CHAPTER 11
NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Sections 304(b) and 306 of the Clean Water Act require EPA to consider non-water quality environmental impacts, including energy requirements, associated with effluent limitations guidelines and standards. In accordance with these requirements, EPA has considered the potential impacts of the regulation on solid waste generation, energy consumption, and air emissions. The estimates of these impacts for the concentrated aquatic animal production (CAAP) industry are summarized in Sections 11.1, 11.2, and 11.3.

11.1 SOLID WASTE

The regulatory option chosen for the final rule will reduce solid waste generation by approximately 2,300,000 pounds/year, mainly because feed management will reduce the solids loads entering the system. Solid wastes include sludge from sedimentation basins (primary settling) and from solids polishing technologies, such as microscreen filters. EPA assumed all solid wastes generated by the CAAP industry are nonhazardous. Federal and state regulations require CAAP facilities to manage solids to prevent release to the environment.

11.1.1 Sludge Characterization

Sludge harvested from settling basins, quiescent zones, or other solids capture technologies at CAAP facilities is similar to other types of animal manures. For example, Chen et al. (1996) provide a comprehensive review of the treatment and characteristics of CAAP sludge from recirculating systems. Table 11.1–1 shows the characteristics of sludge from a recirculating system that was captured from solids filter backwash after settling for 30 minutes. IDEQ (n.d.) also provides a summary of the nutrient content of fish manure, as shown in Table 11.1–2.

Table 11.1–1. Characterization of CAAP Sludge

Parameter	*CAAP Sludge*		
	Range	*Mean*	*Standard Deviation*
Total solids (TS) (%)	1.4–2.6	1.8	0.35
Total volatile solids (% of TS)	74.6–86.6	82.2	4.1
5-day biochemical oxygen demand (mg/L)	1,588–3,867	2,756.0	212.0
Total ammonia nitrogen (N, mg/L)	6.8–25.6	18.3	6.1
Total kjeldahl nitrogen (as nitrogen, % of TS)	3.7–4.7	4.0	0.5
Total phosphorus (as phosphorus, % of TS)	0.6–2.6	1.3	0.7
pH	6.0–7.2	6.7	0.4

Source: Reported in Chen et al., 1996.

Table 11.1–2. Average Nutrient Content Measurements of Fish Manure from Various Treatment Systems

Parameter	*Raceways and Quiescent Zones*	*Settling Basins*	*Earthen Ponds*	*Dried Aged Manure*
% Total nitrogen	7.06	4.18	0.86	1.01
% Total phosphorus	1.71	0.96	0.52	NA
% Total potassium	0.21	0.30	0.50	NA
% Organic matter or volatile solids	77.2	43.0	26.0	10.2

Source: Reported in IDEQ, n.d.
Note: NA = not available.

Naylor et al. (1999) compared fish manure with manure from beef, poultry, and swine. Overall, the nutrient composition of trout manure is similar to that of other animal manures (Table 11.1–3). Like livestock manure, the composition of fish manure is also highly variable due to differences in animal, age, feed, manure handling, and storage conditions.

Table 11.1–3. Rainbow Trout Manure Compared to Beef, Poultry, and Swine Manures (Presented as Ranges on a Dry Weight Basis)

Element	*Fish*	*Beef*	*Poultry*	*Swine*
Nitrogen (%)	2.04–3.94	1.90–7.8	1.3–14.5	0.6–10.0
Phosphorus (%)	0.56–4.67	0.41–2.6	0.15–4.0	0.45–6.5
Potassium (%)	0.06–0.23	0.44–4.2	0.55–5.4	0.45–6.3
Calcium (%)	3.0–11.2	0.53–5.0	0.71–14.9	0.4–6.4
Magnesium (%)	0.04–1.93	0.29–0.56	0.3–1.3	0.09–1.34

Source: Naylor et al., 1999.

11.1.2 Estimating Decreases in Sludge Collection

EPA estimates feed management will reduce raw loads of total suspended solids (TSS) within CAAP facilities by almost 500,000 pounds/year. After the final regulation is implemented, treatment technologies currently in place at CAAP facilities will capture about 276,000 fewer pounds of TSS each year than they do now because of the lower incoming loads. Table 11.1–4 shows the estimates of raw TSS loads and TSS captured in existing treatment technologies at CAAP facilities that would be in-scope for the final regulation. These estimates were calculated as part of the loadings analysis for the final regulatory option (see Chapter 10).

Table 11.1–4. Impacts of the Final Regulatory Option on TSS

	Raw TSS (lb/yr)	*TSS Captured in Treatment Technologies (lb/yr)*	*TSS Released into the Nation's Waters (lb/yr)*
Baseline	20,323,054	12,549,907	7,773,147
Final regulatory option	19,828,936	12,274,233	7,554,703
Change from baseline	-494,118	-275,674	-218,444

EPA estimated the reduction in net sludge production, using the reduction in TSS and assuming sludge from CAAP facilities has a 12% solids content (IDEQ, n.d.):

> Decrease in TSS captured in treatment technologies = 275,674 pounds/year
>
> Decrease in sludge produced = 275,674 pounds/year * (1/0.12) = 2,297,284 pounds/year

EPA estimates that net sludge generation will decrease by approximately 2,300,000 pounds/year.

Net pen systems do not collect solids. Under general requirements for net pen systems, however, facilities must control discharges of solid waste and prevent discharge of water used for transport, which may contain blood and other wastes.

EPA assumed that collected solids will be land-applied as fertilizer at agronomic rates and therefore does not expect any adverse impacts due to solid waste to occur as a result of the regulation. For more information about the analysis, refer to Hochheimer and Escobar, 2004.

11.2 ENERGY

EPA estimates that implementing the final rule will result in a net decrease in energy consumption for CAAP facilities by approximately 43 kilowatt hours/year. The decrease is due to a reduction in the volume of sludge that will need to be pumped from raceways to solids settling ponds, therefore requiring less energy to pump it.

11.2.1 Estimating Decreases in Energy

EPA based its estimates for decreased energy requirements on estimated reductions in the volume of sludge generated due to implementation of the final regulation.

EPA calculated the decrease in net solids production based on the TSS load captured in treatment technologies and a 12% solids content in the sludge:

> Decrease in TSS captured in treatment technologies = 275,674 pounds/year
>
> Decrease in sludge pumped per year = 275,674 * (1/0.12) = 2,297,284 pounds/year

EPA then converted the pounds of sludge into a volume:

> 1 gallon = 8.4 pounds
>
> 275,674 pounds/year * (1 gallon/8.4 pounds) = 273,486 gallons/year

A ¾-horsepower Model 7CYG pump pumping at a rate of 60 gallons/minute would take 76 hours to pump the volume (the annual reduction in net sludge production):

> 273,486 gallons * (1/60 gallons/minute) = 4,558 minutes
>
> 4,558 minutes * (1 hour/ 60 minutes) = 76 hours

EPA then estimated the decrease in energy consumption to be 42.5 kilowatt hours/year:

> 0.75 horsepower * 746 watts/horsepower * 76 hours * 1 watt/1000 kilowatts = 42.5 kilowatt hours

11.2.2 Energy Summary

EPA estimates that implementing this rule will result in a net decrease in energy consumption for some CAAP facilities. The decrease is based on electricity currently used to pump sludge from wastewater settling units that would no longer need to be pumped under the final regulatory option.

EPA does not expect any adverse impacts to occur as a result of the decreased energy requirements for the regulation. For more information about the analysis, refer to Hochheimer and Escobar, 2004.

11.3 AIR EMISSIONS

EPA estimates that implementing the final rule will result in a net decrease of approximately 2,300 pounds/year in air emissions due to the volatilization of ammonia in solids generated at CAAP facilities.

Potential sources of air emissions from CAAP facilities include primary settling operations (e.g., settling basins and lagoons) and the land application of manure. Because the majority of emissions come from land application, EPA only estimated air emissions from land application of sludge.

CAAP sludge emits gases when it is spread on land as fertilizer. Air emissions are primarily generated from the volatilization of ammonia at the point the material is applied to land (Anderson, 2000). Additional emissions of nitrous oxide are liberated from agricultural soils when nitrogen applied to the soil undergoes nitrification and denitrification. Loss through denitrification depends on the oxygen levels of the soil to which manure is applied. Low oxygen levels, resulting from wet, compacted, or warm soil, increase the amount of nitrate-nitrogen released to the air as nitrogen gas or nitrous oxide (OSUE, 2000). A study by Sharpe and Harper (1997), which compared losses of ammonia and nitrous oxide from the sprinkler irrigation of swine effluent, concluded that ammonia emissions made a larger contribution to airborne nitrogen losses. Data for the CAAP industry are insufficient to quantify air emission impacts from the land application of manure; therefore, this analysis uses available information from similar industries and focuses on the volatilization of nitrogen as ammonia. The emission of other constituents is expected to be less significant.

11.3.1 Application Rate

The application rate affects the volatilization rate—if the amount of manure applied causes significant buildup of material on the field surface, causing a mulching effect, then the volatilization rate decreases. For the purposes of this analysis EPA assumed that the CAAP industry applies manure at agronomic rates or lower; applying at agronomic rates will not cause mulching.

11.3.2 Application Method

Manure application methods practiced by the CAAP industry include irrigation, surface application, and subsurface injection. EPA observed that applying solids as fertilizer for cropland at agronomic rates is a common industry practice. When agricultural land is adjacent to a CAAP facility, solids can be vacuumed directly from quiescent zones into a sprinkler system that land-applies the biosolids and water (IDEQ, n.d.).

Significant differences in the volatilization rate of ammonia result from the method used to apply manure (see Table 11.3–1). When manure is sprinkler-irrigated, a greater surface area from which the ammonia can volatilize is available, so the volatilization rate will be higher than from smaller surface areas.

Table 11.3–1. Percent of Nitrogen Volatilizing as Ammonia from Land Application

Application Method		*% Loss* [a]
Surface application	Broadcast (solid)	15–30
	Broadcast (liquid)	10–25
Subsurface injection	Broadcast (solid, immediate incorporation)	1–5
	Broadcast (liquid, immediate incorporation)	1–5
	Knifing (liquid)	0–2
Irrigation	Sprinkler irrigation (liquid)	15–40

Source: MWPS, 1983.

[a] Percent of nitrogen applied that is lost within 4 days of application.

EPA assumed the final regulation would not change the method of land application used by any CAAP facilities. Based on this assumption, no significant change in the rate at which ammonia volatilizes is expected.

11.3.3 Quantity of Animal Waste

The movement of waste off-site changes the location of the ammonia released but not the quantity released. Land application is a common solid waste disposal method in the CAAP industry. Although the final regulatory option does not require land application of manure, for the purposes of estimating the maximum possible amount of emissions EPA assumed all captured solids would be land-applied. Because the final regulation is expected to decrease the amount of solid waste collected from CAAP facilities, the amount of ammonia released as air emissions is expected to decrease since the quantity of waste applied to cropland will decrease.

11.3.4 Calculation of Emissions

EPA estimated the decrease in ammonia emissions resulting from the implementation of the final regulation. The Agency assumed the ammonia content of solid waste from CAAP facilities was approximately 2.83% (Naylor et al., 1999). A factor of 30% was chosen as a conservative (high) estimate of the volatilization rate of ammonia from solids that are land applied. Table 11.3–2 shows estimates for the amount of solids generated, amount of ammonia contained in the solids, and the amount of amount that volatilizes before and after the regulation is implemented.

EPA calculated the ammonia content of the solid waste from CAAP facilities using the following equation:

Ammonia content = amount of solids collected by CAAP facilities * 2.83%

EPA used the following equation to calculate the ammonia volatilized during land application of the solids:

Ammonia volatilization = ammonia content * 30.0%

Table 11.3–2. Ammonia Volatilization from CAAP Solids

	Solids Collected (lb/yr)	***Ammonia in Solids Collected (lb/yr)***	***Ammonia Volatilized (lb/yr)***
Baseline	12,549,907	355,162	106,549
Post-regulation	12,274,233	347,361	104,208
Change from baseline	-275,674	-7,801	-2,341

EPA does not expect any adverse air impacts to occur as a result of the final regulation. For more information about the analysis, refer to Hochheimer and Escobar, 2004.

11.4 REFERENCES

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