United States
Environmental Protection
Agency

Draft Guidance for Aquatic Animal Production Facilities to Assist in Reducing the Discharge of Pollutants

United States Environmental Protection Agency
Office of Water (4303T)
EPA-821-B-02-002
Washington, DC 20460

August 2002

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August 2002

Acknowledgments and Disclaimer

This report has been reviewed and approved for publication by the Engineering and Analysis Division, Office of Science and Technology. This report was prepared with the support of Tetra Tech, Inc. under the direction and review of the Office of Science and Technology.

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SECTION 1
INTRODUCTION

1.1 Scope and Purpose of the Technical Guidance Manual

The primary purpose of this document is to provide technical guidance for concentrated aquatic animal production (CAPP) facilities to meet the requirements of the proposed effluent limitations guidelines and standards. This guidance manual can also be used by all aquatic animal production (AAP) facilities to reduce discharges of pollutants. The manual describes a variety of best management practices (BMPs) and other activities for use by AAP and CAAP facilities to meet the goals of the effluent limitations guidelines. EPA has found that many facilities are currently using BMPs described in this document to successfully reduce pollution loadings.

The guidance manual presents BMPs that can be applied by all sectors of the AAP industry and some BMPs that apply to specific sectors of the industry. This guidance also presents several checklists for use by facilities for BMP plan development and to assist with reporting requirements. The intended audience for the technical guidance manual includes aquaculture facility owners and managers, National Permit Discharge Elimination System (NPDES) permit writers, and other local, state, and federal decision-makers.

1.2 The Aquatic Animal Production Industry

EPA is proposing new effluent limitations guidelines and standards for three subcategories of the concentrated aquatic animal production industry including: flow-through systems, recirculating systems, and net pens.

Flow-through systems consist of single- or multiple-pass units with constantly flowing culture water, and they commonly use raceways or tanks (circular or rectangular). Flow-through systems are found throughout the United States, wherever a consistent volume of water is available. Most flow-through systems use well, spring, or stream water as a source of production water. The water source is chosen to provide a constant flow with relatively little variation in rate, temperature, or quality. Flow-through systems are the primary method used to grow salmonid species such as rainbow trout. These species require high-quality cold water with high levels of dissolved oxygen. Flow-though systems are located where water is abundant, which enables farmers to produce these types of fish cost-effectively. Some other species cultured using flow-through systems are hybrid striped bass, tilapia, and ornamentals.

Recirculating systems are highly intensive culture systems that actively filter and reuse water many times before it is discharged. These systems typically use tanks or raceways to hold the growing animals and have extensive filtration and support equipment to maintain adequate water quality. Recirculating systems use biological filtration equipment to remove ammonia from the production water. Solids removal, oxygenation, temperature control, pH management, carbon dioxide control, and disinfection are other common water treatment processes used in recirculating systems. The size of the recirculating system depends primarily on available capital to fund the project and can be designed to meet the production goals of the operator. Recirculating systems can be used to grow a number of different species. They can be used anywhere in the country because a relatively small volume of water is needed to produce a unit of product.

Net pens and cages are suspended or floating holding systems in which some cultured species are grown. These systems may be located along a shore or pier or may be anchored and floating offshore. Net pens and cages rely on tides, currents, and other natural water movement to provide a continual supply of high-quality water to the cultured animals. In most locations, net pens are designed to withstand the high-energy environments of open waters and are anchored to keep them in place during extreme weather events. Strict siting requirements typically restrict the number of units at a given site to ensure sufficient flushing to distribute wastes and prevent degradation of the bottom below and near the net pens.

EPA does not propose to establish effluent limitations guidelines for other types of production systems, including floating aquaculture production systems (e.g., mussel rafts) or for ponds; however, this manual does address practices that could be used for those systems to help reduce pollutant discharges.

EPA is not proposing regulations for discharges from the following:

- *Ponds*. The culture of aquatic animals in ponds requires high-quality water to sustain and grow the aquatic animal crop. For many aquatic animals raised in ponds, the pond itself serves as a natural biological treatment system to reduce wastes generated by the animals in the pond.

- *Lobster pounds*. Intertidal "pounds" are used for live storage and feeding of lobsters to keep wild caught animals alive pending sale.

- *Crawfish*. Crawfish are typically raised in seasonally filled shallow ponds in conjunction with plant crops. After the plant crop is harvested, remaining plant residues serve as a forage food for the crawfish.

- *Molluscan shellfish production in open waters*. For large-scale production of mollusks for food, operators typically use bottom culture, bottom-anchored racks, or floating (but tethered to the bottom) rafts in open waters. Molluscs do not require added feed because they remove nutrients (in the form of algae) from ambient waters by filtration.

- *Aquariums*. Public aquariums are AAP facilities that display a variety of aquatic animals to the public and conduct research on many different threatened and endangered aquatic species. These systems maintain low stocking densities and very clean, clear water to enhance the visual display of the animals. Discharges from aquariums are likely to be low in total suspended solids (TSS) and nutrients because of the low stocking densities.

- *Alligators*. Alligator production facilities range in size from producers with less than 100 animals to some with many thousands of animals. None of the production facilities discharge effluents from their alligator production systems. Instead, effluents are treated in one or two-stage lagoons and then land applied to crop or forested land.

1.3 Defining the Need for BMPs for the CAAP Industry

The operation of CAAP facilities has the potential to introduce a variety of pollutants and leads to other disturbances in receiving waters that might be harmful to the environment. According to the 1998 U.S. Department of Agriculture (USDA) Census of Aquaculture (USDA, 2000), there are approximately 4,200 commercial aquaculture facilities in the United States. Aquaculture has been among the fastest-growing sectors of agriculture until a recent slowdown that began several years ago caused by declining or level growth among producers of several major species.

Water quality concerns related to pollutant loads are only one of the environmental concerns associated with this industry. Other areas of concern relate to the introduction of invasive species from CAAP facilities, which can pose serious potential and observed risks to native fishery resources and wild native aquatic species from the establishment of escaped individuals (Carlton, 2001; Volpe et al., 2000). Some CAAP facilities may also use drugs, such as oxytetracycline or formalin, and chemicals, such as a variety of copper-containing pesticides, that may be released into receiving waters. For some applications of these drugs and chemicals, there is a belief that further information is needed to fully evaluate risks to ecosystems and human health associated with their use in some situations. Finally, CAAP facilities also might inadvertently introduce pathogens into receiving waters, with potentially serious adverse impacts on native biota. This guidance document describes practices that can be used by CAAP facilities to minimize the discharge of pollutants and minimize potential adverse impacts that pollutants might have on receiving waters.

1.4 Current Regulatory Structure: NPDES Program

The NPDES regulations specify the applicability of the NPDES permit requirement to concentrated aquatic animal production facilities (40 CFR 122.24 and Appendix C to Part 122). To be a concentrated aquatic animal production facility, the facility must either meet the criteria in 40 CFR Part 122, Appendix C, or be designated on a case-by-case basis (40 CFR 122.24(b)). A hatchery, fish farm, or other facility is a concentrated aquatic animal production facility if it contains, grows, or holds aquatic animals in either of two categories: cold water or warm water. The cold water species category includes ponds, raceways, or other similar structures which discharge at least 30 days per year, but it does not include: facilities which produce less than 9,090 harvest weight kilograms (approximately 20,000 pounds) per year; and facilities which feed less than 2,272 kilograms (approximately 5,000 pounds) during the calendar month of maximum feeding. The warm water category includes ponds, raceways, or other similar structures which discharge at least 30 days per year, but it does not include: ponds which discharge only during periods of excess runoff; or facilities which produce less than 45,454 harvest weight kilograms (approximately 100,000 pounds) per year (40 CFR Part 122, Appendix C).

1.5 State BMP Programs

A number of states, including Alabama, Arizona, Arkansas, Florida, Hawaii, and Idaho, were found to have recommended BMPs for aquaculture. In addition, BMPs have been developed for specific types of species. BMPs are addressed in manuals or regulations, depending on the state. Data were collected from in-house resources and through Internet research and might not represent every state that has developed BMPs for aquaculture.

Alabama

Dr. Claude Boyd and his colleagues, with funding from the Alabama Catfish Producers (a division of the Alabama Farmers Federation) has developed a set of BMPs for aquaculture facilities in Alabama. The BMPs are described in a series of guide sheets that have been adopted by USDA's Natural Resources Conservation Service (NRCS) to supplement the Service's technical standards and guidelines (Auburn University and USDA, 2002). The NRCS technical standards are intended to be referenced in Alabama Department of Environmental Management rules or requirements promulgated for aquaculture in Alabama. The guide sheets address a variety of topics, including reducing storm runoff into ponds, managing ponds to reduce effluent volume, controlling erosion in watersheds and on pond embankments, using settling basins and wetlands, and implementing feed management practices.

Arizona

Arizona's regulation for BMPs for feeding operations covers aquaculture facilities classified as feeding operations for purposes of regulation of discharge water quality (Statutory reference: ARS 49-245-47; CWA Section 318).

The Arizona Department of Environmental Quality has rules that regulate aquaculture through three general, goal-oriented BMPs. These BMPs address manure handling, including harvesting, stockpiling, and disposal; treatment and discharge of aquaculture effluents containing nitrogenous wastes; and closing of aquaculture facilities when they cease operation (Fitzsimmons, 1999).

Compliance with these BMPs is intended to minimize the discharge of nitrates from facilities without being too restrictive for farm operations. The draft document *Arizona Aquaculture BMPs* describes BMPs that can minimize nitrogen impacts from aquaculture facilities. A list of resources is also available for additional information about Arizona aquaculture and BMPs (Fitzsimmons, 1999).

Arkansas

The Arkansas Bait and Ornamentals Fish Growers Association (ABOFGA) developed a list of BMPs to help its members make their farms more environmentally friendly. More specifically, the Association provides a set of BMPs that help to conserve water, reduce effluent, capture solids, and manage nutrients. Members may voluntarily agree to adopt the BMPs on their farms (ABOFGA, n.d.). For more information, contact the University of Arkansas at Pine Bluff.

Florida

Florida's aquaculture certificate of registration and BMP regulation requires any person engaging in aquaculture to be certified by the Florida Department of Agriculture and Consumer Services and to follow BMPs (Regulatory reference: Chapter 5L-3.003, 5L-3). *Aquaculture Best Management Practices*, a manual prepared by the Department, establishes BMPs for aquaculture facilities in Florida. By legislative mandate (Chapter 5L-3), the BMPs in the manual are intended to preserve environmental integrity while eliminating cumbersome, duplicative, and confusing environmental permitting and licensing requirements. When these BMPs are followed, facilities meet the minimum standards necessary for protecting and maintaining offsite water quality and wildlife habitat. All certified aquaculturists are required to follow the BMPs in

Chapters II through X of the manual, which address federal permitting; construction; compliance monitoring; shipment, transportation, and sale; water resources; nonnative and restricted nonnative species; health management; mortality removal; and chemical and drug handling (FDACS, 2000).

Hawaii

Hawaii recently developed a practical BMP manual to assist aquaculture farmers in managing their facilities more efficiently and complying with discharge regulations. The manual, *Best Management Practices for Hawaiian Aquaculture* (Howerton, 2001), is available from the Center for Tropical and Subtropical Aquaculture.

Hawaii is also developing a BMP for traditional use of a *loko kuapa*-style Hawaiian fish pond. Because of changes in the land tenure, decreases in native population, total loss of traditional pond management practices, and benign neglect, fishpond production has declined in Hawaii. Although Hawaii's fishpond production efficiency is too low to justify the economic cost, Hawaii is making major efforts to restore and put into service several of these traditional structures as sustainable development demonstrations and as opportunities for maintaining ties to a nearly extinct element of cultural heritage (SOEST, n.d.).

Idaho

In combination with site-specific information, *Idaho Waste Management Guidelines for Aquaculture Operations* can be used to develop a waste management plan to meet water quality goals. Such a waste management plan would address Idaho's water quality concerns associated with aquaculture in response to the federal Clean Water Act and Idaho's Water Quality Standards and Wastewater Treatment Requirements. The manual is also intended to assist aquaculture facility operators in developing BMPs to maintain discharge levels that do not violate the state's water quality standards (IDEQ, n.d.).

Other BMP Guidance Documents

BMPs have also been developed for specific species, including shrimp, hybrid striped bass, and trout. The Global Aquaculture Alliance, in *Codes of Practice for Responsible Shrimp Farming*, has compiled nine recommended codes of practice that are intended to serve as guidelines for parties who want to develop more specific national or regional codes of practice or formulate systems of BMPs for use on shrimp farms. These codes of practice address a variety of topics, including mangroves, site evaluation, design and construction, feeds and feed use, shrimp health management, therapeutic agents and other chemicals, general pond operations, effluents and solid wastes, and community and employee relations (Boyd, 1999). The purpose of the document is to provide a framework for environmentally and socially responsible shrimp farming that is voluntary, proactive, and standardized. The document also provides a background narrative that reviews the general processes involved in shrimp farming and the environmental and social issues facing the industry (Boyd, 1999).

The Hybrid Striped Bass Industry: From Fish Farm to Consumer is a brochure that provides guidance to new and seasoned farmers in the proper handling of fish from the farm to the consumer. Although the brochure is primarily geared toward providing quality fish products to consumers, the information it provides about the use of drugs and chemicals, including pesticides and animal drugs and vaccines, can be used to benefit the environment (Jahncke et al., 1996).

The Trout Producer Quality Assurance Program of the U.S. Trout Farmer's Association (USTFA) is a two-part program that emphasizes production practices that enable facilities to decrease production costs, improve management practices, and avoid any possibilities of harmful drug or other chemical residues in fish. Part 1 discusses the principles of quality assurance, and Part 2 provides information about the highest level of quality assurance endorsed by the USTFA. Although the program addresses a variety of subjects related to trout production, the discussion on waste management and drugs and chemicals can be applied to protecting the environment (USTFA, 1994).

1.6 Overview of Guidance Manual

The following information is discussed in detail in this manual:

- Section 2 describes a checklist of requirements under the proposed effluent guidelines.
- Section 3 describes how to create a BMP Plan in compliance with the proposed regulations for flow-through, recirculating, and net pen systems.
- Section 4 describes other BMPs for all systems, including systems not included in the scope of the proposed regulation (ponds).
- Appendix A lists additional resources available to assist facilities with implementing BMPs.
- Appendix B is an example of a BMP plan developed by EPA and state regulators.
- Appendix C includes fact sheets describing BMP practices.

1.7 References

ABOFGA (Arkansas Bait and Ornamental Fish Growers Association). N.d. *Best Management Practices (BMP's) for Baitfish and Ornamental Fish Farms*. Arkansas Bait and Ornamental Fish Growers Association, in cooperation with the University of Arkansas at Pine Bluff, Aquaculture/Fisheries Center.

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SECTION 2
REQUIREMENTS CHECKLIST FOR CAAP FACILITIES

2.1 Introduction

EPA developed regulatory options for concentrated aquatic animal production (CAAP) facilities with the following components:

- Management of removed solids and excess feed through treatment technologies and best management practices (BMPs).
- A BMP plan to describe practices to minimize the potential for nonnative species escapement and proper facility operation and maintenance.
- Drug and chemical reporting requirements.
- Active feed monitoring for net pen systems.

Table 2-1 illustrates the BMPs described under the proposed rule by subcategory. The combinations of treatment technologies and management practices are based primarily on the type of production system used at a facility. The type of production system determines the relative volume and strength of wastewater produced at a particular facility and the treatability of the wastewater using cost-efficient treatment technologies and management practices. The size of a facility (or production level) determines the overall volume of water discharged and associated pollutant load. EPA used the type of production system and facility size to determine the BMPs and treatment technologies that form the proposed regulatory option.

Table 2-1. Production System Types and Regulatory Options

Required BMPs and Technologies	*Flow-Through*		*Recirculating*	*Net Pen*
	Medium[a]	*Large*[b]		
Drug and chemical reporting requirements		x	x	x
Option of alternative compliance: TSS limits and BMP Plan as per requirements below OR only a BMP plan	x	x	x	
a. Management of removed solids and excess feed	√	√	√	

Required BMPs and Technologies	*Flow-Through*		*Recirculating*	*Net Pen*
	Medium[a]	*Large*[b]		
b. Proper operation and maintenance	X	X	X	
c. Minimize potential for escapes of nonnatives		X	X	X
d. Training for staff	X	X	X	
e. Minimize discharge of net-fouling organisms				X
f. Avoid discharges of blood, vicera, and substances associated with washing nets				X
g. Prohibition of discharges of feed bags, chemicals used to clean nets, and materials containing tributylin compounds				X
Certification that a BMP plan has been developed	X	X	X	X
Active feed monitoring				X

X=Required components
√=Alternative components that may not be required based on system configuration and compliance alternative.
[a]Facilities producing 100,000 up to 475,000 lbs annually are medium facilities.
[b]Facilities producing more than 475,000 lb annually are large facilities.

2.2 Checklist

2.2.1 General Reporting Requirements

Under the proposed regulation, regulated facilities must notify the permitting authority of the addition of any investigational new animal drug, any drug that is not used according to label requirements, and any chemical that is not used according to label requirements. (This reporting requirement does not apply to flow-through facilities producing 100,000 to 475,000 lb per year.) The notification procedure is as follows:

- ✓ For drugs and chemicals not used according to label requirements, facilites must provide an oral report to the permitting authority within 7 days after initiating application of the drug or chemical. The oral report should identify the drug or chemical added and the reason for adding the drug or chemical.

- ✓ For drugs and chemicals not used according to label requirements, facilities must provide a written report to the permitting authority within 30 days after the conclusion of the addition of the drug or chemical. The report should identify the drug or chemical added, the reason for treatment, date(s) and time(s) of the addition (including duration), the total amount of active ingredient added, the total amount of medicated feed added (only for drugs applied through medicated feed), and the estimated number of aquatic animals medicated by the addition.

- ✓ For investigational new animal drugs, facilities must provide a written report to the permitting authority within 30 days after conclusion of the addition of the drug or chemical. The written report should identify the drug or chemical added, the reason for treatment, date(s) and time(s) of the addition (including duration), the total amount of active ingredient added, the total amount of medicated feed added (only for drugs applied through medicated feed), and the estimated number of aquatic animals medicated by the addition.

In addition to the above reporting requirements, facilities must submit a BMP plan certification.

- ✓ The owner or operator of any facility subject to the proposed regulation must certify that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

2.2.2 Flow-Through System Requirements

Flow-through facilities subject to the proposed regulation must develop a BMP plan to achieve some or all of the objectives and specific requirements listed below. Checklists at the end of this section provide more details for specific requirements based on annual production levels and facility design.

- ✓ Manage removed solids and excess feed by minimizing the reintroduction of solids removed through the treatment of the water supply, and prevent excess feed from entering the production system.

- ✓ Minimize the discharge of unconsumed food and minimize the discharge of feeds containing high levels of fine particulates or high levels of phosphorus.

- ✓ Clean raceways at frequencies that minimize the disturbance and subsequent discharge of accumulated solids during routine activities such as harvesting and grading of fish.

- ✓ Maintain in-system technologies to prevent overflow of any floating matter and subsequent bypass of treatment technologies.

- ✓ Ensure proper storage of drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.

- ✓ Collect animal mortalities on a regular basis. Store and dispose of aquatic animal mortalities to prevent discharge to waters of the United States.

- ✓ Develop and implement practices to minimize the potential escape of nonnative species.
- ✓ Ensure that facility staff are familiar with the BMP plan and have been adequately trained in specific procedures required by the plan.

2.2.3 Recirculating System Requirements

Recirculating facilities subject to the proposed regulation should develop a BMP plan to achieve some or all of the objectives and the specific requirements listed below. Checklists at the end of this section provide more details for specific requirements based on annual production levels and facility design.

- ✓ Manage removed solids and excess feed by minimizing the reintroduction of solids removed through the treatment of the water supply, and prevent excess feed from entering the production system.
- ✓ Properly operate and maintain a concentrated aquatic animal production facility by maintaining in-system technologies to prevent overflow of any floating matter and subsequent bypass of treatment technologies.
- ✓ Ensure proper storage of drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
- ✓ Collect animal mortalities on a regular basis. Store and dispose of aquatic animal mortalities to prevent discharge to waters of the United States.
- ✓ Develop and implement practices to minimize the potential escape of nonnative species.
- ✓ Facilities should ensure that facility staff are familiar with the BMP plan and have been adequately trained in specific procedures required by the plan.

2.2.4 Net Pen Requirements

Net pen facilities subject to the proposed regulation must meet the following requirements:

- ✓ Maintain a real-time monitoring system to monitor the rate of feed consumption (active feed monitoring). The system should be designed to allow detection or observation of uneaten feed passing through the bottom of the net pens and to prevent accumulation.
- ✓ Develop a BMP plan to achieve the following objectives and requirements:

1. Operate the facility to minimize the concentration of net-fouling organisms that are discharged during events such as changing and cleaning nets and screens ashore.

2. Avoid the discharge of blood, viscera, fish carcasses, or transport water containing blood associated with the transport or harvesting of fish into the waters of the United States.

3. Avoid the discharge of substances associated with in-place pressure washing nets into the waters of the United States. The use of air-drying, mechanical, and other nonchemical procedures to control net fouling are strongly encouraged.

4. Develop and implement practices to minimize the potential escape of nonnative species.

5. Discharges of feed bags and other solid wastes are prohibited.

6. Discharges of chemicals used to clean nets, boats, or gear in open waters are prohibited.

7. Discharges of materials containing or treated with tributyltin compounds are prohibited.

2.3 References

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CHECKLIST FOR GENERAL REPORTING REQUIREMENTS

Part A: For drugs and chemicals not used according to label requirements:

Name of drug or chemical: ______________________________

Start date/time of application:____________________________

End date/time of application: ____________________________

Duration: ____

Reason for use: ____

____

____

Total amount of active ingredient added: ______________________________

Total amount of medicated feed added
(Only for drugs applied through medicated feed):_______________________

Estimated total number of animals medicated by addition: ______________

❑ **Oral report to permitting authority**

Date and time of oral report:______________________

❑ **Written report to permitting authority**

Date and time of written report:___________________

DRUG/CHEMICAL	DATE	TIME	DURATION

CHECKLIST FOR GENERAL REPORTING REQUIREMENTS

Part B: For investigational new animal drugs:

Name of drug or chemical: ______________________________

Start date/time of application:____________________________

End date/time of application: ____________________________

Duration: ____

Reason for use: ____
____
____

Total amount of active ingredient added: ______________________________

Total amount of medicated feed added
(Only for drugs applied through medicated feed):______________________

Estimated total number of animals medicated by addition: ______________

❑ **Written report to permitting authority**

Date and time of written report:____________________

DRUG/CHEMICAL	DATE	TIME	DURATION

REQUIREMENTS FOR FLOW-THROUGH SYSTEMS WITH TSS LIMITS

Facilities with full-flow that produce 100,000 to 475,000 lb per year (Includes treatment from off-line settling basin that recombines with bulk flow)

- ❑ **TSS limits (net concentrations):**

  Maximum Monthly Average: 6 mg/L
  Maximum Daily Average: 11 mg/L

- ❑ **Develop a BMP plan with the following components:**
  - ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
  - ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
  - ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.
  - ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
  - ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR FLOW-THROUGH SYSTEMS FOR ALTERNATIVE COMPLIANCE WITHOUT TSS LIMITS

Facilities with full-flow that produce 100,000 to 475,000 lb per year
(Includes treatment from off-line settling that recombines with bulk flow)

❑ **Develop a BMP plan with the following components:**

- ✓ Description of management of removed solids and excess feed including the following practices that meet the following components:
  - ➢ Practices that minimize the reintroduction of solids removed through the treatment of the water supply.
  - ➢ Practices that minimize excess feed from entering the aquatic animal production system.
  - ➢ Practices that minimize the discharge of feed containing high levels of fine particulates or high levels of phosphorus.
  - ➢ Description of raceway cleaning practices that minimize the disturbance and subsequent discharge of accumulated solids during routine activities, such as harvesting and grading of fish.
- ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
- ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
- ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.
- ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
- ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR FLOW-THROUGH SYSTEMS WITH TSS LIMITS

Facilities with a separate off-line settling basin (OLSB)
that produce 100,000 to 475,000 lb per year
(Includes facilities that discharge from OLSB separate from bulk discharge)

- [ ] **TSS limits (net concentrations) for OLSB discharge only:**

  Maximum Monthly Average: 67 mg/L
  Maximum Daily Average: 87 mg/L

- [ ] **Develop a BMP plan with the following components:**

  ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.

  ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.

  ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.

  ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.

  ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

- [ ] **For bulk discharge, develop a BMP plan with the following components:**

Description of management of removed solids and excess feed including the following practices that meet the following components:

  ✓ Practices that minimize the reintroduction of solids removed through the treatment of the water supply.

  ✓ Practices that minimize excess feed from entering the aquatic animal production system.

  ✓ Practices that minimize the discharge of feed containing high levels of fine particulates or high levels of phosphorus.

- ✓ Description of raceway cleaning practices that minimize the disturbance and subsequent discharge of accumulated solids during routine activities, such as harvesting and grading of fish.

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR FLOW-THROUGH SYSTEMS FOR ALTERNATIVE COMPLIANCE WITHOUT TSS LIMITS

Facilities with a separate off-line settling basin (OLSB) that produce 100,000 to 475,000 lb per year (Includes facilities that discharge from OLSB separate from bulk discharge)

- ❑ **Develop a BMP plan with the following components:**
  - ✓ Description of management of removed solids and excess feed including the following practices that meet the following components:
    - ➢ Practices that minimize the reintroduction of solids removed through the treatment of the water supply.
    - ➢ Practices that minimize excess feed from entering the aquatic animal production system.
    - ➢ Practices that minimize the discharge of feed containing high levels of fine particulates or high levels of phosphorus.
    - ➢ Description of raceway cleaning practices that minimize the disturbance and subsequent discharge of accumulated solids during routine activities, such as harvesting and grading of fish.
  - ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
  - ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
  - ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.
  - ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
  - ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR FLOW-THROUGH SYSTEMS WITH TSS LIMITS

Facilities with full-flow that produce more than 475,000 lb per year (Includes treatment from off-line settling basin that recombines with bulk flow)

- ❑ **TSS limits (net concentrations):**

  Maximum Monthly Average: 6 mg/L
  Maximum Daily Average: 10 mg/L

- ❑ **Develop a BMP plan with the following components:**
  - ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
  - ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
  - ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.
  - ✓ Description of practices to minimize the potential escape of nonnative species
  - ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
  - ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

- ❑ **Drug and chemical reporting requirements.**

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR FLOW-THROUGH SYSTEMS FOR ALTERNATIVE COMPLIANCE WITHOUT TSS LIMITS

Facilities with full-flow that produce more than 475,000 lb per year (Includes treatment from off-line settling that recombines with bulk flow)

- ❑ **Develop a BMP plan with the following components:**
  - ✓ Description of management of removed solids and excess feed including the following practices that meet the following components:
    - ➢ Practices that minimize the reintroduction of solids removed through the treatment of the water supply.
    - ➢ Practices that minimize excess feed from entering the aquatic animal production system.
    - ➢ Practices that minimize the discharge of feed containing high levels of fine particulates or high levels of phosphorus.
    - ➢ Description of raceway cleaning practices that minimize the disturbance and subsequent discharge of accumulated solids during routine activities, such as harvesting and grading of fish.
  - ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
  - ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
  - ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.
  - ✓ Description of practices to minimize the potential escape of nonnative species
  - ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
  - ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.
- ❑ **Drug and chemical reporting requirements.**

REQUIREMENTS FOR FLOW-THROUGH SYSTEMS WITH TSS LIMITS

Facilities with a separate off-line settling basin (OLSB) that produce more than 475,000 lb per year (Includes facilities that discharge from OLSB separate from bulk discharge)

❑ **TSS limits (net concentrations) for OLSB discharge only:**

Maximum Monthly Average: 55 mg/L
Maximum Daily Average: 69 mg/L

❑ **Develop a BMP plan with the following components:**

- ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
- ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
- ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.
- ✓ Description of practices to minimize the potential escape of nonnative species.
- ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
- ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

❑ **For bulk discharge, develop a BMP plan with the following components:**

- ✓ Description of management of removed solids and excess feed including the following practices that meet the following components:
    - ➢ Practices that minimize the reintroduction of solids removed through the treatment of the water supply.
    - ➢ Practices that minimize excess feed from entering the aquatic animal production system.
    - ➢ Practices that minimize the discharge of feed containing high levels of fine particulates or high levels of phosphorus.

- Description of raceway cleaning practices that minimize the disturbance and subsequent discharge of accumulated solids during routine activities, such as harvesting and grading of fish.

❑ **Drug and chemical reporting requirements.**

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR FLOW-THROUGH SYSTEMS FOR ALTERNATIVE COMPLIANCE WITHOUT TSS LIMITS

Facilities with a separate off-line settling basin (OLSB) that produce more than 475,000 lb per year (Includes facilities that discharge from OLSB separate from bulk discharge)

- ❑ **Develop a BMP plan with the following components:**
  - ✓ Description of management of removed solids and excess feed including the following practices that meet the following components:
    - ➢ Practices that minimize the reintroduction of solids removed through the treatment of the water supply.
    - ➢ Practices that minimize excess feed from entering the aquatic animal production system.
    - ➢ Practices that minimize the discharge of feed containing high levels of fine particulates or high levels of phosphorus.
    - ➢ Description of raceway cleaning practices that minimize the disturbance and subsequent discharge of accumulated solids during routine activities, such as harvesting and grading of fish.
  - ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
  - ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
  - ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.
  - ✓ Description of practices to minimize the potential escape of nonnative species.
  - ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
  - ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

- [ ] **Drug and chemical reporting requirements.**

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR RECIRCULATING SYSTEMS WITH TSS LIMITS

Facilities that produce 100,000 lb or more per year

❑ **TSS limits (net concentrations) for all discharges:**

Maximum Monthly Average: 30 mg/L
Maximum Daily Average: 50 mg/L

❑ **Develop a BMP plan with the following components:**

- ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
- ✓ Description of storage practices for drugs and chemicals that avoid inadvertent spillage or release into the aquatic animal production facility.
- ✓ Description of practices to collect animal mortalities on a regular basis and to store and dispose of mortalities to prevent discharge to waters of the United States.
- ✓ Description of practices that minimize the potential escape of nonnative species.
- ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
- ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.

❑ **Drug and chemical reporting requirements.**

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR RECIRCULATING SYSTEMS FOR ALTERNATIVE COMPLIANCE WITHOUT TSS LIMITS

Facilities that produce 100,000 lb or more per year

- ❑ **Develop a BMP plan with the following components:**
  - ✓ Description of management of removed solids and excess feed including the following practices that meet the following components:
    - ➢ Practices that minimize the reintroduction of solids removed through the treatment of the water supply.
    - ➢ Practices that minimize excess feed from entering the aquatic animal production system.
    - ➢ Practices that minimize the discharge of feed containing high levels of fine particulates or high levels of phosphorus.
    - ➢ Description of raceway cleaning practices that minimize the disturbance and subsequent discharge of accumulated solids during routine activities, such as harvesting and grading of fish.
  - ✓ Description of practices that maintain in-system technologies to prevent overflow of floating matter and subsequent bypass of treatment technologies.
  - ✓ Description of storage practices for drugs and chemicals to avoid inadvertent spillage or release into the aquatic animal production facility.
  - ✓ Description of practices to collect animal mortalities on a regular basis, and practices to store and dispose of mortalities to prevent discharge to waters of the United States.
  - ✓ Description of practices to minimize the potential escape of nonnative species.
  - ✓ Discussion of training and briefing for staff regarding specific procedures required by the BMP plan.
  - ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.
- ❑ **Drug and chemical reporting requirements.**

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

REQUIREMENTS FOR NET PEN SYSTEMS

Facilities that produce 100,000 lb per year or more, except net pen facilities located in the State of Alaska producing native species of salmon

- ❑ **Maintain real-time monitoring system to monitor the rate of feed consumption.**
- ❑ **Develop a BMP plan to meet the following requirements and objectives:**
  - ✓ Operate the facility to minimize the concentration of net-fouling organisms that are discharged during events such as changing and cleaning nets and screens ashore.
  - ✓ Avoid the discharge of blood, viscera, fish carcasses, or transport water containing blood associated with the transport or harvesting of fish into the waters of the United States
  - ✓ Avoid the discharge of substances associated with pressure-washing nets into the waters of the United States. The use of air-drying, mechanical and other nonchemical procedures to control net fouling are strongly encouraged.
  - ✓ Develop and implement practices to minimize the potential escape of nonnative species.
  - ✓ Discharges of feed bags and other solid wastes into the waters of the United States are prohibited.
  - ✓ Discharges of chemicals used to clean nets, boats, or gear into the waters of the United States are prohibited.
  - ✓ Discharges of materials containing or treated with tributyltin compounds into the waters of the United States are prohibited.
  - ✓ Certification by owner or operator of the facility that a BMP plan has been developed and that it meets the objectives as defined in the proposed regulation.
- ❑ **Drug and chemical reporting requirements.**

Refer to Section 3 for more detail on how to write a BMP plan and Appendix B for an example of a BMP plan.

CALCULATING MEDICATED FEED CONTENT

Drug treatments for aquaculture operations are commonly added to the diet to reduce the labor involved with administering the treatment. Fish requiring drug treatment are considered to have reduced appetites and therefore are commonly fed at only 1% of their estimated body weight per day. The amount drug added to feed varies depending on the severity of the infection and type of drug used. A common treatment level for oxytetracycline is 75 mg/kg (Brown, 1993).

Pounds of feed per day * dosage * conversion factor

Where

Pounds of feed per day = daily feeding levels (lbs)

Dosage = amount of drug in a given mass of feed (mg drug/kg feed)

Conversion factor = 0.4536 kg/lb

An example calculation for a drug treatment of oxytetracycline at 75 mg/kg for 5000 lb of fish at a feed rate of 1% per day is presented below.

5000 lb fish * 1% feed rate = 50 lb feed per day

50 lb feed * 0.4536 kg/lb (conversion factor) * 75mg/kg dosage = 0.0037 lb of oxytetracycline per day.

Where

Feed rate = the amount of feed offered per day based on a percentage of body weight

SECTION 3
HOW TO WRITE A BMP PLAN

3.1 Introduction

A best management practice (BMP) is a practice or combination of practices that provide an effective means of preventing or reducing levels of pollutants in facility discharges.

Facility operators design BMP plans to include a series of practices such as health management, feed management, effluent discharge management, and drug and chemical use. BMP plans are flexible and allow facility operators to design measures and practices that work within their facility management framework.

In the context of the CAAP proposed effluent guidelines, the BMP plan includes components that are designed to minimize the discharge of solids from the facility. The goal of this plan is to control conventional and nutrient pollutants in the discharge. The CAAP facility is expected to provide written documentation of a best management plan and keep necessary records to demonstrate the implementation of the plan. This type of regulatory structure allows individual facilities to develop a plan tailored to the unique conditions of the CAAP facility, while reducing the discharge of pollutants consistent with the goals of the Clean Water Act.

3.2 Guidance for Developing a BMP Plan

The goal of a BMP plan is to describe the standard operating procedures and BMPs used to minimize, collect, and dispose of pollutants generated during facility operation.

The following components are based on information from requirements in existing NPDES permits (USEPA Regions 1 and 10) for CAAP facilities in Idaho (USEPA, 1999), Maine (USEPA, 2002), and Massachusetts (USEPA, 2001). A BMP plan for CAAP facilities should include the following components:

1. Management of removed solids and excess feed (only for facilities under alternative compliance without TSS limits.)

    a. Describe pollution control equipment or methods used to enhance solids collection. (e.g. quiescent zones, settling basins)

    b. Describe how excessive solids buildup will be identified to trigger more frequent cleaning of raceways/culture tanks and equipment to prevent more suspended and dissolved materials in the discharge.

c. Describe feeding methods used to minimize the amount of feed and residual in the discharge.

d. Describe the preventive maintenance program for cleaning equipment used for cleaning culture units so that delays in cleaning due to equipment failure are avoided.

e. Describe inputs and outputs from the facility including water, dissolved pollutants, solids, fish, feed, and mortalities due to predation or disease.

f. Describe the cleaning of culture tanks/raceways and other equipment and how practices minimize the disturbance and subsequent discharge of accumulated solids during routine activities such as harvesting and grading of fish.

2. Proper operation and maintenance of a CAAP facility

   a. Describe maintenance procedures for in-system technologies to prevent the overflow of any floating matter and subsequent by-pass of treatment technologies.

   b. Describe the proper storage of drugs and chemicals to avoid the inadvertent spillage or release into the aquatic animal production facility.

   c. Describe the collection of aquatic animal mortalities, the frequency of the collections, and how mortalities are stored and disposed to prevent discharge into the waters of the United States.

3. Practices to minimize the potential escape of nonnative species (not applicable to flow-through facilities producing 100,000 to 475,000 lb per year.)

   a. Describe in detail precautions taken by the facility to prevent the loss of nonnative species. This description should include a schedule for preventive maintenance and inspection of the containment system, escape recovery protocols, and fish transfer procedures during stocking and grading.

   b. For net pen systems, describe secondary containment equipment. Secondary containment involves the use of a second set of containment netting around a net pen system. The secondary containment netting should be positioned to capture any fish that might escape the primary containment netting because of damage to the net pen system that could occur during a storm event or other structural failure.

4. Personnel training. Describe the training to be provided for employees to ensure that they understand the goals and objectives of BMPs and their role in complying with the goals and objectives of the BMP plan.

5. For net pen facilities, describe practices to minimize the discharge of net-fouling organisms, the prevention of discharges of blood, viscera, and fish carcasses associated with the transport and harvest of fish, the prevention of discharges of substances associated with in-place pressure washing of nets, and the prevention of discharges of feed bags, chemicals used to clean nets and gear, and materials containing tributyltin compounds.

6. Include a statement certifying that the facility manager and the individuals responsible for implementing of the BMP plan have reviewed and endorsed the plan.

Implementation Notes

Include a diagram or map of the facility to illustrate the layout of the operation.

(See sample BMP plan in Appendix B.)

Additional Resources

IDEQ (Idaho Division of Environmental Quality). N.d. *Waste Management Guidelines for Aquaculture Operations*. Boise, ID. <http://www2.state.id.us/deq/ro_t/tro_water/aquacult_open.htm>. Accessed September 2001.

Summerfelt, S.T., and B.J. Vinci. 2002. Best waste management practices for coldwater recirculating systems. In *Proceedings of The Fourth International Conference on Recirculating Aquaculture*, ed. T.T. Rakestraw, L.S. Douglas, and G.J. Flick, pp. 375-381. Roanoke, VA, July 18-21, 2002.

USTFA (U.S. Trout Farmer's Association). 1994. *Trout Producer Quality Assurance Program*. U.S. Trout Farmer's Association. Charles Town, WV.

CHECKLIST FOR BMP PLAN
WITH TSS LIMITS

Proper operation and maintenance of a CAAP facility

- ❑ Description of maintenance procedures for in-system technologies to prevent the overflow of any floating matter and subsequent by-pass of treatment technologies.
- ❑ Description of proper storage of drugs and chemicals to avoid the inadvertent spillage or release into the aquatic animal production facility.
- ❑ Description of the collection of aquatic animal mortalities, the frequency of collections, and how mortalities are stored and disposed to prevent discharge into the waters of the United States.

Practices to minimize potential escape of nonnative species

- ❑ Description of precautions taken by the facility to prevent the loss of nonnative species.
- ❑ Description of containment system.
- ❑ Escape recovery protocols.
- ❑ Fish transfer procedures used during stocking and grading.

Personnel training

- ❑ Training for employees to learn procedures for BMPs.
- ❑ Assurance that employees understand their role in complying with the objectives of the BMP plan.

Statement of BMP review and endorsement

- ❑ Statement of certification signed by facility manager or individuals responsible for implementation of the BMP plan.

CHECKLIST FOR BMP PLAN
UNDER ALTERNATIVE COMPLIANCE WITHOUT TSS LIMITS

Management of removed solids and excess feed

- ❑ Description of pollution control equipment and solids collection.
- ❑ Explanation of how excessive solids buildup will trigger more frequent cleanings of raceways or culture units.

- ❑ Description of feed management practices used to minimize the amount of excess feed.
- ❑ Description of preventive maintenance program used to prevent delays in cleaning due to equipment failure.
- ❑ Description inputs and outputs from the facility, including water, dissolved pollutants, solids, fish, feed, and mortalities.
- ❑ Describe the cleaning of culture tanks or raceways another other equipment and how practices minimize the disturbance and subsequent discharge of accumulated solids during routine activities such as harvesting and grading of fish.

Proper operation and maintenance of a CAAP facility

- ❑ Description of maintenance procedures for in-system technologies to prevent the overflow of any floating matter and subsequent by-pass of treatment technologies.
- ❑ Description of proper storage of drugs and chemicals to avoid the inadvertent spillage or release into the aquatic animal production facility.
- ❑ Description of the collection of aquatic animal mortalities, the frequency of collections, and how mortalities are stored and disposed to prevent discharge into the waters of the United States.

Practices to minimize potential escape of nonnative species

- ❑ Description of precautions taken by the facility to prevent the loss of nonnative species.
- ❑ Description of containment system.
- ❑ Escape recovery protocols.
- ❑ Fish transfer procedures used during stocking and grading.

For net pen facilities

- ❑ Operate the facility to minimize the concentration of net-fouling organisms that are discharged during events such as changing and cleaning nets and screens ashore.
- ❑ Avoid the discharge of blood, viscera, fish carcasses, or transport water containing blood associated with the transport or harvesting of fish into the waters of the United States
- ❑ Avoid the discharge of substances associated with pressure-washing nets into the waters of the United States. The use of air-drying, mechanical and

other nonchemical procedures to control net fouling are strongly encouraged.

- ❑ Develop and implement practices to minimize the potential escape of nonnative species.
- ❑ Discharges of feed bags and other solid wastes into the waters of the United States are prohibited.
- ❑ Discharges of chemicals used to clean nets, boats, or gear into the waters of the United States are prohibited.
- ❑ Discharges of materials containing or treated with tributyltin compounds into the waters of the United States are prohibited.

Personnel training

- ❑ Training for employees to learn procedures for BMPs.
- ❑ Assurance that employees understand their role in complying with the objectives of the BMP plan.

Statement of BMP review and endorsement

- ❑ Statement of certification signed by facility manager or individuals responsible for implementation of the BMP plan.

3.3 Guidance for Drug and Chemical Reporting Requirements

The goal of drug and chemical reporting requirements is to minimize drug and chemical discharges from a facility. Reporting requirements include the following:

1. For a written report for drugs and chemicals not used according to label requirements, list the following information:

    - Product name of the drug or chemical.
    - Reason for treatment
    - Dates and times of the addition (including duration).
    - The total amount of active ingredient added.
    - The total amount of medicated feed added (only for drugs applied through medicated feed).
    - Estimated number of aquatic animals medicated by the addition.

Submit written report within 30 days after conclusion of the addition of the drug or chemical.

Provide an oral report to the permitting authority within 7 days after initiating application of a drug or chemical that is not used according to label requirements.

2. For a written report for investigational new animal drugs, list the following information:

    - Product name of the drug or chemical.
    - Reason for treatment
    - Dates and times of the addition (including duration).
    - The total amount of active ingredient added.
    - The total amount of medicated feed added (only for drugs applied through medicated feed).
    - Estimated number of aquatic animals medicated by the addition

Submit written report within 30 days after conclusion of the addition of the drug or chemical.

Implementation Notes

1. For drug and chemical use and handling, keep original containers, and purchase and mix only the necessary amounts to reduce storage requirements and avoid potential leaks or spills.
2. Store drugs and chemicals in a designated space away from rearing areas, feeds, and water sources. Avoid storage areas with drains; this will help contain a spill if one should occur.
3. Use drugs or chemicals only as directed on the label.
4. Educate personnel on proper handling, use, and spill containment procedures.
5. Maintain accurate records for treatment application.

Additional Resources

The U.S. Food and Drug Administration Web site has more information on drug and chemical use in aquaculture:

http://www.fda.gov/cvm/index/aquaculture/appendixa6.htm
<http://www.fda.gov/cvm/index/aquaculture/aqualibtoc.htm>

3.4 References

USEPA (U.S. Environmental Protection Agency). 1999. NPDES Permit no. ID-G13-0000. Issued by USEPA Region 10 to Aquaculture Facilities in Idaho. Signed September 10, 1999.

USEPA (U.S. Environmental Protection Agency). 2001. NPDES Permit no. MA0005916. Issued by USEPA Region 1 to Woods Hole Oceanographic Institution, Environmental Systems Laboratory.

USEPA (U.S. Environmental Protection Agency). 2002. NPDES Permit no. ME0036234. Issued by USEPA Region 1 to Acadia Aquaculture, Inc. Signed February 21, 2002.

SECTION 4
BMPs FOR CAAP FACILITIES

4.1 Introduction

The following section describes BMPs for the CAAP industry. Practices for the following CAAP activities are provided:

- 4.2 Feed Management
- 4.3 Designing and Maintaining Quiescent Zones
- 4.4 Designing and Maintaining Sedimentation Basins (Primary Settling)
- 4.5 Secondary Settling with Microscreens
- 4.6 Secondary Settling with Vegetated Ditches
- 4.7 Secondary Settling with Constructed Wetlands
- 4.8 Solids Disposal
- 4.9 Active Feed Monitoring
- 4.10 Practices to Minimize the Potential Escape of Nonnative Species
- 4.12 Net Pen Siting
- 4.13 Net Cleaning
- 4.14 Discharge Management
- 4.15 Erosion Control
- 4.16 Managing Rainwater and Reducing Overflow
- 4.17 Using Drugs and Chemicals: Fertilizers, Therapeutic Agents, and Water Quality Enhancers for Ponds
- 4.18 Oxidation Lagoons
- 4.19 References

Each section describes the practice and guidance for its implementation. Each practice also includes a summary of systems for which the practices are applicable.

4.2 Feed Management

Systems: Pond, flow-through, recirculating, net pens, and alligators

Feed is the primary input of pollutants to CAAP systems. Feed management recognizes the importance of effective, environmentally sound use of feed. Facility operators should continually evaluate their feeding practices to ensure that feed placed in the system is consumed at the highest rate possible. For all systems, observing feeding behavior and noting the presence of excess feed can be used to adjust feeding rates to ensure maximum feed consumption and minimal excess.

The primary operational factors associated with proper feed management are development of precise feeding regimes based on the weight of the cultured species and regular observation of feeding activities to ensure that the feed offered is consumed. An advantage of this practice is that proper feed management decreases the costs associated with the use of excess feed that is never consumed by the cultured species. Excess feed distributed to systems breaks down, and some of the resulting products remain dissolved in the system water.

Guidance for Flow-through and Recirculating Systems

1. Avoid overfeeding fish. Regardless of the delivery system, focus on directing feed to the fish.

2. Store feed properly to reserve the nutrient quality. Minimize humidity to prevent growth of molds or bacteria on feed. Follow manufacturers' recommendations for feed shelf life.

3. Handle feed with care to prevent fines. If fines are present, remove and dispose of them properly.

4. Know the feed requirements of the cultured species to determine the percentage of body weight per day. Use size of fish, water temperature, projected growth rates, and biomass in the system to determine appropriate feeding rates (Westers, 1995).

5. Use high-quality feeds to improve feed conversion and efficient use of nutrients.

6. Observe feeding behavior to monitor feed utilization.

Implementation Notes

- Feed only the amount that will be consumed in 20 minutes. (US Trout Farmers Association, 1994).
- Use feed delivery systems that have devices for the removal of fine particles from feed.
- Generally, frequent feedings of smaller amounts are better than giving the day's ration in a few feedings (IDEQ, n.d.)
- Oxygen levels drop dramatically where large amounts of feed are fed at one time.
- Fish should be fed during the coolest parts of the day in hot weather; reduce feeding when water temperatures reach 65–70 °F for trout. Feeding

in low-oxygen environments reduces dietary efficiency and can result in fish health problems.

- Use of demand feeders allows fish to set the frequency and duration of feeding.
- Blowers, as well as automated delivery systems that supply discrete amounts of feed frequently over a long period of time, may also be used to distribute feed in raceways or tanks.
- Regardless of the method of feed distribution, it is important to observe feeding behavior and prevent overfeeding.
- Overfeeding can affect the health of the fish by contributing to liver and kidney problems.
- Excess feed results in economic losses and degrades water quality, which can adversely affect the health of the aquatic animals.

Guidance for Pond Systems

The following is based on guidance from Alabama aquaculture BMP fact sheet BMP No. 7, "Feed Management" (Auburn University and USDA, 2002g).

1. Use high-quality feed that contains adequate, but not excessive, nitrogen and phosphorus.

2. Protect feed quality by storing feed in well-ventilated, dry bins or, if bagged, in a well-ventilated, dry room. Always use fresh feed to maximize the efficiency with which fish can use it.

3. Apply feed uniformly across the surface of the pond using a mechanical feeder.

4. Do not overfeed fish. Avoid overfeeding by observing fish feeding behaviors. Do not apply more feed than the fish will eat.

5. Maintain adequate levels of dissolved oxygen. Fish stressed by poor water quality conditions will be less efficient in their ability to convert feed to flesh.

6. For daily feed applications in catfish ponds, do not exceed 30 lb/ac in unaerated ponds. In ponds with 2 hp of aeration per acre, daily feed applications can be increased to 100 to 120 lb/ac. These feed amounts are maximum amounts to be applied on a given day, not annual averages.

Implementation Notes

- Because feed management is the main source of nutrients in the pond systems, good feed management, reasonable stocking rates, and adequate aeration are effective tools for enhancing effluent quality.
- Percentages of 4.5% to 5.1% (28% to 32% crude protein) for nitrogen and 0.75% to 1.0% phosphorus are acceptable levels of these elements in feeds for growout.
- Mechanical feeders dispense feed evenly around the edges of the pond to ensure that fish have an opportunity to eat an adequate amount of feed.
- One sign of overfeeding is the accumulation of feed in the corners of the pond.
- Overfeeding is costly and results in unnecessary nutrient inputs into the pond.
- Several factors influence feed consumption, including water temperature, poor environmental conditions like low levels of dissolved oxygen or high concentrations of ammonia, and disease or parasite problems.
- Mechanical aeration prevents low dissolved oxygen concentrations, thereby avoiding fish stress and improving the effectiveness of the pond to assimilate wastes from feeding, ensuring the water quality of the pond and the effluent.

Guidance for Net Pen Systems

In addition to the above practices, feed management practices for net pen facilities should a real-time monitoring system to monitor the rate of feed comsumption. Excess feed is the primary source of sediment accumulation beneath net pens, which can have an adverse effect on the benthic community. Refer to section 4.9 for more detail.

4.3 Designing and Maintaining Quiescent Zones

Systems: Flow-through

Quiescent zones are used in raceway flow-through systems (typically concrete raceways) in which the last approximately 10% of the raceway serves as a settling area for solids.

Quiescent zones usually are constructed with a wire mesh screen that extends from the bottom of the raceway to above the maximum water height to prevent the cultured species from entering the quiescent zone. Reducing the turbulence usually caused by the swimming action of the cultured species allows the solids to settle in the quiescent zone. The collected solids are then available to be efficiently removed from the system.

Guidance

The following design guidance is based on the *Idaho Waste Management Guidelines for Aquaculture Facilities* (IDEQ, n.d.).

1. A quiescent zone (QZ) is a settling zone; therefore, the dimensions of the QZ must be adequate to ensure that the overflow rate (V_o) is smaller than the settling velocity (V_s):

   $V_o = ft^3/s/ft^2$ or cubic feet per second of flow per square foot of settling area = ft/s (velocity)

   V_s = settling velocity of biosolids in feet per seconds

2. The accepted range of V_s values for biosolids in raceways is 0.031 ft/s to 0.164 ft/s, so the dimensions for QZs should provide a V_o value smaller than 0.031 ft/s.

3. Widths of troughs or raceways and their QZs are usually proportional to flow rate, which is directly related to the amount of fish that the rearing area will support.

4. Example: A QZ with a width of 18 feet, a length of 20 feet, and a flow of 6cfs has an overflow rate (V_o) of 0.017 ft/s. This value is just over half of the lower range for V_s values of QZs, meeting the criteria for QZ dimensions.

5. Other design options: sloped, recessed floors of QZ. (See *Idaho Wastewater Management Guidelines* for more detail.)

6. The most common method of solids removal from QZs is by suction through a vacuum head. Facilities may use standpipes in each QZ to connect to a common 4-to 8-in. PVC pipe that carries the slurry of water and solids to the off-line settling basin. Suction is provided by head pressure from the raceway water depth and by gravity, or by pumps.

7. Slurry transport pipes and pumps should be properly sized to carry the required flow and provide adequate suction. Without adequate suction, the vacuum head will resuspend the particles before they can be vacuumed. To operate a 12- to 18-in. wide vacuum head, 100 gpm is ideal.

8. Pumps should be designed to handle 12% solids, moss, leaves, and other debris, which might collect in the QZ.

9. Where lift is needed, it is more efficient and cost-effective to connect pipes from several QZs by gravity flow to a sump or lift station with a

stationary pump than it is to move a portable pump from one QZ to another.

10. Design piping systems to minimize settling of solids within the pipes. Consider clean-outs throughout the piping system. Long-radius bends are better than short radius bends. Pipes should be sloped to provide adequate cleaning velocities.

11. Design system hydraulics to prevent system components from freezing.

12. Consider spare parts for key equipment and a contingency plan for maintaining compliance in the event of equipment failures.

13. Consider the use of baffles in the raceway or trough to direct water flow. Water flows underneath the baffles, increasing flow velocity along the bottom of the pond or raceway and moving solids downstream where they can be collected in QZs. Placement of baffles varies with raceway or pond dimensions, flow, and fish size.

Implementation Notes

- The settled solids should be removed regularly so they cannot become entrained in the wastewater flow and contribute to the pollutant loadings of the facility. Two operational factors associated with operating QZs are (1) the necessity to clean the screens, and (2) the regular removal of collected solids from the QZs.
- QZs should be cleaned as frequently as possible, at least once every 2 weeks (IDEQ, n.d.)
- Screens separating the rearing area from the QZ should be cleaned daily to promote laminar flow.
- System designs that provide gentler handling of solids are better preferred because systems where more turbulence occurs need larger settling areas to compensate for the settling requirement of small particles.
- System designs that allow for frequent or continuous harvest of solids are preferable and should require smaller settling zones.
- Rectangular settling zones or quiescent zones promote flow that is evenly distributed over the entire surface area (laminar flow).
- Cleaning of the QZs also creates a highly concentrated waste stream that should be treated before it is discharged into a receiving water body.

4.4 Designing and Maintaining Sedimentation Basins (Primary Settling)

Systems: Ponds, flow-through, and recirculating

Sedimentation basins separate solids from water using gravity settling of the heavier solid particles (Metcalf and Eddy, 1991). In the simplest form of sedimentation, particles that are heavier than water settle to the bottom of a tank or basin. Periodically, the basin is cleaned of the accumulated solids. Sedimentation basins (also called settling basins, settling ponds, sedimentation ponds, or sedimentation lagoons) are used extensively in the wastewater treatment industry and are commonly found in many flow-through AAP facilities. Most sedimentation basins are used to produce a clarified effluent (for solids removal), but some sedimentation basins remove water from solids to produce a more concentrated sludge.

How Sedimentation Basins Work

Settling in sedimentation basins occurs when the horizontal velocity of a particle entering the basin is less than the vertical (settling) velocity in the tank. The settling properties of an effluent, particularly the settling velocities, are determined and sedimentation basins are sized to accommodate the expected flow through the basin. The length of the sedimentation basin and the detention time can be calculated so that particles with a particular settling velocity will settle to the bottom of the basin (Metcalf and Eddy, 1991).

Other design factors include the effects of inlet and outlet turbulence, short-circuiting of flows within the basin, solids accumulation in the basin, and velocity gradients caused by disturbances within the basin (such as those from solids removal equipment).

Guidance for Flow-Through Systems

For flow-through systems, there are two types of settling basins: off-line settling (OLS) basins and full-flow settling (FFS) basins. Off-line settling basins are settling zones that receive water and solids slurry removed from QZs and rearing areas. These basins are the second settling area in the solids collection system after QZs. QZs in combination with OLS basins are the most commonly used solids collection system (IDEQ, n.d). A full-flow settling basin may not include QZs; instead, this system has one or two large settling areas that collect solids from the water flow from the entire facility. Solids might not be removed from individual rearing units.

OLS basins

1. Solid entering OLS basins are usually smaller because of the turbulence associated with the pumps and pipes that carry solids from the QZs. The range of accepted V_s value range for these smaller particles is 0.00151 ft/s

to 0.00302 ft/s. The V_o value for OLS should be less than 0.00151 ft/s (IDEQ, n.d.)

2. OLS basins are usually 3.5 ft deep but may be deeper. Depth is not required for settling efficiency, but it is required for solids storage. (A depth of 3.5 ft provides adequate storage if solids are removed monthly (IDEQ, n.d.).

3. Facilities may also use several OLS basins to improve solids removal efficiency. When one basin is undergoing solids harvesting, flow can be redirected to another basin (IDEQ, n.d.). Multiple OLS basins may be operated in a series or in parallel. Basins linked in a series generally have a V_o value smaller than 0.00151 ft/s. Basins linked in parallel divide the flow and reduce the water velocity, which improves the V_o and weir rate.

FFS basins

1. Solids particles flowing to FFS basin systems are larger than solids in OLS basins because they are exposed to less turbulence, but they are smaller than solids from QZs. The recommended V_o value for FFS basins is 0.013 ft/s or less (IDEQ, n.d.).

2. The design should include a bypass channel for the FFS basin so solids can be removed (IDEQ, n.d.).

3. FFS systems should include two basins operated in parallel so that one basin remains operational when solids are being harvested from the other basin (IDEQ, n.d.).

Implementation Notes

- System operators should attempt to minimize the breakdown of particles (into smaller sizes) to maintain or increase the efficiency of sedimentation basins (IDEQ, n.d.).
- Proper design, construction, and operation of the sedimentation basin are essential for the efficient removal of solids (IDEQ, n.d.).
- Solids must be removed at proper intervals to ensure the designed removal efficiencies of the sedimentation basin. For both OLS and FFS basins, IDEQ recommends a minimum harvest frequency of every 6 months. Infrequent harvests could result in the breakdown of solids and the release of dissolved nutrients into the receiving waters.
- FFS basins are most commonly used at smaller facilities with low flow volumes.

- For FFS basins, some facilities might batch crop their fish so that they can all be harvested at the same time. Then solids can be harvested from the FFS basins when the facility is empty (IDEQ, n.d.).

4.5 Secondary Settling with Microscreen Filters

Systems: Flow-through and recirculating

Solids polishing is the use of a secondary wastewater treatment technology to further reduce solids discharged from flow-through systems. Several technologies are available, including microscreen filters, vegetated ditches, and constructed wetlands. Microscreen filters are fine mesh filters with automatic backwash that collect solids. Polishing ponds are secondary sedimentation basins used to settle solids from the discharge of the primary sedimentation basin.

Microscreen filters are commonly used filtration systems that consist of a synthetic screen of specific pore size that is used to remove solids from the effluent stream. Pore sizes for microscreen filters vary from 15 to 60 micrometers(μm)(Metcalf and Eddy, 1991). Most microscreen filters operate by pumping the wastewater stream into a space inside the filter. The water passes through the screen and solids are trapped inside the screen. The solids can be discharged to further treatment or to a solids holding unit.

Guidance

1. Microscreening involves the use of variable low-speed (up to 4 revolutions/min), continuously backwashed, rotating drum filters operating under gravity conditions. The wastewater enters the open end of the drum and flows outward through the rotating screening cloth. The solids are backwashed by high-pressure jets into a trough located within the drum (Metcalf and Eddy, 1991).

2. Typical values for design parameters:

a. Screen size:	15 to 60 μm Stainless steel or polyester screen cloths are available in sizes ranging from 15 to 60 μm
c. Hydraulic loading:	75 to 150 gal/ft^2/min
d. Drum diameter:	8 to 16 ft
d. Drum submergence:	70% to 75% of height; 60% to 70% of area
e. Drum speed:	15 ft/min at 3-in. headloss; 115 to 150 ft/min at 6-in headloss.

Implementation Notes

- Pilot plant studies are recommended, especially if units are to be used to remove solids from stabilization pond effluents.
- When installing this technology in a facility, consider the characterization of the suspended solids; the selection of unit design parameter values that will provide adequate capacity to meet maximum hydraulic loadings with critical solids characteristics; design parameters that also will provide desired performance over the expected range of hydraulic and solids loadings; and provision of backwash and cleaning facilities to maintain the screen.
- Filters require cleaning to remove trapped particles. Sprayers are used to remove collected particles and to provide additional filter cleaning. Filters may also be cleaned using a periodic rinse cycle with a heated solution.

4.6 Secondary Settling with Vegetated Ditches

Systems: Ponds, flow-through, and recirculating

Vegetated ditches are another effective means of removing solids from effluent. A vegetated ditch is an excavated ditch that serves as a discharge conveyance, treatment, and storage system. The walls of the ditch are excavated at an angle that supports the growth of a dense vegetation layer. The vegetation layer aids in treating the discharge and reduces the susceptibility of the ditch banks and bottom to erosion. The length and width of the ditch are designed to allow for the slowing and temporary storage of the discharge as it flows toward the receiving water body. The vegetation layer increases the ability of the ditch to remove both coarse and fine particulate matter and the associated pollutants, such as BOD, settleable solids, and suspended solids.

Vegetated ditches are channels lined with grass or other plants that can convey or move water, treat discharges by removing sediment and solids, and store water prior to discharge. The walls of a vegetated ditch are excavated at a slope that allows for the growth of a dense vegetation layer, and the length and width of the ditch are designed to slow the flow of the discharge.

Guidance

1. Ditches should be designed to convey the volume of wastewater discharged with appropriate length and slope of ditch as well as suitable vegetation to maximize pollutant removal.

2. Install riprap in bottoms of ditches in places that are susceptible to erosion.

Implementation Notes

Vegetated ditches require regular maintenance. Maintenance practices include the following:

- Repairs to ditch as needed.
- Weed and brush control to prevent competition with desirable species. (mowing and herbicides)
- Irrigation during dry season to maintain vegetation.
- Routine inspection for repairs and after heavy rains.

4.7 Solids Polishing with Constructed Wetlands

Systems: Ponds, flow-through, and recirculating

Constructed wetland treatment systems also promote secondary solids removal from effluent discharges. These systems consist of shallow pools constructed on non-wetland sites. Constructed wetlands provide substrate for specific emergent vegetation types such as cattail, bulrush, and reeds. Constructed wetlands are designed to treat discharges through physical, chemical, and biological processes. The vegetation causes the discharge to slow and flow in a more serpentine manner, increasing the likelihood of solids settling. The vegetation also aids in the adsorption of potential pollutants through plant and bacterial uptake, and it increases the oxygen level in the discharge flowing through it.

Constructed wetland treatment systems consist of shallow pools constructed on non-wetland sites with water at depths of usually less than 2 ft. They have varying success in aquaculture operations. Constructed wetlands can be designed to provide several different benefits, including treatment of the discharge through biological and chemical processes, temporary storage of discharges, recharge of aquifers, and reduction in discharge volume to receiving water bodies.

Guidance

1. Site evaluation and selection. Consider site characteristics such as topography, soil characteristics, existing land use, flood hazard, and climate (Metcalf and Eddy, 1991).

2. Determination of pretreatment level. The minimum pretreatment for a wetland system should be primary treatment or aerated ponds with a short detention time. Use of oxidation ponds that generate high concentrations of algae should be avoided prior to wetland treatment because algae removal through wetlands is inconsistent. Phosphorus

removal prior to application to wetlands is recommended because wetlands remove minimal phosphorus (Metcalf and Eddy, 1991).

3. Vegetation selection and management. Emergent plants, plants rooted in the soil that penetrate the surface of the water, are used in constructed wetlands. Constructed wetlands provide substrate for specific emergent vegetation types such as cattail, bulrush, and sedges (Metcalf and Eddy, 1991).

4. Determination of design parameters. The primary design parameters for constructed wetland systems are hydraulic detention time, basin depth, basin geometry (width and length), 5-day biochemical oxygen demand (BOD_5), loading rate, and hydraulic loading rate (Metcalf and Eddy, 1991).

5. Vector control measures. Wetlands can provide breeding habitat for mosquitoes; design plans might need to include measures for controlling mosquitoes with mosquito fish or chemical control agents (Metcalf and Eddy, 1991).

6. Detailed design of system components (Metcalf and Eddy, 1991).

7. Determination of monitoring requirements (Metcalf and Eddy, 1991).

Implementation Notes

- Once the system is operating properly, it should be inspected regularly to remove dead or fallen vegetation, check for erosion and channelization, and monitor sedimentation levels.
- Periodic harvest and proper disposal of the vegetation can also increase nutrient removal.
- The wetlands require large areas for treatment of relatively small volumes of water; therefore, facilities with limited available land for expansion are not able to use constructed wetlands.
- In many parts of the United States, constructed wetlands have seasonal differences in pollutant removal efficiencies. For example, in colder climates, constructed wetlands might discharge some dissolved nutrients during the colder season and become a sink for these pollutants during warmer months.

4.8 Solids Disposal

Systems: Ponds, flow-through, recirculating, and alligators

4.8.1 Dewatering

Dewatering is the physical process used to reduce the moisture content of sludge to make the sludge easier to handle before it is transported or composted. Several techniques are used to dewater sludge. Some rely on natural evaporation, whereas others use mechanically assisted physical means like filtration, squeezing, capillary action, vacuum withdrawal, and centrifugal separation (Metcalf and Eddy, 1991). Chemicals can be added to assist with the dewatering process.

Guidance

1. The selection of dewatering devices should be determined by the type of sludge to be dewatered and the availability of space. Drying beds or lagoons can be used where land availability is not an issue. Mechanical devices are more likely to be used on sites where space is restricted.

2. Some sludges, such as aerobically digested sludges, do not respond well to mechanical dewatering.

4.8.2 Composting

Composting is a process in which organic material undergoes biological degradation to a stable end product (Metcalf and Eddy, 1991). Approximately 20% to 30% of the volatile solids are converted to carbon dioxide and water. As the organic material in the sludge decomposes, the compost heats to temperatures in the range of 120 to 160 °F, and pathogenic organisms are destroyed.

Guidance

Composting generally involves the following steps:

1. Mixing dewatered sludge with an amendment or bulking agent. Fish manure is usually dense, wet, and nitrogen-rich; therefore, it is necessary to mix the manure with materials like straw, corn stalks, yard trimmings, or wood chips to add carbon and absorb excess moisture.

2. Aerating the compost pile by adding air or mechanically turning the compost.

3. Recovery of the bulking agent.

4. Further curing and storage.

5. Final disposal.

4.8.3 Land Application

Land application is the most common sludge disposal process in the aquaculture industry (Chen, 2002). Land application of sludge is defined as the spreading of sludge on or just below the soil surface (Metcalf and Eddy, 1991). Application methods include using sprinklers and tank trucks to apply the sludge directly to the land. Sludge may be applied to agricultural land, forest land, disturbed land, and dedicated land disposal sites. In all of these cases, the land application is designed with the objective of further providing sludge treatment (Metcalf and Eddy, 1991). Sunlight, soil microorganisms, and dryness combine to destroy pathogens and other toxic organic substances found in sludge.

Guidance

Sprinkler application

1. When agricultural land is adjacent to an AAP facility, solids can be vacuumed directly from quiescent zones and into a sprinkler system that applies solids and water.

2. Application rates should not cause surface runoff or contaminate groundwater.

3. The sprinkler line should have a small settling pond at the end of the line to allow for emergency cleaning during freezing weather.

Field application

1. For use of slurry on fields, consider site conditions (weather), timing of application, application rates, crop type, crop uptake capacity, and land availability (IDEQ, n.d.)

2. Consider the slope of the field and the location of surface water to prevent slurry from entering surface waters during or after application.

3. Avoid field areas with exposed bedrock or shallow soil because nutrients might leach into the groundwater.

4. Plan ahead and maintain good working relationships with nearby farmers to find fallow fields during the growing season and accessible fields during the winter months.

4.8.4 Publicly Owned Treatment Works

Publicly owned treatment works (POTWs) are wastewater treatment plants that are constructed and owned by a municipal government for the purpose of treating municipal and industrial wastewater from homes and businesses within its borders and/or surrounding areas. Facilities that discharge to POTWs are considered to be indirect dischargers because their wastewater is directed to a POTW for treatment before being discharged to surface water. Some aquaculture facilities are indirect discharges.

4.8.5 Storage Tanks and Lagoons

Manure, or sludge, from aquaculture facilities has to be properly treated and disposed. Storage tanks or storage lagoons are used to store either untreated or treated wastewater until the water can be treated, or until the treated wastewater can be reused by the production system. Holding tanks, storage tanks, and surge tanks are used through the aquaculture industry to hold wastewater and treated wastewater before they are returned to the culture system.

Guidance

1. Storage lagoons are usually shallow, bermed earthen ponds with a high surface area-to-volume ratio to facilitate rapid drying of slurry. For example, a lagoon with dimensions of 300 ft by 50 ft and a depth of 1 ft is needed to store 120,000 gal (IDEQ, n.d.)

2. To avoid nutrient leaching, facilities should avoid building storage lagoons on or near exposed bedrock, on thin or sandy soil, or in locations with high groundwater.

3. Storage lagoons should be sited away from natural drainage areas prone to flooding.

4.9 Active Feed Monitoring

System: Net pens

In addition to general feed management, feed management practices for net pen facilities should include a real-time monitoring system to monitor the rate of feed consumption. Excess feed is the primary source of sediment accumulation beneath net pens, which can have an adverse effect on the benthic community.

Active feed monitoring is considered a management practice for all net pen facilities. This relatively new but proven technology is used by some facility operators in the salmon industry. Some type of remote monitoring equipment, such as an underwater video camera, is lowered from the surface to the bottom of a net pen during feeding to monitor for uneaten feed pellets as they pass by the camera.

The goal of active feed monitoring is to further reduce pollutant loads associated with feeding activities. Various technologies have been reported, including video cameras with human or computer interfaces to detect passing feed pellets. A new

NPDES permit issued in Maine (USEPA, 2002) also suggests that ultrasonic equipment might be available. Most facilities that use this technology use a video monitor at the surface that is connected to the video camera. An employee watches the monitor for feed pellets passing by the video camera and then stops feeding activity when a predetermined number of pellets (typically only two or three) pass the camera.

4.10 Practices to Minimize the Potential Escape of Nonnative Species

Systems: Ponds, flow-through, recirculating, and net pens

Practices to minimize the potential escape of nonnative species are designed to prevent nonnative aquatic organisms from escaping and adversely affecting local wild populations. These practices might include precautions such as double netting for net pen systems or screens over influent and effluent drains for flow-through systems. Practices might also include protocols for escape recovery and steps taken to prevent fish from escaping during stocking and grading activities.

Guidance

1. Describe the precautions the facility will take to prevent nonnative aquatic organisms from escaping and adversely affecting local wild populations.

    a. Describe in detail the precautions the facility will take to minimize the potential escape of nonnative species.

    b. Include a description of a schedule for preventative maintenance and inspection of the containment system, methods of escape recovery protocols, and fish transfer procedures during stocking and grading.

2. For net pen systems, describe secondary containment equipment. Secondary containment involves the use of a second set of containment netting around a net pen system. The secondary containment netting should be positioned to capture any fish that might escape the primary containment netting because of damage to the net pen system that could occur during a storm event or other structural failure.

4.11 Mortality Removal

Systems: Ponds, flow-through, recirculating, and net pens

Mortality of the cultured species in small numbers is a common occurrence in aquaculture systems. The timely removal of mortalities ensures against the spread of disease and the introduction of excess nutrients into the system. There are no known disadvantages to the timely removal of mortalities; however, when ponds have large numbers of mortalities, removal might be costly and require seines and crews similar to those used during harvest.

Guidance

1. Maintain good water quality to prevent disease outbreaks.

2. Avoid overstocking rearing units to reduce stress and promote optimal culture water quality.

3. Inspect culture units daily to check for the presence of mortalities.

4. Many of the mortalities float to the surface of the culture water and can be collected by hand or with nets.

4.12 Net pen siting

System: Net pens

Siting involves the preimplementation planning that should take place to ensure that the net pen system is located in an area of adequate flow. Net pens located in areas without sufficient tidal flow have an increased probability of solids buildup below the pens. The net pens should also be located in areas that are protected from storm events so they do not become a hazard to navigation.

Guidance

1. Evaluate prospective sites to determine flushing rates, as well as the direction in which waste products will be carried as a function of tidal flow and wind generation (Stickney, 2002).

2. Identify any physical conditions, such as water depth, that may affect dispersal of nutrients

3. Consider establishing operations in suitable offshore environments to reduce nearshore environmental impacts.

4. Consider sites that can be used for polyculture as a means of reducing nutrient accumulations beneath the net pens (Stickney, 2002).

5. Consider rotating pen locations, if possible, to minimize impacts on benthic communities.

4.13 Net cleaning

System: Net pens

The regular cleaning of the production nets helps to ensure a constant flow of water through the production area of the net pen. As the net pen sits in the culture area, marine organisms attach and grow on the nets. These organisms reduce the area of the openings. The reduction in area reduces the water flow through the net pen and the amount of dissolved oxygen available, and it increases the buildup of metabolic waste.

Guidance

1. Minimize the concentration of net-fouling organisms that are discharged during events such as changing and cleaning nets.

2. Remove fouled nets, transport ashore, air dry, and clean with pressure washers, if necessary. Avoid discharges of cleaning water or net-fouling organisms to open waters.

3. Avoid discharges of chemicals used to clean nets or other gear in open waters.

4. Do not use materials containing or treated with tributylin.

4.14 Discharge Management

System: Ponds

Ponds can release effluents through overflow from rain events and intentional draining. Effluent volume can be reduced by operating ponds to maximize storage capacity to reduce overflow and by draining ponds only when necessary. Discharge management applies practices to *reduce the volume* of water discharged and to improve the quality of the effluent discharged.

Water might be intentionally discharged from ponds to facilitate harvests or to improve the quality of the water in the pond by flushing or exchanging the water with new water additions. For catfish ponds, draining might occur any time during the year. Scheduling drainings, when possible, to minimize the release of sediment and nutrients can reduce the potential pollutants in pond effluent. The following summary is based on guidance from Alabama Aquaculture BMP Practice No. 10, "Managing Ponds to Improve Quality of Draining Effluent" (Auburn University and USDA, 2002j).

Guidance

1. When possible, construct seine-through ponds that do not have to be drained for harvest.

2. Harvest fish by seining and without partially or completely draining the pond unless it is necessary to harvest in deep ponds, restock, or repair pond earthwork. Where possible, avoid discharge when harvesting fish.

3. Avoid flushing new supplies of water into the pond by discharging a portion of the production water. Research has proven that mechanical

aeration is a more effective mean of preventing low dissolved oxygen levels than the practice of water exchange.

4. Discharge due to rainfall events can be prevented by maintaining the water level below the tops of the overflow pipes. When makeup water is added, it should be kept 3 to 4 in. below the tops of overflow pipes, preventing storm overflow. Pond edges can be deepened if water becomes shallow around the edges.

5. Design new ponds with structures that allow the ponds to be drained near the surface instead of from the bottom. Where practical, alter drain structures for surface discharge when old ponds are drained for harvest or renovation.

6. Typically ponds must be drained completely to repair the pond and the surrounding area. The frequency of draining varies from every few years up to every 20 years. When ponds must be drained completely, it is recommended that the final 20% to 25% of the pond volume be discharged into a settling basin or held for 2 or 3 days to minimize suspended solids and then discharged slowly.

7. When draining ponds, drain from the surface to the bottom. If necessary, swivel-type drains can be installed to take in water from the surface and be lowered to completely drain the pond. Most catfish pond drains usually have the discharge pipe inlet at the pond bottom.

8. Use riprap at discharge points to protect against erosion.

Implementation Notes

- During final draining the valve should be opened to one-fourth its maximum capacity. At the beginning of rainfall the valve should be closed and not reopened until the water has cleared.
- Where ponds are located in close proximity, water from the pond being drained for harvest can be transferred to adjacent ponds for reuse.

4.15 Erosion Control

System: Ponds

Erosion occurs in ponds as a result of wave action, water currents from aerators, inadvertent damage from vehicles and other farm equipment, and rain affecting bottoms, dams and embankments of empty ponds (Auburn University and USDA, 2002d; Auburn University and USDA, 2002e). Soil particles suspended by erosion increase TSS concentrations in pond waters and effluents, and clay particles increase turbidity. Sediment that has been removed from ponds but improperly disposed of can erode and cause contamination of surface water with suspended solids.

Erosion can also occur within the pond watershed, on the sides and tops of pond embankments, in emergency spillways, and from farm roads around the pond, access roads to the farm, and stream crossings. These sources of sediment increase suspended solids concentrations and turbidity in pond waters. Erosion control minimizes the input of solids added to pond waters and also reduces the levels of suspended solids in pond effluents.

In the pond, wave action against embankments causes soil particles to detach. Grass cover above the normal water level on the wet side of embankments provides protection from wave action. Erosion is most severe when water levels are low and bare soil is exposed to waves and rain. Aerators can also increase erosion by generating strong water currents that can suspend soil particles from the pond bottoms and detach soil particles from pond banks. Sediment accumulates in ponds over time and eventually needs to be removed. If sediment is placed in unvegetated piles, rain falling on the piles causes erosion and the runoff has high concentrations of suspended solids.

In the pond watershed, erosion from soil surfaces can result from rain events that loosen soil particles. Runoff flowing downslope can suspend and transport the loose particles. The energy of flowing water can result in gullies. Bare soil exposed on farm roads or the tops of embankments erodes easily; erosion potential also increases with a steeper slope. In addition, livestock traffic can also expose bare soil or create paths that are highly erodible. If cattle wade in ponds, they suspend sediment and increase turbidity.

The following guidance is based on Alabama Aquaculture BMP No. 3, "Erosion Control on Watershed and Pond Embankments;" No. 4, "Pond Management to Minimize Erosion," and No. 5, "Control of Erosion by Effluents" (Auburn University and USDA, 2002c; Auburn University and USDA, 2002d; Auburn University and USDA, 2002e).

Guidance

1. Close drains as soon as the maintenance or other activities for which the pond was drained are completed.

2. If possible, prevent damage to levees or embankments caused by equipment or vehicles. If damage does occur, make repairs immediately to prevent erosion.

3. Install stationary mechanical aerators such that water currents caused by these devices do not cause erosion of pond banks or bottoms.

4. Position tractor-powered emergency aerators to avoid erosion.

5. Sediment should be used where possible to repair pond earthwork. If sediment is removed from ponds, it should be stabilized to prevent erosion.

6. Use earthen berms, riprap, or vegetation to minimize erosion from wave action in the pond.

7. Control erosion in watersheds by providing vegetative cover, eliminating gully erosion, and using diversions to route water away from areas of high erosion potential.

8. Eliminate steep slopes on farm roads and cover these roads with gravel, especially roads built on soil with high clay content.

9. Use a 3:1 (horizontal:vertical) ratio or flatter side slopes for pond embankments in new construction.

10. Provide grass cover on the sides of pond dams or embankments and grass or gravel on the tops of dams or embankments.

11. NRCS recommends that new ponds or extensions of existing ponds should be constructed to maintain 40% to 50% of the owner's 100-year floodplain area near the channel.

Implementation Notes

- For watershed ponds, enough watershed area to supply water to fill ponds during the winter and spring is desirable; however, excessive overflow from ponds could cause erosion of pond outlet structures and increase TSS in effluents.
- Diversions can be useful for controlling water in the watershed. A diversion is a channel constructed across the slope with a supporting ridge on the lower side.
- Maintain storage between the top of the overflow pipe (approximately 3 to 4 in.) and the surface of the water.
- Water overflowing out of ponds also flushes out products added to ponds to enhance water quality and fish production (e.g., fertilizer, lime, salt); therefore, overflow discharges can waste resources and affect fish production.

4.16 Managing Rainwater and Reducing Overflow

System: Ponds

Rainwater management includes practices that minimize overflows from ponds during rain events. Storm runoff or overland runoff is the water that flows over the land surface following rainfall events. The amount of water entering ponds depends on the size and characteristics of the watershed and the intensity of the storm event. Rainwater management practices are influenced by the pond type, levee or watershed. Moreover, the volume of effluent from ponds in response to heavy rains depends on the watershed area-to-pond surface ratio.

There are two common types of pond discharge: release of effluents following rainfall events and intentional draining for harvest or repair of the ponds. Effluent volume can be reduced by operating ponds to maximize storage capacity and draining them only when necessary.

Discharge from a pond due to overflow after a rain or storm event occurs when the amount of water entering the pond exceeds the capacity of the pond to store water. Discharge due to overflow can be mostly avoided if the pond is not full to the top of the overflow pipes when rain occurs. When overflows do occur, the impact of potential effluents can be minimized by maintaining good water quality in the pond system by using aeration. The following guidance is based on Alabama Aquaculture BMP No. 9, "Managing Ponds to Improve Quality of Overflow Effluent," and BMP No. 2, "Managing Ponds to Reduce Effluent Volume"(Auburn University and USDA, 2002b; Auburn University and USDA, 2002i).

Guidance

1. Maintain adequate storage capacity to capture rain falling or running into ponds during summer and early fall by maintaining the water level below the top of the stand pipe drain.

2. Use diversions or grade stabilization structures to divert excess runoff around ponds, or, if possible, build an additional pond to increase water storage capacity.

3. Maintain good vegetative cover on all parts of the watershed. Where possible, replace short or sparse vegetation with taller, denser vegetation.

4. Improve the quality of the overflow by maintaining adequate dissolved oxygen levels using mechanical aeration.

5. Avoid the practice of rearing livestock on farm watershed and allowing livestock to walk on pond embankments and near ponds. Livestock

produce manure that may wash into the ponds and degrade the quality of the water by adding additional nutrients.

Implementation Notes

- For watershed ponds, enough watershed area to supply water to fill ponds during the winter and spring is desirable; however, excessive overflow from ponds can cause erosion of pond outlet structures and increase total suspended solids in effluents.
- Diversions can be useful for controlling water in the watershed. A diversion is a channel constructed across the sloping landscape with a supporting ridge on the lower side.
- Maintain storage between the top of the overflow pipe (approximately 3 to 4 in) and the surface of the water.
- Water overflowing out of ponds also flushes out products added to ponds to enhance water quality and fish production (e.g., fertilizer, lime, salt); therefore, overflow discharges can waste resources and affect fish production.

4.17 Using Drugs and Chemicals: Fertilizers, Therapeutic Agents, and Water Quality Enhancers for Ponds

System: Ponds

Guidance for pond systems

1. For pond systems, apply fertilizers only when necessary to promote phytoplankton blooms (Auburn University and USDA, 2002h).
2. Use Secchi disk visibility to determine if fertilizer is necessary (Auburn University and USDA, 2002h).
3. Manage pond water levels to prevent or minimize effluent release if possible (Auburn University and USDA, 2002h).
4. Apply agricultural limestone to ponds with a total alkalinity below 20 ppm (Auburn University and USDA, 2002h).
5. Only use water quality enhancers that have been approved by FDA and EPA, and follow the label instructions carefully (Auburn University and USDA, 2002l).

4.18 Oxidation Lagoons

Systems: Flow-through, recirculating, and alligator

Oxidation lagoons, also know as stabilization ponds, are usually earthen, relatively shallow wastewater treatment units used to separate solids and treat soluble organic wastes (Metcalf and Eddy, 1991). The basins are cleaned of solids as needed, which might be as long as once every 20 years. Oxidation ponds are used extensively in the wastewater treatment industry and are commonly used by the alligator industry for the treatment of wastewater generated during alligator pen cleaning.

Oxidation lagoons are usually classified as aerobic, anaerobic, or aerobic-anaerobic (facultative) according to the nature of the biological activity in the pond. Aerobic and facultative lagoons require that oxygen be added to all or parts of the lagoon constantly; therefore, in order to reduce costs, most lagoons in the alligator industry are operated as anaerobic lagoons.

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APPENDIX A
ADDITIONAL RESOURCES

Pond systems

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APPENDIX B
EXAMPLE BMP PLAN

Example BMP Plan[1]

FantaSea Fish Farm
Prepared October 6, 2000
for EPA NPDES Workshop
held November 8, 2000

Goal: To describe the standard operating procedures and best management practices used to minimize, collect, and dispose of pollutants generated during facility operations.

Description: FantaSea Fish Farm is a Class 3 aquaculture facility that produces approximately 250,000 lbs of rainbow trout annually. The facility was initially constructed in 1962. The facility expanded to include a third use of raceways and an off-line settling pond system in 1987. The facility presently has 12 100 fit long raceways, a small hatchery building, an office/shop, and an OLS pond for waste treatment (see attached diagram). The fish farm is located near Jerome, Idaho (T_, R_, Sec_). The facility has a non-consumptive water right for 14 cfs of water from Ideal Springs. The facility has two discharge points, both of which go into Ideal Creek. FantaSea Fish Farm's NPDES permit number is IDG130000. The facility was covered under the Idaho General Permit for Aquaculture Facilities March 1, 2000. FantaSea Fish Farm's previous NPDES permit number was ID000000-0.

Source: The FantaSea Farm uses water that comes from Ideal Spring. Ideal Spring is a pure spring source with TSS levels generally measured at less than 2.0 mg/L (see historic DMRs). Aquatic vegetation grows in the spring and the ditch leading to the raceways. An inflow trash rack screen is used to catch vegetation from the springs and ditch prior to entering the facility. The trash rack screen is cleaned at least daily to prevent vegetation from affecting the water flow to the facility. The spring and head ditch is manually cleaned twice a year to prevent build up of aquatic vegetation. The ditch has an adjustable head gate that controls the water flow to the facility from the spring area.

Influent weir: FantaSea Farm uses an influent weir to measure flow for the facility. Their weir is a calibrated suppressed rectangular weir. The weir is located below the trash rack screen to prevent debris from interfering with weir measurements. The weir is checked for level annually. The weir face and box area is swept clean prior to any measurements being taken. The staff gauge is placed along the weir box wall six times the head distance upstream of the weir crest. The weir has a 3/16 in. blade crest that falls off to a 45° angle to allow

[1] Prepared by Rob Sharpnack, DEQ and Carla Fromm, USEPA

water to spring free of the blade. If the blade is nicked, bent, or rounded it is to be replaced. Weir calibration and testing curve validation is conducted annually.

Immediately below the catch pool for the weir is the influent fish screen used to prevent fish from swimming out of the rearing areas and into the springs.

Raceways: At the bottom of each raceway is a 20 ft. long quiescent zone (QZ). The QZ distance meets the minimum desing criteria set forth by the State of Idaho in the *Idaho Waste Management Guidelines for Aquaculture Operations* for QZ length. Each QZ has a wastewater drain line connection that allows each QZ to be vacuumed individually. The vacuum hose is attached to slotted pipe that is 2 ft. long that serves a vacuum head. Floats are attached to the vacuum hose to prevent the hose from stirring up solids during cleaning events. Gravity transports the wastewater from the QZ to the OLS pond for treatment and storage.

The delivery rate of wastewater to the OLS pond for raceway or QZ cleaning is 200 gpm. The delivery rate for the OLS system is the average time it takes to fill a known volume (the empty OLS pond). QZ cleaning is done sporadically throughout the work week.

Quiescent zones are vacuumed every two weeks and prior to fish grading or harvesting events. The screens in front of the QZ are cleaned daily to removr moss and dead fish. Screens are cleaned to facilitate settling of biosolids from the raceway and to prevent blowouts.

The purpose of the QZ area is to settle out biosolids for easy collection and rapid removal from the rearing environment to prevent their discharge from the facility. Fish that get into the QZs are removed promptly when discovered.

The raceways are screened to prevent avian predators from eating the fish. This benefits the waste management on the farm by reducing direct mortality from injured fish. The netting reduces indirect mortality by reducing the incidence of disease on the facility. Healthy fish consume feed better, which prevents uneaten feed from going to waste. Also, healthy fish are more active in the raceway which allows accumulated biosolids to be moved more readily down the raceway to the QZs, facilitating cleaning and faster removal of biosolids.

Raceways above the QZ are vacuumed before any scheduled fish grading or harvesting events to prevent unnecessary disturbance and subsequent discharge of biosolids from the raceways.

The level of the roadways around the raceways has been graded down to be approximately 1 ft below the level of the raceway walls. This prevents stormwater and windblown dirt from entering the raceways and adding to the waste management load for the facility.

There is approximately 2.5 ft of drop between the first and second use of raceways to allow for passive oxygen recharge of the raceway water. There is 3.5 ft of drop between the second and third raceway use. Between raceway sections the waterfalls onto a splashboard before entering the next lower section. The purpose of this splashboard is to break up the water stream leaving the upper raceway and expose as much surface area of the water to open air as possible to maximize the replenishment of dissolved oxygen levels in the raceway waters. After the third and final use, water falls 3.5 ft to a concrete pad before flowing into the tail ditch and off of the facility. We feel that the accomplishes the same goal as the splashboards between raceway sets (i.e. it maximizes DO levels for wastewater entering Ideal Creek).

Influent and effluent settleable solids from the raceways has always been < 0.1 ml/L. Net TSS results have been between 1.0 mg/L and 4.0 mg/L. Facility flow fluctuates through the year and ranges form 12 to 14 cfs. In 1990-91, six phosphorus and nitrogen samples were taken from the raceway influent and effluent. Net phosphorus results for the raceways averaged 0.07 mg/L. Net nitrite + nitrate results were 0.02 mg/L. Net TKN results were 0.3 mg/L. Net ammonia results were 0.2 mg/L.

OLS Pond: The OLS pond is set up to handle a design flow of 300 gpm. The dimensions of the OLS pond are 30 ft by 30 ft (surface area of 900 sq ft). The pond slopes to a maximum depth of 3.5 ft. Wastewater comes into the OLS pond from the gravity flow system pipe that spills onto the access ramp. This helps to distribute the flow across the width of the settling pond. Water leaves the pond through an 8 in. standpipe. The standpipe is attached to a 90° elbow that can swivel inside the pond. There is a collar around the standpipe that causes the water that is discharged to be pulled from 20 in. below the pond surface. The collar prevents floating materials from washing out of the pond. The water leaving the pond goes back to a box with a calibrated v-notched weir. The weir is used to verify flow rates through the OLS pond during cleaning events.

When the OLS pond is harvested, the water in the pond is slowly decanted by removing the collar from around the standpipe and slowing rotating the standpipe on the 90° elbow to gradually lower the water level in the pond. Once the pond is decanted, a tractor is driven into the pond and the slurry is stirred to a uniform consistency to allow for pumping. The sludge is pumped from the OLS pond into a “honey wagon” which takes it a field for land application. Solids content of the slurry varies between 6 % and 12 %.

The OLS pond is harvested twice annually. (Spring and Fall)

Effluent settleable solids results for the OLS pond has always been <1.0 ml/L. Gross TSS results have ranged from 20 mg/L to 87 mg/L. Monthly average flows for the OLS pond have historically ranged from 0.01 mgd to 0.03 mgd. In 1990-1991, six phosphorus and nitrogen samples were taken from the OLS pond influent and effluent. Gross phosphorus results for the OLS pond averaged 3.2 mg/L. Net nitrite + nitrate results were 0.62 mg/L. Net TKN results were 5.3 mg/L. Net ammonia results were 1.8 mg/L.

Feeding: FantaSea Fish Farm recognizes that the fish feed management is critical in operating an environmentally friendly and profitable fish farm. Approximately 250,000 lb of trout are produced per year on about 300,000 lb of feed, at a conversion rate of 1.2. Feed used is produced from Best Feed for Fish and generally is composed of __% ash, ___% phosphorus, and 30% fat. Feed contents do change based on availability of constituents to the feed manufacturer. FantaSea uses commercially available sinking extruded diets to feed our fish. We fee that using extruded diets leads to the best feed conversion ratios and this minimizes the amount of waste generated by the facility. Specific quantities of feed are fed through demand feeders on each outdoor raceway depending on the quantity, size, and condition of the fish in that raceway. There are two demand feeders on each raceway. Demand feeders allow the fish to decide how much food they need and when they want to feed. This maximizes feeding opportunity and lowers feed conversions by providing a steady, stress free, feeding environment with little wastage. Demand feeders are filled daily or as necessary. Fish in the hatchery building are fed by hand several times per day.

Bagged feeds are stored in the shop area and are used on a “first in, first out” basis to prevent lengthy storage of feed. Use of fresh diets improves dietary efficiency. No feed is used if it has exceeded the storage period recommended by the manufacturer. The largest diets are purchased in bulk and stored in feed bins. Feed can be poured from the bins and fines screened off before the feed is put in the demand feeders.

Demand feeders need to be constantly adjusted to the conditions on the facility to maximize feeding efficacy. Any feeder discovered to be out of adjustment (feeding too freely or jammed up) is immediately corrected by an employee.

Employees are to observe the feeding behavior of the fish at all times. Fish that are not feeding well should have their feed restricted until they are again feeding normally to prevent feed from being wasted and discharged.

All the demand feeders are set up with a windshield to prevent the undesired release of feed on windy days.

Fish are taken off feed prior to harvest, movement or grading to minimize mortality that can occur from those activities.

Hatchery Building: The hatchery building is where trout eggs are hatched and the fish raised up to a size where they can be moved outdoors to the production raceways to finish growing to market size. The troughs and small raceways in the hatchery building all have screened QZs at their bottom ends. The troughs, small raceways, and their corresponding QZs all are cleaned daily. The troughs and raceways all have a separate drain line that allows the cleaning wastewater to be diverted to the OLS pond. Water flow has been measured for the trough and small raceway QZ drains and is 30 gpm and 75 gpm, respectively. Quiescent zone cleaning flows are recorded and used in the calculations for the discharge from the OLS pond. Water used in the hatchery building is diverted from the influent ditch below the weir and is discharged to the head ditch above the first raceways near pond #1a. Mortality from the hatch house is disposed of with mortality collected from the raceways.

Mortality: Mortalities generally range from 1% to 7% of fish on hand, now that the raceways are screened, and depending on the disease and timing of the disease outbreak. Normal operational mortality is disposed of in a "mort pit," dug for this purpose. The mort pits are dug at least 100 ft from any surface water. None of the mort pits previously used are closer than ¼ mile from the nearest well. Soil depth in the area is generally 10 ft. Below the soil is fractured basalt. Depth to ground water is about 45 ft. Mort pits are dug not deeper than 6 ft in depth to allow for 4 ft of soil above the basalt. As the mort pit is used, soil and lime are applied in layers to prevent odors and vector attraction, and aid in the decomposition of the material. The mort pit is full when it gets with 2 ft of the surface and then is covered with soil from the initial excavation.

Therapeutants: All drugs, disinfectants, and chemicals used at this facility are used in a manner consistent with label directions. Therapeutants are only used as needed. Therapeutant use at this facility has been infrequent in the past. All drugs, disinfectants, and chemicals are stored in a cabinet in the office building in their original containers. The chemical cabinet is in a dry well-ventilated place, away from water, and with no floor drains. Material Safety data sheets for all chemicals used at the facility are kept within a binder in the chemical cabinet. Treatments are only made up for the amount necessary for immediate use. Water from disinfection treatments is neutralized prior to discharge. Records are kept as required by the NPDES permit for all drug and chemical usage, including the use of medicated diets. Medicated diets are stored away from normal diets and used as recommended.

Disposal of Biosolids: Sludge and slurry that have been collected in the OLS pond are recycled by land application to nearby cropped fields. Farmers that accept the slurry must agree to disc it under within 24 hours of application and prior to any irrigation water being applied to the field. All land application must be done in such a manner as to prevent the materials from entering surface or ground waters. The dates, locations, concentration, and amounts of land application are kept in a record. Fields used for land application are approved by IDEQ prior to application. FantaSea Farm works with local farmers to insure that the land applied biosolids are applied at agronomic rates appropriate for crop and soils conditions.

Endorsement: This BMP plan has been written and endorsed by FantaSea management and staff responsible for the day-to-day operations and maintenance of the facility.

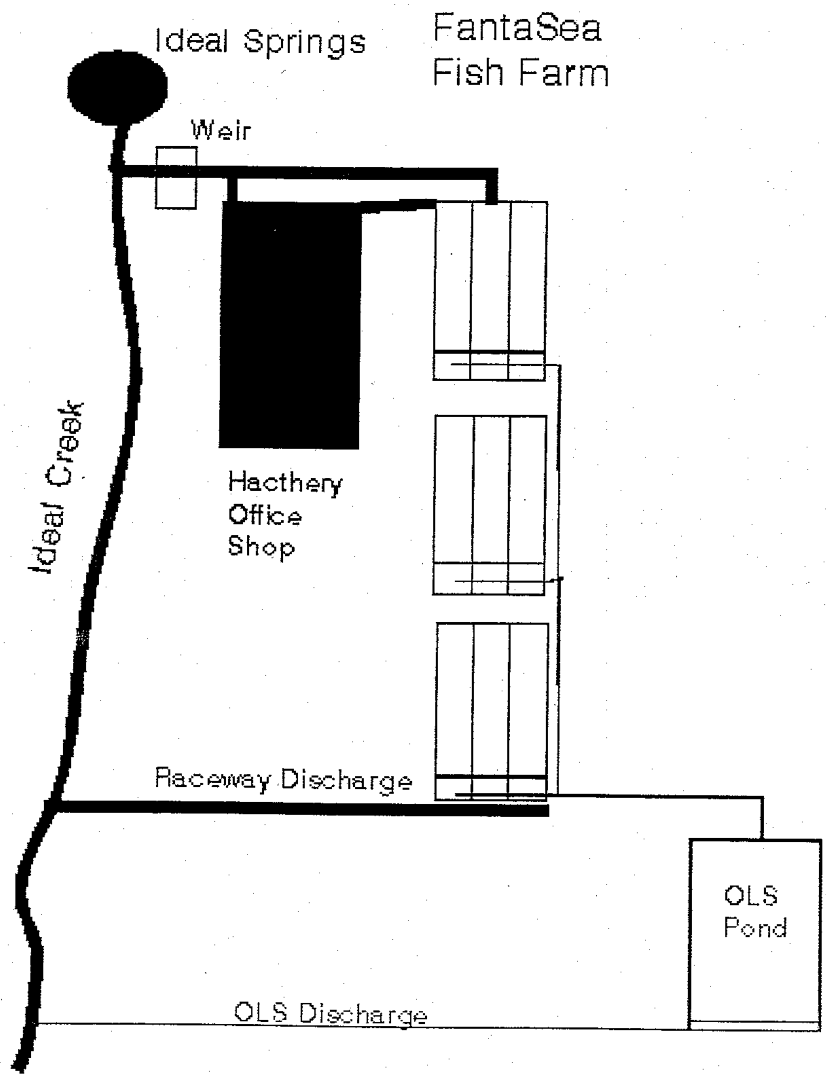

Figure 1: Facility Diagram

CERTIFICATION OF COMPLETION AND IMPLEMENTATION OF THE BEST MANAGEMENT PRACTICES PLAN

FantaSea Fish Farm
ID-G13-0000

This BMP plan has been written, reviewed and is being implemented at FantaSea Fish Farm. The BMP plan is available to employees and IDEQ, EPA, and IDA upon request.

____

Facility Owner/Operator

Submitted ___(date)_________, which is within 9 months of receiving authorization to discharge.

APPENDIX C
BMP FACT SHEETS

Fact Sheet #1: Feed management in flow-through and recirculating systems

What is feed management?

Good feed management minimizes nutrient inputs into pond water. The primary operational factors associated with proper feed management include development of precise feeding regimes based on the weight of the cultured species and regular observation of feeding activities to ensure that the feed offered is consumed. An advantage of this practice is that proper feed management decreases the costs associated with the use of excess feed that is never consumed by the cultured species. Excess feed distributed to systems breaks down, and some of the resulting products remain dissolved in the system water.

How does it work?

Fish do not convert all of the applied feed to flesh. The difference between the input of a substance in feed and the amount of a substance in the harvested fish represents the amount of the substance that enters the pond ecosystem as uneaten feed and in fish feces and metabolites. Uneaten feed and feces are decomposed to metabolites, like carbon dioxide, ammonia, and phosphate, by pond bacteria. These substances are nutrients for the production of phytoplankton, and they also represent potential pollutants in pond effluent. Nutrient inputs and phytoplankton abundance increase as feeding rates increase. Mechanical aeration is used to maintain adequate levels of dissolved oxygen and encourage the oxidation of ammonia to nitrate by nitrifying bacteria. Deterioration of water quality from increased nutrient inputs stresses fish, and causes them to eat less, grow slowly, and be more susceptible to disease. Lowered water quality in ponds also increases the pollution potential of pond effluents.

Practices

1. Uneaten food should be avoided. Feed waste should not exceed 3% to 5%.

2. Do not overfeed fish.

3. Store feed properly to reserve the nutrient quality. Minimize humidity to prevent growth of molds or bacteria on feed. Follow manufacturers' recommendations for feed shelf life.

4. Handle feed with care to prevent fines. If fines are present, remove and dispose of them properly.

5. Know the feed requirements of the cultured species to determine percent of body weight per day. Use size of fish, water temperature, projected growth rates, and biomass in the system to determine appropriate feeding rates (Westers, 1995).

6. Use high quality feeds to improve feed conversions and efficient use of nutrients.

Implementation Notes

- Feeding by hand ensures observation of fish feeding behavior.
- Feed only the amount that will be consumed in 20 minutes. (US Trout Farmers Association, 1994)
- Generally, frequent feedings of smaller amounts are better than giving the day's ration in a few feedings (IDEQ, n.d.)
- Oxygen levels drop dramatically where large amounts of feed are fed at one time.
- Fish should be fed during the coolest parts of the day in hot weather; reduce feeding when water temperatures reach 65-70 F for trout. Feeding in low oxygen environments reduces dietary efficiency and can result in fish health problems.
- Use of demand feeders allow fish to set the frequency and duration of feeding.
- Blowers may also be used to distribute feed in raceways or tanks, or automated delivery systems that supply discrete amounts of feed frequently over a long period of time.
- Regardless of method of feed distribution, it is important to observe feeding behavior and prevent overfeeding.
- Overfeeding can affect the health of the fish by leading to liver and kidney problems.
- Excess feed results in economic losses and degrades the water quality, which can impact the health of the fish.

Additional Resources

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Fact Sheet #2: Feed management in pond systems


Channel Catfish feeding at the surface of the water. Source: www.aquanic.org, 2002.

The following is based on Alabama Aquaculture BMP no. 7, "Feed Management," by Auburn University and U.S Department of Agriculture.

What is feed management?

Good feed management minimizes nutrient inputs into pond water.

How does it work?

Fish do not convert all of the applied feed to flesh. The difference between the input of a substance in feed and the amount of a substance in the harvested fish represents the amount of the substance that enters the pond ecosystem as uneaten feed and in fish feces and metabolites. Uneaten feed and feces are decomposed to metabolites, like carbon dioxide, ammonia, and phosphate, by pond bacteria. These substances are nutrients for the production of phytoplankton, and they also represent potential pollutants in pond effluent. Nutrient inputs and phytoplankton abundance increase as feeding rates increase. Mechanical aeration is used to maintain adequate levels of dissolved oxygen and encourage the oxidation of ammonia to nitrate by nitrifying bacteria. Deterioration of water quality from increased nutrient inputs stresses fish, and causes them to eat less, grow slowly, and be more susceptible to disease. Lowered water quality in ponds also increases the pollution potential of pond effluents.

Practices

1. Select high quality feed that contains adequate, but not excessive, nitrogen and phosphorus.
2. Apply feed uniformly across the surface of the pond using a mechanical feeder.
3. Avoid over feeding by observing fish feeding behaviors. Do not apply more feed than the fish will eat.
4. Maintain adequate levels of dissolved oxygen. Fish stressed by poor water quality conditions will be less efficient in their ability to convert feed to flesh.
5. For catfish ponds, daily feed application should not exceed 30 lb/ac in unaerated ponds. In ponds with 2 hp of aeration per acre, daily feed application usually can be increased to 100 to 120 lb/ac. These feed amounts are maximum amounts to be applied on a given day, not annual averages.

Implementation Notes

- Because feed management is the main source of nutrients in pond systems, good feed management, reasonable stocking rates, and adequate aeration are effective tools for enhancing effluent quality
- Mechanical feeders spread feed evenly around the edges of the pond to ensure that fish have an opportunity to eat an adequate amount of feed.
- One sign of overfeeding is the accumulation of feed in the corner of the pond.
- Overfeeding is costly and results in unnecessary nutrient inputs into the pond.
- Several factors influence feed consumption including water temperature, poor environmental conditions like low levels of dissolved oxygen or high concentrations of ammonia, and disease or parasite problems.
- Managers need to observe the feeing behavior of fish to avoid overfeeding.

Additional Resources

Auburn University and U.S. Department of Agriculture (USDA). 2002. Alabama Aquaculture BMP fact sheets, No. 7: Feed Management. <www.al.nrcs.usda.gov/Sosections/Engineering/BMP index.html>. Accessed May 23, 2002.

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Fact Sheet #3: Erosion Control for Pond systems

The following is based on Alabama Aquaculture BMP No. 4, "Pond Management to Minimize Erosion."

What is erosion control?

Erosion occurs in ponds as a result of wave action, water currents from aerators, inadvertent damage from vehicles and other farm equipment, and rain impacting bottoms, dams and embankments of empty ponds. Soil particles suspended by erosion increase total suspended solids (TSS) concentrations in pond waters and effluents, and clay particles increase turbidity. Sediment that has been removed from ponds but improperly disposed of can erode and cause contamination of surface water with suspended solids.

Erosion can also occur within the pond watershed on the sides and tops of pond embankments, in emergency spillways, and from farm roads around the pond, access roads to the farm, and stream crossings. These sources of sediment increase suspended solids concentrations and turbidity in pond waters.

Erosion control minimizes the input of solids added to pond waters and also reduces the levels of suspended solids in pond effluents.

How does it work?

Within the pond, wave action causes water to impact on embankments and detach soil particles. Grass cover above the normal water level on the wet side of embankments provides protection from wave action. Erosion will be most severe when water levels are low and bare soil is exposed to waves and rain. Aerators can also increase erosion by generating strong water currents that can suspend soil particles from the pond bottoms and detach soil particles from pond banks. Sediment accumulates in ponds over time, and eventually the sediment will need to be removed. If sediment is placed in unvegetated piles, rain falling on the piles will cause erosion and the runoff will have high concentrations of suspended solids.

Within the pond watershed, erosion form soil surfaces can result from rain events that loosen soil particles. Runoff flowing downslope can suspend and transport the loose particles. The energy of flowing water can result in gullies. Bare soil exposed on farm roads or the tops of embankments erodes easily. Erosion potential also increases with a steeper slope. Livestock traffic can also expose bare soil or create paths that erode. If cattle wade in ponds, they will suspend sediment and increase turbidity.

Erosion control within watershed for roads, dams, and embankments involves protecting the land surface from the impacts of rain events.

Protecting all soil surfaces with vegetation or gravel

Practices

1. Close drains as soon as the maintenance or other activities for which the pond was drained are completed.

2. If possible, prevent damage to levees or embankments caused by equipment or vehicles. If damage does occur, make repairs immediately to prevent erosion.

3. Stationary mechanical aerators should be installed so that water currents caused by these devices do not cause erosion of pond banks or bottoms.

4. Tractor-powered emergency aerators should be positioned to avoid erosion.

5. Sediment should be used where possible to repair pond earthwork. If sediment is removed from ponds, it should be stabilized to prevent erosion.

6. Earthen berms, rip rap, or vegetation can be used to minimize erosion from wave action in the pond.

7. Control erosion in watersheds by providing vegetative cover, eliminating gully erosion, and using diversions to route water away from areas of high erosion potential.

8. Eliminate steep slopes on farm roads and cover these roads with gravel, especially roads build of soil with a high clay content.

9. Use a 3:1 (horizontal: vertical) ratio or flatter side slopes for pond embankments in new construction.

10. Provide grass cover on sides of pond dams or embankments and grass or gravel on tops of dams or embankments.

11. NRCS recommends that new ponds or extensions of existing ponds should be constructed to maintain 40% to 50% of the owner's 100-year flood plan area near the channel.

Implementation notes

- For watershed ponds, enough watershed area to supply water to fill ponds during the winter and spring is desirable; however, excessive overflow from ponds could cause erosion of pond outlet structures and increase total suspended solids in effluents.
- Diversions can be useful for controlling water within the watershed. A diversion is a channel constructed across the slope with a supporting ridge on the lower side.
- Maintain storage between the top of the overflow pipe (approximately 3 to 4 in) and the surface of the water. (See diagram)

Fact Sheet # 4: Discharge management for ponds

The following is based on Alabama Aquaculture BMP No. 2, "Managing Ponds to Reduce Effluent," and Alabama Aquaculture BMP No. 10, "Managing Ponds to Improve Quality of Draining Effluent."

What is discharge management?

Ponds can release effluents due to overflow from rain events and when they are intentionally drained. Effluent volume can be reduced by operating ponds to maximize storage capacity to reduce overflow and by draining ponds only when necessary. Discharge management applies practices to reduce the volume of water discharged and to improve the quality of the effluent discharged.

How does it work?

Water may be intentionally discharged from ponds to facilitate harvests or to improve the quality of the water in the pond by flushing or exchanging the water with new water additions.

For catfish ponds, draining may occur any time during the year. Scheduling drainings, when possible, to minimize the release of sediment and nutrients can reduce the potential pollutants in pond effluent.

Practices

1. When possible, construct seine-through ponds that do not have to be drained for harvest.

2. Harvest fish by seining and without partially or completely draining the pond unless it is necessary to harvest in deep ponds, to restock, or to repair pond earthwork.

3. Avoid flushing new supplies of water into the pond by discharging a portion of the production water. Research has proven mechanical aeration to be a more effective method of preventing low dissolved oxygen levels than the practice of water exchange.

4. Maintain the water level below the tops of the overflow pipes. When make-up water is added it should be kept 3 to 4 in below the tops of overflow pipes, preventing storm overflow.

5. Design new ponds with structures that allow ponds to be drained near the surface instead of from the bottom. Where practical, alter drain structures for surface discharge when old ponds are drained for harvest or renovation.

6. Typically ponds must be drained completely after about 15 to 20 years to repair earthwork. When ponds must be drained completely, it is recommended that the final 20% to 25% of the pond volume be discharged into a settling or held for 2 to 3 days to minimize suspended solids and then discharged slowly.

7. If possible, install a swivel-type drain that can take in water from the surface and lowered to completely drain the pond. (Most catfish pond drains usually

have the discharge pipe inlet at the pond bottom.)

8. Use riprap at discharge points.

Implementation Notes

- During final draining the valve should be opened to one-quarter its maximum capacity. At the beginning of rainfall the valve should be closed and not reopened until the water has cleared.
- Where ponds are located in close proximity of one another water from the pond being drained for harvest can be transferred to adjacent ponds for reuse.

Additional Resources

Auburn University and U.S. Department of Agriculture (USDA). 2002. Alabama Aquaculture BMP fact sheets, No. 2: Managing Ponds to Reduce Effluent Volume. <www.al.nrcs.usda.gov/ Sosections/Engineering/BMP index.html>. Accessed May 23, 2002.

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