No Final Report
Project Cancelled.
See notes:

John - I'm concerned
that the balance here
is quite large.
Also "The Company"
filed Chapter 11 in
Nov. 1994. Is this
Project going to finish?
T

I met with
Dwight + PCA
- all on hold
until Spring - yes
it may cancel -
They have not asked for
an extension - may
not dep. or then
~~situation~~

Date of Report: January 1, 1995

LCMR Research Work Plan 1993 - Progress Report

I. Project Title: A4-3 Demonstration of Production Scale Waste Collection in Aquaculture.

Program Manger: Dwight Wilcox
Minnesota Aquafarms, Inc.
25 Industrial Park Drive
P.O. Box 592
Chisholm, MN 55719

218-254-5736 or 218-254-5733
Fax: 218-254-2220

A. Legal Citation: M.L. 93 Chpt. ,Art. , Subd. 3(d).

Total Biennial LCMR Budget:	$100,000
BALANCE REMAINING	$ 80,598

Appropriation Language as drafted 7/27/92:

This appropriation is from the future resources fund to the commissioner of the pollution control agency for a contract with Minnesota Aquafarms to, evaluate operational efficiencies of a fish waste collection system and to evaluate the potential for the waste collection system to meet state water quality requirements.

B. LMIC Language: Not Applicable

C. Status of Match Requirements:
Match required:
Funds Raised to Date:

II. Project Summary:

Goal: This project will determine the efficiency of *in-situ* fish waste collection and its impact on the background mine pit environment based on production scale operations.

General Methodology:

The efficiency of a production scale, net pen (*in-situ*) collection system will be determined by a mass balance evaluation of loading and waste collection rates (measurement and analysis of all materials added to the mine pit environment, the materials collected and removed through the waste collection system and fish growth).

The Minnesota Aquafarms facility will be utilized as the test facility. This includes approximately 1.8 million pounds of chinook salmon and rainbow trout.

The collection system that Minnesota Aquafarms will install is based on the "unit funnel" design described in FishPro and Woodward-Clyde, 1991. There are no known production scale installations of this device in the world. The funnel is made of high density polyethylene. However, this material is typically utilized for lining of landfills and other collection basins. Ultimately, the solids will be utilized for agriculture or silvaculture.

The effect of aquacultural waste collection on the background mine pit environment will be evaluated by interpreting monthly reports of water quality parameters. Changes in these parameters will be evaluated in relation to aquacultural loading rates and waste collection efficiencies.

Significance: Exhausted mine pits are one of Minnesota's unique man made resources. The use of these unused waters can lead to significant economic development and industrial diversification.

Net pen aquaculture is suited for application in mine pits, however, it can have several environmental impacts, including elevated phosphorous, decreased dissolved oxygen and increased algal populations. A recent United States Environmental Protection Agency report[1] concluded that although waste collection is theoretically possible, it has yet to be proven on a production scale to be technically and economically feasible.

The objectives of this study, to determine overall waste collection efficiencies of a production scale waste collection system and evaluating its impact on ambient background water quality, are not a requirement of the September 22, 1992 MPCA stipulation agreement.

The State of Minnesota will benefit from this project through A: the demonstration of a production scale (not a prototype) waste collection system that will be applicable to potential aquacultural ventures in other mine pits and quarries in the state and, B: demonstration that waste collection can improve selected ambient water quality parameters that have been of concern to the Agency.

III. Statement of Objectives:

a. Determine operational efficiencies of a production scale waste collection system, thereby demonstrating technical feasibility of waste collection in net pen aquaculture.

b. Monitor and evaluate changes to mine pit water quality parameters as a result of collection operations.

---

[1]FishPro and Woodward-Clyde, 1991. Collection and Treatment Technologies for In-water Salmonid Production Facilities. EPA Contract 68-C8-0034.

IV. **Research Objectives:**

A. **Equipment evaluation**

A.1. Determine operational efficiencies of waste collection system.

A.1.a. Context within project: This step will evaluate and determine the collection efficiency and cost of operation for the collector system.

A.1.b. Methods: The waste effluent from the collector will be evaluated using mass balance analysis of four sampling procedures.

1. A 24 hour composite sub-sample of the total waste stream will be taken once per month over the course of one year. This will characterize and provide an estimate of the total waste stream volume and mass throughout the year under all operational conditions. In conjunction with the composite sampling, the feed fed during the sampling period will also be weighed and analyzed. Specific Growth Rates for all fish will be estimated on a monthly basis throughout the study period. The combination of growth rates and biomass composition will provide an estimate of each parameter retained by the fish. The effluent and feed analysis will be reviewed to estimate total mass loading of each parameter and the efficiency of the collection system to collect and remove these materials.

The results of the analysis will be analyzed to determine seasonal trends and variations in the efficiency of collection. Mass balance analysis will be used to estimate total annual reductions in loading.

2. Eight samples of the effluent will collected at set time intervals over a 24 hour period for four consecutive days. This four day evaluation period will be repeated over the course of the year at 5°, 10°, 15° and 18° C. This will provide analysis of variations within the day to identify periods for optimizing or adjusting collection efforts so as to maximize collection. In conjunction with the consecutive day sampling, the feed fed during the sampling period will also be weighed and analyzed. Specific Growth Rates and whole fish analysis will be utilized to estimate retention of inputs by the fish.

Mass balance analysis will be used to account for inputs and outputs to estimate daily collection rates at various operational temperature regimes.

3. At each of the four temperature periods evaluated under item **2.** fish will be fed a diet with a non-digestible tracer in it. At the end of the feed period, fish from each pen will be selected and gut evaluated for the tracer. This will provide an estimate of the digestibility of the feed, the total amount of material potentially excreted from the gut and the amount of solids potentially available for collection.

4. Control evaluations will be performed at each sample period by collection of a two meter composite sample of the surface water at a permanent sample station located 200 feet west of the fish rearing facility.

With this information characterizing: 1) feed inputs, 2) collected waste and 3) fish growth and retention of the input materials, all inputs and outputs of feed and fish waste can be identified. Therefore, a mass balance of inputs minus outputs would estimate amount of loss to the environment and provide a quantitative estimate of gross collector efficiency.

Based on the mass balance approach, a model will be developed to predict the loading rates of aquaculture over all temperature regimes with varying degrees of collection efficiency.

A.1.c. Materials: Materials and supplies to perform this task include sample containers and other general supplies and materials.

A.1.d. Budget:

There will be 14- 24 hour samplings and 128 samplings for the consecutive four day testings and 18 control analysis.(160 sampling series). Each series will include total Phosphorous ($14), total solids ($10), COD ($21), pH($3), NH_4-N ($15), NO_2+NO_3-N($15), TKN ($15), for a total of $ 93 per series.

There will be 12 fish gut analysis including Phosphorous ($14), total solids ($10), COD ($21), TON ($15), and tracer ($30), for a total of $ 90 per series

There will be 36 whole fish analysis for total phosphorous ($14), total solids ($10), COD ($21), TON ($15) for a total of $60 per series.

Prior to each waste sampling period the feed will be analyzed for total phosphorous ($14), total solids ($10), COD ($21), TON ($15), for a total of $60 per series. There will be 31 feed samples analyzed.

Equipment leased for the duration of the project (24 months) includes: Two computers, balance, drying oven, composite sampler, thermal controlled incubator/reactor, flow meter, spectrophotometer. Lease fee is approximately $300.00 per month over the entire duration of the project.

	Total
160 Sampling Series @$93	14,880.00
31 Feed analysis @$60	2,511.00
36 Whole fish analysis @$60	2160.00
12 Gut Analysis @90	1080.00
1507 Man hours @$15.26/hr	22,997.00
1440 Man hours @$21.98/hr.	31,649.00
Miscellaneous Supplies	2,000.00
Leased Equipment @$300/month	7,200.00
TOTAL	84,477.00
Amount Expended	19,402.00
TOTAL REMAINING	**$65,075.00**

A.1.e. Time line:

7/93	1/94	6/94	1/95	6/95
24 hour composite sampling				
x x	XXXXXXXXXXXXXX	x	x	
Within day sampling				
x x	X X	X X	X	x x

A. **Status:** The Company continued sampling throughout period until November, however, due to failure of a portion of the collection system, results were not representative of potential collection efficiency. In order to conserve contract financial resources, the Company requested in November a temporary suspension of the program until operational problems could be resolved. Once problems are resolved, the Company will resubmit a revised work plan, if it believes adequate time remains in the contract period to provide valuable information.

Problems: Several units of the collection system failed in August 1994. With selected units out of operation, sampling was limited to only units actually operating. These results underestimated potential collection

efficiency. The Company, filed chapter 11 bankruptcy in November 1994. With limited capital reserves, it was unable to repair and modify the collection system in a timely fashion. Without a fully functioning system, analysis of the efficiency would not be accurate and the project's objective could not be completed.

Progress: The Company has requested a suspension of the project until it can make repairs. If adequate time remains in the contract period, a revised work plan will be submitted.

B. Monitoring of ambient conditions

B.1. Evaluate changes to mine pit water quality parameters as a result of collection operations.

B.1.a. Context within the project: This objective will evaluate ambient water quality conditions in the mine pit and to interpret changes to these ambient concentrations in relation to reduced loading rates due to collection.

B.1.b. Methods: Weekly and monthly water quality data, collected by the company independent of this project, will be evaluated and interpreted in relation to load reductions due to waste collection. This includes: oxygen and temperature profiles at one meter intervals, total phosphorous, nitrate, nitrite, unionized ammonia, pH, chloride, fecal coliform bacteria and total kjeldahl nitrogen.

A model will be developed, or an existing model calibrated, to describe the potential relationship between the degree of waste collection and the resulting ambient water concentrations.

This study will cooperate with the University of Minnesota, Natural Resource Research Institute in their efforts to analysis organic sediment accumulation, sediment oxygen demand and nutrient release rates in pits with aquaculture.

B.1.c. Materials: There will be no major material expenses for this objective.

B.1.d. Budget:

	Total	Expended	BALANCE
390 Man hours @$15.26/hr.	5,951.00	0	5,951.00
390 Man hours @$21.98/hr.	8,572.00	0	8,572.00
Miscellaneous supplies	1,000.00	0	1,000.00
TOTAL	15,523.00	0.00	15,523.00

B.1.e. Time line:

	7/93		1/94		6/94		1/95		6/95	
Evaluate Weekly sampling										
	x	x	x	XX	X X X X X X X X		x	x	x	
Evaluate Monthly sampling										
	x	x	x	X	X X X X X X X X		x	x	x	

B. **Status:** Water samples continued to be collected and evaluated for the parameters of interest in this study. Because this object was to evaluate in-lake water quality changes due to the collection system, and the collection has partially failed, a complete evaluation can not be made at this time. The Company has requested suspension of the grant until problems can be resolved.

Problems: No problems have been encountered implementing this objective, however, because of its ties to the first objective, it can not be carried out.

Progress: The Company has requested a temporaty suspension of the project until such time that it can be determined if the objectives can be carried out.

IV. Evaluation: The project will be evaluated based the timely completion of the work tasks with the results providing an accurate estimate, with a reasonable confidence interval, of the efficiency of waste collection in nets pens and its impact on ambient water quality

V. Context within the field: Waste collection in net pen aquaculture is not being done successfully any where in the world. In 1991, the USEPA[1] completed a literature review of potential best management practices available for aquaculture and concluded that waste collection was theoretically possible but unproven.

This project would verify the theoretical calculations and provide production scale evidence evaluating net pen waste collection efficiencies.

Total capital and equipment cost of the project for installation of the collectors will exceed $800,000 and will be totally paid for by the Company. Annual ambient water quality monitoring will exceed $35,000 during the course of the study, also paid for by the Company. LCMR provides $100,000, for the evaluation of the efficiency of the collection system and interpreting its effect on background water quality conditions and does not include any analysis required by the stipulation agreement nor its underlying permit. It is the intent of the Company to provide for the capital costs of the collection system, while LCMR funds only the evaluation and analysis of the system and its effect on the background environment.

Relationship of Study to Stipulation Agreement:

Minnesota Aquafarms begin research of waste collection in 1990, resulting in the design and actual construction of an initial prototype in May 1992. The Company proposed to install these devices in 1993, as indicated in the original LCMR project proposal (submitted February 1992) before any discussion with the Agency concern-

ing a stipulation agreement. Minnesota Aquafarms suggested to the Minnesota Pollution Control Agency, incorporation of these two Company proposed projects as the primary items in the stipulation agreement, which the Agency eventually accepted and approved on September 22, 1992. The Company has formally committed itself to carry out its original corporate plans for waste collection under the auspices of the Agency through the stipulation agreement.

The Company is not requesting LCMR funding to fulfill the requirements of the stipulation agreement.

As stated by Loren Voigt, Supervisor, Law Enforcement Unit, the Minnesota Pollution Control Agency in the December 8, 1992 hearing before LCMR Commission, the Agency has determined that there is no provision of the proposed project that is a requirement of the September 22, 1992 Stipulation Agreement or the 1988 operational permit.

VI. Benefits: Conflicts will continue to erupt between potential aquacultural users of resources and those responsible for protection of those resources, until it can be demonstrated that aquaculture is an environmentally benign industry.

This project will assist in the development of management techniques to minimize aquaculture's potential impacts to the environment, evaluate the feasibility of net pen waste collection and provide estimates of short and long term environmental changes that may result from implementation of the evaluated technology.

In 1992, then Minnesota PCA adopted rules that require waste collection in all permitted aquacultural facilities, however, only limited data is available to support this requirement as a best management practice. This project will provide baseline data supporting the efficiency of potential waste collection systems that may be utilized in other aquacultural facilities. The findings may be used for economic feasibility studies regarding aquaculture development and by regulatory agencies in the development of rules and guidelines for future aquacultural ventures throughout the state of Minnesota.

VII. Dissemination: The data relating to the collection efficiency and changes to the ambient mine pit water quality will be provide to the public through special and periodic reports to the Minnesota Pollution Control Agency. Agencies and industry can utilize this study in determining whether projected collection efficiencies for future installations or applications are realistic and whether the projected results are within desired objectives.

Summary reports describing the project and its findings will be provided to the public through the Minnesota Pollution Control Agency. In addition, reports will be prepared for presentations at the Minnesota American Fisheries Society chapter meeting and will be submitted for publication in an appropriate journal (AFS Transactions, Progressive Fish Culturalist, Journal of the Fisheries Research Board of Canada etc.)

All data will be made available to the University of Minnesota's Natural Resource Research Institute. In addition, the company will provide actual samples when requested by NRRI.

Time: Initial planning, scheduling, material acquisition will be performed beginning in July 1993. The project's data collection period while span throughout 1994 with analysis and all final reports completed by June, 1995.

Cooperation: The study has no formal cooperators at this time, however, the company will continue to extend its full cooperation to NRRI's research into the dynamics of mine pit waters.

X. Reporting Requirements: Semiannual status reports will be submitted not later than Jan. 1, 1994, July 1, 1994, Jan. 1, 1995 and a final status report by June 30, 1995.

PERSONNEL
This study will be performed by staff of Minnesota Aquafarms.

KEY PERSONNEL: Dwight Wilcox

Education
1968-73 Madelia High School
1973-77 University of Minnesota, St. Paul
Bachelor of Science with Distinction, majors in fisheries and animal science.

Work Experience
1990 to Present Fisheries Biologist, Minnesota Aquafarms Inc.
Responsibilities include all phases of aquaculture operation and environmental monitoring. Assist in the development and implementation of fish production, feed and manpower scheduling, growth and fish health monitoring, water quality analysis and evaluation, computer programming and research and development for the company. Currently conducting research on waste collection and disposal in net pen aquaculture.

1979 to 1990 Reservation Biologist, White Earth Reservation
My responsibilities were to develop and protect the natural resources of the Reservation through the Department's Biology Section. Supervised five permanent employees and a program budget of approximately $250,000.

1977-1979 Natural Resource Specialist, Minnesota DNR
Developed implemented a scientific study on Leech Lake, MN to determine the effects of water level fluctuations on fish populations. Prepared DNR Special Pub.: "Effects of Water Level Fluctuations in Fisheries Populations, Leech Lake, Minn", 1979.

1977 Biological Aide, US Fish and Wildlife Service
Worked with lamprey control including surveying of streams to assess populations and preparation and chemical treatment of streams with a lampreycide.

1976 Labor 1, Minnesota DNR
1976 Research Assistant, University of Minnesota
1975 Biological Technician, US Bureau of Land Management
1975 Laboratory Technician, University of Minnesota