases when fossil fuels are burned. Based on data from the U.S. Energy Information Administration (EIA), approximately 40 percent of the United States' electricity generation in 2022 was from renewable or nuclear sources (U.S. EIA, 2023). Based on this information, the EPA estimated increased air emissions from only the portion of the electricity generation that comes from the burning of fossil fuels. Criteria air pollutants are those pollutants for which a National Ambient Air Quality Standard (NAAQS) has been set and include sulfur dioxide (SO_2) and nitrogen oxides (NO_x). Greenhouse gases are gases, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), that absorb radiation, thereby trapping heat in the atmosphere and contributing to climate change.[10] Pollutant-specific national emission factors are described in the NWQEI MPP Process Wastewater Memo (U.S. EPA, 2023a).

- **Emissions from fuel consumption by trucking material off site (e.g., solid waste and high chlorides wastewater):** Air emissions are generated from operating vehicles to transport materials through burning diesel fuel, which releases criteria air pollutants and greenhouse gases. The EPA's process for generating pollutant-specific air emission factors as well as inputs, assumptions, and equations used to make these estimates are described in the NWQEI MPP Process Wastewater Memo (U.S. EPA, 2023a).
- **Methane emissions from uncovered anaerobic lagoons**: Anaerobic wastewater treatment (e.g., anaerobic lagoon) uses microorganisms that consume biodegradable organic compounds, reducing organic matter and BOD in wastewater. The process generates CH_4 and CO_2. This combination of gases, predominantly CH_4, is commonly referred to as biogas. The EPA expects that the microbial consumption of biodegradable organic compounds is currently occurring downstream at Publicly Owned Treatment Works (POTWs) or in the receiving waters; under the proposed rule, the treatment of organic matter and BOD would be performed at the MPP facility instead of the receiving waters or POTW. For this analysis, the EPA does not consider the biogas from anaerobic wastewater treatment as added (or incremental) air emissions as a result of the proposed ELG. MPP facilities may release biogas directly to the atmosphere, collect biogas for energy generation (i.e., boiler fuel), or destroy it via flaring.[11] For facilities that the EPA determined will need to install anaerobic lagoon(s), the EPA calculated the incremental methane emissions from anaerobic lagoons that would occur at the MPP facilities. This calculation is intended to show the amount of methane that facilities may be able to capture and reuse as a result of the proposed rule from the reduction of organic matter occurring at the MPP facility. The calculated methane emissions occurring at the MPP facilities are not included in the net air emissions calculations, as these emissions would be offset by the decrease in methane emissions from POTWs and receiving waters. The EPA's inputs, assumptions, and equations used to make these estimates are described in the NWQEI MPP Process Wastewater Memo (U.S. EPA, 2023a).
- **N_2O and particulate matter emissions associated with biological treatment:** While MPP facilities can use a variety of biological treatment systems to manage MPP process wastewater, the EPA's proposed treatment systems include an activated sludge system that achieves biological nitrification using microorganisms to convert ammonia to nitrate in an aerobic environment. Air emissions from activated sludge systems include ammonia (NH_3), which along with NO_x and sulfur oxides (SO_x), can contribute to the formation of Particulate Matter 2.5 Microns (PM2.5) (fine inhalable particles of diameters typically 2.5 micrometers and smaller). Biological treatment systems also release N_2O emissions. For those facilities that it determined will need to install biological treatment under the proposed regulatory options, the EPA calculated incremental PM2.5 and N_2O emissions from biological treatment at the MPP facilities. The EPA expects that nitrification of MPP process wastewater is currently occurring downstream at POTWs or in the receiving waters and that, under the proposed rule, the biological treatment of MPP process wastewater would be performed at the MPP facility instead of the receiving waters or POTW. For this analysis, the EPA does not consider the air emissions from biological treatment as added (or incremental) air emissions as a result of the proposed ELG. The EPA's inputs, assumptions, and equations used to make these estimates are described in the NWQEI MPP Process Wastewater Memo (U.S. EPA, 2023a).

[10] The EPA calculated either NO_x or N_2O emissions for the energy usage air emission analysis to avoid double counting. NO_x emissions include N_2O emissions.
[11] Based on responses to the MPP Questionnaire, 41 facilities reported collecting biogas for destruction (via flare) or energy generation. MPP facilities may choose to install biogas collection systems in addition to anaerobic lagoons; therefore, the results of this analysis may overestimate the net emission of methane from anaerobic lagoons.

In summary, for MPP facilities that discharge MPP process wastewater, the EPA estimated the increases in air emissions for the following pollutants:

- NO_x, CO_2, CH_4, and SO_2 from energy usage.
- CH_4 emissions from anaerobic lagoons.
- PM2.5 and N_2O emissions from biological treatment.

Table 12-3 presents the increases in air emissions in tons per year under the proposed regulatory options for MPP process wastewater.

Table 12-3. Net Incremental Increases in Air Emissions By Source for MPP Process Wastewater Regulatory Options

Source and NWQEI	Regulatory Option 1	Regulatory Option 2	Regulatory Option 3
Energy Use			
Increase in Energy Use (MWh/yr.)	104,000	386,000	558,000
Increase in NO_x (tons/yr.)	15.6	57.7	83.1
Increase in CO_2 (tons/yr.)	26,600	98,300	142,000
Increase in CH_4 (tons/yr.)	2.22	8.19	11.8
Increase in SO_2 (tons/yr.)	16.6	61.3	88.3
Transportation/Fuel			
Increase in Fuel Usage (GPY)	128,000	331,000	405,000
Increase in NO_x (tons/yr.)	2.15	5.56	6.78
Increase in CO_2 (tons/yr.)	960	2,490	3,030
Increase in CH_4 (tons/yr.)	0.0297	0.0769	0.0937
Increase in SO_2 (tons/yr.)	0.00328	0.00851	0.0104
Wastewater Treatment			
Increase in CH_4 (tons/yr.)	0	0	0
Increase in PM2.5 (tons/yr.)	0	0	0
Increase in N_2O (tons/yr.)	0	0	0
Increase in Solids Generation (tons/yr.)	384,000	996,000	1,214,000

Source: U.S. EPA, 2023a.

Abbreviations: yr. = year.

Note: Results presented as three significant figures.

For all facilities producing more than 5 million pounds per year with high chlorides processes, the EPA calculated the incremental increases in air emissions (NO_x, CO_2, CH_4, SO_2) from electricity usage and air emissions (N_2O, CO_2, CH_4) from natural gas usage. Additional inputs, assumptions, and equations used to make these estimates are described in the NWQEI High Chlorides Wastewater Memo (U.S. EPA, 2023b). Table 12-4 presents the increase in energy usage in tons per year for the high chlorides wastewater evaporation system for facilities producing more than 5 million pounds per year.

Table 12-4. Net Incremental Increases in Air Emissions (Tons/Year) for High Chlorides Wastewater Evaporation for Facilities Producing More than 5 Million Pounds per Year

Treatment/ Management System	Increase in NO_x Emissions	Increase in N_2O Emissions	Increase in CO_2 Emissions	Increase in CH_4 Emissions	Increase in SO_2 Emissions
Chloride Evaporation	<55	<5	<1,600,000	<40	<60

Source: U.S. EPA, 2023b.

12.3 Solid Waste Generation

Solids are generated from wastewater treatment of MPP process wastewater. The EPA's proposed treatment systems for MPP process wastewater assume solid waste from wastewater treatment will be hauled to off-site landfills. The EPA estimated solids generation under the regulatory options evaluated by using MPP facility treatment in place to identify the technologies the EPA expects facilities to install. For facilities the EPA determined will need to install DAF, biological treatment, or chemical phosphorus removal with ferric chloride, the EPA calculated the incremental solids generated for the treatment technologies. The EPA's inputs, assumptions, and equations used to make these estimates are described in the NWQEI MPP Process Wastewater Memo (U.S. EPA, 2023a). Table 12-5 presents the incremental increases in solids generation for discharging MPP facilities that incurred costs under the proposed regulatory options.

Table 12-5. Net Incremental Increases in Solid Waste Generation for MPP Process Wastewater Regulatory Options

Regulatory Option	Increase in Solid Waste Generation (Tons/yr.)
Option 1	384,000
Option 2	996,000
Option 3	1,210,000

Source: U.S. EPA, 2023a.

Abbreviations: yr. = year.

Note: Results presented as three significant figures.

12.4 References

1. U.S. EIA. 2023. *Electricity Explained: Electricity in the United States* (June). DCN MP00327. Available online at: https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php
2. U.S. EPA. 2023a. *Non-Water Quality Environmental Impacts (NWQEI) for the Meat and Poultry Products (MPP) Proposed Rule—MPP Process Wastewater* (November). DCN MP00318.
3. U.S. EPA. 2023b. *Non-Water Quality Environmental Impacts (NWQEI) for the Meat and Poultry Products (MPP) Proposed Rule—High Chlorides Wastewater* (November). DCN MP00336.
4. U.S. EPA. 2023c. *U.S. EPA MPP Questionnaires Memorandum* (November). DCN MP00234.
5. U.S. EPA. 2023d. *Meat and Poultry Products (MPP) Profile Methodology Memorandum* (November). DCN MP00306.

13. Limitations and Standards

As described in Section 9, the U.S. Environmental Protection Agency evaluated three regulatory options based on combinations of treatment technologies and production thresholds for direct and indirect dischargers of meat and poultry products (MPP) process wastewater. This section explains data characteristics, preparation, statistical analysis, and results for effluent limitations. The EPA evaluated conventional limitations for biochemical oxygen demand (BOD), total suspended solids (TSS), and oil and grease (O&G), as well as total nitrogen (TN) and total phosphorus (TP) limitations for indirect dischargers. The EPA also evaluated limitations for TN, TP, fecal coliform, and *E. coli* for direct dischargers.

The EPA also considered establishing requirements for high chlorides wastewater discharges. See the Preamble for details on the EPA's proposed approach for handling high chlorides wastewater.

Section 13.1 describes data preparation, including appropriate data selection, standardization, and aggregation for the analysis. Section 13.2 describes the statistical methodology that EPA used to calculate concentration averages, variabilities, and resulting limitations. Section 13.3 lists the limitations for all analytes, with further tables and figures in Appendix B. All data analyses were completed in R software (R Foundation, 2023).

13.1 Data Preparation

13.1.1 Data Description

The *Analytical Database Methodology for the Meat and Poultry Products Proposed Rulemaking* memorandum (the Database Memo) describes the EPA's methodology for compiling wastewater sampling data from publicly available sources and other collection efforts executed as part of the proposed rule (U.S. EPA, 2023a). The data sources include facility-specific wastewater monitoring data from the *Detailed Questionnaire for the Meat and Poultry Products Effluent Guidelines* (Detailed Questionnaire), data from the EPA sampling, 2021 Discharge Monitoring Report (DMR) data, and data from the EPA state and region offices. The EPA selected a subset of data from these sources for use in the calculation of limitations.

As described in Section 9, the EPA evaluated four different technology bases, also referred to as model technologies (two for direct dischargers and two for indirect dischargers):

- **Direct Wastewater Treatment Technology System Targeting Phosphorus and Partial Denitrification (P with Partial N Treatment for Direct Dischargers):** Screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve nitrification and partial denitrification, chemical phosphorus removal with ferric chloride, sand filtration,[12] chlorination/dechlorination.
- **Direct Wastewater Treatment Technology System Targeting Phosphorus and Full Denitrification (P with Full N Treatment for Direct Dischargers):** Screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve nitrification and full denitrification, chemical phosphorus removal with ferric chloride, sand filtration,[12] chlorination/dichlorination.
- **Indirect Wastewater Treatment Technology System Targeting Conventionals (BOD, O&G, and TSS Treatment for Indirect Dischargers):** Screening/grit removal, DAF (for O&G treatment).
- **Indirect Wastewater Treatment Technology System Targeting Phosphorus and Full Denitrification (P with Full N Treatment for Indirect Dischargers):** Screening/grit removal, DAF (for O&G treatment), anaerobic lagoon (for BOD pretreatment), biological treatment with activated sludge to achieve

[12] Sand filtration does not apply to rendering facilities.

nitrification and full denitrification, chemical phosphorus removal with ferric chloride, sand filtration.[12]

The EPA excluded data that did not represent treatment consistent with the technology basis. For example:

- The EPA excluded data for *E. coli* and fecal coliform at facilities that did not disinfect final effluent (either through ultraviolet [UV] or chlorination/dechlorination).
- The EPA excluded TN data or TP data based on an evaluation of wastewater treatment at the Best Available Technology Economically Achievable (BAT) facilities (U.S. EPA, 2023b). For example, TP data from a facility operating BAT for nitrogen treatment but not for phosphorus were excluded.

To calculate limitations for the BOD, O&G, and TSS Treatment for Indirect Dischargers technology, the EPA used data from direct or indirect discharging MPP facilities with similar levels of treatment for MPP process wastewater (screening and DAF). Where a facility had more advanced treatment, the EPA used sampling data collected at the primary treatment effluent and any data from the MPP Questionnaire at the primary treatment effluent to characterize this level of treatment.

As the technology basis for nitrogen removal (i.e., biological nitrogen removal using nitrification and denitrification) is different than the technology basis for phosphorus removal (i.e., chemical phosphorus removal using precipitation), the EPA identified some facilities as demonstrating BAT performance consistent with P with Full N Treatment for Direct Dischargers for one pollutant but not the other. Accordingly, the data used to calculate limitations for TN and TP differed.

- To calculate limitations for TN, the EPA used data from direct or indirect discharging MPP facilities identified as BAT for TN; see *Evaluation of Technology Basis and Identification of BAT Facilities* (U.S. EPA, 2023b) for details on this evaluation.
- To calculate limitations for TP, the EPA used data from direct or indirect discharging MPP facility identified as BAT for TP; see *Evaluation of Technology Basis and Identification of BAT Facilities* (U.S. EPA, 2023b) for details on this evaluation.

To calculate limitations for *E. coli* and fecal coliform, the EPA used data from any direct or indirect discharging MPP facility with treatment consistent with P with Full N Treatment for Direct Dischargers technology basis.

As described in the Preamble, the EPA evaluated treatment for high chlorides that achieves zero discharge of the segregated high chlorides wastewater. In addition to considering zero discharge, the EPA also calculated effluent limitations based on one facility operating a forced circulation evaporation system. The EPA used the MPP process wastewater effluent from this facility's wastewater treatment system to calculate possible limitations for chlorides in process wastewater based on operating the technology basis for treatment of high chlorides.

See Table 13-1 for details on technology bases, analytes, and levels of control evaluated for limitations. Limitations for chlorides are not included, as the EPA is not proposing limitations for this analyte.

Table 13-1. Limitations by Technology Basis

Technology Basis	BOD	O&G	TSS	TP	TN	Fecal Coliform	*E. coli*
P with Partial N Treatment for Direct Dischargers				NSPS, BAT		NSPS,[a] BPT[a]	NSPS,[a] BPT[a]
P with Full N Treatment for Direct Dischargers				NSPS, BAT	NSPS, BAT	NSPS, BPT	NSPS, BPT
BOD, O&G, and TSS Treatment for Indirect Dischargers	PSES, PSNS	PSES, PSNS	PSES, PSNS				
P with Full N Treatment for Indirect Dischargers	PSES,[b] PSNS[b]	PSES,[b] PSNS[b]	PSES,[b] PSNS[b]	PSES,[a] PSNS[a]	PSES,[a] PSNS[a]		

Abbreviations: NSPS = New Source Performance Standards, BPT = Best Practicable Technology, PSES = Pretreatment Standards for Existing Sources, PSNS = Pretreatment Standards for New Sources.

a — Transferred from P with Full N Treatment for Direct Dischargers.

b — Transferred from BOD, O&G, and TSS Treatment for Indirect Dischargers.

For the proposed limitations, the EPA combined data sets across all MPP processes to give a single limit per analyte for the industry. As the raw materials for MPP processes are animals/animal products, principally composed of carbon, nitrogen, and phosphorus, the EPA found combining data from different MPP processes to be reasonable. The EPA did not receive adequate data with which to calculate unique limitations for MPP facilities that perform different MPP processes, either in number of observations or in number of facilities represented in the data set used for limitations.

Throughout this section, the EPA discusses the number of facilities represented in the data set. In addition, the treatment technologies considered for the proposed rule are similar across all types of processing (see Section 9). As described in Section 7, BOD, O&G, TSS, TP, TN, fecal coliform, and *E. coli* were all identified in influent wastewater at treatable levels for all processing types. The treatment technologies can remove these pollutants to the levels demonstrated by the data evaluated for limitations.

In addition to selecting the analytes to be evaluated for limitations (BOD, O&G, TSS, *E. coli*, fecal coliform, TP, and TN), the EPA also used data collected for total Kjeldahl nitrogen (TKN) and nitrate-nitrite nitrogen (nitrate-nitrite). In the absence of TN data, the EPA used the sum of TKN and nitrate-nitrite to represent TN. In addition, the EPA excluded *E. coli* data with unknown dilution.

The EPA used only a subset of the 2021 DMR data collected. Only DMR data with a statistical basis of daily results or monthly average were evaluated for limitations. DMR data of other statistical bases (maximum, daily maximum, weekly average, maximum monthly average, etc.) were excluded as they were not consistent with the proposed limitation bases being evaluated. As described in Section 13.2, the EPA combined daily sampling results to calculate daily maximum limitations and averaged daily sampling results as part of calculating monthly average limitations. Using data already reported as daily maximum results would misrepresent the definition of daily limitations and would introduce a high bias.

In total, the EPA used data from 35 facilities in the limitations analysis. Of these, 18 had data from DAF effluent (BOD, O&G, and/or TSS based on BOD, O&G, and TSS Treatment for Indirect Dischargers) and 23 had data from final effluent (based on P with Full N Treatment for Direct Dischargers). These facilities were classified as poultry first processing (15), meat first processing (10), rendering (five), meat further processing (four), and poultry further processing (one) based on the type of operation identified in the *Meat and Poultry Products Profile Methodology Memorandum* (U.S. EPA, 2023c). This data set, which has been subset to the appropriate facilities, analytes, and effluent monitoring locations, can be found in the *Limitations Supplemental Data* (U.S. EPA, 2023d).

13.1.2 Data Editing Criteria and Aggregation

The EPA reviewed the data described in Section 13.1.1 and completed steps to prepare those data for statistical analysis. In some cases, the EPA either excluded or substituted certain data. The following sections describe the EPA's preparation and evaluation, as well as the reasons individual results were excluded, substituted, or aggregated for the calculation of limitations.

Time Period and Intervals

The EPA used analytical data from January 2018 to January 2023 to focus the resulting limitations on the most current system operation. In conversations with states and regions, the EPA is aware of various ongoing initiatives and compliance requirements to target additional treatment of TN and TP at MPP facilities. The Database Memo lists the date ranges of the different data sources.

Since the EPA is proposing daily as well as monthly limitations, the length of time between data points at facilities is an important factor in this methodology. The EPA's review of each data source and set of data for individual facilities noted different sampling intervals, or days between reported concentrations. With the goal of calculating both a monthly average limitation and a daily maximum limitation, the EPA identified which concentrations would most appropriately inform each calculation. Values used to calculate monthly average limitations—referred to in this document as "monthly-interval data"—were identified as those reported as monthly average results (e.g., some data from DMR), as well as questionnaire data with values occurring about one month apart (≥28 days). Values used to calculate daily maximum limitations—referred to in this document as "daily-interval data"—were defined as occuring fewer than 28 days apart. Where occasional aberrations occurred, the logical increment was applied; e.g., a series of monthly values including an early date (such as 21 days from the previous date) was still assigned as monthly-interval data, and a series of weekly values with a skipped month (such as 30 days from the previous date) was still assigned as daily-interval data. Interval assignments are specified in *Limitations Supplemental Data* (U.S. EPA, 2023d), in the "Interval" field.

Concentrations Below the Detection Limit

Concentrations were marked as detected or non-detected (ND) relative to their method detection limits (MDLs). A concentration is ND if it is known to have a low value beneath an analytical detection limit, ranging from zero to its MDL. These values are also called left-censored, since they lack information to the left of a lower bound. In the limitation calculations, NDs were substituted with their MDLs.

However, not all NDs were identified as such in the given data. ND identifications primarily appeared in the EPA sampling data and data from the Detailed Questionnaire. To identify other possible NDs, the EPA generated one timeline of concentrations for each facility, analyte, and data source combination.[13] If the minimum value of the series occurred at least three times consecutively, this was a strong indicator of a concentration having reached a lower analytical limit; values equal to it in the series were therefore marked as ND. In some series, the minimum was consistent, then changed to a different value for the remainder of the period; both minimums were treated as MDLs (e.g., see Appendix B Figure B-1, plot "F19, Fecal Coliform"). This step resulted in adding ND identifications to TP (ranging from 0.025 to 0.100

[13] The EPA evaluated DMR and Virginia Department of Environmental Quality data together, because they formed contiguous series of monthly values across years.

milligrams per liter [mg/L]), fecal coliform (1 to 3 most probable number per 100 milliliters [MPN/100 mL]), and *E. coli* concentrations (1 MPN/100 mL) in different series. All NDs in the data set, both original and added in this way, were of these three analytes, making up 50 percent of *E. coli*, 34 percent of fecal coliform, and 14 percent of TP data.

At three different facilities, TP concentrations taken during the EPA sampling had NDs with MDLs greater than the detected results within the same data set. For example, 0.49 mg/L was the highest detected concentration at one facility, but five NDs had MDLs at 3.20 mg/L. NDs with MDLs greater than all the detected values in a data set can invalidate statistical calculations (see Section 13.2.3), and were therefore removed from this analysis (11 results were removed in total, marked in *Limitations Supplemental Data* [U.S. EPA, 2023d], in the “High-MDL Exclusions” field). The detected values and NDs with lower MDLs were retained, resulting in smaller sample sizes at those facilities and from this data source.

Additional Data Exclusions

In reviewing the data, the EPA identified samples with partial or anomalous concentrations. These values are described in this section and were excluded from the remainder of the analysis.

Rather than providing TN concentrations, some facilities provided concentrations of TKN and/or nitrate-nitrite. For dates with incomplete data, the EPA could not calculate TN as a sum of TKN and nitrate-nitrite, and therefore excluded the data. This resulted in the removal of one entire facility, since it only provided nitrate-nitrite data. Where TN was available on a given date, only TN was retained. Excluded records are identified in *Limitations Supplemental Data* (U.S. EPA, 2023d), in the “Nitrogen Exclusions” field.

One TN concentration taken during an EPA sampling event was two magnitudes higher than a duplicate concentration (180 mg/L, compared to a duplicate value of 4.5 mg/L). It was outside the range of values at the facility, as it was 20 times greater than the next-highest measurement. The corresponding TKN value was also 180 mg/L. In its own review of the Sampling Episode Report (SER), the facility identified these results as abnormal or in error. The EPA therefore removed these two high points, with both marked in *Limitations Supplemental Data* (U.S. EPA, 2023d), in the “Anomaly Exclusions” field.

Aggregation

Some samples were replicates, meaning the sample was taken from the same data source, at the same facility and monitoring location, of the same analyte, on the same date. The EPA took the mean of replicates to produce one value per day. These means were calculated from reported concentrations when detected and from MDLs when ND. If at least one of the replicates was detected, the resulting mean was labeled as detected, in recognition of the analyte having been measured as present. If all were ND, the mean was marked as ND. This aggregation of replicate results decreased the total number of records by 5 percent.

Where a concentration of TKN and a concentration of nitrate-nitrite were both available, the EPA summed the two values to estimate TN. The EPA defined these paired concentrations as being from the same facility, data source, and date. All TKN concentrations were detected, whereas nitrate-nitrite was ND in nearly half of the samples, represented in the summations by their MDLs (all at 0.06 mg/L). In total, 39 TN concentrations were calculated using this method, making up 11 percent of all TN concentrations in this analysis.

Next, to serve as additional inputs to the calculation of monthly average limitations, the EPA aggregated daily-interval data within calendar months. Where a facility had daily-interval data for an analyte, concentrations were averaged within months to create a new series of monthly-interval data (graphed in Appendix B Figure B-1). The EPA did not consider series with date ranges of less than one week as representative of a month; this excluded the EPA sampling data, which spanned for approximately five days at each facility. Importantly, these newly aggregated series were in addition to, not instead of, original data on the daily scale. Thus, a series of daily data at a facility could serve as an input to both the daily-interval calculations as-is, and to the monthly-interval calculations after aggregation within calendar months, addressed in percentile calculations below (Section 13.2.5).

At some facilities, different data sources contributed to measurements within the same time period. Where more than one concentration of an analyte was available at the same place and at the same time, the EPA took the mean of the concentrations, as has typically been done in ELGs (e.g., U.S. EPA, 2015). Although there were no instances of different sources with measurements on the same date in daily-interval data, there were different monthly-interval data sources that occurred within the same calendar months. This included, but was not limited to, series of daily-interval data aggregated within months. Therefore, the EPA averaged monthly-interval concentrations that shared the same facility, analyte, and calendar month. As with previous aggregation steps, where at least one value was detected, the mean was marked as detected.

Following the aggregation of replicates and nitrogen analytes, the calculation of additional monthly data sets, and combining the different sources of data, each of the 34 facilities ultimately had one or two series of concentrations per analyte: one series of daily-interval data and/or one series of monthly-interval data. These served as the basis for calculations of statistical metrics that defined the limitations and are available in *Limitations Supplemental Data* (U.S. EPA, 2023d), in the "Post-Aggregation" spreadsheet.

Influent Data

After excluding and aggregating the data, the EPA applied data editing criteria by pollutant and facility to select the datasets to be used for developing the limitations. These criteria are referred to as the long-term average (LTA) test. The EPA often uses the LTA test to ensure that the pollutants are present in the influent at sufficient concentrations to evaluate treatment effectiveness at the facility for the purpose of calculating effluent limitations. By applying the LTA test, the EPA ensures that the limitations result from treatment of the wastewater and not simply the absence or substantial dilution of that pollutant in the wastestream. For each pollutant for which the EPA calculated a limitation, the influent first had to pass a basic requirement that at least 50 percent of the influent measurements had to be detected at any concentration. If the data set at a facility passed the basic requirement, then the data had to pass one of the following two criteria to pass the LTA test:

- Criterion 1: At least 50 percent of the influent measurements in a data set at a facility were detected at levels equal to or greater than 10 times the baseline value.
- Criterion 2: At least 50 percent of the influent measurements in a data set at a facility were detected at any concentration and the influent arithmetic average was equal to or greater than 10 times the baseline value.

The EPA used the baseline values that were developed for the previous MPP effluent limitations guidelines and standard (ELGs), finalized in 2004. The baseline values are typically equal to the nominal quantitation limit identified for the analytical method for a pollutant. See the *Pollutants of Concern (POC) Analysis for the Meat and Poultry Products Proposed Rule* (U.S. EPA, 2023e) for details on how baseline values were identified. No baseline value is available for TN; consistent with the POC analysis, EPA used the MDL of 0.012 mg/L in place of baseline value for the purpose of this LTA test.

If the data set at a facility failed the basic requirement, then the EPA excluded the facility's effluent data for that pollutant when calculating limitations. If the data set for a facility passed the basic requirement but failed both criteria, the EPA excluded the facility's effluent data for that pollutant when calculating limitations.

For the 34 facilities included in the EPA's limitations analysis, the EPA compiled influent data by analyte. Influent data were available for 13 facilities.[14] The EPA lacked influent data for 21 facilities, but—because all the available influent data pass the LTA test, showing that pollutants are present in the influent at sufficient concentrations to evaluate treatment effectiveness—the EPA reasonably assumes that additional facility data would demonstrate a similar result. Therefore, the EPA continued to include data for all facilities in the limitations analysis. If additional influent data become available (through public comment, additional sampling, or other data submissions), the EPA will further evaluate the data following proposal. See Appendix B, Table B-1, for a summary of the data by facility and results of the LTA test.

13.2 Statistical Analysis

The proposed limitations for pollutants are "daily maximums" and "maximums for monthly averages." Definitions provided in 40 CFR 122.2 state that the daily maximum limitation is the "highest allowable 'daily discharge'" and the maximum for monthly average limitation (also referred to as the "monthly average limitation") is the "highest allowable average of 'daily discharges' over a calendar month, calculated as the sum of all 'daily discharges' measured during a calendar month divided by the number of 'daily discharges' measured during that month." Daily discharges are defined as the "'discharge of a pollutant' measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of samplings."

The effluent limitations and standards are based on LTA effluent values and variability factors (VFs; one on the daily scale and another on the monthly scale) that account for variation in treatment performance within a particular treatment technology over time. For simplicity, in the remainder of this document, the final effluent limitations and/or standards are referred to as "limitations."

In establishing daily maximum limitations, the EPA's objective is to restrict the discharges on a daily basis at a level that is achievable for a facility that targets its treatment at the LTA. The EPA acknowledges that variability around the LTA results from normal operations, such that facilities at times discharge at levels that are greater than or less than the LTA. To allow for the possibly higher daily discharges, the EPA has established the daily maximum limitation. A facility that discharges consistently at the daily maximum limitation would not be operating its treatment to achieve the LTA, which is part of the EPA's objective in establishing the daily maximum limitations. That is, targeting treatment to achieve the limitations may result in frequent values in exceedance due to routine variability in treated effluent.

In establishing monthly average limitations, the EPA's objective is to provide an additional restriction to help ensure that facilities target their average discharges to achieve the LTA. The monthly average limitation requires continuous dischargers to provide ongoing control, on a monthly basis, that complements controls imposed by the daily maximum limitation. To meet the monthly average limitation, a facility must counterbalance a value near the daily maximum limitation with one or more values well below it. To achieve compliance, these values must result in a monthly average value at or below the monthly average limitation.

13.2.1 Autocorrelation

The EPA considered whether autocorrelation was likely to be present in the effluent data. When data are said to be positively autocorrelated, it means that consecutive measurements are related; for example, a high measurement on one day would likely indicate a high measurement on the next day as well. In such a case, the variability of the data (more specifically, the σ parameter in Section 13.2.3) would increase. The EPA has not incorporated an autocorrelation adjustment into its estimates of VFs or LTAs for the proposed rule. In many industries, measurements in final effluent are likely to be similar from one day to

[14] One other facility did provide data for one of two streams entering the wastewater treatment system. It was excluded from the analysis, though, as the characterization data were representative of a wastewater that was only partially treated (e.g., the stream entered the treatment system downstream of the DAF).

the next because of the consistency from day to day in the production processes, and in final effluent discharges due to the hydraulic retention time of wastewater in basins, holding ponds, and other components of wastewater treatment systems. To determine if autocorrelation exists in the data, a statistical evaluation is necessary. For proposal, the EPA has assumed no autocorrelation adjustment is necessary because of the following:

- Based on data collected from industry through site visits and the MPP Questionnaire, MPP treatment systems include units such as equalization tanks, holding ponds, or basins. Retention times of these systems are likely on the order of days, not months, likely making autocorrelation irrelevant or negligible on a monthly scale.
- Many equally spaced, detected measurements for each pollutant are required to estimate autocorrelation. Often, series of data used in this limitations analysis had inconsistent intervals. For example, one series may contain data for daily or every other day concentrations, skipping weekends; another series may be weekly on average but actually have data in six- to nine-day increments. Frequent gaps exist due to NDs, a lack of measurements, or both. Such inconsistencies would make autocorrelation estimates unlikely to be reliable.
- Large sample sizes are needed for potential evaluation of autocorrelation; the EPA considers series with at least 30 values sufficient. In Appendix B, Figure B-2 shows timelines of monthly-interval series with at least 30 values and Figure B-1 shows those of daily-interval series (as well as others with fewer values). Despite their sufficient sample sizes, some of these series are not usable due to gaps or irregular spacing, and not all combinations of analyte and interval are represented.
- Transferring any autocorrelation estimates calculated from one series to other series may be inappropriate in this application. MPP data used for the calculation of daily limitations are available for daily, weekly, biweekly, and irregular sub-monthly intervals. Since autocorrelation estimates are specific to their time increments only, a different estimate would be needed for each actual increment. Also, analytes have different chemical properties, and thus could be affected differently by the same treatment systems, adding uncertainty to the representativeness of any transfers across analytes.

If additional sampling data are collected, through the comment period or via additional sampling, the EPA intends to evaluate autocorrelation and, if necessary, adjust the limitations for the final rule.

13.2.2 Modified Delta Lognormal Distribution

For the limitation calculations, the EPA used the modified delta lognormal distribution, which is a mixed distribution due to its two components.

- First, detected values are assumed to follow the lognormal distribution (shown as the curve in Figure 13-1), which is continuous.
- Second, NDs are treated as additional discrete values represented by their MDLs (shown as the bars in Figure 13-1; discussed in Kahn and Rubin, 1989).

This is a modification of what is also called the zero-adjusted lognormal distribution (Rigby et al., 2019), since discrete values are numbers other than zero. This distribution has been applied to pollution concentrations in multiple applications, including ELGs (Owen and DeRouen, 1980; U.S. EPA, 1995, 2002a, 2002b, 2004, 2015). In series of concentrations without NDs, results are equal to those of a lognormal distribution. Assuming a distribution is necessary because calculations based on data sets with small sample sizes are less likely to be representative of a system, especially calculations quantifying the upper tail of a distribution (as described below).

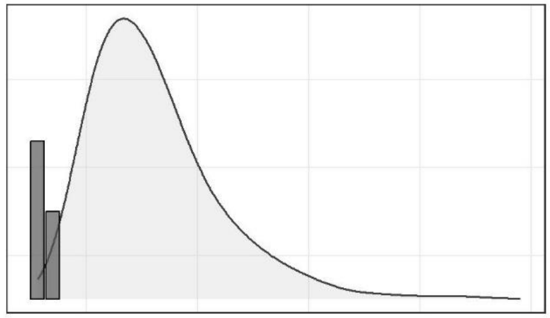

Figure 13-1. Example of a Modified Delta Lognormal Distribution

Although bacteria, including fecal coliform and *E. coli*, are often measured as discrete values (i.e., counts of colonies, without fractions), some available data were provided with fractional values. These bacterial values were used as-is and treated as continuous, like the other analytes.

Calculations using the distribution were performed within series of concentrations defined by common facility, analyte, and time interval (daily- or monthly-interval data). After the EPA calculated the metrics of each series, they were combined. The following sections describe these steps, all completed using R software (R Foundation, 2023; graphs made using R package ggplot2, Wickham, 2023).

13.2.3 Distribution Parameters

For the LTA and VF metrics of a series to be calculated, its distributional parameters must first be quantified. Not all lognormal distributions look the same: the center can move to the left or right (greater than zero), and they can be wide or narrow. These characteristics are defined using two parameters:

- The μ parameter is equal to the mean of the natural-log-transformed concentrations, defining the location of the distribution.
- The σ parameter defines the scale of how widely or narrowly the concentrations are distributed and is the standard deviation of the population of log-transformed values.

Figure 13-2 shows how different ranges of each parameter affect the resulting shape of a lognormal distribution.

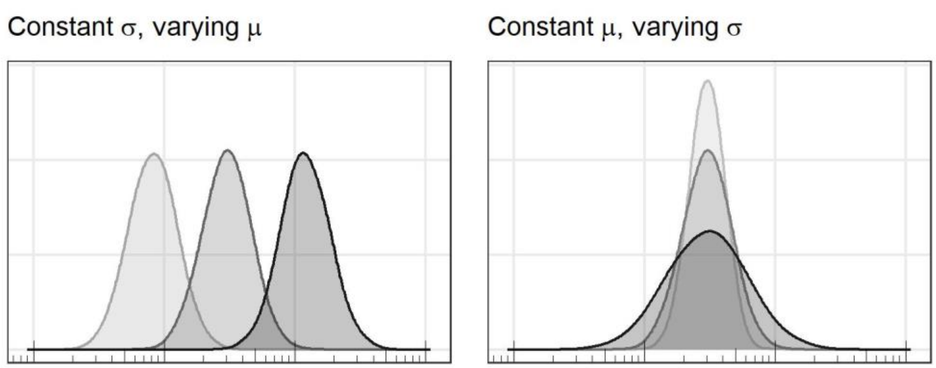

Figure 13-2. Example Lognormal Distributions Varying by the Parameters μ (Left) and σ (Right)

Note: Low values of μ and σ are represented by light gray, and high values are represented by dark gray. The X axis is on the log scale, making lognormal distributions appear normally distributed.

The EPA computed these parameters using software functions based in maximum likelihood estimation, a common statistical method used for this purpose. The software functions work by finding the maximum point of the lognormal distribution's log-likelihood function, which is derived from its probability density function. The software uses numerical maximization, an iterative optimization method, to converge on μ

and σ values for each series. Details of the distributional formulas and computational methods are found in Rigby et al., 2019 (Chapters 10, 11, and 19). In practice, the EPA computed the parameters using R function gamlss() for series of concentrations without NDs (Rigby and Stasinopoulos, 2023) and gamlssZadj() for those with any NDs (Enea et al., 2019); R code is provided in Appendix B, Table B-2. The EPA used these functions to produce a column of μ values and a column of σ values, one pair per series of concentrations.

However, these methods can only be applied to series with at least two distinct detected values. For series with fewer values, the EPA computed μ as the arithmetic mean of the untransformed concentrations, using MDL substitutions for NDs. It is not possible to calculate a σ or standard deviation for these series because they inherently have no or negligible variation. Sets with fewer than two distinct detected values therefore cannot contribute to VF calculations but do contribute to analytes' LTA calculations.

The two parameters of location and scale served as the inputs to the remaining calculations.

13.2.4 LTA Calculations

In calculating the limitations, the EPA determined an average performance level (the LTA) over time that a facility with well-designed, well-operated model technologies can achieve, using data from facilities that use the model technologies. Statistically, the LTA is the mean of the underlying statistical distribution of the daily values. The EPA expects that all facilities subject to the limitations will design and operate their treatment systems to achieve the LTA performance level consistently, since facilities with well-designed and well-operated model technologies have demonstrated that this can be done.

The EPA defines the LTA using both the continuous and discrete portions of the modified delta lognormal distribution. The continuous portion of the distribution, representing detected concentrations, is defined as the expected value of the lognormal distribution (Kahn and Rubin, 1989). An expected value represents the most likely LTA of a data set, and its formula is derived from the lognormal distribution's probability density function (e.g., Rigby et al., 2019). Equation 13-1 is the expected value of the continuous lognormal distribution (E_c), where μ and σ are the parameters calculated as described in Section 13.2.3.

$$E_c = e^{\left(\mu + \frac{\sigma^2}{2}\right)} \quad \textit{Equation 13-1}$$

The mean of the discrete portion of the modified delta lognormal distribution (E_d), representing NDs, is simply a weighted average of their MDLs:

$$E_d = \frac{1}{\delta}\sum_{i=1}^{k} \delta_i L_i \quad \textit{Equation 13-2}$$

where δ is the proportion of ND values and the sum of δ_i , $i = 1, \ldots, k$, which represents the proportion of ND values associated with the i^{th} detection limit, L_i.

In practice, the EPA calculated this by taking the mean of series' NDs, which had been substituted with their MDLs and undergone earlier aggregation steps. Equation 13-2 is what "modifies" the delta lognormal distribution.

The discrete and continuous expected values proportionally combine to define the LTA of a series:

$$LTA = \delta E_d + (1 - \delta)E_c \quad \textit{Equation 13-3}$$

For series without NDs, which make up most of the series in this analysis, δ is zero; the continuous expected value E_c is therefore the LTA.

LTA calculations differed in some circumstances. This distribution-based LTA calculation method is only possible in series with at least two distinct detected values, where parameters are quantifiable. In the remaining series with one or no distinct detected values, the EPA used the arithmetic mean of the untransformed concentrations, with MDL substitutions for NDs, as the LTA. Also, the daily-interval data aggregated within calendar months to become monthly-interval data were not used for LTA calculations, since their monthly and daily LTAs would be the same. Differently stated, the EPA calculated the LTA of a daily-interval data series for a facility and analyte and did not recalculate another LTA using the same data aggregated to a monthly interval. This also ensured consistency within each facility.

At this stage, each combination of common facility, analyte, and interval (daily or monthly) had an LTA. The next step was to calculate a corresponding VF to each LTA.

13.2.5 Percentile Calculations

In addition to the LTA, which describes an average concentration of each series, limitations must reflect the demonstrated variability or range of those concentrations. The EPA calculates effluent limitations based on percentiles that should be both high enough to accommodate reasonably anticipated variability within control of the facility and low enough to reflect a level of performance consistent with the Clean Water Act (CWA) requirement that these effluent limitations be based on the “best” technology. The daily maximum limitation is an estimate of the 99^{th} percentile of the distribution of the daily measurements. The monthly average limitation is an estimate of the 95^{th} percentile of the distribution of the monthly averages of the daily measurements.

The EPA uses the 99^{th} and 95^{th} percentiles to draw a line at a definite point in the statistical distributions that would ensure that facility operators work to establish and maintain the appropriate level of control. These percentiles reflect a longstanding Agency policy judgment. Statistical methods provide a logical and consistent framework for determining values that form a reasonable basis for effluent limitations. Limitations development accounts for the reasonably anticipated variability in discharges that may occur at a well-operated facility. By targeting the LTA, a well-operated facility will be able to always meet the effluent limitations because the EPA has incorporated an appropriate allowance for variability.

The EPA’s methodology for establishing effluent limitations based on certain percentiles of the statistical distributions may give the impression that the EPA expects occasional exceedances of the limitations. This conclusion is incorrect. The EPA promulgates limitations that facilities can always meet by properly operating and maintaining their treatment technologies. The EPA does not expect facilities to operate their treatment systems so as to violate the limitations at some pre-set rate merely because probability models are used to develop limitations. If an exceedance is caused by an upset condition, the facility would have an affirmative defense to an enforcement action if the requirements of 40 CFR 122.41(n) are met. Exceedances caused by a design or operational deficiency, however, are indications that the facility’s performance does not represent the appropriate level of control. Public commenters often raise the issue of exceedances or excursions of limitations (i.e., values that exceed the limitations). For a summary of court rulings on this point from other ELGs, see U.S. EPA, 2015, Section 13.5.3, “Compliance with Limitations.”

The facility-specific data sets represent operation of treatment systems that represents the BAT or Best Available Demonstrated Control Technology (BADCT). In some cases, however, although these facilities were operating model technology, these data sets, or periods of time within a data set, may not necessarily represent the optimized performance of the technology. As described in Section 13.1, the EPA excluded certain data from the data sets used to calculate the effluent limitations. At the same time, however, the data sets used to calculate effluent limitations still retain some observations that likely reflect periods of less-than-optimal performance or periods where the facility was targeting less than optimal effluent quality (e.g., only limitations identified in an individual permit as opposed to the best effluent quality possible). The EPA retained these data in developing the limitations because they help to characterize the variability in treatment system effluent.

The calculation of a percentile assumes the same modified delta lognormal distribution. The EPA calculated percentiles using a software function that solves for the inverse cumulative distribution function of the lognormal, in combination with the proportion of NDs, or δ (Rigby et al., 2019, Chapters 2 and 9; functions gen.Zadj() and qLOGNOZadj() from Enea et al., 2019; Kahn and Rubin, 1989). The output is the concentration at which, for example, 99 percent of the values in a modified delta lognormal distribution with a given μ, σ, and δ are smaller. For series without NDs, the EPA used a standard lognormal function only requiring μ and σ (qLOGNO from Rigby and Stasinopoulos, 2023). The R code is provided in Appendix B, Table B-3.

Each series' 99^{th} percentile concentrations were calculated from daily-interval data, and each series' 95^{th} percentile concentrations were calculated from monthly-interval data. The series of daily-interval data averaged within calendar months were included in these 95^{th} percentiles of monthly-interval data, since distributions of averages across time have different, lower variability than more frequent measurements.

Percentile calculations are dependent on σ to inform the spread of the distribution, and therefore could only be calculated for series with at least two distinct detected values.

13.2.6 VF Calculations

The VF is an allowance for the variability in pollutant concentrations when processed through well-designed, well-operated treatment systems. It incorporates all components of variability, including shipping, sampling, storage, and analytical variability. VFs are calculated from the data from facilities using the model technologies. If a facility designs and operates its treatment system to meet the relevant LTA, the EPA expects the facility should be capable of always meeting the proposed limitations. VFs ensure that normal fluctuations in a facility's treatment are accounted for in the limitations. By accounting for these reasonable excursions above the LTA, the EPA's use of VFs results in limitations that are typically well above the actual LTAs.

As a metric, the VF scales the calculated percentiles relative to their distributions' LTAs and is therefore unitless. Narrow distributions have percentiles relatively near their LTAs, and thus are greater than but near 1; wide distributions have percentiles relatively far from their LTAs and can be multiple times larger. The VF equations are:

$$VF_d = {}^{P_{99}}/_{LTA} \qquad \textit{Equation 13-4}$$

$$VF_m = {}^{P_{95}}/_{LTA} \qquad \textit{Equation 13-5}$$

Where: d = daily interval
m = monthly interval
P = percentile as labeled

The percentiles and LTAs were calculated from the same series of concentrations, sharing the same facility, analyte, and interval. Where a facility-analyte combination had sufficient daily-interval data as well as monthly-interval data, it had both a VF_d and a VF_m. Where daily-interval data were averaged within calendar months to create monthly-interval data, both VF calculations used the same LTA, calculated from the daily-interval data. Because percentiles can only be calculated from series with enough variability, only series with at least two distinct detected values had VFs.

13.2.7 Limitation Calculations

At this stage, each facility-analyte-interval series had an LTA, a VF_d if it had enough daily-interval data, and a VF_m if it had enough monthly-interval data. The EPA performed several checks of these metrics. No VFs were less than 1. Within each distribution, no LTAs were greater than their 95th or 99th percentiles, and no 95th percentiles were greater than corresponding 99th percentiles. All LTAs and percentiles were superimposed on their series' concentrations graphically to check whether LTAs were plausibly near distribution means and high percentiles were at upper tails (Appendix B, Figure B-3 through Figure B-10).

Some facilities had two LTAs for the same analyte: one calculated from a daily-interval series and another from a monthly-interval series. Since each facility should be represented by one LTA, the EPA took the mean of the two values to produce that single LTA. Metrics for all facilities are listed in Table B-4 through Table B-11. In these tables, each row is one series, labeled by facility code (to protect confidential business information [CBI]) and interval. If a daily series had at least two distinct detected values, its 99th percentile and daily VF columns were populated; similarly, if a monthly series had at least two distinct detected values, its 95th percentile and monthly VF columns were populated. Rows with both daily and monthly VFs came from daily-interval series that were averaged within calendar months.

Next, the EPA calculated one LTA for each analyte by taking the median of all facilities' LTAs, producing industry-wide values. Similarly, the EPA calculated one median daily VF and one median monthly VF for each analyte, combining those of all facilities. Calculating medians rather than means across facilities recognizes that some sets of metrics formed skewed distributions when combined, making the median a more representative measure of centrality. Figure 13-3 shows box plots of the LTAs and the VF_d and VF_m values. Each point represents one facility, colored by its type of MPP processing. Boxes extend from the 25th to the 75th percentile (interquartile range, or IQR), with a thick line at the median, a diamond at the mean, and whiskers extending up to 1.5 times the IQR. Facilities' values are also listed in Appendix B, Table B-4 through Table B-11, with medians in Table 13-2 below.

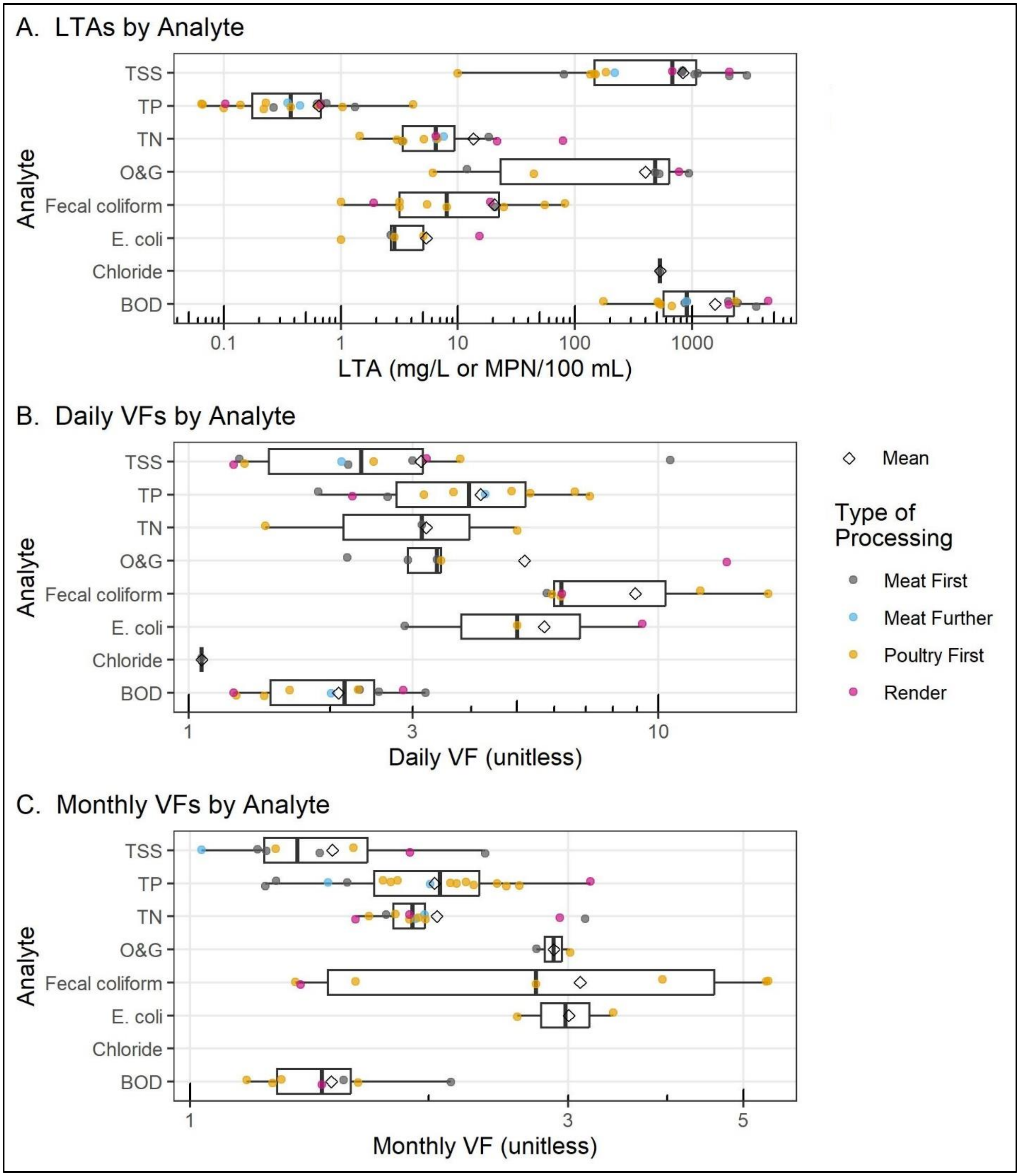

Figure 13-3. Box Plots of All Facilities' LTAs and VFs for Each Analyte

With one LTA, VF_d, and VF_m per analyte, the EPA calculated a daily maximum limitation and a monthly average limitation using:

$$Daily\ maximum\ limit = median\ LTA \times median\ VF_d \qquad \textit{Equation 13-6}$$

$$Monthly\ average\ limit = median\ LTA \times median\ VF_m \qquad \textit{Equation 13-7}$$

See Table 13-2 for a breakdown of the number of facilities informing the LTA, VF_d, and VF_m per analyte and the results of the statistical analysis. Columns list the number of facilities that informed each median LTA and VF, the resulting overall LTAs and VFs, and the daily maximum and monthly average limitations.

Table 13-2. Resulting Limitations for All Analytes

Analyte	Number of Facility LTAs	Number of Facility Daily VFs	Number of Facility Monthly VFs	Median LTA (mg/L or MPN/100 mL)	Median Daily VF (Unitless)	Median Monthly VF (Unitless)	Daily Max Limitation (mg/L or MPN/100 mL)	Monthly Average Limitation (mg/L or MPN/100 mL)
BOD	14	10	7	903	2.16	1.47	1,950	1,320
O&G	7	5	2	484	3.38	2.88	1,630	1,390
TSS	15	10	8	676	2.34	1.37	1,580	925
Chlorides	1	1	0	533	1.07	—	569	—
E. coli	5	3	2	2.88	5.01	3.01	14.4	8.66
Fecal coliform	11	6	7	8.07	6.21	2.73	50.1	22.1
TN	12	3	12	6.50	3.14	1.91	20.4	12.4
TP	19	10	16	0.373	3.97	2.07	1.48	0.772

Abbreviations: mg/L = milligrams per liter, mL = milliliters, MPN = most probable number.

Notes: Units are in mg/L for all analytes, except *E. coli* and fecal coliform which are in MPN/100 mL. Values are presented as three significant figures. Chlorides only have daily-interval data over five days. As a result, only a daily maximum limitation was calculated. No monthly average chloride limitation could be calculated due to lack of data.

The number of facilities informing LTAs was always greater than or equal to the number of facilities informing VFs, since series with fewer than two distinct detected values could have arithmetic means, but not standard deviations, calculated. TP had the most facility-level data, whereas chlorides data were only available from one facility on a daily interval. All facilities' LTAs and VFs used to calculate these overall medians are listed in Appendix B, Table B-4 through Table B-11, and graphed in Figure 13-3 below.

13.2.8 Sensitivity Analyses

As an additional check, the EPA reran the analysis without concentrations that were spaced at annual intervals (i.e., 12 months apart) or quarterly intervals (i.e., three months apart). In the main analysis, these 19 concentrations were classified as monthly-interval data and most were aggregated with monthly data from other sources at the same facility (in Section 13.1.2). Their interval suggests that they might be representative of one year or one quarter, rather than one month. The EPA does not have further information from the facilities to clarify this uncertainty; therefore, the EPA removed these 19 concentrations and reran the calculations as a sensitivity analysis. Their omission changed the BOD and TN limitations by a range of -5.0 percent to +0.6 percent. This occurred because two monthly series were made up of only quarterly concentrations; their removal decreased the number of LTAs and monthly VFs by one for each of BOD and TN, affecting the medians. Given the small effect of these concentrations on the results, the EPA retained them in the interest of using the most data available to inform national limitations.

The EPA also reran the analysis using a left-censored lognormal distribution rather than a modified delta lognormal distribution, to quantify the effect of this applied distributional form. Although both distributions are based in the lognormal shape, the left-censored distribution differs in the handling of NDs: rather than being mixed, comprising a discrete (ND) part and a continuous (detected) part, it handles NDs as continuous values. It does so using the lognormal cumulative distribution function to calculate likelihoods, considering NDs as values between their MDL and zero. The EPA used functions from package gamlss.cens to recalculate μ and σ parameters for all series with at least one ND (for more details on the functions, see Chapter 6 of Stasinopoulos et al., 2017, and Stasinopoulos et al., 2018). Although results were the same for analytes without NDs, this method was found to be sensitive to the most skewed distributions with NDs. A few values of σ for bacteria were large, inflating expected values and percentiles. Modified delta lognormal distributions' σ values are not affected by NDs, making them less sensitive. Therefore, the EPA continued to base the main limitation calculations on the modified delta lognormal distribution, as it has historically.

13.3 Summary of Limitations

Section 13.3.1 summarizes the effluent limitations by technology basis, and Section 13.3.2 presents the proposed effluent limitations for MPP process wastewater by level of control.

13.3.1 Summary of Limitations by Technology Basis

Results for all limitations evaluated are shown in Table 13-3 and Table 13-4 for direct and indirect dischargers, respectively. The daily maximum and monthly average limitations in Table 13-3 and Table 13-4 are based on the values shown in Section 13.2.7.

Table 13-3. NSPS, BAT, and BPT Limitations by Technology Basis for Direct Dischargers

Treatment System	TP (mg/L)	TN (mg/L)	Fecal Coliform (MPN/100 mL)	*E. coli* (MPN/100 mL)
Daily Maximum Limitations				
P with Partial N Treatment for Direct Dischargers	1.48		50.1[a]	14.4[a]
P with Full N Treatment for Direct Dischargers	1.48	20.4	50.1	14.4
Monthly Average Limitations				
P with Partial N Treatment for Direct Dischargers	0.772		22.1	8.66
P with Full N Treatment for Direct Dischargers	0.772	12.4	22.1	8.66

Abbreviations: Best Practicable Technology (BPT), mg/L = milligrams per liter, mL = milliliters, MPN = most probable number, New Source Performance Standards (NSPS).

a — Transferred from P with Full N Treatment for Direct Dischargers.

Table 13-4. PSES and PSNS Limitations by Technology Basis for Indirect Dischargers

Treatment System	BOD (mg/L)	O&G (mg/L)	TSS (mg/L)	TP (mg/L)	TN (mg/L)
Daily Maximum Limitations					
BOD, O&G, and TSS Treatment for Indirect Dischargers	1,950	1,630	1,580		
P with Full N Treatment for Indirect Dischargers	1,950[a]	1,630[a]	1,580[a]	1.48[b]	20.4[b]
Monthly Average Limitations					
BOD, O&G, and TSS Treatment for Indirect Dischargers	1,320	1,390	925		
P with Full N Treatment for Indirect Dischargers	1,320[a]	1,390[a]	925[a]	0.772[b]	12.4[b]

Abbreviations: mg/L = milligrams per liter, mL = milliliters, MPN = most probable number, PSES = Pretreatment Standards for Existing Sources, PSNS = Pretreatment Standards for New Sources.

a — Transferred from BOD, O&G, and TSS Treatment for Indirect Dischargers.

b — Transferred from P with Full N Treatment for Direct Dischargers.

Effluent limitations for direct dischargers were developed as follows:

- P with Full N Treatment for Direct Dischargers establishes limitations for TP, TN, fecal coliform, and *E. coli*.
- P with Partial N Treatment for Direct Dischargers establishes limitation for TP, fecal coliform, and *E. coli*.

Effluent limitations for indirect dischargers were developed as follows:

- BOD, O&G, and TSS Treatment for Indirect Dischargers limitations for all pollutants are based on DAF effluent data from facilities operating treatment systems that include the technology basis as either their sole treatment or as a component of a larger treatment system.
- BOD, O&G, and TSS limitations for P with Full N Treatment for Indirect Dischargers are based on DAF effluent data and transferred from BOD, O&G, and TSS Treatment for Indirect Dischargers. The technology basis for BOD, O&G, and TSS treatment is included in both technology systems; therefore, the EPA assumes both technologies can achieve the same level of treatment in the effluent from wastewater treatment.[15]
- TN and TP limitations for P with Full N Treatment for Indirect Dischargers are transferred from P with Full N Treatment for Direct Dischargers. The technology basis for TP treatment and TN treatment includes these treatment technologies; therefore, the EPA assumes both technologies can achieve the same level of treatment in the effluent from wastewater treatment.

See Sections 9 and 10 and the Preamble for additional details on the EPA's selection of the technology systems and development of the technology bases.

13.3.2 Long-Term Averages and Effluent Limitations for MPP Process Wastewater

Table 13-5 presents LTAs and effluent limitations for MPP process wastewater for existing and new sources. As described in the Preamble, the proposed limitations vary by ELG subpart; these subparts are also noted in Table 13-5.

Due to routine variability in treated effluent, an MPP facility that targets its treatment to achieve pollutant concentrations at a level near the values of the daily maximum limitation or the monthly

[15] The EPA will reevaluate this approach for the final rulemaking and consider calculating separate limitations for BOD, O&G, and TSS for P with Full N Treatment for Indirect Dischargers.

average limitation may experience frequent values exceeding the limitations. For this reason, the EPA recommends that facilities design and operate their treatment systems to achieve the LTA for the model technology. In doing so, a system that is designed to achieve the BAT/NSPS level of control would be expected to meet those limitations.

Table 13-5. LTAs and Limitations for Existing and New Sources

ELG Subpart	Level of Control	Pollutant	LTA	Daily Maximum Limitation	Monthly Average Limitation
A–D, F–L	BPT[a]	Fecal coliform (MPN/100 mL)	8.07	50.1	22.1
	BAT,[a] NSPS[b]	TN (mg/L)	6.50	20.4	12.4
		TP (mg/L)	0.373	1.48	0.772
		E. coli (MPN/100 mL)	2.88	14.4	8.66
	PSES,[a] PSNS[b]	BOD (mg/L)	903	1,950	1,320
		TSS (mg/L)	676	1,580	925
		O&G (mg/L)	484	1,640	1,390

Abbreviations: Best Practicable Technology (BPT), mg/L = milligrams per liter, mL = milliliters, MPN = most probable number, New Source Performance Standards (NSPS), PSES = Pretreatment Standards for Existing Sources, PSNS = Pretreatment Standards for New Sources.

a — For existing sources.

b — For new sources.

13.4 References

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Appendix A

For completeness, the U.S. Environmental Protection Agency evaluated regulatory options 2 and 3. Table A-1 and Table A-2 present the annualized cost and removals for Best Practicable Control Technology Currently Available (BPT) and Best Conventional Pollutant Control Technology (BCT) used to calculate the incremental cost per pound for Regulatory Options 2 and 3, respectively. Table A-3 includes the results of the Publicly Owned Treatment Works (POTW) Test and Industry Cost Test for both regulatory options. Regulatory Option 2 affects the same population of facilities as Regulatory Option 1 (see Section 9); thus, the incremental costs and removals are identical.

Table A-1. Incremental Costs and Conventional Pollutant Removals—Regulatory Option 2

Level of Control	Annualized Costs (M 2022$, Post-Tax)	Total Incremental Removals (M lbs.)	Industry Incremental Removal Cost (2022$/lbs.)
Subcategories A—D			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$1.63	12.8	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$162	627	$0.26
Subcategories F—I			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$2.11	5.98	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$162	263	$0.62
Subcategory J			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$0.64	2.90	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$51.50	177	$0.29
Subcategory K			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$6.64	164	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$219	377	$1.00
Subcategory L			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$1.42	22.0	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$68.90	73.0	$1.32

Source: U.S. EPA. 2023. Pollutant Loadings and Removals Methodology for the Meat and Poultry Products Proposed Rulemaking (November). DCN MP00302; U.S. EPA. 2023. Regulatory Impact Analysis for Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (RIA) (November). EPA-821-R-23-014.

Abbreviations: BOD = biochemical oxygen demand, lbs. = pounds, M = million, N = nitrogen, O&G = oil and grease, P = phosphorus, TSS = total suspended solids.

Note: Values presented as three significant figures.

Table A-2. Incremental Costs and Conventional Pollutant Removals—Regulatory Option 3

Level of Control	Annualized Costs (M 2022$, Post-Tax)	Total Incremental Removals (M lbs.)	Industry Incremental Removal Cost (2022$/lbs.)
Subcategories A—D			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$12.70	28.2	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$205	661	$0.30
Subcategories F—I			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$5.94	11.2	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$350	366	$0.97
Subcategory J			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$0.68	2.91	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$52.70	178	$0.30
Subcategory K			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$7.21	170	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$243	400	$1.03
Subcategory L			
BPT (BOD, O&G, and TSS Treatment for Indirect Dischargers)	$1.73	26.2	NA
BCT (P with Full N Treatment for Indirect Dischargers)	$71.90	77.9	$1.36

Source: U.S. EPA. 2023. Pollutant Loadings and Removals Methodology for the Meat and Poultry Products Proposed Rulemaking (November). DCN MP00302; U.S. EPA. 2023. Regulatory Impact Analysis for Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (RIA) (November). EPA-821-R-23-014.

Abbreviations: BOD = biochemical oxygen demand, lbs. = pounds, M = million, N = nitrogen, O&G = oil and grease, P = phosphorus, TSS = total suspended solids.

Note: Values presented as three significant figures.

Table A-3. BCT Cost Test Results—Regulatory Option 2 and 3

Subcategory	Industry Incremental Removal Cost	POTW Benchmark (2022$)	Industry Cost Ratio	Industry Cost Benchmark	Test 1 Results	Test 2 Results
Regulatory Option 2						
A–D	$0.26	$1.476	2.04	1.29	Pass	Fail
F–I	$0.62	$1.476	1.76	1.29	Pass	Fail
J	$0.29	$1.476	1.33	1.29	Pass	Fail
K	$1.00	$1.476	24.5	1.29	Pass	Fail
L	$1.32	$1.476	20.5	1.29	Pass	Fail
Regulatory Option 3						
A–D	$0.30	$1.476	0.678	1.29	Pass	Pass
F–I	$0.97	$1.476	1.82	1.29	Pass	Fail
J	$0.30	$1.476	1.27	1.29	Pass	Pass
K	$1.03	$1.476	24.2	1.29	Pass	Fail
L	$1.36	$1.476	20.5	1.29	Pass	Fail

Note: Values presented as three significant figures.

Appendix B

This appendix provides supplemental information on limitations and standards (see Section 13).

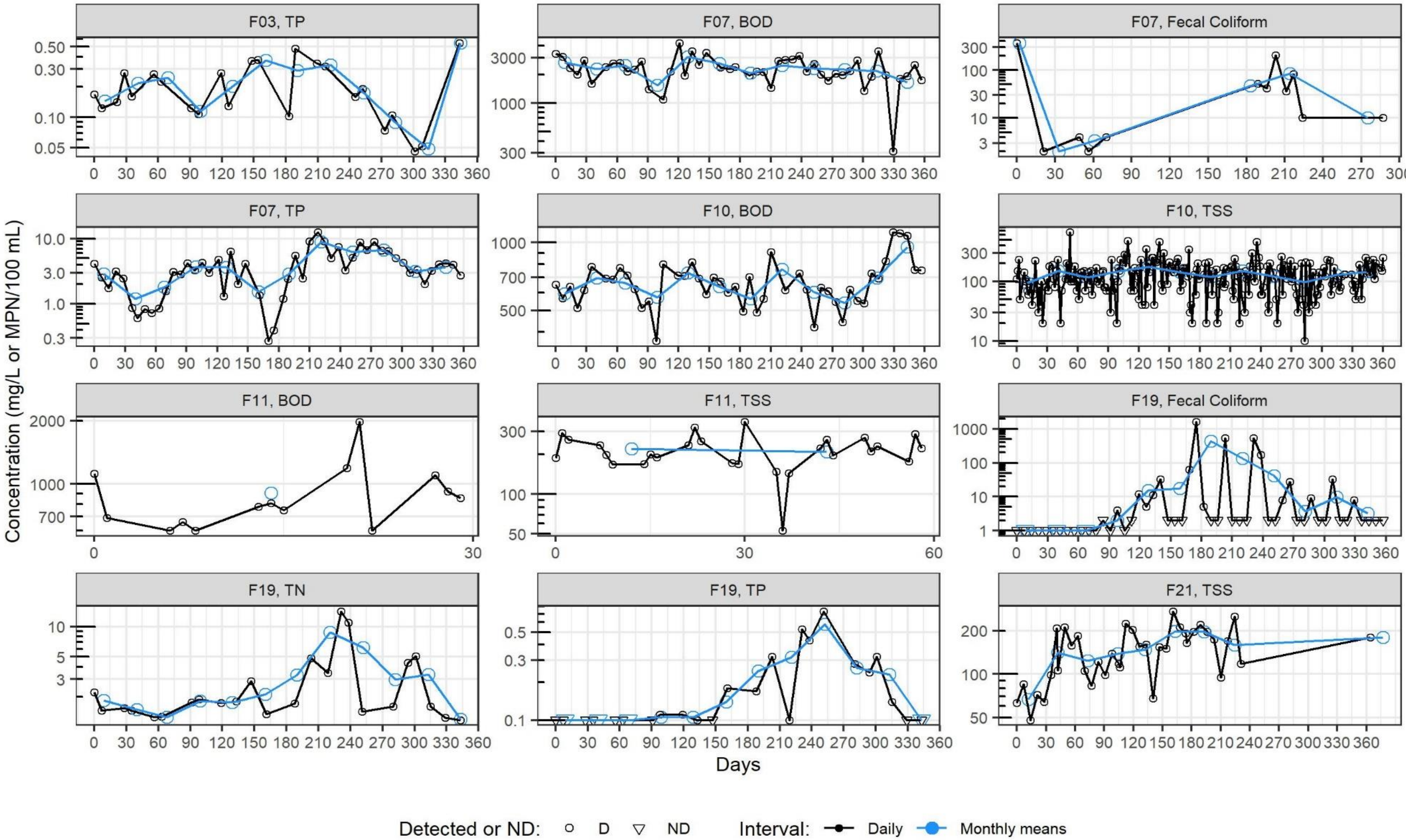

Figure B-1. Timelines of Series Used for Daily Calculations (Black) Averaged Within Calendar Months (Blue)

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Note: Monthly means are graphed at the midpoint of each month. All data are from the MPP Questionnaires. Facilities and dates are masked to protect confidential business information (CBI). Series are labeled by facility code and analyte. Units are in milligrams per liter (mg/L) for all analytes, except fecal coliform in most probably number per 100 milliliter (MPN/100 mL). Some of these averaged monthly series were later aggregated with other data sources' monthly-interval data at the same facility.

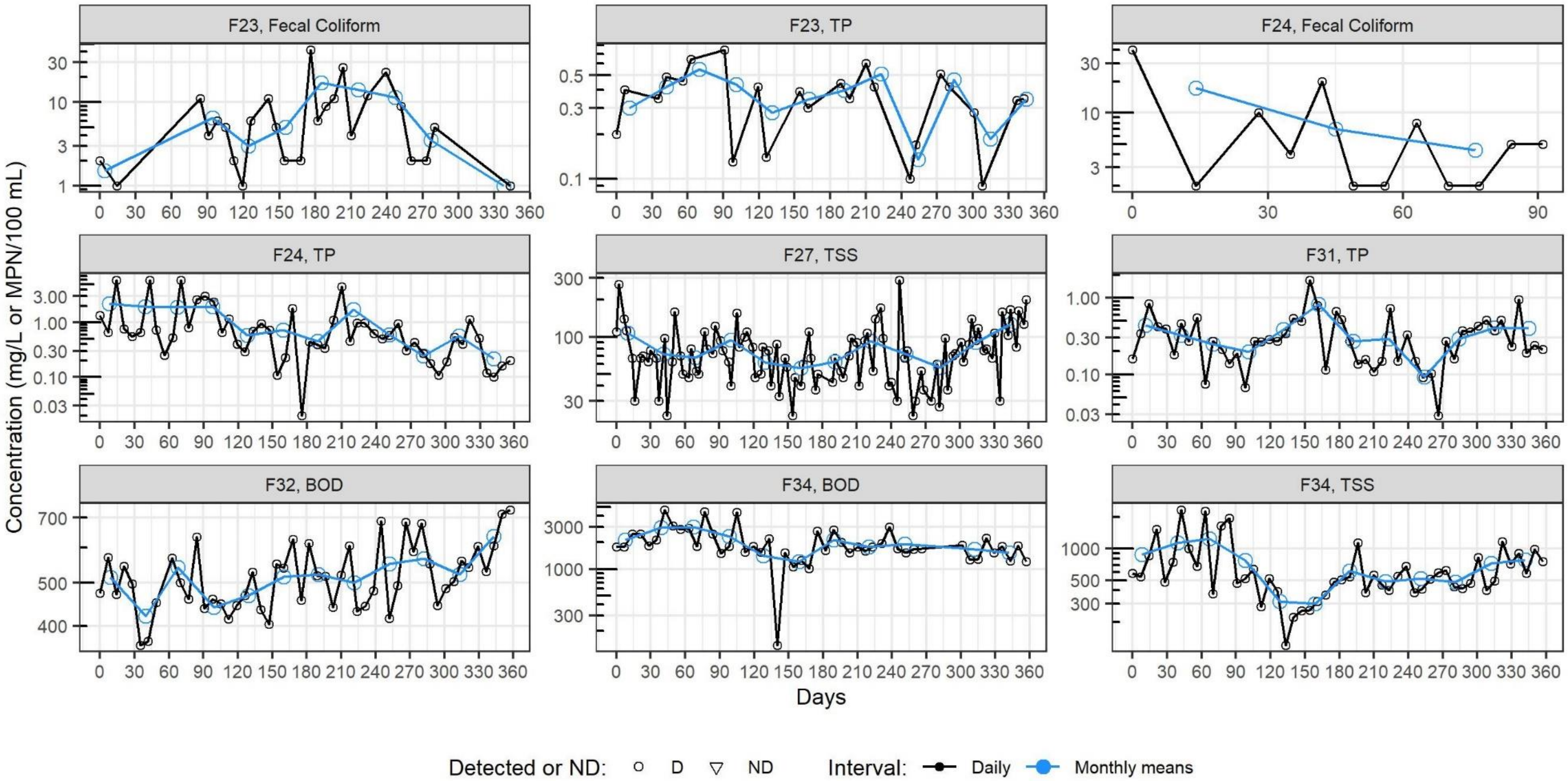

Figure B-1. Timelines of Series Used for Daily Calculations (Black) Averaged Within Calendar Months (Blue)

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Note: Monthly means are graphed at the midpoint of each month. All data are from the MPP Questionnaires. Facilities and dates are masked to protect CBI. Series are labeled by facility code and analyte. Units are in mg/L for all analytes, except fecal coliform in MPN/100 mL. Some of these averaged monthly series were later aggregated with other data sources' monthly-interval data at the same facility.

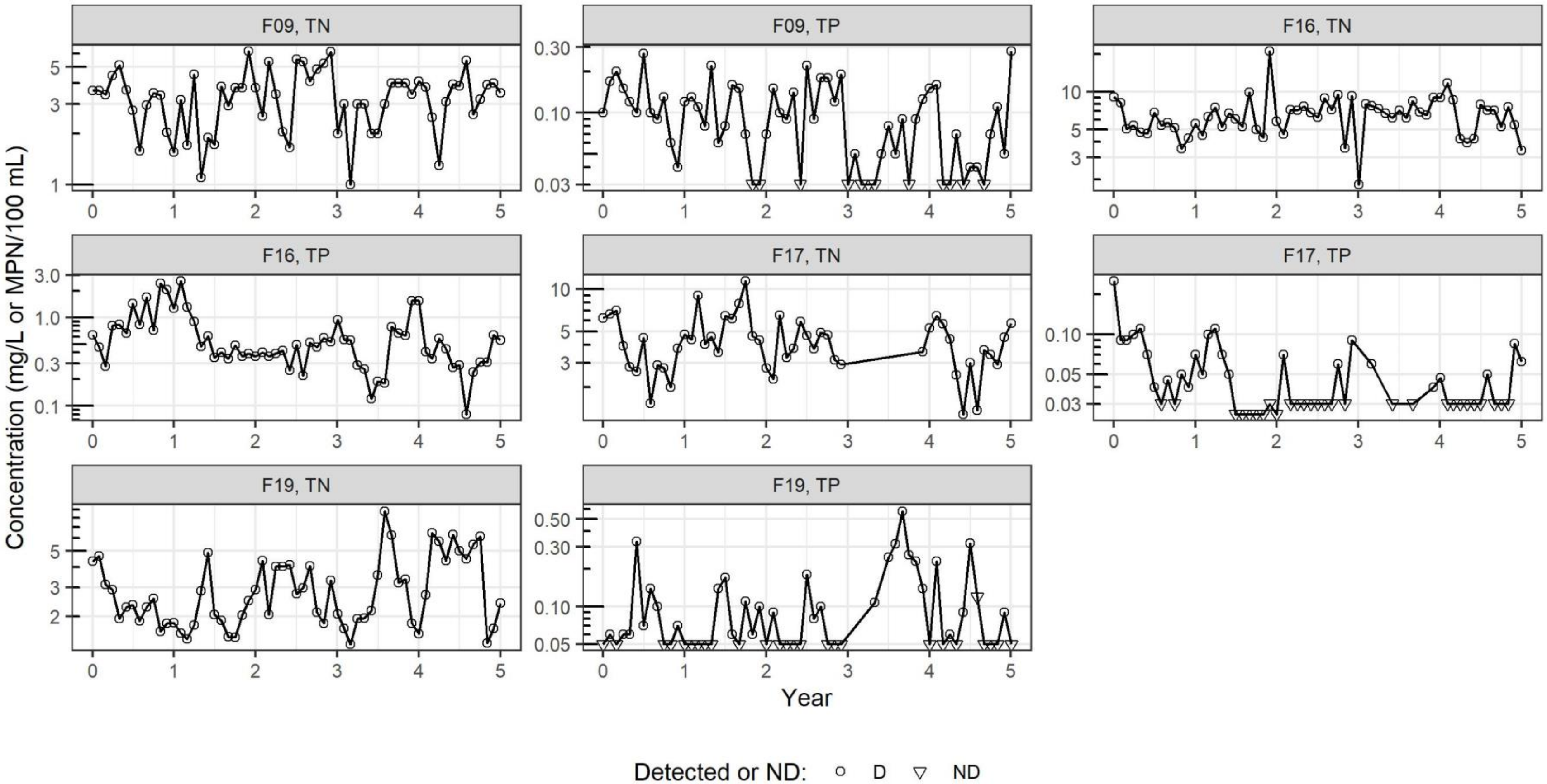

Figure B-2. Timelines of All Monthly-Interval Series with at Least 30 Values, Following Aggregation of All Data Sources

Note: The equivalent timelines for daily-interval series are all visible in Figure B-1 (in addition to others with <30 values).

Table B-1. Summary of LTA Test

Facility	Pollutant	Number of Observations	Percentage Detected	>50% Detected[a]	Baseline Value[b]	% Observations ≥10 × Baseline	Criterion 1 Pass/Fail[c]	Mean Concentration	Criterion 2 Pass/Fail[d]
F02	BOD (mg/L)	5	100%	Yes	2	100%	Pass	3,121.10	Pass
F02	O&G (mg/L)	5	100%	Yes	5	60%	Pass	67.70	Pass
F02	TN (mg/L)	5	100%	Yes	0.012	100%	Pass	246.95	Pass
F02	TP (mg/L)	5	100%	Yes	0.01	100%	Pass	42.55	Pass
F02	TSS (mg/L)	5	100%	Yes	4	100%	Pass	3,384.55	Pass
F04	BOD (mg/L)	3	100%	Yes	2	100%	Pass	9,716.67	Pass
F04	*E. coli* (MPN/100 mL)	4	100%	Yes	1	100%	Pass	111,050,750.00	Pass
F04	FC (MPN/100 mL)	4	100%	Yes	1	100%	Pass	29,859,325.00	Pass
F04	O&G (mg/L)	4	100%	Yes	5	75%	Pass	1,127.90	Pass
F04	TP (mg/L)	3	100%	Yes	0.01	100%	Pass	93.33	Pass
F04	TSS (mg/L)	3	100%	Yes	4	100%	Pass	5,488.33	Pass
F07	BOD (mg/L)	48	100%	Yes	2	100%	Pass	4,085.21	Pass
F08	BOD (mg/L)	5	100%	Yes	2	100%	Pass	3,150.00	Pass
F08	O&G (mg/L)	5	100%	Yes	5	100%	Pass	1,327.67	Pass
F08	TSS (mg/L)	47	100%	Yes	4	100%	Pass	1,723.83	Pass
F10	TSS (mg/L)	52	100%	Yes	4	100%	Pass	2,006.19	Pass
F11	BOD (mg/L)	14	100%	Yes	2	100%	Pass	925.21	Pass
F11	TSS (mg/L)	27	100%	Yes	4	100%	Pass	226.59	Pass
F17	BOD (mg/L)	5	100%	Yes	2	100%	Pass	1,167.60	Pass
F17	*E. coli* (MPN/100 mL)	5	100%	Yes	1	100%	Pass	10,478.00	Pass
F17	FC (MPN/100 mL)	5	100%	Yes	1	100%	Pass	3,629.80	Pass
F17	O&G (mg/L)	5	100%	Yes	5	60%	Pass	42.89	Fail
F17	TN (mg/L)	5	100%	Yes	0.012	100%	Pass	87.00	Pass
F17	TP (mg/L)	5	100%	Yes	0.01	100%	Pass	16.40	Pass
F17	TSS (mg/L)	5	100%	Yes	4	100%	Pass	1,376.80	Pass
F19	*E. coli* (MPN/100 mL)	5	100%	Yes	1	100%	Pass	781,102.00	Pass
F19	FC (MPN/100 mL)	5	100%	Yes	1	100%	Pass	333,405.27	Pass
F19	TN (mg/L)	5	100%	Yes	0.012	100%	Pass	156.00	Pass
F19	TP (mg/L)	5	80%	Yes	0.01	100%	Pass	18.44	Pass

Table B-1. Summary of LTA Test

Facility	Pollutant	Number of Observations	Percentage Detected	>50% Detected[a]	Baseline Value[b]	% Observations ≥10 × Baseline	Criterion 1 Pass/Fail[c]	Mean Concentration	Criterion 2 Pass/Fail[d]
F20	BOD (mg/L)	5	100%	Yes	2	100%	Pass	5,346.33	Pass
F20	Chloride (mg/L)	5	100%	Yes	1	100%	Pass	1,286.60	Pass
F20	*E. coli* (MPN/100 mL)	5	100%	Yes	1	100%	Pass	5,133,021.67	Pass
F20	FC (MPN/100 mL)	5	100%	Yes	1	100%	Pass	3,960,200.00	Pass
F20	O&G (mg/L)	5	100%	Yes	5	100%	Pass	4,558.90	Pass
F20	TP (mg/L)	5	100%	Yes	0.01	100%	Pass	34.80	Pass
F20	TSS (mg/L)	5	100%	Yes	4	100%	Pass	4,429.00	Pass
F22	BOD (mg/L)	2	100%	Yes	2	100%	Pass	13,500.00	Pass
F27	TSS (mg/L)	100	100%	Yes	4	100%	Pass	903.76	Pass
F32	BOD (mg/L)	51	100%	Yes	2	100%	Pass	2,212.65	Pass
F34	BOD (mg/L)	102	100%	Yes	2	100%	Pass	2,680.25	Pass
F34	TSS (mg/L)	98	100%	Yes	4	100%	Pass	2,789.35	Pass

Abbreviations: BOD = biochemical oxygen demand, FC = fecal coliform, LTA = long-term average, mg/L = milligrams per liter, mL = milliliters, MPN = most probable number, O&G = oil and grease, TN = total nitrogen, TP = total phosphorus, TSS = total suspended solids.

a — The basic criterion for the LTA test is whether at least 50 percent of the influent concentrations for the pollutant are detected.

b — There is no baseline value applicable to TN. The EPA instead used the MDL.

c — At least 50 percent of the influent concentrations were detected at levels 10 times the baseline value or higher.

d — The influent arithmetic average was 10 times the baseline value or higher.

Table B-2. R Code Used to Calculate Parameters μ and σ

Parameter	ND(s) in Series	Abbreviations: ND = non-detect. R Code to Calculate Parameters	Package Name
μ	No	fitted(gamlss(Conc ~ 1, family = LOGNO, what = “mu”)[1])	gamlss
μ	Yes	gamlssZadj(ConcZ, family = LOGNO)$mu.coefficients	gamlss.inf
σ	No	fitted(gamlss(Conc ~ 1, family = LOGNO, what = “sigma”)[1])	gamlss
σ	Yes	exp(gamlssZadj(ConcZ, family = LOGNO)$sigma.coefficients	gamlss.inf

Note: Two different functions are applicable: gamlss() for series without NDs (Rigby and Stasinopoulos, 2023) and gamlssZadj() for series with any NDs (Enea et al., 2019). In the R code, “Conc” is a column of concentrations (in milligrams per liter [mg/L] or most probable number per 100 milliliters [MPN/100 mL]) in a series, and ConcZ is a column replacing ND values with zeroes, as required by the software.

Table B-3. R Code Used to Calculate Percentiles

ND(s) in Series	R Code to Calculate Percentiles	Package Name
No	qLOGNO(mu = Mu, sigma = Sigma, p = 0.99)	gamlss
Yes	gen.Zadj(family = “LOGNO”) qLOGNOZadj(mu = Mu, sigma = Sigma, xi0 = Delta, p = 0.99)	gamlss.inf

Abbreviations: ND = non-detect.

Note: For series without NDs, the EPA used qLOGNO (Rigby and Stasinopoulos, 2023), which references function qnorm() (R Foundation, 2023). For series with any NDs, function gen.Zadj() first generates functions used to implement a mixed zero-adjusted lognormal distribution, the name of a delta lognormal distribution in this package (Enea et al., 2019). The generated function qLOGNOZadj() then calculates the percentile, run one row at a time. In the R code, “Mu” is a column of μ parameters, “Sigma” is a column of σ parameters, and “Delta” is a column of δ parameters, one of each per series. The code was run with p = 0.99 for daily-interval data, and p = 0.95 for monthly-interval data.

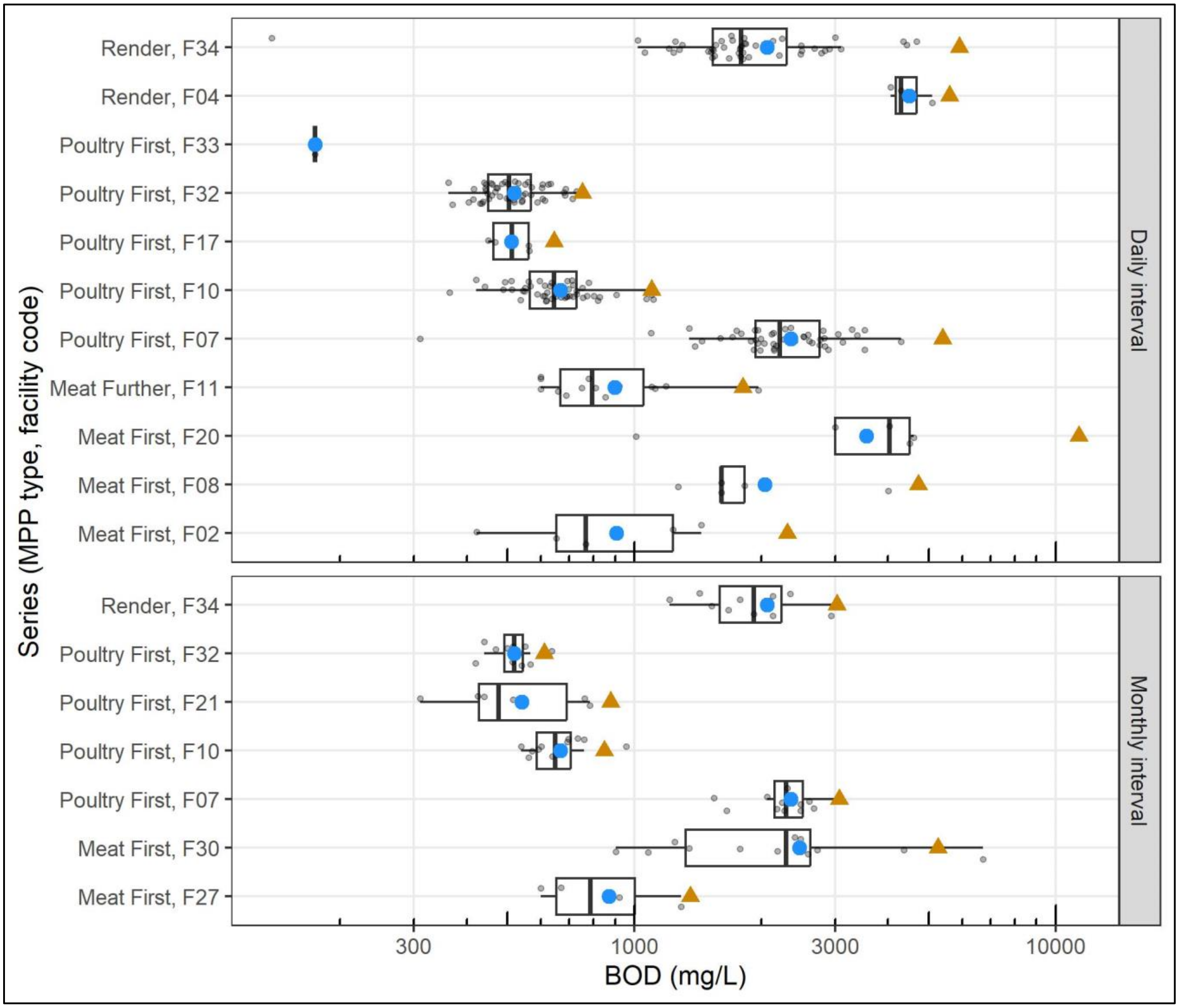

Figure B-3. Series' BOD Concentrations (Gray Points), LTAs (Blue Points), and Percentiles (Orange Triangles, as 99th for Daily and 95th for Monthly)

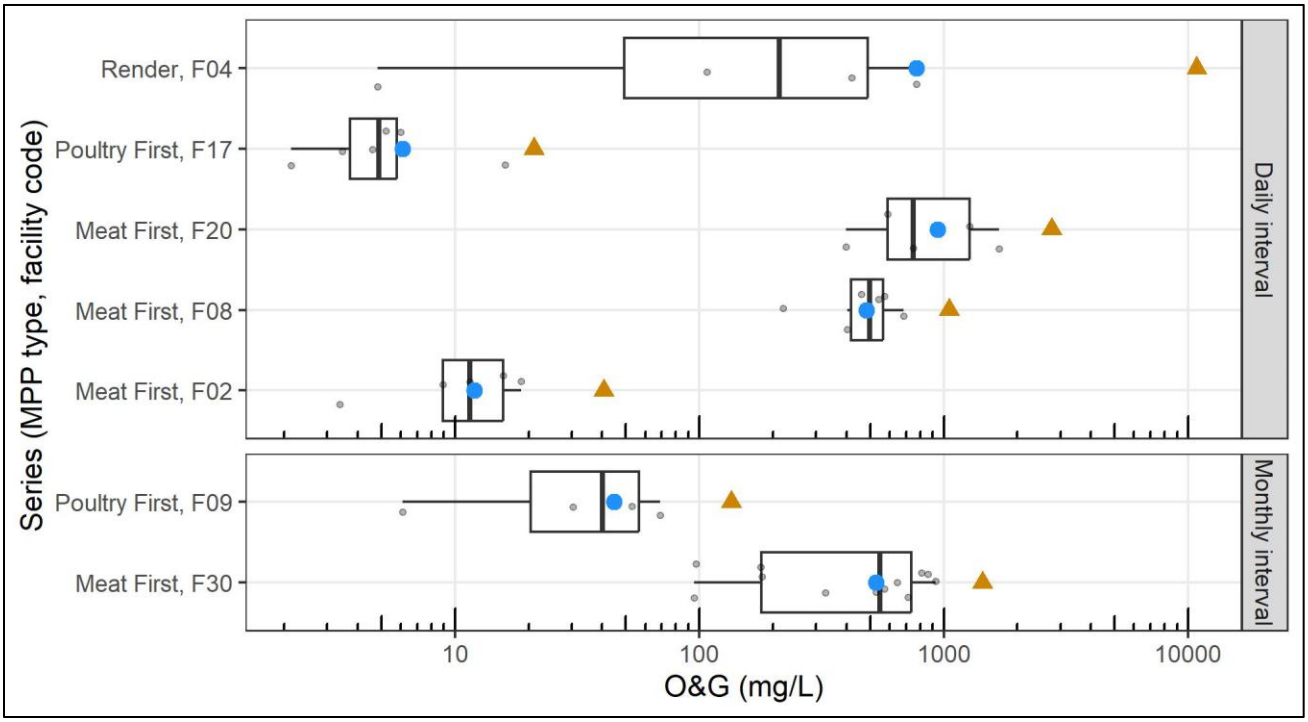

Figure B-4. Series' O&G Concentrations (Gray Points), LTAs (Blue Points), and Percentiles (Orange Triangles, as 99th for Daily and 95th for Monthly)

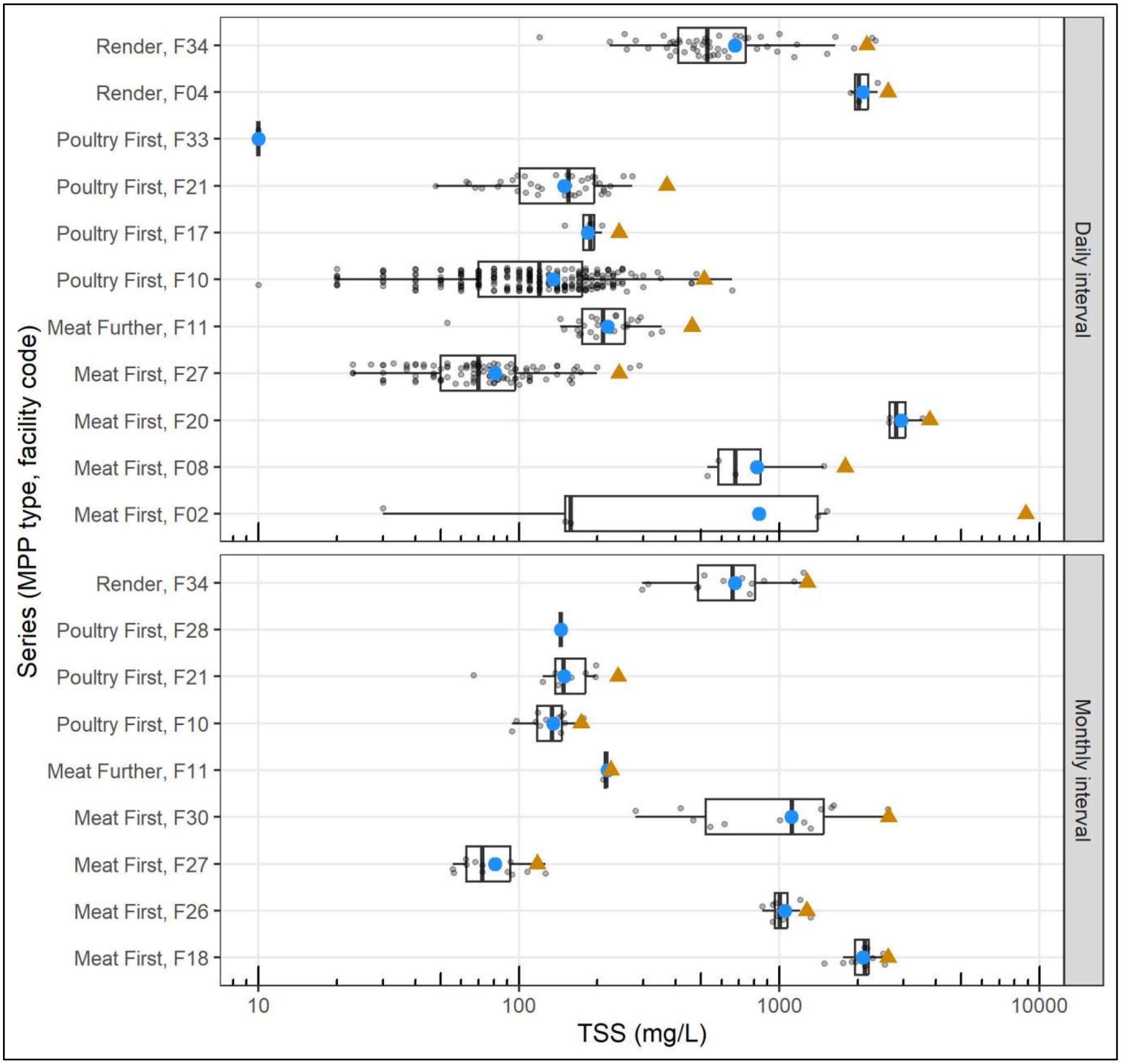

Figure B-5. Series' TSS Concentrations (Gray Points), LTAs (Blue Points), and Percentiles (Orange Triangles, as 99th for Daily and 95th for Monthly)

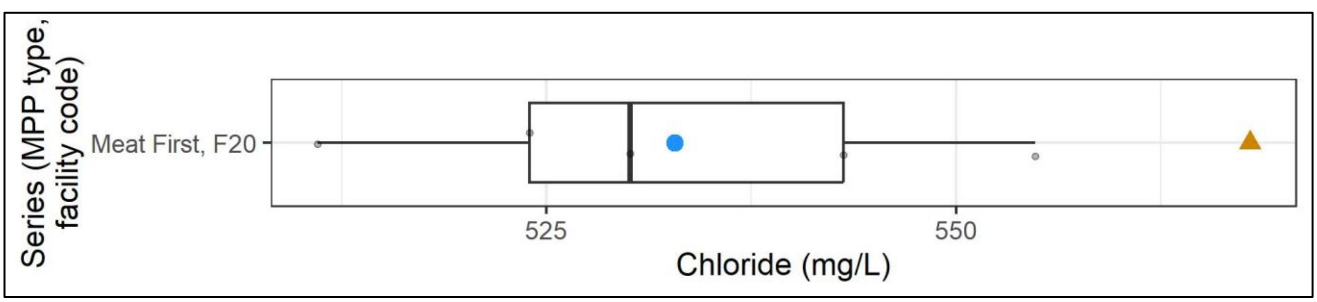

Figure B-6. The Daily Chloride Series' Concentrations (Gray Points), LTA (Blue Point), and 99th Percentile (Orange Triangle)

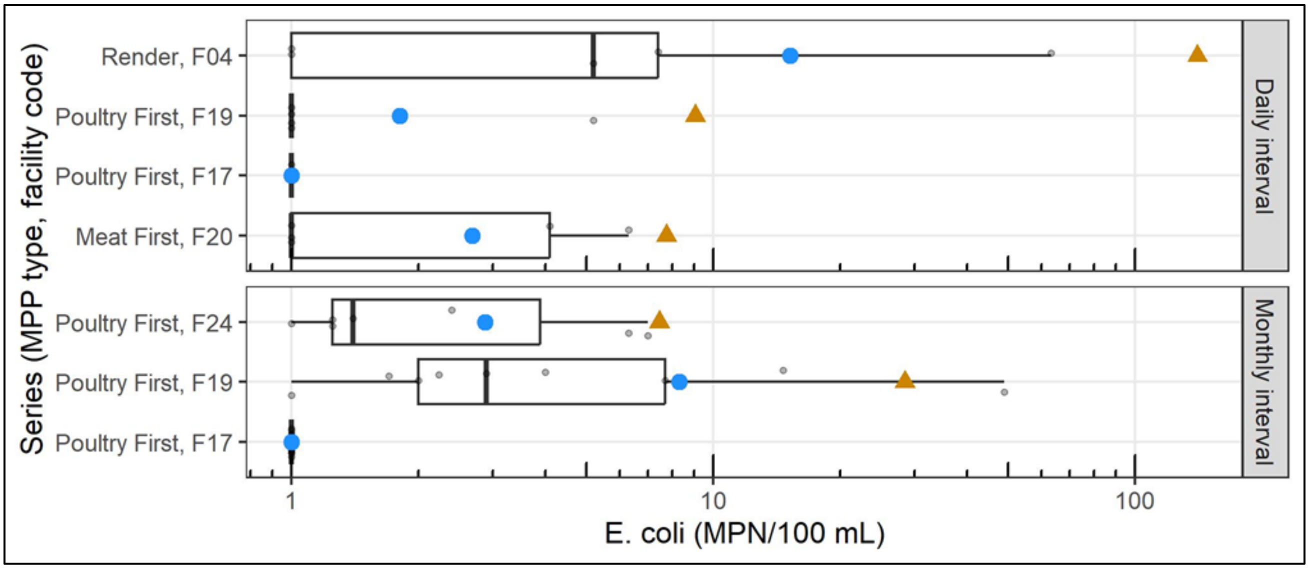

Figure B-7. Series' *E. coli* Concentrations (Gray Points), LTAs (Blue Points), and Percentiles (Orange Triangles, as 99th for Daily and 95th for Monthly)

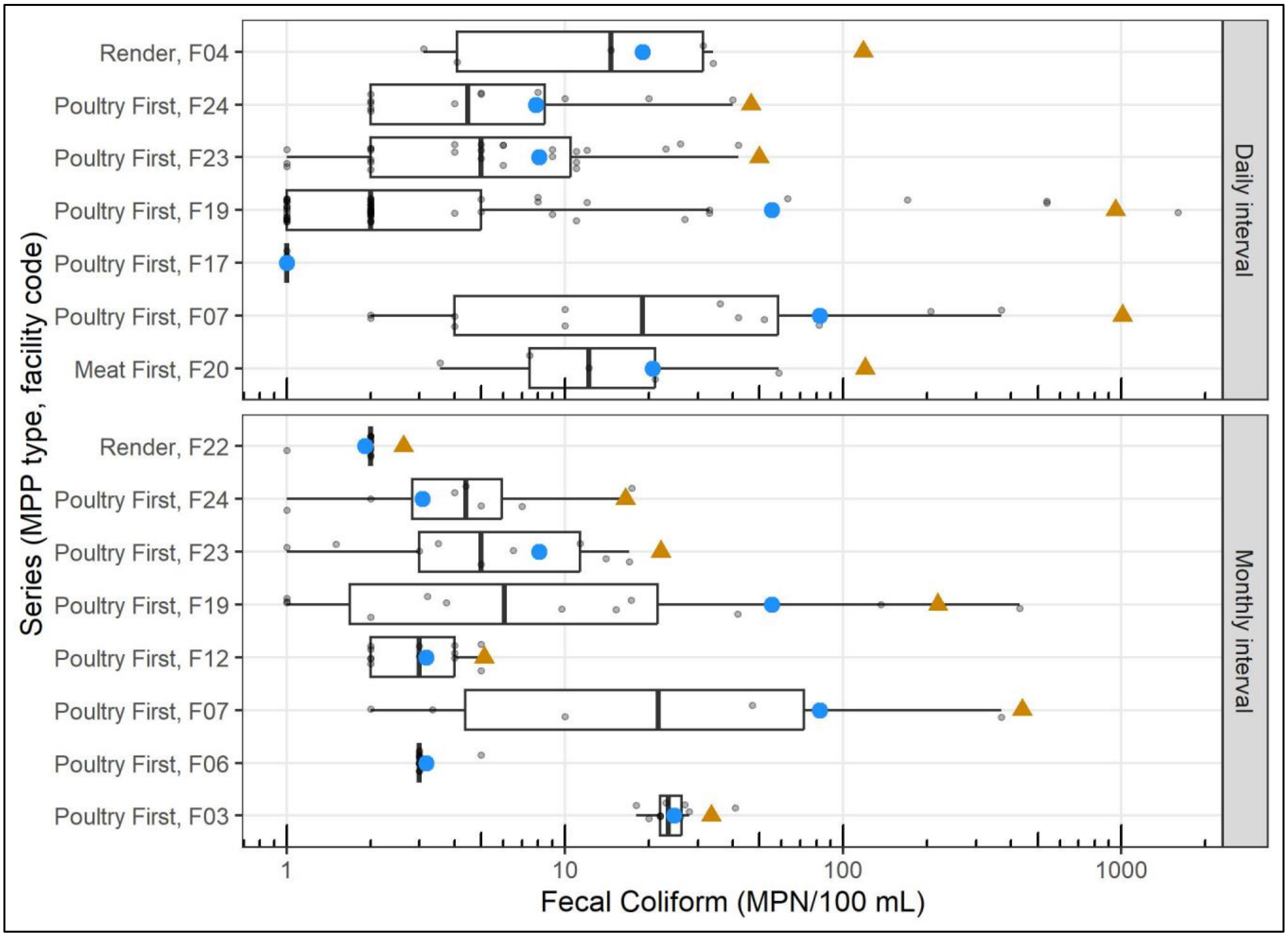

Figure B-8. Series' Fecal Coliform Concentrations (Gray Points), LTAs (Blue Points), and Percentiles (Orange Triangles, as 99th for Daily and 95th for Monthly)

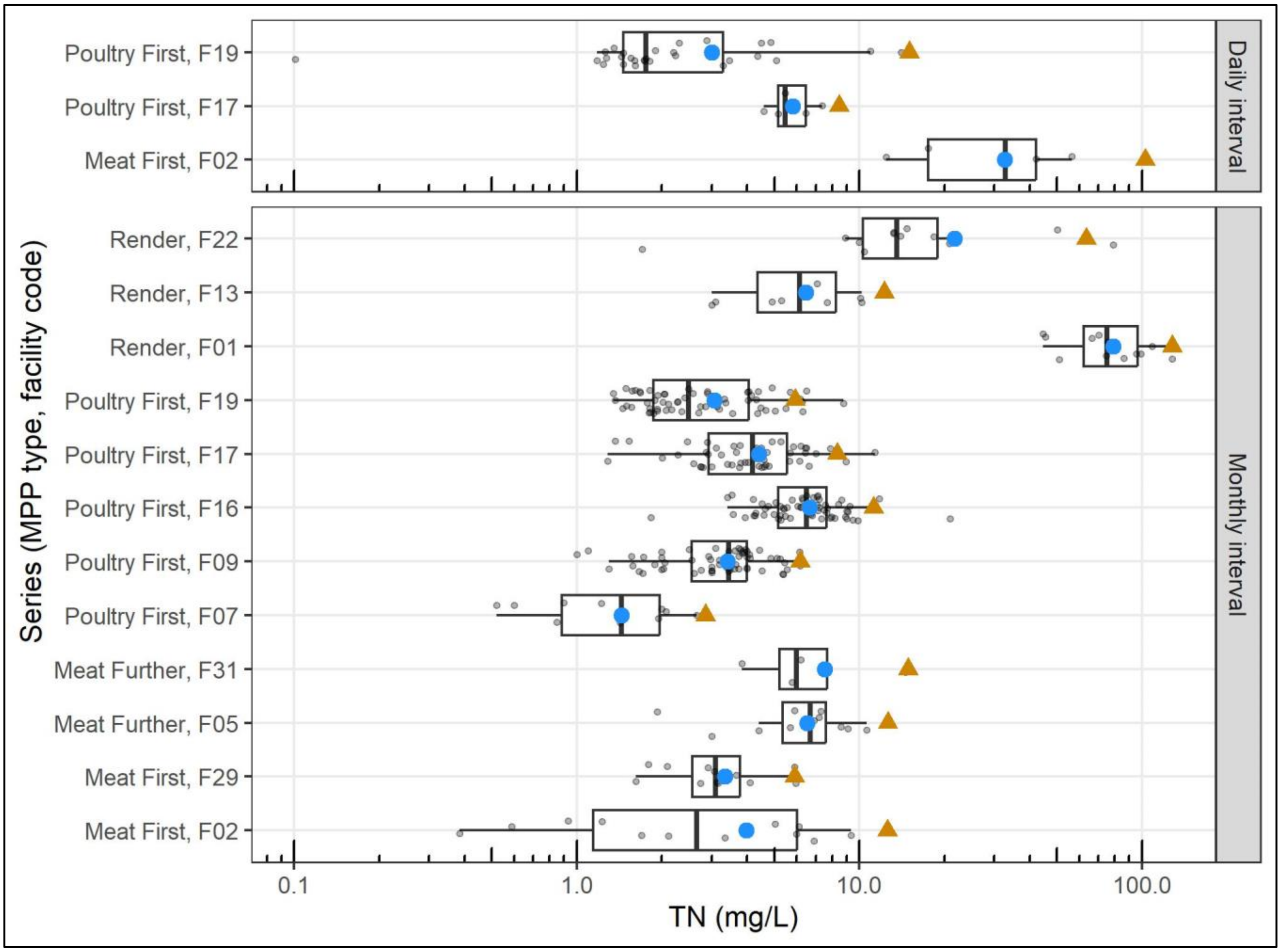

Figure B-9. Series' TN Concentrations (Gray Points), LTAs (Blue Points), and Percentiles (Orange Triangles, as 99th for Daily and 95th for Monthly)

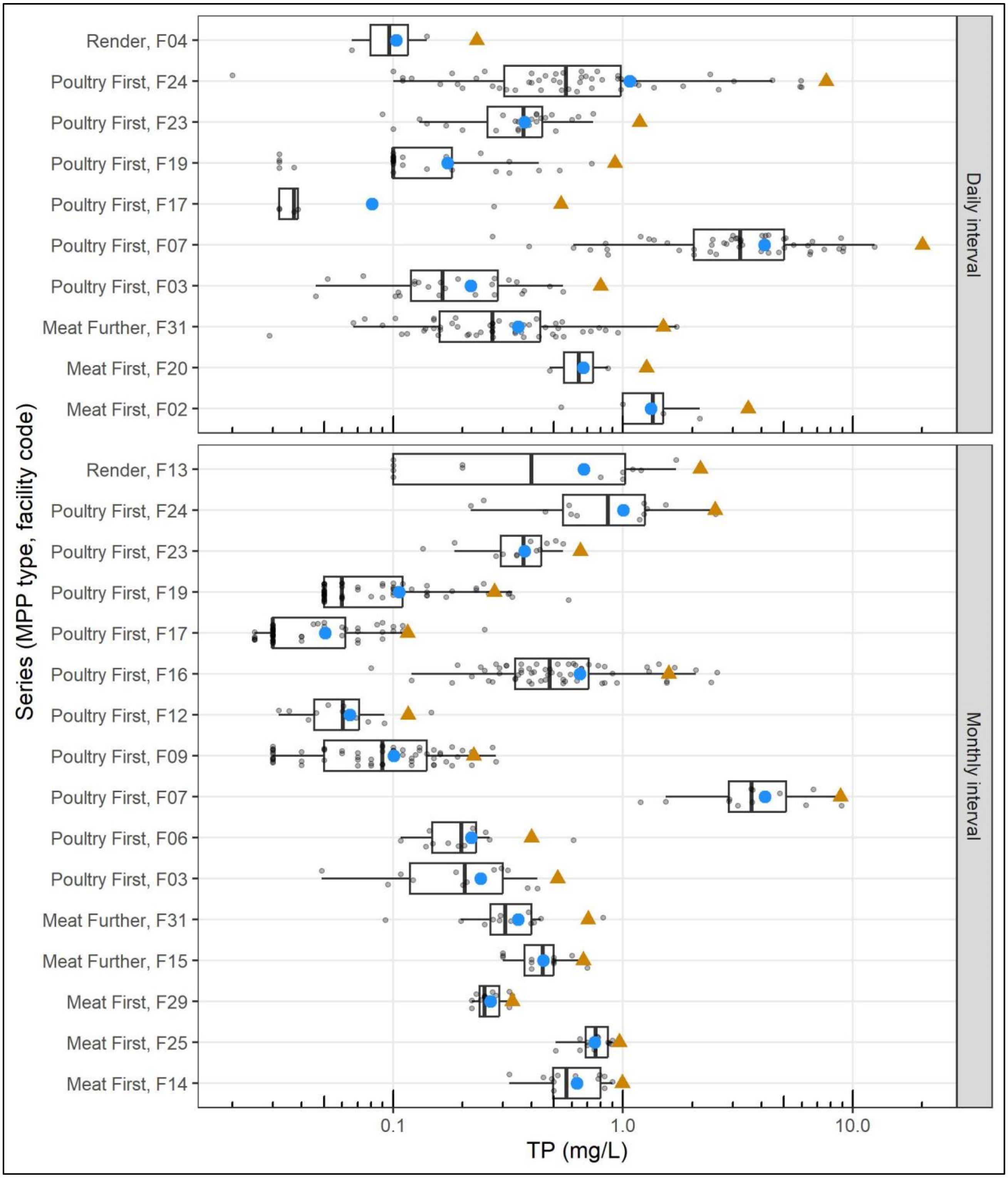

Figure B-10. Series' TP Concentrations (Gray Points), LTAs (Blue Points), and Percentiles (Orange Triangles, as 99th for Daily and 95th for Monthly)

Table B-4. Metrics Calculated for Each Series of BOD Concentrations (in mg/L): LTAs, Percentiles, and VFs

Analyte	Processing Type	Facility	Interval of Data	For LTA					For Daily VF		For Monthly VF			
				# Values	% ND	≥2 Distinct Detected Values	Series LTA	Facility LTA	Daily 99th Percentile	Daily VF (Unitless)	# Monthly Values	% ND of Monthly Values	Monthly 95th Percentile	Monthly VF (Unitless)
BOD	Meat First	F02	Daily	5	0%	Yes	907.78	907.78	2309.45	2.54				
BOD	Meat First	F08	Daily	5	0%	Yes	2043.27	2043.27	4728.43	2.31				
BOD	Meat First	F20	Daily	5	0%	Yes	3555.17	3555.17	11362.35	3.20				
BOD	Meat First	F27	Monthly	4	0%	Yes	869.71	869.71			4	0%	1358.82	1.56
BOD	Meat First	F30	Monthly	12	0%	Yes	2462.46	2462.46			12	0%	5258.24	2.14
BOD	Meat Further	F11	Daily	14	0%	Yes	897.59	897.59	1808.06	2.01				
BOD	Poultry First	F07	Daily	48	0%	Yes	2349.72	2349.72	5395.64	2.30	12	0%	3062.50	1.30
BOD	Poultry First	F10	Daily	48	0%	Yes	668.77	668.77	1098.13	1.64	12	0%	849.34	1.27
BOD	Poultry First	F17	Daily	4	0%	Yes	510.26	510.26	644.56	1.26				
BOD	Poultry First	F21	Monthly	6	0%	Yes	539.90	539.90			6	0%	878.88	1.63
BOD	Poultry First	F32	Daily	51	0%	Yes	519.57	519.57	752.77	1.45	12	0%	612.14	1.18
BOD	Poultry First	F33	Daily	1	0%	No	175.00	175.00						
BOD	Render	F04	Daily	3	0%	Yes	4484.67	4484.67	5596.75	1.25				
BOD	Render	F34	Daily	48	0%	Yes	2064.19	2064.19	5909.23	2.86	11	0%	3027.03	1.47

Abbreviations: BOD = biochemical oxygen demand, LTA = long-term average, mg/L = milligrams per liter, ND = non-detect, VF = variability factor.

Table B-5. Metrics Calculated for Each Series of O&G Concentrations (in mg/L): LTAs, Percentiles, and VFs

Analyte	Processing Type	Facility	Interval of Data	For LTA					For Daily VF		For Monthly VF			
				# Values	% ND	≥2 Distinct Detected Values	Series LTA	Facility LTA	Daily 99th Percentile	Daily VF (Unitless)	# Monthly Values	% ND of Monthly Values	Monthly 95th Percentile	Monthly VF (Unitless)
O&G	Meat First	F02	Daily	5	0%	Yes	12.01	12.01	40.59	3.38				
O&G	Meat First	F08	Daily	6	0%	Yes	483.80	483.80	1053.95	2.18				
O&G	Meat First	F20	Daily	5	0%	Yes	941.61	941.61	2761.20	2.93				
O&G	Meat First	F30	Monthly	12	0%	Yes	527.00	527.00			12	0%	1442.39	2.74
O&G	Poultry First	F09	Monthly	4	0%	Yes	44.71	44.71			4	0%	135.06	3.02
O&G	Poultry First	F17	Daily	6	0%	Yes	6.11	6.11	21.08	3.45				
O&G	Render	F04	Daily	4	0%	Yes	775.17	775.17	10845.40	13.99				

Abbreviations: LTA = long-term average, mg/L = milligrams per liter, ND = non-detect, O&G = oil and grease, VF = variability factor.

Table B-6. Metrics Calculated for Each Series of TSS Concentrations (in mg/L): LTAs, Percentiles, and VFs

Analyte	Processing Type	Facility	Interval of Data	For LTA					For Daily VF		For Monthly VF			
				# Values	% ND	≥2 Distinct Detected Values	Series LTA	Facility LTA	Daily 99th Percentile	Daily VF (Unitless)	# Monthly Values	% ND of Monthly Values	Monthly 95th Percentile	Monthly VF (Unitless)
TSS	Meat First	F02	Daily	5	0%	Yes	836.21	836.21	8857.44	10.59				
TSS	Meat First	F08	Daily	5	0%	Yes	819.37	819.37	1794.64	2.19				
TSS	Meat First	F18	Monthly	12	0%	Yes	2092.85	2092.85			12	0%	2612.20	1.25
TSS	Meat First	F20	Daily	5	0%	Yes	2941.49	2941.49	3779.01	1.28				
TSS	Meat First	F26	Monthly	12	0%	Yes	1048.86	1048.86			12	0%	1275.19	1.22
TSS	Meat First	F27	Daily	101	0%	Yes	80.77	80.77	242.15	3.00	12	0%	117.66	1.46
TSS	Meat First	F30	Monthly	12	0%	Yes	1115.72	1115.72			12	0%	2631.42	2.36
TSS	Meat Further	F11	Daily	27	0%	Yes	218.58	218.58	462.56	2.12	2	0%	225.92	1.03
TSS	Poultry First	F10	Daily	251	0%	Yes	135.67	135.67	513.53	3.79	12	0%	173.76	1.28
TSS	Poultry First	F17	Daily	4	0%	Yes	184.04	184.04	242.36	1.32				
TSS	Poultry First	F21	Daily	38	0%	Yes	149.40	149.40	370.33	2.48	9	0%	240.09	1.61
TSS	Poultry First	F28	Monthly	1	0%	No	145.00	145.00						
TSS	Poultry First	F33	Daily	1	0%	No	10.00	10.00						
TSS	Render	F04	Daily	3	0%	Yes	2094.87	2094.87	2617.40	1.25				
TSS	Render	F34	Daily	52	0%	Yes	675.90	675.90	2169.79	3.21	12	0%	1279.58	1.89

Abbreviations: LTA = long-term average, mg/L = milligrams per liter, ND = non-detect, TSS = total suspended solids, VF = variability factor.

Table B-7. Metrics Calculated for the Series of Chloride Concentrations (in mg/L): LTAs, Percentiles, and VFs

Analyte	Processing Type	Facility	Interval of Data	For LTA					For Daily VF		For Monthly VF			
				# Values	% ND	≥2 Distinct Detected Values	Series LTA	Facility LTA	Daily 99th Percentile	Daily VF (Unitless)	# Monthly Values	% ND of Monthly Values	Monthly 95th Percentile	Monthly VF (Unitless)
Chloride	Meat First	F20	Daily	5	0%	Yes	532.70	532.70	568.67	1.07				

Abbreviations: LTA = long-term average, mg/L = milligrams per liter, ND = non-detect, VF = variability factor.

Table B-8. Metrics Calculated for Each Series of *E. coli* Concentrations (in MPN/100 mL): LTAs, Percentiles, and VFs

Analyte	Processing Type	Facility	Interval of Data	For LTA					For Daily VF		For Monthly VF			
				# Values	% ND	≥2 Distinct Detected Values	Series LTA	Facility LTA	Daily 99th Percentile	Daily VF (Unitless)	# Monthly Values	% ND of Monthly Values	Monthly 95th Percentile	Monthly VF (Unitless)
E. coli	Meat First	F20	Daily	5	60.0%	Yes	2.68	2.68	7.74	2.89				
E. coli	Poultry First	F17	Daily	5	100.0%	No	1.00	1.00						
E. coli	Poultry First	F17	Monthly	12	100.0%	No	1.00							
E. coli	Poultry First	F19	Daily	5	40.0%	Yes	1.81	5.06	9.06	5.01				
E. coli	Poultry First	F19	Monthly	9	0%	Yes	8.31				9	0%	28.45	3.42
E. coli	Poultry First	F24	Monthly	7	0%	Yes	2.88	2.88			7	0%	7.45	2.59
E. coli	Render	F04	Daily	5	40.0%	Yes	15.22	15.22	140.53	9.24				

Abbreviations: LTA = long-term average, mL = milliliters, MPN = most probable number, ND = non-detect, VF = variability factor.

Table B-9. Metrics Calculated for Each Series of Fecal Coliform Concentrations (in MPN/100 mL): LTAs, Percentiles, and VFs

Analyte	Processing Type	Facility	Interval of Data	For LTA					For Daily VF		For Monthly VF			
				# Values	% ND	≥2 Distinct Detected Values	Series LTA	Facility LTA	Daily 99th Percentile	Daily VF (Unitless)	# Monthly Values	% ND of Monthly Values	Monthly 95th Percentile	Monthly VF (Unitless)
Fecal Coliform	Meat First	F20	Daily	5	0%	Yes	20.68	20.68	119.85	5.79				
Fecal Coliform	Poultry First	F03	Monthly	12	0%	Yes	24.71	24.71			12	0%	33.55	1.36
Fecal Coliform	Poultry First	F06	Monthly	12	91.7%	No	3.17	3.17						
Fecal Coliform	Poultry First	F07	Daily	12	0%	Yes	82.34	82.34	1010.04	12.27	6	0%	439.87	5.34
Fecal Coliform	Poultry First	F12	Monthly	12	41.7%	Yes	3.17	3.17			12	41.7%	5.12	1.62
Fecal Coliform	Poultry First	F17	Daily	5	60.0%	No	1.00	1.00						
Fecal Coliform	Poultry First	F19	Daily	57	68.4%	Yes	55.46	55.46	950.35	17.13	12	25.0%	219.04	3.95
Fecal Coliform	Poultry First	F23	Daily	26	0%	Yes	8.07	8.07	49.98	6.19	9	0%	22.05	2.73
Fecal Coliform	Poultry First	F24	Daily	12	0%	Yes	7.85	5.46	46.60	5.93				
Fecal Coliform	Poultry First	F24	Monthly	4	0%	Yes	3.07				7	0%	16.48	5.37
Fecal Coliform	Render	F04	Daily	5	0%	Yes	18.95	18.95	118.04	6.23				
Fecal Coliform	Render	F22	Monthly	10	0%	Yes	1.91	1.91			10	0%	2.63	1.38

Abbreviations: LTA = long-term average, mL = milliliters, MPN = most probable number, ND = non-detect, VF = variability factor.

Table B-10. Metrics Calculated for Each Series of TN Concentrations (in mg/L): LTAs, Percentiles, and VFs

Analyte	Processing Type	Facility	Interval of Data	For LTA					For Daily VF		For Monthly VF			
				# Values	% ND	≥2 Distinct Detected Values	Series LTA	Facility LTA	Daily 99th Percentile	Daily VF (Unitless)	# Monthly Values	% ND of Monthly Values	Monthly 95th Percentile	Monthly VF (Unitless)
TN	Meat First	F02	Daily	5	0%	Yes	32.69	18.34	102.64	3.14				
TN	Meat First	F02	Monthly	12	0%	Yes	3.98				12	0%	12.57	3.15
TN	Meat Further	F05	Monthly	12	0%	Yes	6.54	6.54			12	0%	12.60	1.93
TN	Meat First	F29	Monthly	12	0%	Yes	3.35	3.35			12	0%	5.91	1.77
TN	Meat Further	F31	Monthly	4	0%	Yes	7.53	7.53			4	0%	14.89	1.98
TN	Poultry First	F07	Monthly	12	0%	Yes	1.44	1.44			12	0%	2.86	1.98
TN	Poultry First	F09	Monthly	61	0%	Yes	3.40	3.40			61	0%	6.19	1.82
TN	Poultry First	F16	Monthly	61	0%	Yes	6.66	6.66			61	0%	11.20	1.68
TN	Poultry First	F17	Daily	5	0%	Yes	5.81	5.11	8.47	1.46				
TN	Poultry First	F17	Monthly	50	0%	Yes	4.42				50	0%	8.36	1.89
TN	Poultry First	F19	Daily	29	0%	Yes	3.00	3.03	15.03	5.02				
TN	Poultry First	F19	Monthly	61	0%	Yes	3.06				61	0%	5.94	1.94
TN	Render	F01	Monthly	12	0%	Yes	78.94	78.94			12	0%	127.71	1.62
TN	Render	F13	Monthly	8	0%	Yes	6.46	6.46			8	0%	12.22	1.89
TN	Render	F22	Monthly	12	0%	Yes	21.71	21.71			12	0%	63.61	2.93

Abbreviations: LTA = long-term average, mL = milliliters, MPN = most probable number, ND = non-detect, TN = total nitrogen, VF = variability factor.

Table B-11. Metrics Calculated for Each Series of TP Concentrations (in mg/L): LTAs, Percentiles, and VFs

Analyte	Processing Type	Facility	Interval of Data	For LTA					For Daily VF		For Monthly VF			
				# Values	% ND	≥2 Distinct Detected Values	Series LTA	Facility LTA	Daily 99th Percentile	Daily VF (Unitless)	# Monthly Values	% ND of Monthly Values	Monthly 95th Percentile	Monthly VF (Unitless)
TP	Meat First	F02	Daily	5	0%	Yes	1.32	1.32	3.51	2.65				
TP	Meat First	F14	Monthly	12	0%	Yes	0.63	0.63			12	0%	0.99	1.58
TP	Meat First	F20	Daily	2	0%	Yes	0.67	0.67	1.27	1.89				
TP	Meat First	F25	Monthly	12	0%	Yes	0.75	0.75			12	0%	0.97	1.28
TP	Meat First	F29	Monthly	12	0%	Yes	0.26	0.26			12	0%	0.33	1.24
TP	Meat Further	F15	Monthly	12	0%	Yes	0.45	0.45			12	0%	0.67	1.49
TP	Meat Further	F31	Daily	52	0%	Yes	0.35	0.35	1.50	4.28	12	0%	0.70	2.01
TP	Poultry First	F03	Daily	24	0%	Yes	0.22	0.23	0.80	3.66				
TP	Poultry First	F03	Monthly	11	0%	Yes	0.24				12	0%	0.52	2.17
TP	Poultry First	F06	Monthly	12	0%	Yes	0.22	0.22			12	0%	0.40	1.83
TP	Poultry First	F07	Daily	51	0%	Yes	4.12	4.14	20.09	4.87				
TP	Poultry First	F07	Monthly	12	0%	Yes	4.15				12	0%	8.85	2.13
TP	Poultry First	F09	Monthly	61	19.7%	Yes	0.10	0.10			61	19.7%	0.22	2.23
TP	Poultry First	F12	Monthly	12	0%	Yes	0.06	0.06			12	0%	0.12	1.79
TP	Poultry First	F16	Monthly	61	0%	Yes	0.65	0.65			61	0%	1.58	2.44
TP	Poultry First	F17	Daily	5	40.0%	Yes	0.08	0.07	0.54	6.64				
TP	Poultry First	F17	Monthly	53	52.8%	Yes	0.05				53	52.8%	0.12	2.28
TP	Poultry First	F19	Daily	29	48.3%	Yes	0.17	0.14	0.92	5.34				
TP	Poultry First	F19	Monthly	56	46.4%	Yes	0.11				61	47.5%	0.28	2.60
TP	Poultry First	F23	Daily	24	0%	Yes	0.37	0.37	1.18	3.17	12	0%	0.65	1.75
TP	Poultry First	F24	Daily	52	0%	Yes	1.07	1.04	7.65	7.14				
TP	Poultry First	F24	Monthly	12	0%	Yes	1.00				12	0%	2.51	2.51
TP	Render	F04	Daily	2	0%	Yes	0.10	0.10	0.23	2.23				
TP	Render	F13	Monthly	12	33.3%	Yes	0.68	0.68			12	33.3%	2.17	3.20

Abbreviations: LTA = long-term average, mL = milliliters, MPN = most probable number, ND = non-detect, TP = total phosphorus, VF = variability factor.