Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Industry Point Source Category (40 CFR 432)

EPA-821-B-01-007

January 2002

U.S. Environmental Protection Agency
Office of Water (4303T)
Washington, DC 20460

Complete proposed document available at:
http://www.epa.gov/ost/guide/mpp/
The Final Development Document is available as well.

SECTION 9

POLLUTANT LOADINGS

This section presents annual pollutant loading estimates for the meat and poultry products (MPP) industry. EPA estimated the pollutant loadings for the MPP industry to evaluate the effectiveness of the treatment technologies, to estimate benefits gained from removing pollutants discharged from each of the industry model facility groupings, and to evaluate the cost-effectiveness of the technology options in reducing the pollutant loadings. EPA defined baseline loadings, technology option loadings, and pollutant removals as follows:

- Baseline loadings - Pollutant loadings in meat and poultry processing wastewater being discharged to surface water or through publicly owned treatment works (POTWs) to surface water.

- Technology option loadings - Estimated pollutant loadings in meat and poultry processing wastewater after implementation of technology option, also referred to as post-compliance or treated pollutant loadings. In calculating these loadings EPA assumed that all MPP facilities would operate wastewater treatment and pollution prevention technologies equivalent to the technology option for which they have been costed. Costing methodology and estimates are discussed in detail in Section 11.

- Pollutant removals - The difference between baseline loadings and technology option loadings.

EPA estimated baseline loadings, technology option loadings, and pollutant removals for every model facility grouping (facility groupings are described further in Section 11). This section discusses the methodology that EPA used to estimate pollutant loadings and removals, and presents the resultant estimated pollutant loadings and expected removals as follows:

- Sections 9.1.1 through 9.1.4 discusses the data sources and methodology that EPA used to estimate baseline pollutant loadings,

- Sections 9.2.1 through 9.2.4 present the data sources and methodology that EPA used to estimate technology option pollutant loadings, and
- Section 9.3 discusses the method to estimate pollutant removals.

9.1 BASELINE POLLUTANT LOADINGS

This section presents baseline pollutant loadings for the meat and poultry products industry. EPA estimated the baseline pollutant loadings for each model facility grouping based on wastewater discharges to surface waters or through publicly owned treatment works (POTWs) to surface waters.

The following is a summary of methods used by EPA to select data sources and compute baseline loads:

- Section 9.1.1 presents sources used by EPA to compute baseline concentrations for the pollutants of concern
- Section 9.1.2 outlines the methods used by EPA to compute average concentrations from detailed survey analytical data and from EPA sampling episodes
- Section 9.1.3 presents the hierarchy used by EPA to impute baseline concentrations for all 37 pollutants of concern for the 151 (48 direct and 103 indirect discharge) facilities
- Section 9.1.4 describes the methodology used to estimate pollutant loadings for the various pollutants of concern.

9.1.1 Sources and Use of Available Data

EPA used analytical data provided by the industry in the detailed surveys and analytical data from facilities sampled to compute baseline pollutant concentrations. The analysis includes a total of 48 direct and 103 indirect discharge facility detailed surveys. For the 151 direct and indirect discharge facilities, EPA used baseline concentrations reported for 1999, the base year of

the MPP detailed survey. In addition to the analytical data from the 151 facilities, EPA used sampling data from 11 facilities, including two facilities sampled by EPA. Nine facilities carried out self-sampling with technical oversight provided by EPA.

9.1.2 Calculation of Average Concentrations from Analytical Data

For each facility and for each pollutant of concern (POC) in the baseline loading analysis, EPA used average concentrations provided in the detailed survey. When a facility did not provide average concentrations, but un-averaged, self-monitoring data instead, EPA calculated an average value to use as the baseline concentration. In computing average baseline concentrations for use in the proposal, the Agency did not edit any analytical data provided in the detailed survey. In addition, EPA did not use sample detection limits or the maximum and minimum concentration values, when average values were not available in the survey. However, for EPA sampling episodes where concentrations of pollutants were reported below the sample detection limit, the Agency used the reported sample detection limit as the concentration. Analytical data from EPA sampling episodes were averaged on a daily basis at each sample location.

9.1.3 Establishment of Baseline Concentration Data

EPA derived baseline concentrations for each POC for each of the 151 facilities (48 direct and 103 indirect) used to generate baseline pollutant loads. These concentration estimates were then used to generate baseline pollutant concentrations for each of the 19 model facility groupings being analyzed by EPA.

EPA used the following hierarchy to calculate baseline concentrations for each facility:

1. When a facility provided concentration data (average values provided in the detailed survey and averages calculated by EPA from un-averaged self monitoring data as described previously in Section 9.1.2) for any of the 37 POCs, EPA used this average concentration.

2. For facilities where baseline concentrations were available from EPA sampling episodes, EPA used these concentrations. In addition, in the absence of any

baseline concentration data in the detailed survey, EPA transferred analytical data from the EPA sampling episodes for facilities in identical model facility groupings and with identical treatments-in-place. For example, for a poultry first processor (P1) facility with BAT-4 treatment-in-place, EPA used sampling episode data from available poultry first processor (P1) facilities with BAT-4 treatment-in-place. When such sampling data were available from more than one EPA sampling episode, EPA used an average concentration value of these episodes to transfer data to facilities in identical model facility groupings and with identical treatments-in-place. However, for the 11 facilities with EPA sampling episode data belonging to these facilities, the reported pollutant concentrations from respective individual episodes were used, without using an average concentration.

3. For facilities with no data after the above two steps, EPA used average concentrations from detailed survey data from other facilities in identical model facility groupings and with identical treatments-in-place to derive pollutant concentrations.

4. When survey data from facilities in identical model facility groupings were not available, EPA used an average of survey and sample data from facilities with identical treatments-in-place but in *similar* model facility groupings. EPA defined *similar* model facility groupings as those which have at least one of the processes for which an equivalent is being sought. For example, to impute baseline concentrations for a meat first processor and renderer (R13) facility, EPA considered the following: meat first processor (R1), meat first and further processor (R12), meat first, further processor, and renderer (R123), and meat further processor, and renderer (R23) as *similar* model facility groupings. EPA's rationale for this definition is that the above four meat model facility groupings have either the meat first processor model facility grouping (R1) or renderer model facility grouping (R3). The Agency used only available meat model facility groupings from the above four potential model facility groupings to impute

baseline concentrations. However, EPA did not use poultry facility data to derive concentrations for facilities categorized as meat, or vice versa.

5. For POCs where detailed survey and sampling episode data were not available to transfer according to the above four steps, the Agency used average concentrations of both detailed survey and sampling episode data from facilities in identical model facility groupings and with similar treatments-in-place to calculate an average baseline concentration for each pollutant in a model facility grouping. EPA defined a *similar* treatment-in-place as one that has the essential features of the technology to which it is being considered as an equivalent. At this stage of data imputation, except for microbiologicals, EPA used both direct and indirect discharge facilities to transfer analytical data between identical model facility groupings. For example, to obtain the baseline concentration of copper for a poultry first and further processor (P12) facility with PSES-2 treatment-in-place, EPA used an average of copper baseline concentration data from poultry first and further processor (P12) facilities with BAT-2 treatment-in-place. Though these two treatment technologies are not identical, for the purposes of data imputation EPA considered them as similar technologies for the treatment of certain pollutants.

6. When data from facilities in identical model facility groupings and with similar treatments-in-place were not available, an average concentration from facilities in similar model facility groupings, as defined in step 4, and with similar treatments-in-place, as defined in step 5, was used instead. Both detailed survey data and EPA sampling episode data were used to compute average concentrations.

7. When all of the above imputation methods (steps 1-6 for non-microbiologicals, steps 1-4 for microbiologicals) failed to derive pollutant concentrations, either because analytical data were lacking in the detailed survey, or because the model facility grouping the facility belonged to did not have EPA sampling episode data, the Agency used facility data from treatment options from the next tier level, but

in identical model facility groupings. For example, for poultry first processor (P1) model facility grouping with BAT-3 treatment in place when no data was available from P1 meat model facility grouping with BAT-3 treatment, EPA used the following hierarchy: (a) transfer concentration data from P1 facilities with BAT-2 treatment technology, (b) transfer data from P1 facilities with BAT-4 treatment technology. In either of the above two cases, EPA used average concentrations from a group of facilities rather than a single value reported by an individual facility.

8. At the next level of data imputation, EPA used a combination of items 6 and 7 above, using data from facilities in similar model facility groupings and with treatments-in-place from the next tier level to derive baseline pollutant concentrations.

9. For all microbiologicals, EPA transferred data within identical discharge types only. The Agency did not use microbiological data from indirect dischargers to derive concentrations for direct dischargers or vice versa. Other than this exemption, EPA followed the logic described above for deriving baseline concentration for microbiologicals.

When the baseline concentration of a pollutant derived by the above methods was lower than the corresponding concentration with the identical treatment-in-place and in the identical model facility grouping from the proposed treatment option, EPA equated the baseline concentration to the concentration of the pollutant in the proposed option. However, for facilities with available data from the detailed survey (i.e., step 1 above), and for the 11 facilities with data from EPA sampling episodes and facilities where analytical data from EPA sampling episodes were transferred between facilities in identical model facility groupings and with identical treatments-in-place (i.e., step 2 above), the Agency did not replace derived pollutant concentrations with concentrations from the proposed options, even when the baseline concentrations were lower than the concentrations in the corresponding proposed options.

Table 9-1 illustrates the sequence of the above 10 steps.

Table 9-1. Summary of Imputation Methods Used for Derivation of Baseline Concentrations

Step	Description	Model facility grouping	Treatment-in-place	Data Source
1	Use available detailed survey data	Identical	Identical	Facility-specific as provided in detailed survey
2	Use available analytical data from EPA sampling episodes for 11 facilities sampled and facilities in identical model facility grouping and with identical treatments-in-place	Identical	Identical	Facility-specific and averaged EPA sampling episodes
3	Use average concentrations of analytical data from detailed survey in identical model facility groupings and with identical treatments-in-place	Identical	Identical	Averaged detailed survey data when facility did not provide analytical data
4	Use average of detailed survey and EPA sampling episode data with identical treatments-in-place, but in similar model facility groupings	Similar	Identical	Detailed survey and EPA sampling episode data
5	Use average of detailed survey and EPA sampling episode data in identical model facility groupings but with similar treatments-in-place. Not used for microbiologicals	Identical	Similar	Detailed survey and EPA sampling episode data
6	Use average of detailed survey and EPA sampling episode data in similar model facility groupings and with similar treatments-in-place	Similar	Similar	Detailed survey and EPA sampling episode data
7	Use data in identical model facility groupings and with treatments-in-place from next tier levels	Identical	Next tier level of treatment-in-place	Detailed survey and EPA sampling episode data
8	Use data in similar model facility groupings and treatments-in-place from next tier levels	Similar	Next tier level of treatment-in-place	Detailed survey and EPA sampling episode data
9	For micribiologicals, data transfer was only within identical discharge types (direct or indirect) only	Similar or identical	Use data from direct and indirect facilities when deriving data for direct and indirect facilities, respectively.	Detailed survey and EPA sampling episode data
10	Use concentrations from proposed options when baseline concentration of pollutant is less than that in the proposed options, with the exception of concentrations derived in steps 1 and 2 above	Identical	Identical	Technology options as described in Section 9.2.3 and presented in Tables C-47 through C-75 in Appendix C

Certain pollutants that would normally sum to equal another pollutant (e.g., nitrate/nitrite and TKN should sum to total nitrogen) may not do so in these calculations, since the individual baseline concentrations for these pollutants were derived using data from different facilities and sampling episodes. For this proposal, EPA determined that these concentrations be reported as they are recorded in the detailed survey and in the EPA sampling episodes, and as calculated by the imputation methods described above. The Agency made a similar determination for derived concentrations of pollutants such as BOD_5 and $CBOD_5$, fecal coliform and total coliform, total phosphorus and dissolved phosphorus, etc.

The size of the facility (small or non-small) was not considered when transferring data within model facility groupings and treatments-in-place.

After pollutant concentration data were imputed separately for each direct and indirect facility, EPA calculated average concentration for 19 model facility groupings using concentration data from the individual facilities, separating small facilities from non-small facilities.

Average baseline concentrations for all 37 POCs for each model facility grouping are presented in Tables C-1 through C-29 in Appendix C.

When a particular meat model facility grouping was not represented by any of the facilities in the detailed survey, EPA used available, similar model facility groupings in the detailed survey to derive average pollutant concentrations for the missing model facility grouping. For example, in the meat model facility grouping for direct discharging non-small facilities, only R1, R12 and R13 model facility groupings were represented in direct discharging detailed survey. Similarly for direct discharging non-small poultry model facility grouping, only P1, P12, P123, and P13 model facility groupings were represented in the detailed survey. EPA used averages to compute the meat and poultry model facility grouping concentrations that best represented the model facility grouping without facilities in the detailed survey. This calculation used both small and non-small facilities. The model facility grouping averages that were derived using this method are identified with a footnote in Tables C-1 through C-29 in Appendix C, where applicable.

9.1.4 Calculation of Pollutant Loadings

EPA estimated baseline pollutant loadings for all 37 POCs using the average baseline concentrations, described in Section 9.1.3 for each model facility grouping and national flow (median) values derived from the screener survey for small and non-small facilities. Table 9-2 shows the median flow values as projected from the screener survey for direct and indirect dischargers.

Table 9-2. Median Flow for Direct and Indirect Dischargers by Model Facility Grouping and Size

Model Facility Grouping	Flow for Facilities (MGD)			
	Small	**Medium**	**Large**	**Very Large**
Meat first processors (R1)	0.00046	0.028	N/A[a]	N/A
Meat first/further processors (R12)	0.00058	0.440	N/A	N/A
Meat first/further processors and renderers (R123)	0.00120	2.11	3.42	N/A
Meat first processors and renderers (R13)	0.00140	0.630	0.932	2.90
Meat further processors (R2)	0.00038	0.09	0.017	0.00995
Meat further processors and renderers (R23)	0.000073	0.580	N/A	N/A
Poultry first processors (P1)	0.0160	0.720	0.885	1.90
Poultry first/further processors (P12)	0.00035	0.350	0.901	1.60
Poultry first/further processors and renderers (P123)	N/A	0.470	2.81	2.80
Poultry first processors and renderers (P13)	N/A	0.420	1.59	1.7
Poultry further processors (P2)	0.00077	0.086	0.434	0.0308
Poultry further processors and renderers (P23)	0.00350	0.049	0.850	N/A
Mixed poultry/meat further processors (M2)	0.00058	0.250	N/A	N/A
Mixed poultry/meat further processors and renderers (M23)[b]	0.00255	N/A	N/A	N/A
Renderers (REND)	0.140	0.034	0.090	0.177

[a] No facilities are represented in this model facility grouping
[b] Indirect dischargers only

The following equation was used for conventional pollutants, nutrients, metals and pesticides:

Load = Flow x Conc x 8.345

where

Load = pollutant loading, lbs/day

Flow = flow rate, million gallons per day

Conc = pollutant concentration, mg/L

8.345 = conversion factor, lbs/gal and mg/L.

For microbiological pollutants, the loads were computed using the following equation:

Load = Flow x Conc x 37.8

where

Load = pollutant loading, million cfu/day

Flow = flow rate, million gallons per day

Conc = pollutant concentration, cfu/100 mL

37.8 = conversion factor, L/gal and mL/L.

For Cryptosporidium, the loads were computed using the following equation:

Load = Flow x Conc x 3.78

where

Load = pollutant loading, million cysts/day

Flow = flow rate, million gallons per day

Conc = pollutant concentration, cysts per L

3.78 = conversion factor, L/gal.

EPA estimated pollutant loadings for the entire industry using the national estimates of the number of facilities in each meat model facility grouping multiplied by the model facility

grouping loadings. Tables 9-3 and 9-4 present the number of facilities in each model facility grouping, as projected from the screener survey for direct and indirect dischargers.

Table 9-3. Number of Direct Discharger Facilities by Model Facility Grouping and Size

Model Facility Grouping	Number of Facilities			
	Small	**Medium**	**Large**	**Very Large**
Meat first processors (R1)	17	6	N/A[a]	N/A
Meat first/further processors (R12)	N/A	N/A	N/A	N/A
Meat first/further processors and renderers (R123)	25	17	7	N/A
Meat first processors and renderers (R13)	17	17	7	12
Meat further processors (R2)	43	10	1	1
Meat further processors and renders (R23)	N/A	4	N/A	N/A
Poultry first processors (P1)	N/A	17	25	7
Poultry first/further processors (P12)	N/A	6	2	8
Poultry first/further processors and renderers (P123)	N/A	2	3	1
Poultry first processors and renders (P13)	N/A	7	8	2
Poultry further processors (P2)	N/A	10	1	2
Poultry further processors and renders (P23)	N/A	N/A	N/A	N/A
Mixed poultry/red meat further processors (M2)	9	5	N/A	N/A
Renderers (REND)	6	7	6	8

[a] No facilities are represented in this model facility grouping

Table 9-4. Number of Indirect Discharger Facilities by Model Facility Grouping and Size

Model Facility Grouping	Number of Facilities			
	Small	**Medium**	**Large**	**Very Large**
Meat first processors (R1)	265	N/A[a]	N/A	N/A
Meat first/further processors (R12)	674	28	N/A	N/A
Meat first/further processors and renderers (R123)	50	12	5	N/A
Meat first processors and renders (R13)	12	7	3	5
Meat further processors (R2)	2,489	160	4	4
Meat further processors and renders (R23)	32	7	N/A	N/A
Poultry first processors (P1)	19	32	48	12
Poultry first/further processors (P12)	20	11	4	14
Poultry first/further processors and renderers (P123)	N/A	3	7	2
Poultry first processors and renders (P13)	N/A	2	2	1
Poultry further processors (P2)	272	133	4	18
Poultry further processors and renderers (P23)	4	9	6	N/A
Mixed poultry/meat further processors (M2)	707	97	N/A	N/A
Renderers (REND)	17	26	21	28
Mixed poultry/meat further processors and renders (M23)[b]	4	N/A	N/A	N/A

[a] No facilities are represented in this model facility grouping.
[b] indirect dischargers only

Tables 9-5 and 9-6 present the baseline loads generated for direct and indirect facilities, respectively.

Table 9-5. Baseline Loadings for Direct Dischargers

Pollutant Groups of Concern	Small Facility Baseline Loading	Non-Small Facility Baseline Loading	Units
Conventional pollutants [a]	2,633,600	46,926,729	lbs/yr
Toxic pollutants [b]	118,884	52,971,558	lbs/yr
Nutrients [c]	257,489	61,295,253	lbs/yr
Other Pollutants of Concern			
Aeromonas	37,398,048	74,124,203,180	million cfu/yr
Carbonaceous biochemical oxygen demand (CBOD)	10,971	5,436,829	lbs/yr
Chemical oxygen demand (COD)	7,211,921	45,006,868	lbs/yr
Chloride	831,715	289,715,129	lbs/yr
Cryptosporidium	440	40,016	million cysts/yr
Dissolved biochemical oxygen demand	22,325	2,890,205	lbs/yr
Dissolved phosphorus	24,345	6,097,899	lbs/yr
E. coli	37,590,901	78,926,098,937	million cfu/yr
Fecal coliform bacteria	4,012,138	35,157,310,463	million cfu/yr
Fecal streptococci	2,506,958	1,273,974,840	million cfu/yr
Orthophosphate	62,845	4,435,234	lbs/yr
Salmonella	17,007	6,738,113	million cfu/yr
Total coliform	35,508,476	96,100,436,605	million cfu/yr
Total dissolved solids (TDS)	3,721,125	907,402,228	lbs/yr
Total organic carbon (TOC)	68,602	5,932,150	lbs/yr
Total residual chlorine	1,212	475,125	lbs/yr
Volatile residue	784,276	114,282,048	lbs/yr

[a] Conventional pollutants: biochemical oxygen demand (BOD), hexane extractable material (HEM) and total suspended solids (TSS)

[b] Toxic pollutants: ammonia as nitrogen, carbaryl, nitrate-nitrite, barium, copper, chromium, *cis*-Permethrin, manganese, molybdenum, nickel, titanium, *trans*-Permethrin, vanadium, and zinc

[c] Nutrients: total nitrogen and total phosphorus

Table 9-6. Baseline Loadings for Indirect Dischargers

Pollutant Groups of Concern	Small Facility Baseline Loading	Non-Small Facility Baseline Loading	Units
Conventional pollutants [a]	31,966,596	1,018,858,887	lbs/yr
Toxic pollutants [b]	1,143,985	75,299,529	lbs/yr
Nutrients [c]	7,095,318	94,112,866	lbs/yr
Other Pollutants of Concern			
Aeromonas	19,184,904,649	1,084,294,192,937	million cfu/yr
Carbonaceous biochemical oxygen demand (CBOD)	18,098,643	547,829,773	lbs/yr
Chemical oxygen demand (COD)	28,814,396	941,098,914	lbs/yr
Chloride	22,053,547	752,413,059	lbs/yr
Cryptosporidium	229,949	4,310,247	million cysts/yr
Dissolved biochemical oxygen demand	14,962,017	381,609,489	lbs/yr
Dissolved phosphorus	477,206	14,902,848	lbs/yr
E. coli	66,192,758,859	3,257,404,839,755	million cfu/yr
Fecal coliform bacteria	46,703,268,777	2,944,853,206,446	million cfu/yr
Fecal streptococci	57,574,999,260	1,131,842,917,041	million cfu/yr
Orthophosphate	237,447	9,640,839	lbs/yr
Salmonella	583,562	44,105,854	million cfu/yr
Total coliform	71,410,481,190	3,326,332,420,450	million cfu/yr
Total dissolved solids (TDS)	38,778,129	1,423,824,756	lbs/yr
Total organic carbon (TOC)	9,442,455	197,631,108	lbs/yr
Total residual chlorine	3,333	113,586	lbs/yr
Volatile residue	26,271,375	1,197,019,690	lbs/yr

[a] Conventional pollutants: biochemical oxygen demand (BOD), hexane extractable material (HEM) and total suspended solids (TSS)

[b] Toxic pollutants: ammonia as nitrogen, carbaryl, nitrate-nitrite, barium, copper, chromium, *cis*-Permethrin, manganese, molybdenum, nickel, titanium, *trans*-Permethrin, vanadium, and zinc

[c] Nutrients: total nitrogen and total phosphorus

9.2 TECHNOLOGY OPTIONS LOADINGS

This section presents the methods used by EPA to develop pollutant loading estimates after implementation of various technology options being considered for the MPP industry. EPA defined options loadings as the estimated pollutant loadings in MPP wastewater after implementation of the selected technology option, also referred to as treated pollutant loadings. EPA estimated options loadings for all the MPP model facility groupings for each technology option being considered.

In order to estimate the technology option loadings, EPA first derived the treated pollutant concentrations for first processing, further processing and rendering wastewaters for each technology option. EPA then estimated technology option *concentrations* for each model facility grouping, from which technology option *loadings* could then be derived.

The following is a summary of the methods used by EPA to select data sources and compute technology option loads:

- Section 9.2.1 describes data sources used by EPA to compute technology option loadings for the pollutants of concern,
- Section 9.2.2 presents the methods used by EPA to compute average concentrations for first processing, further processing and rendering wastewaters for each technology option,
- Section 9.2.3 discusses the methods used by EPA to estimate technology option concentrations for each model facility grouping, and
- Section 9.2.4 outlines the methodology used to estimate technology option loadings for each model facility grouping.

9.2.1 Sources and Use of Available Data

To develop options loading estimates for the MPP industry, EPA used wastewater sampling data from MPP facilities with unit processes contained within each technology option

being considered. As described in detail in Section 3, multi-day sampling was conducted at 11 MPP facilities. EPA performed multi-day sampling at two facilities, and nine facilities performed the multi-day sampling on behalf of EPA. EPA used the data from the two EPA sampled facilities, but only eight of the nine self-sampled facility sampling episodes in estimating options loadings. EPA discarded the data from sampling episode 6446 because the Agency needs to perform further review of the sampling data for this facility.[1] To a limited extent, in the absence of transferable sampling episode data, EPA used data received in the MPP detailed surveys to estimate option loadings.

All data values (such as pollutant concentrations and flows) used in the development of option loading estimations were derived as arithmetic averages. If pollutant concentrations were reported below the sample detection limit, EPA used the sample detection limit. The Agency used data from multiple sites for some options. In these cases, EPA first averaged the data for each site and then averaged the sites' averages with each other.

9.2.2 Calculation of Average Technology Option Pollutant Concentrations for First Processing, Further Processing and Rendering Wastewaters

This section describes in detail how, for each technology option, EPA calculated treated pollutant concentrations for wastewater from the three basic MPP operations (first processing, further processing and rendering). EPA used these values later to calculate the treated pollutant concentrations for each of the 15 model facility groupings identified from the MPP screener surveys.

For each technology option, facilities were chosen from sampling episodes that had all the technical unit processes of that technology option. Data from these sampling episodes were then used to derive treated pollutant concentrations for first processing, further processing, and rendering wastewaters after treatment by a particular technology option. If more than one facility

[1] This facility was one of nine that performed self-sampling on behalf of EPA. Note that EPA does not anticipate that the exclusion of sampling episode 6446 will significantly impact the technology option selection for proposal: This facility was one of five that EPA selected to represent BAT-2 technology option performance. EPA had sampling data from four other facilities using similar levels of treatment to use as the basis for proposal development.

was chosen for a technology option, then the treated pollutant concentration was derived from the average of all the facilities.

To the extent possible with available data, EPA set the treated pollutant concentrations for first processing, further processing, and rendering wastewaters for each technology option equal to the average effluent concentrations of the sampled facility or facilities that were chosen as representative of the technology option. However, whenever this specific data was unavailable, EPA calculated the concentration by one of three methods, depending on available data.

Method 1: When appropriate influent[2] data was available, it was multiplied by a factor that would estimate the pollutant concentration after treatment. This factor was derived using pollutant removal data from sampled facilities (in instances where several facilities were used in the calculations, the average removal of the facilities was used). The following equation was used:

Treated pollutant concentration = (influent concentration) x (1 - removal fraction)

where

pollutant removal fraction for a facility was calculated as follows[3]:

(influent concentration - effluent concentration) / (influent concentration)

Method 2: This method was based on estimating a facility pollutant mass balance between the final effluent and its components of first processing, further processing, and rendering wastewaters (as applicable). From this relationship, an equation to calculate the treated pollutant concentrations for first processing wastewater could be derived as follows:

[2] An influent wastestream could consist entirely of one type of wastewater (first processing, further processing, or rendering), or any mixture of the three. When an influent concentration was used in calculating the treated concentration of the first processing, further processing, or rendering wastewater, it consisted solely of the appropriate wastewater type.

[3] Influent and effluent pollutant concentrations were derived from the arithmetic average concentrations for each sampling episode. All negative removal rates were set at zero.

Total pollutant effluent load = treated pollutant load from first processing + treated pollutant load from further processing + treated pollutant load from rendering operations

Substituting loads with concentrations and flows:

(Final effluent concentration x total flow) = (treated concentration of first processing wastewater x first processing wastewater flow) + (treated concentration of further processing wastewater x further processing wastewater flow) + (treated concentration of rendering wastewater x rendering wastewater flow)

Treated concentration of first processing wastewater = [(final effluent concentration x total flow) - (treated concentration of further processing wastewater x further processing wastewater flow) - (treated concentration of rendering wastewater x rendering wastewater flow)] / (first processing wastewater flow).

Method 3: When a specific technology option was not represented in the sampling episodes, then concentrations were derived assuming that the removal fractions between different technology option levels would be the same for meat and poultry facilities (i.e., the removal fraction between meat BAT-2 and meat BAT-3 treatment options would be the same as the removal fraction between poultry BAT-2 and poultry BAT-3 treatment options). This removal fraction would then be applied to the treated pollutant concentrations calculated for the technology option that was one step lower. This method is described in greater detail in the technology options discussion where this method was applied.

For the equations that follow, the following notations were used:

R1 = treated meat first processing wastewater concentration
R2 = treated meat further processing wastewater concentration
R3 = treated meat rendering wastewater concentration
P1 = treated poultry first processing wastewater concentration
P2 = treated poultry further processing wastewater concentration
P3 = treated poultry rendering wastewater concentration
influent@xxxx = influent concentration of sampling episode xxxx

effluent@xxxx = effluent concentration of sampling episode xxxx (discharge effluent, unless otherwise noted).

Technology Options for Direct Discharging Meat Facilities

This subsection describes how EPA calculated treated pollutant concentrations for wastewater from the three basic MPP operations (first processing, further processing, and rendering) for direct discharging meat facilities.

BAT-1 Technology Option for Meat Facilities

The BAT-1 technology option consists of the following unit processes: dissolved air flotation (DAF) (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), limited nitrification (ammonia (NH_3) removal), and disinfection (pathogen removal).

The BAT-1 and BAT-2 options consist of the same unit processes; however, under BAT-1, EPA assumed that MPP facilities would only achieve limited nitrification in comparison to BAT-2. Thus, EPA set the BAT-1 treated pollutant averages for meat facilities equal to the BAT-2 treated averages calculated for meat facilities (see next section), except for ammonia (NH_3 as N), nitrate/nitrite and total Kjeldahl nitrogen (TKN) concentrations.

The following methodology describes how EPA calculated BAT-1 concentrations for ammonia, nitrate/nitrite, and TKN.

EPA first estimated the ammonia concentration for meat first processing by taking an average of effluent ammonia concentrations from meat facilities 0280, 0287, 0318, and 0336, as reported in the MPP detailed surveys. These facilities were chosen, because their biological treatment systems were not considered advanced, and it was assumed that these facilities were not operating their system specifically to achieve full scale nitrification, and therefore would be representative of a BAT-1 treatment effluent.

EPA then assumed that the total nitrogen concentration for the BAT-1 treatment option would be equal to total nitrogen concentration for the BAT-2 treatment option. EPA believes that only the concentrations of the different forms of nitrogen in a given wastestream would

change, but the total nitrogen concentration would not change (i.e., only the forms of nitrogen would change when shifting to a nitrification system).

To calculate the TKN concentration for meat first processing wastewater treated by BAT-1, the following relationships and equations were used to derive TKN estimates:

(TKN of BAT-1) = (ammonia of BAT-1) + (organic nitrogen of BAT-1)

then: (organic nitrogen of BAT-1) = (TKN of BAT-1) - (ammonia of BAT-1)

Assuming the relationship between total nitrogen and organic nitrogen remain the same from BAT-1 to BAT-2:

(organic nitrogen of BAT-1) = (organic nitrogen of BAT-2)

With substitutions:

(TKN of BAT-1) = (ammonia of BAT-1) + (organic nitrogen of BAT-2)

(TKN of BAT-1) = (ammonia of BAT-1) + [(TKN of BAT-2) - (ammonia of BAT-2)].

To calculate the nitrate/nitrite concentration:

Total nitrogen = (nitrate/nitrite) + (TKN)

Nitrate/nitrite = total nitrogen - TKN.

After determining the concentrations for ammonia, nitrate/nitrite, total nitrogen, and TKN for meat first processing, the ratios of ammonia, nitrate/nitrite, and TKN to total nitrogen for meat further processing and rendering were set equal to the ratios of meat first processing. With total nitrogen concentration values derived from BAT-2 treatment option numbers, the ammonia, nitrate/nitrite, and TKN concentrations could be calculated. For example, ammonia for R2 was equal to (ammonia of R1 divided by total nitrogen of R1 (this calculates the ratio)) multiplied by the total nitrogen value for R2.

Table C-30 of Appendix C summarizes the methods used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from meat facilities using BAT-1 treatment technology.

BAT-2 Technology Option for Meat Facilities

The BAT-2 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), nitrification (ammonia removal), and disinfection (pathogen removal),

EPA selected datasets from sampling episodes for facilities 6440, 6441, 6442, and 6447 to derive option concentrations, because these meat facilities all contained the unit processes of the BAT-2 technology option. When wastewater samples from the further processing and/or rendering operations were not available from a facility, appropriate sampling data from another facility (i.e., same wastewater type) were substituted to fill data gaps. EPA used influent rendering wastestream concentrations from sampling episode 6447 to substitute missing rendering wastestream concentrations for sampling episodes 6440, 6441, and 6442. EPA also used influent further processing wastestream concentrations from sampling episode 6335 to substitute missing further processing wastestream concentrations for sampling episode 6447. Table 9-7 summarizes data substitutions.

Table 9-7. Data Substitutions for BAT-2 Technology Option Sampling

Missing Data	Data Substitution
Influent rendering wastewater concentrations for sampling episodes 6440, 6441, and 6442	Influent rendering wastewater concentrations from sampling episode 6447
Influent further processing wastewater concentrations for sampling episode 6447	Influent further processing wastewater concentration from sampling episode 6335

Since EPA selected four facilities to derive treated pollutant concentrations for the BAT-2 treatment technology, wastewater concentrations were calculated for each facility, and the average of the four facilities was taken to derive the option concentrations.

The calculations to derive treated first processing, further processing, and rendering wastewater concentrations for facility 6440 are given below as an example of how concentrations were derived for each facility (refer to Table C-31 of Appendix C for equations):

- *First processing wastewater (R1)*: The first processing waste stream concentration was calculated through a mass balance approach as previously described (Method 2) in the beginning of Section 9.2.2. Because facility 6440 only performed first processing and rendering operations, the mass balance equation was modified to only subtract a rendering allocation load, where:

  Treated concentration of first processing wastewater = [(final effluent concentration x total flow) - (treated concentration of rendering wastewater x rendering wastewater flow)] / (first processing wastewater flow)

- *Further processing wastewater (R2)*: Since facility 6440 only performed first processing and rendering operations, the further processing wastewater calculations were not applicable.

- *Rendering wastewater (R3)*: The calculation for the rendering waste stream concentration followed Method 1 as described previously.

  R3 for facility 6440 = (a) x (influent rendering waste stream concentration of facility 6447) where: (a) = (1 - average removal fraction of facilities 6440, 6441, 6442 and 6447.)

  Since the influent rendering waste stream concentration of facility 6440 was unavailable, data from facility 6447 was used as a substitution.

Table C-31 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from meat facilities using BAT-2 treatment technology.

BAT-3 Technology Option for Meat Facilities

The BAT-3 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), nitrification (ammonia removal) and denitrification (nitrogen removal), and disinfection (pathogen removal).

The dataset from sampling episode 6335 was chosen because this meat facility contained the unit processes of the BAT-3 technology option[4]. Table 9-8 summarizes data substitutions.

Table 9-8. Data Substitutions for BAT-3 Technology Option Sampling

Missing Data	Data Substitution
Influent rendering wastewater concentration for sampling episode 6335	Influent rendering wastewater concentrations from sampling episode 6447

Table C-32 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from meat facilities using BAT-3 treatment technology.

BAT-4 Technology Option for Meat Facilities

The BAT-4 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), nitrification (ammonia removal), denitrification (nitrogen removal), phosphorus removal, and disinfection (pathogen removal).

Since sampling data from a meat facility that contained the unit processes of BAT-4 technology option were unavailable, the treated pollutant concentrations were derived by assuming that the removal fraction between poultry BAT-3 and BAT-4 technology options would be the same as the removal fraction between meat BAT-3 and BAT-4 technology options. This

[4] Facility 6335 is an indirect discharger, however, this facility also contained BAT-3 technology for the treatment of reuse water. EPA used data from the reuse water sampling point at this facility to represent the performance of the BAT-3 technology option.

removal fraction was then used to calculate average BAT-4 treated pollutant concentrations for meat facilities.

Table C-33 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from meat facilities using BAT-4 treatment technology.

Technology Options for Direct Discharging Poultry Facilities

This subsection describes how EPA calculated treated pollutant concentrations for wastewater from the three basic MPP operations (first processing, further processing, and rendering) for direct discharging poultry facilities.

BAT-1 Technology Option for Poultry Facilities

The BAT-1 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), limited nitrification (ammonia removal), and disinfection (pathogen removal).

EPA set the treated pollutant concentrations for BAT-1 poultry facilities equal to the treated pollutant concentrations calculated for BAT-2 poultry facilities (see next section), except for ammonia, nitrate/nitrite and total Kjeldahl nitrogen (TKN).

The Agency first estimated the ammonia concentration for poultry first processing by taking an average of effluent ammonia concentrations from facilities 0020, 0026, and 0308 as reported in the MPP detailed surveys. These facilities were chosen because their biological treatment systems were not considered advanced, and it was assumed that these facilities were not operating their systems specifically to achieve nitrification and therefore would be representative of a BAT-1 treatment effluent. The methodology for deriving the remaining pollutant concentrations was identical to that described previously in Section 9.2.2 for the BAT-1 technology option for meat facilities.

Table C-34 of Appendix C summarizes the methods used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities using BAT-1 treatment technology.

BAT-2 Technology Option for Poultry Facilities

The BAT-2 technology option comprises of the following unit processes: dissolved air flotation (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), nitrification (ammonia removal), and disinfection (pathogen removal).

The dataset from sampling episode 6445 was chosen because this poultry facility contained the unit processes of the BAT-2 technology option. Since facility 6445 only conducted first processing operations, appropriate influent data from other sampled poultry facilities was used. Table 9-9 summarizes data substitutions.

Table 9-9. Data Substitutions for BAT-2 Technology Option Sampling

Missing Data	Data Substitution
Influent further processing wastewater concentrations for sampling episode 6445	Influent further processing wastewater concentrations from sampling episodes 6443 and 6444
Influent rendering wastewater concentrations for sampling episode 6445	Influent rendering wastewater concentrations for sampling episode 6448

Table C-35 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities using BAT-2 treatment technology.

BAT-3 Technology Option for Poultry Facilities

The BAT-3 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), nitrification (ammonia removal), denitrification (nitrogen removal), and disinfection (pathogen removal),.

Since sampling data from a poultry facility that contained the unit processes of BAT-3 technology option were unavailable, the treated pollutant concentrations were derived by assuming that the removal fraction between the poultry BAT-2 and BAT-3 technology options would be the same as the removal fraction between the meat BAT-2 to BAT-3 technology options. This removal fraction was then combined with the poultry BAT-2 treated pollutant concentrations to derive poultry BAT-3 treated pollutant concentrations.

Table C-36 of Appendix C gives the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities using BAT-3 treatment technology.

BAT-4 Technology Option for Poultry Facilities

The BAT-4 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), nitrification (ammonia removal), denitrification (nitrogen removal), phosphorus removal, and disinfection (pathogen removal).

The dataset from sampling episode 6304 was chosen because this poultry facility contained the unit processes of the BAT-4 technology option[5]. Since facility 6304 only conducted first processing operations, appropriate influent data from other sampled poultry facilities was used. Table 9-10 summarizes data substitutions.

Table 9-10. Data Substitutions for BAT-4 Technology Option Sampling

Missing or Replaced Data	Data Substitution
Influent further processing wastewater concentrations for sampling episode 6304	Influent further processing wastewater concentrations from sampling episodes 6443 and 6444
Influent rendering wastewater concentrations for sampling episode 6304	Influent rendering wastewater concentrations for sampling episode 6448

[5] Facility 6304 had sampling points prior and following a polishing filter unit process. EPA used effluent concentrations from the sampling point prior to the filter at this facility to represent performance of the BAT-4 technology option.

Table C-37 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities using BAT-4 treatment technology.

BAT-5 Technology Option for Poultry Facilities

The BAT-5 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), lagoon (oil and grease, BOD_5, and TSS removal), nitrification (ammonia removal), denitrification (nitrogen removal), phosphorus removal, polishing filter, and disinfection (pathogen removal).

The dataset from sampling episode 6304 was chosen because this poultry facility contained the unit processes of the BAT-5 technology option[6]. Since facility 6304 only conducted first processing operations, appropriate influent data from other sampled poultry facilities was used. Table 9-11 summarizes data substitutions.

Table 9-11. Data Substitutions for BAT-5 Technology Option Sampling

Missing or Replaced Data	Data Substitution
Influent further processing wastewater concentrations for sampling episode 6304	Influent further processing wastewater concentrations from sampling episodes 6443 and 6444
Influent rendering wastewater concentrations for sampling episode 6304	Influent rendering wastewater concentrations for sampling episode 6448

Table C-38 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities using BAT-5 treatment technology.

[6] Facility 6304 had sampling points prior and following a polishing filter unit process. EPA used effluent concentrations from the sampling point following the filter at this facility to represent performance of the BAT-5 technology option.

Technology Options for Indirect Discharging Meat Facilities

This subsection describes how EPA calculated treated pollutant concentrations for wastewater from the three basic MPP operations (first processing, further processing and rendering) for indirect discharging meat facilities.

PSES-1 Technology Option for Meat Facilities

The PSES-1 technology option consists of the following unit processes: of dissolved air flotation (advanced oil/water separation) and equalization (oil and grease, and TSS removal).

The dataset from sampling episode 6335 was chosen because this meat facility contained the unit processes of the PSES-1 technology option[7]. Table 9-12 summarizes data substitutions.

Table 9-12. Data Substitutions for PSES-1 Technology Option Sampling

Missing or Replaced Data	Data Substitution
Influent rendering wastewater concentrations for sampling episode 6335	Influent rendering wastewater concentrations for sampling episode 6447

Table C-39 of Appendix C gives the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from meat facilities using PSES-1 treatment technology.

PSES-2 Technology Option for Meat Facilities

The PSES-2 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), equalization (oil and grease, and TSS removal), and nitrification (ammonia removal).

Since sampling data from a meat facility that contained the unit processes of the PSES-2 technology option was unavailable, the treated pollutant concentrations were derived from the calculated treated pollutant concentrations for meat BAT-2 and PSES-1 technology options for

[7] EPA used effluent data from the sampling point located after DAF and equalization of the treatment train to represent the performance of the PSES-1 technology option.

non-microbial and microbial pollutants, respectively. Because PSES-2 and BAT-2 technology options are similar in effective pollutant removals (except for microbial pollutants, due to the disinfection unit process of BAT-2), EPA assumed that the treated pollutant concentrations of both options would be similar for non-microbial pollutants. Also, since EPA believes that only a disinfection process would significantly change the microbial concentrations in MPP wastewaters, microbial pollutant concentrations for meat PSES-2 were set equal to treated pollutant concentrations of meat PSES-1 (since microbial concentrations would not be expected to change significantly in higher PSES option levels).

Table C-40 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from meat facilities using PSES-2 treatment technology.

PSES-3 Technology Option for Meat Facilities

The PSES-3 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), equalization (oil and grease, and TSS removal), nitrification (ammonia removal), and denitrification (nitrogen removal).

Since complete data from a meat facility that contained the unit processes of PSES-3 technology option was unavailable, the treated pollutant concentrations were derived from the calculated treated pollutant concentrations for the meat BAT-3 technology option for non-microbial pollutants. Because PSES-3 and BAT-3 technology options are similar in effective pollutant removals (except for microbial pollutants due to the disinfection unit process of BAT-3), EPA assumed that the treated pollutant concentrations of both options would be similar for non-microbial pollutants. Data from sampling episode 6335 was used to derive microbial pollutant concentrations.[8]

Table C-41 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from meat facilities using PSES-3 treatment technology.

[8] EPA used effluent data from the sampling point located prior to disinfection to represent the performance of the PSES-3 technology option for microbial pollutants.

PSES-4 Technology Option for Meat Facilities

The PSES-4 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), equalization (oil and grease, and TSS removal), nitrification (ammonia removal), denitrification (nitrogen removal) and phosphorus removal.

Since sampling data from a meat facility that contained the unit processes of PSES-4 technology option was unavailable, the treated pollutant concentrations were derived from the calculated treated pollutant concentrations for the meat BAT-4 technology option for non-microbial pollutants. Because PSES-4 and BAT-4 technology options are similar in effective pollutant removals (except for microbial pollutants due to the disinfection unit process of BAT-4), EPA assumed that the treated pollutant concentrations of both options would be similar for non-microbial pollutants. Data from sampling episode 6335 was used to derive microbial pollutant concentrations.[9]

Table C-42 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from meat facilities using PSES-4 treatment technology.

Technology Options for Indirect Discharging Poultry Facilities

This subsection describes how EPA calculated treated pollutant concentrations for wastewater from the three basic MPP operations (first processing, further processing and rendering) for indirect discharging poultry facilities.

PSES-1 Technology Option for Poultry Facilities

The PSES-1 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation) and equalization (oil and grease, and TSS removal).

[9] EPA used effluent data from the sampling point located prior to disinfection to represent the performance of the PSES-4 technology option for microbial pollutants.

EPA chose datasets from sampling episodes 6443 and 6444, because these poultry facilities all contained the technical unit processes of the PSES-1 technology option. Table 9-13 summarizes data substitutions.

Table 9-13. Data Substitutions for PSES-1 Technology Option Sampling

Missing or Replaced Data	Data Substitution
Influent rendering wastewater concentrations for sampling episodes 6443 and 6444	Influent rendering wastewater concentrations for sampling episode 6448

Table C-43 of Appendix C shows the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities utilizing PSES-1 treatment technology.

PSES-2 Technology Option for Poultry Facilities

The PSES-2 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), equalization (oil and grease, and TSS removal), and nitrification (ammonia removal).

Since sampling data from a poultry facility that contained the unit processes of PSES-2 technology option were unavailable, the treated pollutant concentrations were derived from the calculated treated pollutant concentrations of poultry BAT-2. Both technology options are similar in effective pollutant removals, except for microbial pollutants (due to disinfection unit process in BAT-2). EPA therefore decided that the treated pollutant concentrations of both options would be similar for non-microbial pollutants. Microbial pollutant concentrations were derived from sampling episode 6304 data.[10]

Table C-44 of Appendix C contains the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities using PSES-2 treatment technology.

[10] EPA used data from the sampling point located following the diffused air flotation unit process (and before the disinfection unit process) at this facility to represent the performance of the PSES-2 technology option for microbial pollutants.

PSES-3 Technology Option for Poultry Facilities

The PSES-3 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), equalization (oil and grease, and TSS removal), nitrification (ammonia removal), and denitrification (nitrogen removal).

Since appropriate data from a sampled poultry facility that contained the unit processes of PSES-3 technology option were unavailable, EPA derived the treated pollutant concentrations from the calculated treated pollutant concentrations of poultry BAT-3. Both technology options are similar in effective pollutant removals, except for microbial pollutants (due to disinfection unit process in BAT-3). EPA therefore decided that the treated pollutant concentrations of both options would be similar for non-microbial pollutants. Microbial pollutant concentrations were derived from sampling episode 6443 data.[11]

Table C-45 of Appendix C shows the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities using PSES-3 treatment technology.

PSES-4 Technology Option for Poultry Facilities

The PSES-4 technology option consists of the following unit processes: dissolved air flotation (advanced oil/water separation), equalization (oil and grease, and TSS removal), nitrification (ammonia removal), denitrification (nitrogen removal) and phosphorus removal.

Since sampling data from a poultry facility that contained the unit processes of PSES-4 technology option were unavailable, the treated pollutant concentrations were derived from the calculated treated pollutant concentrations of poultry BAT-4. Both technology options are similar in effective pollutant removals, except for microbial pollutants (due to disinfection unit process in BAT-4). EPA therefore decided that the treated pollutant concentrations of both

[11] EPA used microbial effluent concentrations from this facility to represent the treatment performance of the PSES-3 technology option on microbial pollutants.

options would be similar for non-microbial pollutants. Microbial pollutant concentrations were derived from sampling episode 6443 data[12].

Table C-46 of Appendix C shows the equations used to derive average concentrations for first processing, further processing, and rendering effluent wastewaters from poultry facilities utilizing PSES-4 treatment technology.

9.2.3 Development of Average Treated Pollutant Concentrations for each Model Facility Group

This section describes the method by which EPA developed average treated pollutant concentrations for 15 of the 19 model facility groupings used to represent the meat and poultry processing industry. Section 11 provides a discussion of the model facility groupings.[13] As described in Section 9.2.2 above, EPA developed average treated pollutant concentrations for each pollutant and technology option being considered by EPA for meat and poultry first processing (R1 and P1), further processing (R2 and P2), and rendering (R3 and P3). Since there are MPP facilities that perform combinations of these three types of MPP operations, EPA used the average treated pollutant concentrations for first processing, further processing, and rendering and the flow ratios among the various types of processes to derive flow-weighted average treated pollutant concentrations.

EPA calculated flow fractions for different meat and poultry groupings using available data from the MPP detailed survey. Specifically using flow rates reported in the MPP detailed survey, EPA determined the fraction of total flow attributable to each of the processes (first processing, further processing, and rendering). For example, EPA determined from a sample of poultry first and further processing facilities that 74.08 percent of the total flow was attributable to first processing and that the balance of 25.92 percent was from further processing operations. Similar flow fractions were derived for the remaining meat and poultry groupings and are

[12] EPA used microbial effluent concentrations from this facility to represent the treatment performance of the PSES-4 technology option on microbial pollutants.

[13] Note that although EPA organized the MPP industry into 19 model facility groupings, based on the MPP screener survey results, there were direct and indirect discharging facilities in only 15 model facility groups.

presented in Table 9-14 below. Since EPA used both direct and indirect facilities to derive the flow fractions, the same flow fractions were used for both direct and indirect facilities.

Using the flow fractions in Table 9-14 and the average treated pollutant concentrations derived as described in Section 9.2.2, EPA calculated pollutant concentrations for the various meat and poultry facility groupings. Since the flow fractions are expressed as percentages, EPA was able to compute the required concentrations without actual flow rates.

Table 9-14. Flow Fractions Used to Derive Average Treated Pollutant Concentrations

Model Facility Grouping	Flow Fraction		
	First Processing	Further Processing	Rendering
P1	[a]	[a]	[a]
P12	0.7408	0.2592	--
P123	0.553	0.1934	0.2535
P13	0.6857	--	0.3143
P2	[a]	[a]	[a]
P23	--	0.4328	0.5672
R1	[a]	[a]	[a]
R12	0.5266	0.4734	--
R123	0.356	0.32	0.324
R13	0.5235	--	0.4765
R2	[a]	[a]	[a]
R23	--	0.4968	0.5032
M1	[c]	[c]	[c]
M2	[b]	[b]	[b]
M12	[c]	[c]	[c]
M13	[c]	[c]	[c]
M23	[b]	[b]	[b]
M123	[c]	[c]	[c]
Render	--	--	[d]

[a] Average treated pollutant concentrations were derived directly from sampling episode data; flow fractions were not required.

[b] The average treated pollutant concentrations for the "mixed" model facilities groupings were calculated by taking the average of the treated pollutant concentrations of relevant poultry and meat operations (for the corresponding technology option and pollutant). For example, the average treated pollutant concentrations from P2 and R2 were averaged together to derive the average treated pollutant concentration for mixed further processing (M2).

[c] According to the MPP screener survey, there were no direct or indirect facilities in this model facility grouping.

[d] The "Rendering" model facility grouping average concentration was calculated by taking the average of the treated pollutant concentrations of P3 and R3 (for the corresponding technology option and pollutant).

For example, for a P12 facility, the wastewater will consist of first processing (P1) and further processing (P2) wastewater effluents. From Table 9-14, a P12 facility has a flow fraction of 0.7408 for first processing (P1) and 0.2592 for further processing (P2) wastewaters. If the average BOD concentration for first processing wastewater treated by the BAT-2 option were calculated to be 2.00 mg/L, and the further processing (P2) wastewater was calculated to be 5.91 mg/L, then the treated BOD concentration for a BAT-2 P12 facility would be:

$$P12 = (2.00 \text{ mg/L} \times 0.7408) + (5.91 \text{ mg/L} \times 0.2592) = 3.01 \text{ mg/L}$$

Tables C-47 through C-75 in Appendix C present the average treated pollutant concentration for each of the 15 model facility groupings for all pollutants of concern and all technology options being considered by EPA.

9.2.4 Development of Post-Compliance Pollutant Loadings for each Technology Option and each Model Facility Grouping

EPA estimated post-compliance pollutant loadings based on the average treated pollutant concentration for each of the 37 pollutants of concern, for each of the 15 model facility groupings, and for each technology being considered. For each model facility grouping, the number and size of facilities and median facility discharge flow was determined from the MPP screener surveys. EPA then estimated post-compliance pollutant loadings for each size of model facility grouping using the following equations:

$$\text{Load} = \text{Flow} \times \text{Conc} \times \text{CF} \times \text{NF} \qquad \text{(for small facilities)}$$

$$\text{Load} = \text{Flow} \times \text{Conc} \times \text{CF} \times \text{NF} \times 1.08^{14} \qquad \text{(for non-small facilities)}$$

where:

Load = post-compliance pollutant loading, in lbs/day, million cfu/day, or million cysts/day

[14] EPA carefully selected 65 non-small "certainty" facilities to obtain site-specific information on major producers for all types of meat and poultry products as well as facilities identified as good performers by state and regional environmental personnel. These certainty facilities were not included in the screener survey projections for deriving national estimates. The certainty facilities represent eight percent of the total number of non-small facilities as estimated from screener survey projections. Thus, the estimated national loadings for non-small facilities were multiplied by a factor of 1.08 to account for the certainty facilities.

Flow = median flow rate, million of gallons per day (based on an average of 260 production days per year)

Conc = average treated pollutant concentration for the model facility grouping model facility grouping (as presented in Tables C-47 through C-75 in Appendix C), in mg/L, cfu/100 mL, or cysts/liter

CF = conversion factor, which is dependant on the concentration units of the pollutant:

mg/L = 8.345
cfu/100 mL = 37.8
cysts/liter = 3.78

NF = national estimate of the number of facilities for the model facility grouping and size.

Tables 9-15 and 9-16 present a summary of the post-compliance pollutant loadings for direct and indirect dischargers for all technology options being considered by EPA.

9.3 POLLUTANT REMOVALS

From baseline and technology option loadings, EPA estimated national pollutant removals after implementation of each technology option considered. This estimation was done by taking the difference between the baseline loadings and each technology option loadings.

Table 9-15. Technology Option Loading for Direct Dischargers

Pollutant Groups of Concern	Options Loadings									Units
	BAT-1		BAT-2		BAT-3		BAT-4		BAT-5 [d]	
	Small	Non-Small	Small	Non-Small	Small	Non-Small	Small	Non-Small	Non-Small	
Conventional pollutants [a]	336,706	28,405,563	336,706	28,405,563	239,196	19,723,690	74,162	14,848,506	6,628,913	lbs/yr
Toxic pollutants [b]	198,828	41,264,641	46,071	34,173,358	25,292	5,732,508	9,779	2,318,189	379,239	lbs/yr
Nutrients [c]	203,639	46,668,728	203,639	46,668,728	32,788	7,187,084	14,278	4,572,993	1,197,020	lbs/yr
Other Pollutants of Concern										
Aeromonas	8,325,096	3,532,187,013	8,325,096	3,532,187,013	3,857	10,661,121	425,842	445,526,130	3,180,251	million cfu/yr
Carbonaceous biochemical oxygen demand (CBOD)	7,138	1,758,927	7,138	1,758,927	14,621	3,154,816	24,794	4,748,895	942,344	lbs/yr
Chemical oxygen demand (COD)	180,692	21,468,569	180,692	21,468,569	182,071	18,002,535	234,596	20,387,776	9,147,581	lbs/yr
Chloride	639,252	382,961,031	639,252	382,961,031	617,218	45,502,064	811,197	482,396,856	25,058,084	lbs/yr
Cryptosporidium	N/A [e]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Dissolved biochemical oxygen demand	22,182	2,656,730	22,182	2,656,730	12,093	1,498,647	35,425	2,987,222	1,131,145	lbs/yr
Dissolved phosphorus	13,462	4,606,196	13,462	4,606,196	4,299	927,519	4,171	908,830	73,253	lbs/yr
E. coli	817,084	233,031,975	817,084	233,031,975	8,380	3,132,204	62,579	6,283,460	62,928,965	million cfu/yr
Fecal coliform bacteria	1,218,819	335,728,729	1,218,819	335,728,729	102,117	37,120,219	148,585	39,859,694	59,464,254	million cfu/yr
Fecal streptococci	378,959	78,819,775	378,959	78,819,775	80,593	2,409,632	348,410	17,376,440	9,059,549	million cfu/yr
Orthophosphate	12,125	3,620,792	12,125	3,620,792	3,952	1,811,671	3,087	760,102	3,836	lbs/yr

Table 9.15. Technology Option Loading for Direct Dischargers (continued)

Pollutant Groups of Concern	Options Loadings									Units
	BAT-1		BAT-2		BAT-3		BAT-4		BAT-5 [d]	
	Small	Non-Small	Small	Non-Small	Small	Non-Small	Small	Non-Small	Non-Small	
Salmonella	13,419	2,123,747	13,419	2,123,747	16,658	1,982,678	59	1,702,837	1,702,577	million cfu/yr
Total coliform	4,569,483	1,026,186,733	4,569,483	1,026,186,733	308,197	68,403,189	109,808	11,656,001	115,656,674	million cfu/yr
Total dissolved solids (TDS)	3,913,173	1,127,933,751	3,913,173	1,127,933,751	3,938,507	77,121,174	4,357,800	1,114,808,491	179,693,482	lbs/yr
Total organic carbon (TOC)	69,409	8,260,014	69,409	8,260,014	44,575	5,355,750	56,695	5,486,317	1,718,856	lbs/yr
Total residual chlorine	485	80,595	485	80,595	4,473	6,667,097	4,473	6,667,097	N/A	lbs/yr
Volatile Residue	793,525	149,720,716	793,525	149,720,716	582,625	80,907,268	742,666	109,422,341	70,578,145	lbs/yr

[a] Conventional pollutants: biochemical oxygen demand (BOD), hexane extractable material (HEM), and total suspended solids (TSS)

[b] Toxic pollutants: ammonia as nitrogen, carbaryl, nitrate-nitrite, barium, copper, chromium, *cis*-permethrin, manganese, molybdenum, nickel, titanium, *trans*-permethrin, vanadium, and zinc

[c] Nutrients: total nitrogen and total phosphorus

[d] BAT-5 treatment option was considered only for poultry model facility groupings. No direct discharging small BAT-5 poultry facilities exist.

[e] not available

Table 9-16. Technology Option Loading for Indirect Dischargers

Pollutant Groups of Concern	Options Loadings								
	PSES-1		PSES-2		PSES-3		PSES-4		
	Small	Non-Small	Small	Non-Small	Small	Non-Small	Small	Non-Small	Units
Conventional pollutants [a]	14,507,645	820,258,114	1,323,002	59,607,632	834,069	32,688,688	489,800	37,247,151	lbs/yr
Toxic pollutants [b]	1,241,072	97,035,039	174,898	16,290,095	86,554	3,753,669	38,035	1,908,384	lbs/yr
Nutrients [c]	1,387,651	84,759,188	923,307	51,850,941	157,728	8,363,155	102,660	6,726,428	lbs/yr
Other Pollutants of Concern									
Aeromonas	14,820,687,512	1,301,380,789,662	14,073,166,893	1,090,092,557,403	5,048,245,175	437,538,582,222	5,048,245,175	437,538,582,222	million cfu/yr
Carbonaceous biochemical oxygen demand (CBOD)	8,164,026	406,159,450	34,428	2,182,386	65,309	3,316,690	118,228	7,335,951	lbs/yr
Chemical oxygen demand (COD)	13,395,570	693,706,520	657,839	27,907,071	647,220	24,169,551	819,011	29,287,476	lbs/yr
Chloride	17,963,311	502,316,560	14,406,879	620,266,883	18,103,735	474,910,062	18,968,954	797,397,121	lbs/yr
Cryptosporidium	N/A[d]	N/A	2,279,487,921	N/A	N/A	N/A	N/A	N/A	million cysts/yr
Dissolved biochemical oxygen demand	8,015,656	286,463,154	84,615	3,112,088	46,365	1,759,195	125,002	4,787,019	lbs/yr
Dissolved phosphorus	171,422	7,366,753	115,836	5,190,198	35,757	1,326,120	34,719	1,300,034	lbs/yr
E. coli	31,400,159,074	3,206,691,095,489	27,596,967,456	1,472,017,006,101	15,417,053,170	1,591,395,207,841	15,417,053,170	1,591,395,207,841	million cfu/yr
Fecal coliform bacteria	34,245,841,873	3,388,008,109,881	30,550,007,399	1,667,024,622,884	15,443,958,242	1,592,499,542,417	15,443,958,242	1,592,499,542,417	million cfu/yr
Fecal streptococci	31,046,712,271	672,189,574,092	31,041,166,490	667,503,725,714	69,631,637	7,225,374,930	69,631,637	7,225,374,930	million cfu/yr
Orthophosphate	81,615	5,630,590	66,160	3,054,251	24,324	1,408,501	16,136	671,805	lbs/yr
Salmonella	1,356,677	21,790,576	2,143,566	220,245,327	65,621	4,294,742	65,621	4,294,742	million cfu/yr
Total coliform	35,628,502,122	3,123,192,328,783	32,418,068,379	1,628,553,753,188	15,443,958,242	1,592,499,542,417	15,443,958,242	1,592,499,542,417	million cfu/yr
Total dissolved solids (TDS)	32,505,098	904,001,014	31,102,546	1,512,457,571	32,596,519	726,386,727	35,151,094	1,555,476,996	lbs/yr
Total residual chlorine	2,715	144,060	3,608	171,512	48,946	4,638,105	48,946	4,638,105	lbs/yr

Table 9-16. Technology Option Loading for Indirect Dischargers (continued)

Pollutant Groups of Concern	Options Loadings								
	PSES-1		PSES-2		PSES-3		PSES-4		
	Small	Non-Small	Small	Non-Small	Small	Non-Small	Small	Non-Small	Units
Volatile residue	8,009,748	457,871,747	4,566,245	299,329,626	3,244,971	187,301,488	4,218,498	265,971,638	lbs/yr

[a] Conventional pollutants: biochemical oxygen demand (BOD), hexane extractable material (HEM), and total suspended solids (TSS)
[b] Toxic pollutants: ammonia as nitrogen, carbaryl, nitrate-nitrite, barium, copper, chromium, *cis*-permethrin, manganese, molybdenum, nickel, titanium, *trans*-permethrin, vanadium, and zinc
[c] Nutrients: total nitrogen and total phosphorus
[d] not available