FRED Reports

KIZHUYAK HATCHERY FEASIBILITY
Final Report
BY
Roger F. Blackett
Number 32

Alaska Department of Fish & Game
Division of Fisheries Rehabilitation,
Enhancement and Development

KIZHUYAK HATCHERY FEASIBILITY

Final Report

By
Roger F. Blackett
Number 32

Alaska Department of Fish and Game
Division of Fisheries Rehabilitation,
Enhancement and Development

Don W. Collinsworth
Commissioner

Stanley A. Moberly
Director

P.O. Box 3-2000
Juneau, Alaska 99802

May 1984

TABLE OF CONTENTS

LIST OF TABLES

KIZHUYAK HATCHERY FEASIBILITY

Final Report

INTRODUCTION

In 1982, construction of a 20 MW hydroelectric project was begun at Terror Lake, Kodiak Island, Alaska. Since hydroelectric projects often provide an opportunity for fisheries enhancement, funding was provided by the 1981 State Legislature to study the potential for construction and operation of a salmon hatchery in conjunction with this power project. This report discusses: (1) the most feasible site for a hatchery (referred to as the Kizhuyak Hatchery) in the project area; (2) concepts of hatchery operation; (3) cost of hatchery construction and operation; (4) benefits and feasibility of a hatchery; and (5) recommendations on a hatchery at this site.

Hydroelectric Project (Brief Description)

On October 5, 1981, the Federal Energy Regulatory Commission issued a 50-year license to Kodiak Electric Association (KEA) for the construction, operation and maintenance of the Terror Lake Hydroelectric Project. This license was later transferred to the Alaska Power Authority (APA), which assumed control of the project from KEA.

This project consists of: "(1) a 156-foot-high, 2,100-foot-long rockfill and concrete faced dam across the outlet of Terror Lake; (2) a side-channel spillway with a 600-foot-long crest located on the north abutment of the dam; (3) Terror Lake Reservoir (surface area 850 acres, storage capacity 78,000 acre feet at surface elevation of 1,383 feet); (4) a 10-foot diameter, 26,300-foot-long power tunnel extending from the intake at Terror Lake (143 feet below the surface level) to an outlet portal on the west slope of the Kizhuyak River valley at 1,120 feet; (5) a 3,400-foot-long steel penstock, 96 to 56 inches in diameter, connecting the power tunnel to the powerhouse; (6) a 5-foot-high, 80-foot-long earthen dike at the outlet of Mt. Glottof Glacier Lake, which will divert flows from the Uganik River drainage through a 15-foot-wide, 600-foot-long channel into the Upper Terror River; (7) a 40-foot-high, 300-foot-long rockfill dam across Shotgun Creek diverting flows through a 620-foot-long channel into Upper Falls Creek; (8) a 20-foot-high, 480-foot-long concrete dam across Falls Creek diverting flows into an 8-foot diameter, 470-foot-long shaft into a 10-foot diameter, 1,280-foot-long branch tunnel leading into the power tunnel; (9) a 20-foot-high, 100-foot-long concrete dam across Rolling Rock Creek diverting flows into a branch tunnel to the power tunnel; (10) a power house located adjacent to the Kizhuyak River at elevation 115 feet containing two 10 MW generating units with space for a third unit; (11) a 1,500-foot-long tailrace channel conveying flows from the powerhouse to the Kizhuyak River; (12) a switchyard adjacent to the powerhouse; (13) a 17.3 mile-long, 138 KV transmission line from the switchyard to a substation north of the Kodiak Airport; (14) a barge landing near the head

of Kizhuyak Bay, and a 17-mile-long access road from the landing to Terror Lake; and (15) appurtenant facilities." Construction is to be completed in three years with power on line by 1985.

Hatchery Planning Study

In July 1981, the Department of Fish and Game, FRED Division, established a team consisting of the Kodiak Area Biologist, Kitoi Hatchery Manager and an Engineer to investigate the feasibility of a hatchery at the hydroelectric power plant site. Since 1978, studies have been conducted by the Division to determine enhancement opportunities in conjunction with the Terror Lake power project and to provide recommendations to the Habitat Division and other agencies for the planning and development of this project.

Initially, two sites were considered for a hatchery: (1) inland four miles, adjacent to the powerhouse and Kizhuyak River and accessible by dirt road and (2) at the head of Kizhuyak Bay adjacent to the barge landing and road. As planning progressed, it became apparent from the standpoint of operation that the inland site was least desirable, more costly to operate, and had a higher risk of being less successful than a hatchery on the bay. Advantages of a hatchery on the bay are: (1) ability to use saltwater for rearing; (2) closeness to returning adult salmon (broodfish and egg-taking at the hatchery); (3) better protection of broodstock; (4) fry release close to the estuary; and (5) logistically an easier site to supply and operate. Additionally, water from the power house tailrace is composed of two seasonal water sources (Kizhuyak River tributary and Terror Lake). Seasonal changes in water sources and quality could be detrimental to fry survival, and also influence ability of adult salmon to return to a hatchery adjacent to the powerhouse.

Both hatchery sites would require development of well fields and pumps for the primary water source. The Terror Lake hydroelectric project will not allow water to be taken from the powerhouse penstock or directly from the tailrace. A gravity-flow water source of sufficient quantity is not available at either site. Gravel pads, roads, and availability of hydroelectric power are present at both sites. There is not one special advantage that would offset the operational disadvantages of locating a hatchery at the inland site. Therefore, planning has eliminated further consideration of the inland site and has concentrated on the more favorable site located on Kizhuyak Bay.

SITE DESCRIPTION

Hatchery Site

The hatchery could be constructed on a rock/gravel pad of approximately 1.2 acres (175 x 300 feet) at the head of Kizhuyak Bay (site map). This pad was built for the initial hydroelectric project construction camp. An access road leads from the pad to the barge landing site, a helicopter landing pad, temporary fuel storage facilities, and the powerhouse.

Adjacent to the hatchery is a creek that drains three small lakes (site map) and a tributary stream at approximately 1,500 foot elevation. Water flow was estimated at 4 to 5 cfs in April 1982. This creek offers minor potential for developing broodstock holding at the hatchery as well as for a supplemental water source for the hatchery operation.

Terrain and vegetation at the hatchery site consists of a gravel beach, varying in width from 0 to 500 feet with the tide, and a grove, approximately 100 to 150 feet wide of mature cottonwood and black birch between the beach and pad. To the rear of the pad, the terrain, which is covered with grass, black birch, alder and willow, gradually slopes upward until steep rock cliffs are reached about 0.7 miles away.

Land Status

Land in the hatchery site area has been conveyed to the Afognak Native Association. A lease agreement for a hatchery would have to be negotiated with this corporation. A lease agreement between this corporation and the State was negotiated in 1981 for the Kitoi Bay Hatchery on Afognak Island at an annual rental rate of $100 per acre (adjusted for changes in the Consumer Price Index every 5 years).

Salmon Stocks

Approximately 0.7 miles to the east of the hatchery site is the Kizhuyak River. This river has a 1.2-mile-wide floodplain at the mouth. There are several tributaries of spring origin and numerous branches and channels of the river in this delta area. The side channels and tributaries are the major habitat for pink and chum salmon spawning. Few salmon have been observed in the main Kizhuyak River, nor is there any extensive spawning of pink or chum salmon upstream of the lower delta area.

The return of pink salmon to Kizhuyak Bay from 1978 to 1982 has averaged 103,000 fish and ranged from 161,000 in 1981 to 47,000 in 1982 (Table 1). Chum salmon runs have averaged 27,000 fish during this period with a return of 42,000 in 1981 and a low return of 3,000 in 1979. The return of pink and chum salmon occurs between July and October. The pink and chum salmon stocks at the Kizhuyak River would provide donor fish for developing hatchery broodstock. Although these natural runs are relatively minor, they are sufficient for initial broodstock development.

Coho salmon also spawn in the Kizhuyak River and could provide a donor source for coho production at this hatchery.

Harvest Area

Harvest would be primarily by purse seine gear in Kizhuyak Bay. This large bay (about 9-miles-long from the head to Port Lions and 2-miles-wide [see site map]). Provides ample space to harvest returning salmon. Fish returning to the bay would be harvested in the Kizhuyak Section of the General District, which is open to set gill net and purse seine gear. This

Table 1. Pink and chum salmon harvest, escapement, and return to Kizhuyak, Bay, 1978 - 1982.

	HARVEST		Escapement		Return[a/]	
Year	Pink	Chum	Pink	Chum	Pink	Chum
1978	45,634	26,748	2,250	4,200	48,000	31,000
1979	94,902	3,236	29,600	10	125,000	3,000
1980	122,961	17,372	12,800	21,200	136,000	39,000
1981	102,890	7,360	58,250	35,000	161,000	42,000
1982	23,208	6,883	23,650	12,000	47,000	19,000
5 Year Average	77,919	12,320	25,310	14,482	103,000	27,000

a/ Rounded to nearest 1,000

outer fishery would consist of mixed stocks, while the inner Kizhuyak Bay fishery would be primarily a combination of hatchery and naturally produced fish from Kizhuyak River and from several streams flowing into Kizhuyak Bay.

HATCHERY CONCEPTS

Production Goals

Hatchery capacity is planned for the incubation of 70 million pink or chum salmon eggs. The planning team decided that either pink or chum salmon would be produced at this hatchery rather than both species because of the difficulty of achieving the necessary chum salmon escapement for broodfish while harvesting large numbers of pink salmon.

Options that were considered in cost and feasibility analysis are: (1) rearing all fry produced; (2) rearing half the fry produced; or (3) not rearing any fry. Rearing would be up to 60 days in 15 raceways with freshwater and saltwater sources and mixing capability.

Based upon given assumptions (Table 2) and simulated production schedules (Table 3 and 4), the Kizhuyak hatchery could produce 598,000 adult chum salmon of which 548,000 would be available for harvest by year 2000. If pink salmon were incubated, 598,000 adult pink salmon could be produced by 1992, and 529,000 of these fish could be harvested. These projections are considered to be minimal. Marine survival for pink salmon at Kitoi Hatchery during the last four years has ranged from 1% to 3% (1.8% average) for unfed fry and 2% to 6% (3.5% average) for fry reared before release. However, marine conditions for survival of fry have probably been better in recent years than what might be expected over a long term.

Hatchery Facility Plans

This facility would consist of (see plan drawings):

1. A hatchery incubation building (154 x 60 feet) containing up to 96 NOPAD (Zenger) incubators on the ground level and an office, storage, and seasonal employee bunkhouse on the upper level.

2. A building (26 x 18 feet) to house aeration and de-gassing equipment for the hatchery water supply from the well field and Kizhuyak River.

3. A 45 x 26 foot building for a shop/garage and to house a diesel generator for emergency power.

4. Fifteen, 10 x 100 x 3.0 foot-deep concrete raceways with a freshwater system (exchange rate of 3.5 per hour) that would be used for rearing fry and eventually holding adult broodfish for taking eggs. Adult salmon would, upon their own volition, enter the raceways via fishpasses extending to the creek or bay. Fry would reach saltwater via drain channels.

Table 2. Assumptions for Kizhuyak hatchery operation and production simulations.

PINK SALMON	CHUM SALMON
1. Construction completed 1986, facility in operation 1987.	1. Construction completed 1986, facility in operation 1987.
2. Natural salmon return sufficient, with management protection, to provide 8,000 (4,500 females) for broodstock each year and an egg-take of 8.0 million eggs from 1987 through 1989.	2. Natural salmon return sufficient, with management protection, to provide 4,500 (2,400 females) for broodstock each year and an egg-take of 5.0 million eggs from 1987 through 1994.
3. Female fecundity of 1,800 eggs.	3. Female fecundity of 2,100 eggs.
4. Survivals: Egg take to eyed-egg 90% Eyed egg to fry 95% Fry to adult 1.0%[a/]	4. Survivals: Egg take to eyed-egg 90% Eyed egg to fry 95% Fry to adult 1.0%[a/]
5. Age composition of return: Ocean age 1 100%	5. Age composition of return: Ocean age 3 80% Ocean age 4 20%
6. Hatchery fish return harvested at 50% during broodstock development (1989 - 1990).	6. Hatchery fish return harvested at 50% during broodstock development (1991 - 1994).

a/ Partial rearing of fry.

Table 3. Simulated production for a chum salmon hatchery at Kizhuyak Bay.

Year of Operation	Activity	Broodstock No.		Egg Take (million)	Fry Release (millions)		Adult return		Adults Harvested
		Total	Females		Year	No.	Year	No.	
1986	Construction	-	-	-	-	-	-	-	-
1987	Operation & Broodstock Development	4,500	2,400	5.0	1988	4.3	1991	34,400	17,200
1988	"	4,500	2,400	5.0	1989	4.3	1992	43,000	21,500
1989	"	4,500	2,400	5.0	1990	4.3	1993	43,000	21,500
1990	"	4,500	2,400	5.0	1991	4.3	1994	43,000	21,500
1991	"	21,700	12,000	25.2	1992	21.5	1995	180,600	130,600
1992	"	26,000	15,000	31.5	1993	26.9	1996	258,200	208,200
1993	"	26,000	15,000	31.5	1994	26.9	1997	269,000	219,000
1994	"	26,000	15,000	31.5	1995	26.9	1998	269,000	219,000
1995	Operation @ Capacity	50,000	34,000	70.0	1996	59.8	1999	532,200	482,200
1996	"	50,000	34,000	70.0	1997	59.8	2000	598,000	548,000
1997	"	50,000	34,000	70.0	1998	59.8	2001	598,000	548,000

Full capacity production by 2000 at 598,000 adults.
Harvestable chum 548,000 or 91.6% of the return.
Average weight 8.0 lb/fish.
Total weight of harvestable fish/year 4,384,000 lbs.
Annual ex-vessel value X 50¢/lb fresh-frozen $2,192,000 (Price is 1979-1982 average).

Table 4. Simulated production for a pink salmon hatchery at Kizhuyak Bay.

Year of Operation	Activity	Broodstock No.		Egg Take (million)	Fry Release (millions)		Adult return		Adults Harvested
		Total	Females		Year	No.	Year	No.	
1986	Construction	-	-	-	-	-	-	-	-
1987	Operation & Broodstock Development	8,000	4,500	8.0	1988	6.8	1989	68,000	34,000
1988	"	8,000	4,500	8.0	1989	6.8	1990	68,000	34,000
1989	"	42,000	25,000	45.0	1990	38.5	1991	384,700	315,700
1990	Operation @ Capacity	69,000	39,000	70.0	1991	59.8	1992	598,000	529,000
1991	"	69,000	39,000	70.0	1992	59.8	1993	598,000	529,000

Full capacity production by 1992 at 598,000 adults.
Harvestable pinks 529,000 or 88.5% of the return.
Average weight 3.8 lbs/fish.
Total weight of harvestable fish/year 2,010,200 lbs.
Annual ex-vessel value @ 37¢/lb, $743,774 (price is 1979 - 1982 average).

5. Three single family houses 26 x 50 feet for three full-time employees and dependents.

6. Three, 8 x 35 foot freezer vans for storage of fish food.

7. A fuel tank storage, containment and distribution system.

8. Utility distribution, water and sewer systems, driveways, storm drainage, and landscaping.

A beach landing for barges and a road from the beach to the hatchery presently exists and would be shared with the Electric Cooperative. The hatchery site is exposed to storms and high winds. This exposure combined with a substantial tidal area creates a difficult problem for docking and moorage at the hatchery. For this reason, plans do not include a dock for loading or off-loading freight and fuel pumping, or a ramp for skiff moorage. A rock point next to the barge landing (see site map) might provide a location for a short causeway and dock in the future. Skiffs could be kept on trailers when not in use and operated at high tide from the barge landing.

Hatchery Water Supply

Bedrock mountains immediately behind the hatchery site and a saltwater bay in front suggest that a freshwater aquifer of sufficient capacity is unlikely at the hatchery location. Future investigation of a water supply and well field for this hatchery is of prime importance. The most likely location for an aquifer and well field is the Kizhuyak River flood plain about two miles upstream from the hatchery site. This is far enough inland that saltwater intrusion is unlikely. Planning at this point assumes a well field at this inland location with water pumped (200 h.p. pumping requirement) via a pipeline to the hatchery facility.

Water requirements for the hatchery vary from 0 flow in July to 5,000 g.p.m. in April and May (assumes the rearing of all fry). The annual water budget (Table 5) requires 34,500 g.p.m. to be pumped with peak flows at 11 cfs to maintain an exchange rate of 3.5 per hour in the raceways during rearing. Some heating of well water may be required at the beginning of incubation and during rearing depending on well water temperature. Saltwater will be available for rearing via an intake and pipeline from the bay. Pink salmon fry require higher salinity than chum salmon. Appropriate salt/freshwater mixes will have to be determined by experimentation to optimize the conditions for growth and survival of either species. Increased saltwater flow for rearing would decrease freshwater requirements during the peak months.

The freshwater creek adjacent to the hatchery could provide some supplemental and back-up water in addition to the well field. Dependability of this source throughout the year is unknown, but at times several cfs. could be obtained by pumping.

Table 5. Water budget projected for the Kizhuyak hatchery at capacity.[a/]

Month	G.P.M.	Activity
January	1,500	Incubation
February	3,000	"
March	5,000	Emergence & Rearing
April	5,000	" "
May	5,000	" "
June	4,000	" "
July	0	Hatchery Preparation and Maintenance
August	3,000	Broodstock Holding
September	4,000	Egg Taking
October	1,000	Incubation
November	1,500	"
December	1,500	"
Total	34,500	

a/ Does not include domestic requirements.

Water pumped from the well field will enter a conditioning/aerator building, then, via a gravity flow pipeline it will enter hatchery incubators and/or raceways, drain channels, and/or fishpasses to the bay. To maintain gravity water flow throughout the hatchery system, additional earthwork and non-frost suseptible fill material will be required for proper placement and elevation of the hatchery building and raceways.

Hatchery Construction Plan

A series of events would be necessary prior to construction and during construction of this proposed hatchery. Briefly, an optimistic schedule is as follows:

Year One
- Summer - Engineering studies to include water development, topography, soil profiles and surveying.
- Winter - Decision to build or not build a hatchery at this site.

Year Two
- Winter/Spring - Assuming it was decided to build: obtain funding (Legislative Session), begin obtaining permits and approvals and notify APA and contractor to leave pad and roads in place.
- Summer - Contract for design services through DOT/PF (assuming funds available).
- Fall - Hatchery design in progress by engineering consultant.

Year Three
- Summer - Complete permitting process and engineering design.
- Fall - Advertise for construction contract and award.
- Winter - Begin hatchery construction, incubator and equipment installation.

Year Four
- Summer - Beneficial occupancy of hatchery, and shake-down testing.
- Early Fall - First egg takes (5.0 million eggs for pink salmon or 8.0 million eggs for chum salmon) for broodstock development. These eggs could be incubated at the Kitoi Bay Hatchery if there was a construction delay and later transported as eyed-eggs to the new hatchery.

Hatchery Operation Plan

Staffing requirements for this proposed hatchery are considered as approximately the same as the Kitoi Bay Hatchery of nearly equivalent capacity. Personnel would consist of:

Full-time
Hatchery Manager - Fish Culturist V
Assistant Hatchery Manager - Fish Culturist IV
Hatchery Culturist - Fish Culturist III
Hatchery Maintenance Worker - Wage Group III

Seasonal
Fish Culturist II - 6 months, 1 position
Fish Culturist I - 26 man-months, 12 positions

The seasonal schedule of hatchery operations would be typically:

August-September
Broodstock holding and egg taking - initially Kizhuyak River until adults return to the hatchery raceways.

September-October
1. Completion of egg-take
2. Egg incubation
3. Eyed-egg sorting, egg count, incubator seeding

October-March
1. Completion of egg sorting, counting and seeding
2. Eyed-egg to fry incubation

March-June
1. Fry emergence and count (volitional via drains from incubator to raceways)
2. Fry rearing (40 - 60 days, 0.35 to 0.75 g size)
3. Fry and/or fingerling release and count (volitional to bay via drain channel)

July
1. Facility maintenance, incubator cleaning and repair
2. Water supply system repair and maintenance

Logistics and supply of this hatchery will be from Kodiak and Anchorage. Alternatives for supplying the proposed hatchery are:

1. Direct air charter between Kodiak and Kizhuyak
2. Scheduled flights between Kodiak and Port Lions and skiff between Port Lions and Kizhuyak
3. Road to Anton Larsen Bay and skiff or landing craft to Kizhuyak
4. Direct vessel or skiff travel between Kodiak and Kizhuyak
5. State Ferry between Kodiak, Homer or Seward and Port Lions, and skiff or landing craft to Kizhuyak.

At Kizhuyak, the beach landing, tidal changes, lack of a dock, 30 minute access by vessel to Port Lions or 45 minutes to Anton Larsen Bay with connections to the State Ferry or Kodiak road system suggests consideration of the following equipment for supplying the hatchey with fuel, personnel and freight:

1. Outboard skiff, 20 feet
2. LCM landing craft, 40 foot (minimum)
3. Fuel tank truck, 4-wheel drive, 1,500 gal (minimum)
4. Pickup truck, 4-wheel drive, 3/4 ton

For routine hatchery maintenance and operation, a small dozer with angle blade and detachable forks (JD 350 or equivalent) is needed in addition to other equipment. This dozer would be required to maintain access roads and the beach landing.

Communication will be by radio and telephone. The existing telephone link between Kodiak and the hydroelectric project construction camp could probably also be used by the hatchery.

The facility will need to be fully furnished with necessary equipment and supplies including shop and maintenance equipment, fire suppression equipment, safety and first aid equipment, stand-by replacement parts, pumps, etc. As for all remote facilities, the hatchery will need to be self-supporting with detailed operational plans covering all contingencies, procedures, and operations.

Evaluation Plan

The hatchery operation would be evaluated annually for the purpose of:

1. Determining contribution of hatchery produced fish to the commercial fishery and total survival and return of hatchery fish, and
2. improving quality and survival of hatchery fish to the maximum by research experimentation.

Staffing will consist of a Seasonal Biologist (9-months) and up to six Seasonal Technicians (2 - 3 month positions). A mark-recovery program and commercial fishery sampling would be initiated in conjunction with the hatchery operation. Survival of hatchery fish will be documented and possibly increased by improved methods developed by research.

Management Plan (Salmon Returns)

Generally, the management scheme to assure return of broodfish and natural escapement would be to close the Kizhuyak Bay Statistical Area to commercial fishing until the hatchery manager estimates that sufficient broodfish have collected in a protected area of the bay adjacent to the hatchery. Management biologists, after determining that natural escapement goals will be reached, could then open the bay to commercial fishing. This fishery is regulated by emergency openings and closures to assure harvest of all fish that exceed hatchery broodstock and escapement requirements. Early season fisheries may be held, if a similar situation to Kitoi exists, when males return in greater number than females at the beginning of the run. The early fishery harvests excess males and provides for a more equal sex ratio in the broodfish.

It is anticipated that the outer mixed-stock fishery would be open to fishing during general open fishing periods, but the interception of Kizhuyak bound salmon would not be sufficient to jeopardize broodstock requirements. Regulation of the mixed-stock fishery would depend upon assessment and condition of all the major stocks contributing to this fishery.

HATCHERY COSTS AND BENEFITS

Site Engineering Cost

Engineering studies would be required before selection of the site for hatchery construction. Estimated cost of these studies is $819,000. This cost would be in addition to construction cost. Specific studies and their cost are:

1. Water Source - Well field drilling and pump testing, river freeze-up determination, water analysis and pipeline routing. $615,000
2. Topography, soil profiles, tide levels, snow and rainfall. $181,000
3. Survey and legal description. $23,000

Wells found to be suitable during testing would be used later as production wells for the hatchery water supply. This will decrease the $1.25 million construction cost of well field development by some unknown extent.

Construction Cost

The proposed Kizhuyak hatchery facility is similar in size and remoteness to the Main Bay Hatchery at Prince William Sound, recently completed for the Department of Fish and Game. The Main Bay Hatchery was used as a "model" for determining basic construction costs. These costs were then modified for specific requirements for the Kizhuyak Hatchery.

Total construction cost for the Main Bay Hatchery in 1981 was $10.9 million. This consisted of $9.0 million for construction and $1.9 million to DOT/PF for administration and design. This cost is reduced by $0.5 million (hydro plant at Main Bay) and increased by $0.25 million (additional raceways), $0.75 million (saltwater intake and pipelines), $1.25 million (well field) and $0.25 million (higher mobilization and de-mobilization cost) at Kizhuyak Bay. In 1981 dollars, the actual construction cost for a hatchery at Kizhuyak is estimated at $12.9 million, assuming an inflation rate of 10% per year and actual construction in 1986, the Kizhuyak hatchery cost is projected at $20.8 million.

The $20.8 million cost projection is based upon rearing all fry. If only 50% of the fry was reared, cost would be reduced by $0.81 million and if rearing were eliminated completely, cost would be reduced by $2.82 million. Cost reductions would result from eliminating half the raceways and

reducing water requirements (50% rearing options) and eliminating the raceways, saltwater intake pipeline and water supply for no rearing. In summary, hatchery costs in 1986 are projected to be:

$20.8 million for 100% rearing of fry
$20.0 million for 50% rearing of fry
$18.0 million for 0% rearing of fry

Operation Cost

Costs for operating the Kitoi Bay Hatchery provides a baseline for estimating operating costs for the Kizhuyak Hatchery. Pumping water for the hatchery at Kizhuyak, however, increases the cost substantially over the Kitoi operation which uses a gravity flow system.

Some of the major annual operating costs projected for the Kizhuyak hatchery other than employee salaries and benefits are:

Electrical power (Table 6)	$134,400
Heating fuel (Table 7)	17,900
Vessel charters (3)	9,000
Oregon Moist Pellet (OMP) fish food (98,600 lbs x $.70) FOB Kodiak	69,020
Total	$230,320

Fish food and power costs assume that all fry are reared. In projecting annual operating cost, it is assumed that by 1988 the Kizhuyak hatchery will be purchasing fish food (possibly Alaska Dry Pellet [ADP]) from within the State. Such a dry food would be effectively less expensive because of savings in shipping, storage, freezing, and because of more efficient utilization by the fish.

Annual operation budgets (Table 8) are projected at $448,000 at start-up and $511,000 at capacity (1983 dollars). Administration and hatchery evaluation are anticipated to cost approximately 15% of the operations cost - $67,000 at start-up and $77,000 at capacity.

In addition to construction and operation cost, there will be capital costs for major equipment items and incubators for the hatchery. Capital costs are projected (1983 dollars) at:

800 NOPAD incubator trays @ $750	$225,000
Tractor-crawler (new)	35,000
Truck pick-up (new)	13,000
Truck, fuel (surplus or used)	30,000
Landing craft (surplus or used)	100,000
Total	$403,000

Table 6. Electric power requirements and cost projected for the Kizhuyak hatchery at capacity.

Month	KW Hours General	KW Hours Pumping	Monthly Total	Monthly Cost [a/]
January	12,000	33,257	45,000	$ 6,750
February	12,000	66,514	78,000	11,700
March	12,000	110,856	123,000	18,450
April	12,000	110,856	123,000	18,450
May	12,000	110,856	123,000	18,450
June	10,000	85,680	96,000	14,400
July	10,000	0	10,000	1,500
August	10,000	66,514	76,000	11,400
September	12,000	85,680	98,000	14,700
October	12,000	22,171	34,000	5,100
November	12,000	33,257	45,000	6,750
December	12,000	33,257	45,000	6,750
Total	138,000	758,898	896,000	$134,400

a/ 1983 cost @ 13.8¢ per KWH - commercial power rate Kodiak. Assumed 1987 cost @ 15.0¢ per KWH.

Table 7. Fuel oil requirement and costs projected for the Kizhuyak hatchery.

Month	Fuel Gals.	Cost[a/]
January	1,500	$ 1,875
February	1,500	1,875
March	1,500	1,875
April	1,200	1,500
May	1,000	1,250
June	750	937
July	750	937
August	900	1,125
September	1,000	1,250
October	1,200	1,500
November	1,500	1,875
December	1,500	1,875
Total	14,300	$17,874

a/ 1983 contract price $1.057/gal. #2 Diesel. Contract price by 1987 assumed to be $1.25/gal.

Fuel transportation cost to Kizhuyak estimated at 3 vessel charters @ $3,000 each ($9,000 under line 300).

Table 8. Budget projection for operation of the Kizhuyak hatchery (1983 $).

Start-up (1987 - 1990 chum or 1987 - 1988 pinks)	
Line Item	Budget
100 Salaries & Benefits	$200,000
200 Travel	8,000
300 Contractual	110,000
400 Commodities	70,000
500 Equipment[a/]	60,000
Total	$448,000

Capacity (after 1990 chum or 1988 pinks)	
Line Item	Budget
100 Salaries & Benefits	$240,000
200 Travel	15,000
300 Contractual	170,000
400 Commodities	82,000
500 Equipment[a/]	4,000
Total	$511,000

a/ Equipment - does not include incubators. Includes support equipment for operation - boats, motors, furniture, etc., and replacement items after capacity.

Total cost for site engineering, design, and construction, as well as for capital items is projected at $22,022,000 (Table 9). Annual projected cost (1983 dollars) for hatchery operations, administration, and evaluation is projected at $515,000 before reaching capacity and $588,000 after egg capacity is reached.

Hatchery Benefits

Direct benefits would be provided to the commercial fishermen who annually harvest the salmon produced. Additional benefits would be generated to processors and indirectly to the community through increased revenues and employment as a result of hatchery construction, operation, and increased number of salmon harvested in the area. The hatchery could have a significant beneficial impact on the economy (primarily supported by fishing) of the village of Port Lions. The closest salmon processors to the hatchery that might benefit from increased production are at Anton Larsen Bay, Port Bailey, and Kodiak.

Ex-vessel values, at average (1977 - 1982) prices per pound paid to the fishermen (50¢), for 4.4 million pounds of chum salmon would be nearly $2.2 million and for 2.0 million pounds of pink salmon at 37¢ per pound, $744,000. The Kizhuyak hatchery would have the capability to provide at a minimum this gross amount of new income ($2.2 million for chum or $744,000 for pinks) to commercial fishermen on an annual basis once salmon production was at capacity.

Hatchery Feasibility

FRED Division has developed an economic feasibility model for enhancement benefit-cost analysis. This model combines two programs:

1. broodstock and production simulation based upon survival assumptions, and;
2. economic benefit-cost simulation based upon predictions of production combined with economic assumptions.

An analysis of net present value (NPV) of the facility investment and benefit-cost ratio for a given economic life is generated with use of a microcomputer. This benefit-cost model is especially useful in evaluating feasibility in the planning of new hatcheries and can provide a relatively good prediction if assumptions (based upon existing knowledge and baseline data) are reasonably accurate.

For the Kizhuyak hatchery, feasibility was predicted in terms of 1983 dollars as well as a 25-year simulation for three rearing options (0%, 50%, and 100% rearing for fry) for either chum or pink salmon (Table 10). Assumptions for feasibility simulations are more favorable in terms of hatchery benefits than those given previously (Tables 3 and 4). For example, costs are in 1983 dollars, egg takes begin in 1986 rather than 1987, marine survival rates are increased, etc. In the "best case" prediction of 100% rearing, nearly 1.1 million chum salmon would be produced at hatchery capacity and 1.0 million of those salmon would be

Table 9. Summary of projected costs for the Kizhuyak hatchery.

Year	Projected Costs[a/] (1) Site Engineering ($,1983)	(2) Design and Construction ($,1986)	(3) Capital ($,1983)	(4) Operations[b/] ($,1983)	(5) Administration & Evaluation[b/] ($,1983)	Total $ (1 - 3)	Total $ (4 - 5)
1983-84	819,000	-	-	-	-	819,000	-
1983-86	-	20,800,000	-	-	-	20,800,000	-
1986	-	-	403,000	-	-	403,000	-
1987	-	-	-	448,000	67,000	-	515,000[b/]
1990[c/] or 1995	-	-	-	551,000	77,000	-	588,000[b/]
Total						22,022,000	

a/ Assumes 100% rearing of fry

b/ Annual costs

c/ 1990 at capacity for pinks
1995 at capacity for chums

Table 10. Feasibility predictions for the Kizhuyak hatchery based on production and economic simulations.

		No Rearing	50% Rearing	100% Rearing
Pink Salmon	B:C	0.37:1	0.53:1	0.66:1
	NPV a/ ($, millions)	-13.5	-11.1	-8.6
Chum Salmon	B:C	0.60:1	1:01:1	1.17:1
	NPV ($, millions)	-8.6	+0.3	+4.3

a/ NPV is net present value(value or benefit minus public cost in 1983$).

Simulation Assumptions

1. All facility costs in 1983 $, economic base year 1983, interest rate 3%.

2. Simulation begins for broodstock development in 1986 and continues for 25 years.

3. A facility capable of incubation 70 million chum salmon eggs or incubating 88 million pink salmon eggs.

4. Fecundity (eggs/female): 1,700 for pinks and 2,100 for chum.

5. Survival rates: 90% to eyed-egg, 95% to emergent fry, 95% to reared fingerling, 1.0% emergent fry to adult, 2.0% reared fingerling to adult.

6. Mean weight of pink salmon adults 3.8 lbs with an ex-vessel value of $.41/lb. Mean weight of chum salmon 8.8 lbs with an ex-vessel value of $.513/lb. Harvest cost per lb, $.06 for pinks and $.08 for chum.

7. Commercial harvest interception rates: pinks - 50% (1988 - 1989), 61% to 88% (1990 - 1991), 85% to 92% (1992+). Chums - 50% (1990 - 1993), 52% to 87% (1994 & 1995), 72% to 92% (1996 - 1998), 81% to 92% (1999+).

available for annual harvest. For pink salmon (100% rearing), nearly 1.4 million pink salmon would be produced and 1.2 million available for annual commercial harvest at hatchery capacity.

The net present value (NPV) of the Kizhuyak facility, however, is low compared to other hatchery facilities, because of the high cost of construction and operation at this site. Feasibility analysis (Table 10) shows that only chum salmon with the rearing option would produce a net positive gain if this facility were built. The best alternative of rearing all chum salmon fry is predicted to result in a 1.17:1 benefit:cost ratio and a NPV of $4.2 million. This is a marginal return on dollars invested. Compared with other public hatcheries, it is below the average benefit:cost of 1.75:1 to 2.75:1 and NPV of about $15.0 million.

DISCUSSION AND RECOMMENDATIONS

A hatchery at Kizhuyak Bay could benefit the salmon fishing industry in the Kodiak Region and also provide an economic stimulus to the village of Port Lions. The residents of Port Lions (population of 291) are primarily fishermen who would have the opportunity to harvest salmon close to the village (returning-to-their-backdoor). Annual production of 0.5 to 1.0 million harvestable salmon could provide incentive to re-establish a fish processing plant at Port Lions. It is also anticipated that, either directly or indirectly, there would be employment and support income to Port Lions as well as to Kodiak residents as a result of hatchery construction and operation.

This hatchery, if built, could provide approximately 91% of the chum salmon harvest goal for supplemental production in the Region's preliminary 20 year salmon enhancement plan (draft plan in progress). If pink salmon were produced, the hatchery could provide up to 16% of the supplemental pink salmon harvest desired by year 2002. These estimates are based upon the feasibility simulations where all salmon fry are reared.

Hatchery construction and operation at the Kizhuyak site is extremely expensive (20.8 million construction cost in 1986 $) in comparison to other hatcheries and, possibly, alternative locations, some of which are not remote, in the Kodiak area. The only advantages, as a result of the hydroelectric project, are some existing site preparation work (rock pad, roads, barge landing) and availability of commercial electrical power. Additional site preparation would have to be done for the hatchery. Even with the availability of electrical power, the cost for electricity will be high because of the necessity of pumping water from a distant well field.

Approximately 20% of the funds actually required to construct a State hatchery goes to DOT/PF for design and administration. If a hatchery costs $10 million to construct, about $2 million additional dollars are required for DOT/PF. Design costs range from 6% to 12%. If a private non-profit hatchery operator or Regional Association constructed the same hatchery, it is likely that a savings in cost of $0.5 to $1.0 million might be realized on a $10.0 million facility.

Feasibility analysis, based upon benefit-cost model simulations, shows that the return value (benefit) for dollars invested is marginal, at best, for a hatchery at Kizhuyak. The real question to be answered by this analysis is: Are there other alternative salmon enhancement projects in the Kodiak area that would provide a greater return value for dollars spent? Obviously, under the conditions of limited funds available for salmon enhancement and rehabilitation, only those facilities or projects that will result in the best return value (benefit) to the public, relative to cost, should be considered. Projects, hatcheries, or any public facility constructed with a negative or marginal NPV or benefit tends to divert public funds from more feasible and worthwhile projects that could provide far greater public benefit in the long term.

Investment of State funds into facilities and projects that will increase renewable fishery resources certainly seems prudent at this time. The economic well being of many Alaskan communities, including Kodiak, is dependent upon the fishing industry. Annual salmon harvests and the income generated from salmon processing are important industry components of the Kodiak Region. The need to increase salmon harvests has recently been recognized by the Regional Planning Team, who are involved in the preparation of a 20-year salmon plan. Hatcheries will quite likely be a major element of the plan to increase salmon production and harvest.

Recommendations on the feasibility of constructing a salmon hatchery at Kizhuyak Bay are as follows:

1. Although a chum salmon hatchery at Kizhuyak Bay that reared all of the emergent fry would produce a long term positive benefit, the low NPV and benefit: cost ratio suggests marginal feasibility and location. It is, therefore, probably not the best use of State dollars to build this hatchery.

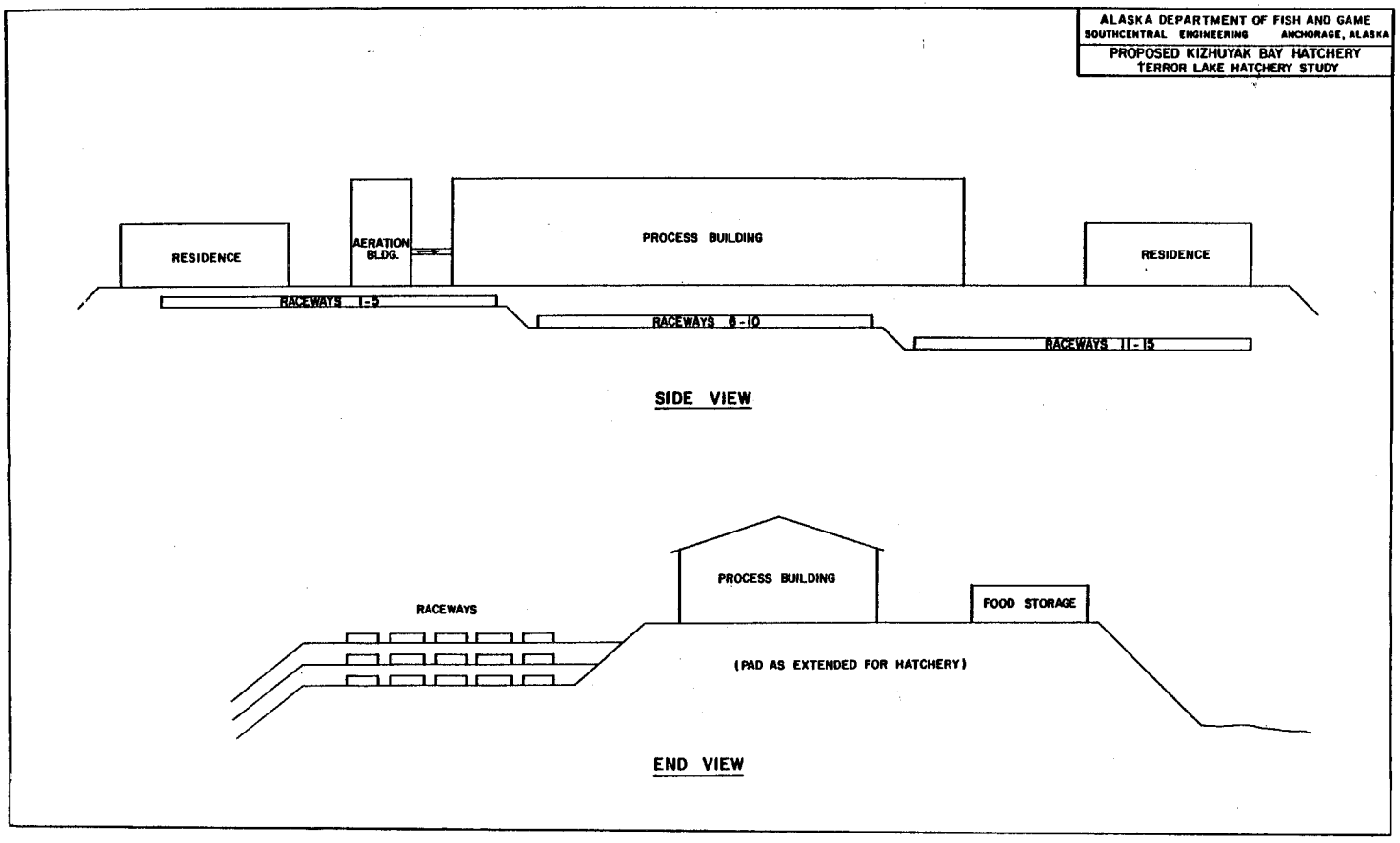
2. Other alternative locations for hatcheries that could possibly provide a greater return on investment than Kizhuyak should be investigated in the Kodiak area. Further funding for a hatchery at Kizhuyak should not be allocated until the feasibility of construction at other locations is determined.

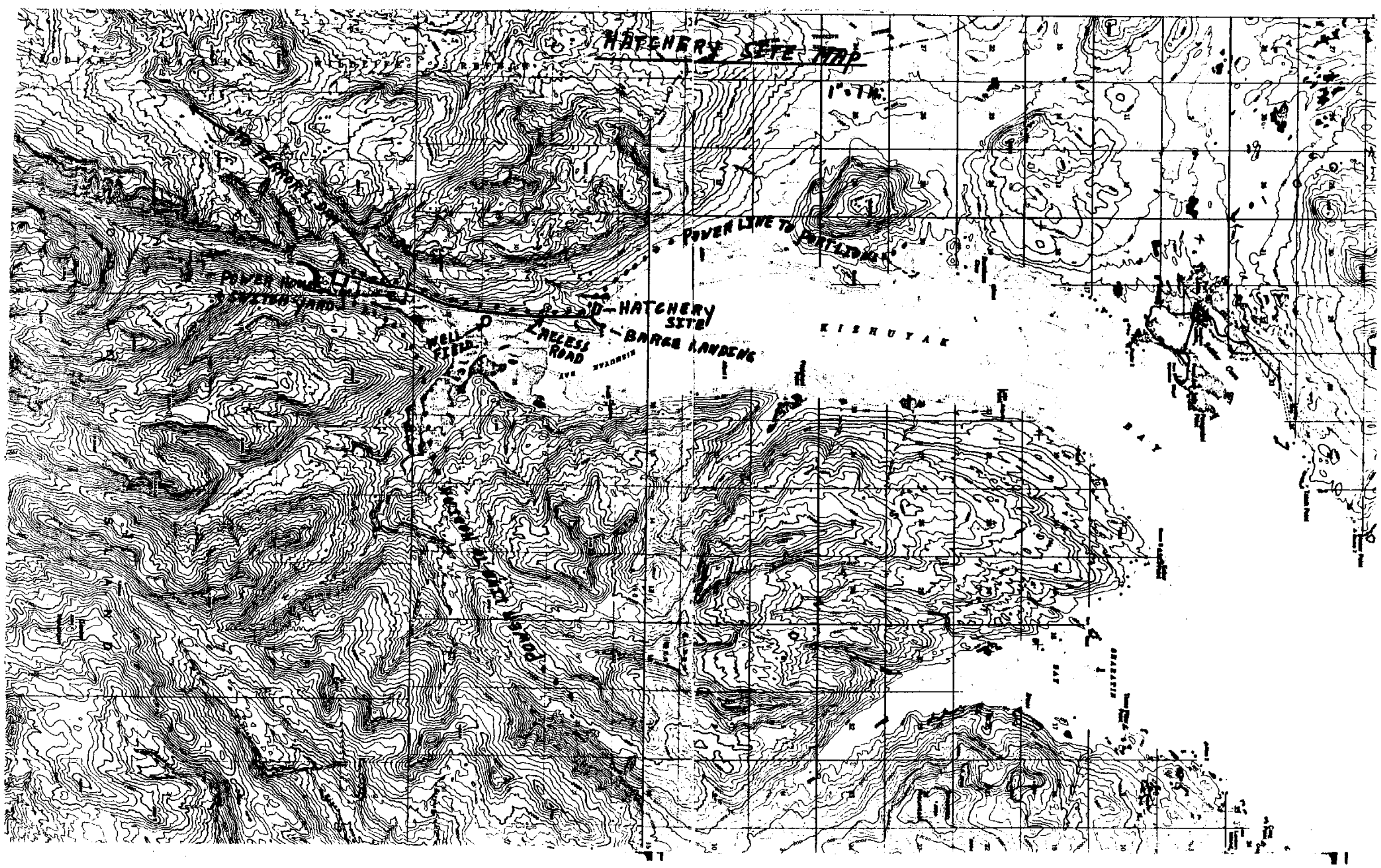
3. In conjunction with salmon enhancement planning in the Kodiak Region and recognition of the important need and value of increasing future salmon harvests, it is recommended that $125,000 in capital funding be appropriated to the Kodiak Area Office of FRED Division for investigating alternative hatchery sites and enhancement projects.

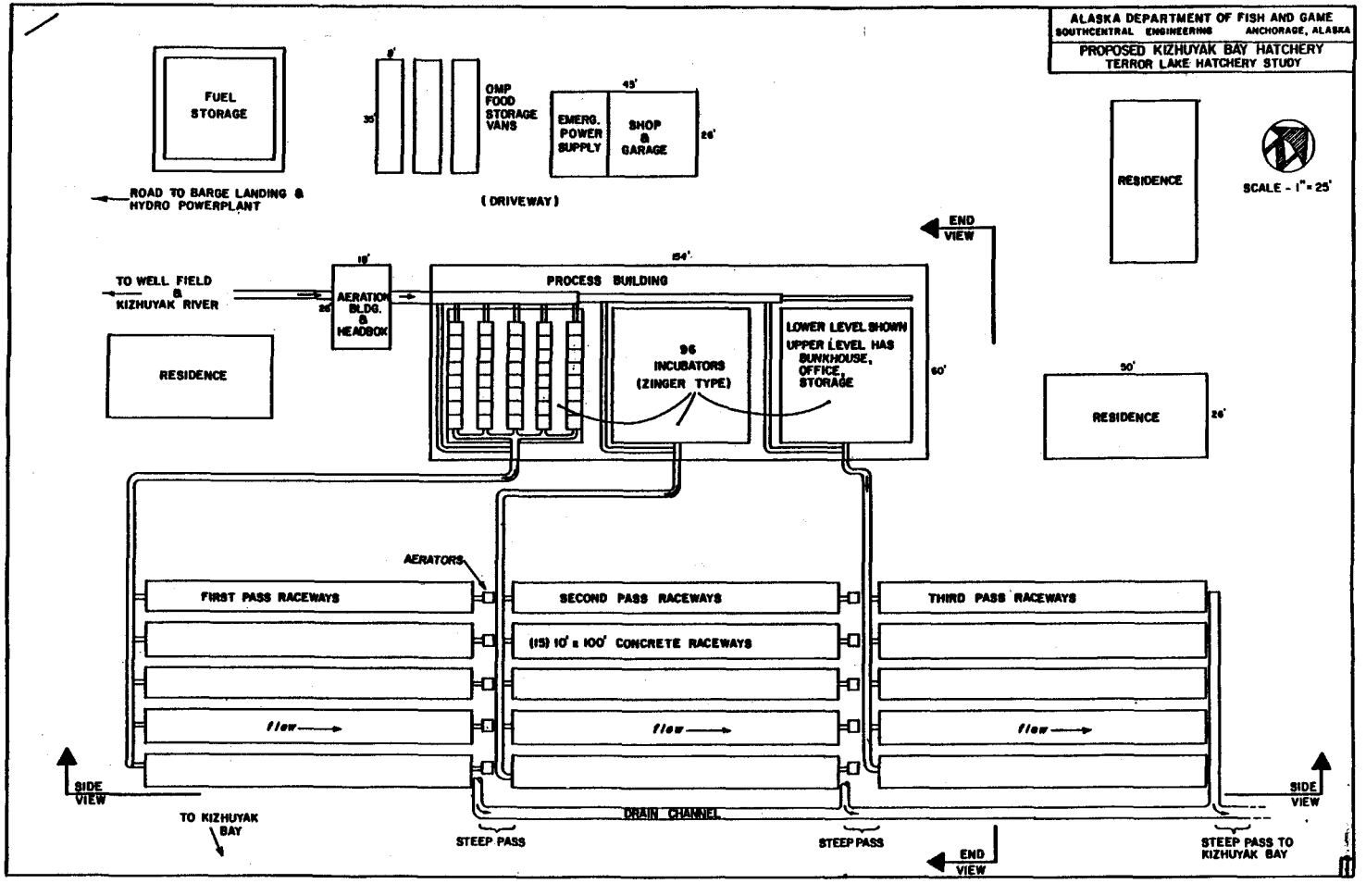
ACKNOWLEDGEMENTS

Members of the FRED Division planning team who participated in this study and contributed information for this report are Tim Joyce, Hatchery Manager, Kitoi; Steve Flodin, Tobin Spurkland, Dennis Morford, and Al Brawner, Engineers in Anchorage; and Jeff Hartman, Senior Culturist in Anchorage. Regional staff in Anchorage participated in planning meetings and provided guidance for this report.

MAPS AND PLANS


ALASKA DEPARTMENT OF FISH AND GAME
SOUTHCENTRAL ENGINEERING ANCHORAGE, ALASKA
PROPOSED KIZHUYAK BAY HATCHERY
TERROR LAKE HATCHERY STUDY
RESIDENCE
AERATION BLDG.
PROCESS BUILDING
RESIDENCE
RACEWAYS 1-5
RACEWAYS 6-10
RACEWAYS 11-15
SIDE VIEW
PROCESS BUILDING
FOOD STORAGE
RACEWAYS
(PAD AS EXTENDED FOR HATCHERY)
END VIEW


HATCHERY SITE MAP
POWER LINE TO PORT LIONS
POWER HOUSE
SWITCHYARD
HATCHERY SITE
BARGE LANDING
ACCESS ROAD
WELL FIELD
KISHUYAK
BAY


ALASKA DEPARTMENT OF FISH AND GAME
SOUTHCENTRAL ENGINEERING ANCHORAGE, ALASKA
PROPOSED KIZHUYAK BAY HATCHERY
TERROR LAKE HATCHERY STUDY
FUEL STORAGE
OMP FOOD STORAGE VANS
EMERG. POWER SUPPLY
SHOP & GARAGE
ROAD TO BARGE LANDING & HYDRO POWERPLANT
(DRIVEWAY)
RESIDENCE
SCALE - 1" = 25'
END VIEW
TO WELL FIELD & KIZHUYAK RIVER
AERATION BLDG. & HEADBOX
PROCESS BUILDING
96 INCUBATORS (ZINGER TYPE)
LOWER LEVEL SHOWN UPPER LEVEL HAS BUNKHOUSE, OFFICE, STORAGE
RESIDENCE
RESIDENCE
AERATORS
FIRST PASS RACEWAYS
SECOND PASS RACEWAYS
THIRD PASS RACEWAYS
(15) 10' x 100' CONCRETE RACEWAYS
flow
flow
flow
SIDE VIEW
TO KIZHUYAK BAY
DRAIN CHANNEL
STEEP PASS
STEEP PASS
END VIEW
SIDE VIEW
STEEP PASS TO KIZHUYAK BAY