COMPREHENSIVE

FINAL REPORT

STATE OF MONTANA
WARMWATER - COOLWATER
FISH HATCHERY STUDY

FOR:

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

1420 EAST 6th AVENUE
HELENA, MONTANA 59620

SEPTEMBER 28, 1984

PREPARED BY:

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SECTION I

Scope of the Montana Warmwater/Coolwater Fish Hatchery Study

A. Contractual Scope of Work

The 1983 Montana Legislature approved a Department of Fish, Wildlife and Parks proposal for a study to compare the merits of meeting warm and coolwater fish needs by improving the Miles City Hatchery (obtained under a 30-year lease arrangement with the U.S. Fish and Wildlife Service) versus building a new hatchery at Fort Peck Reservoir.

The objective of the study is to provide the Department of Fish, Wildlife and Parks with comparative hatchery construction costs, amortized over an appropriate period, plus operating costs to provide the following numbers and sizes of fish by two alternative methods:

Species	Size	Number
Walleye	Fry	42,000,000
Walleye	2" Fingerling	2,100,000
Northern Pike	Fry	5,000,000
Northern Pike	2" Fingerling	550,000
Largemouth Bass	1" Fingerling	500,000
Smallmouth Bass	1" Fingerling	500,000
Crappie	1" Fingerling	300,000
Channel Catfish	2" Fingerling	22,000
Reservoir Forage Fish	1" Fingerling	300,000

The hatchery is to have a 50 year design life. The methods to be considered and evaluated are:

1. Construct more rearing ponds, increase the quantity and dependability of the water supply, and make other improvements at the present Miles City Hatchery.

2. Construct a new hatchery-rearing pond complex at an assured water supply below Fort Peck Dam. This system would be similar to the water supply provided for the federal hatchery below Garrison Dam in North Dakota.

Associated Engineers III, Inc. located in Springfield, Illinois was selected by the Department to complete the study and was placed under contract on February 14, 1984. On September 7, 1984, the contract was officially changed by the Department of Fish, Wildlife and Parks to the firm of "Fisheries Design Group - Cochran & Wilken, Inc." due to the purchase of the Springfield, Illinois office by the staff involved in fish hatchery design work.

B. Methodology and Acknowledgements

In order to develop this comprehensive report, a variety of data sources were secured, physical field inspections were completed, and discussions and meetings with involved personnel were undertaken.

The following list is a summary of methods used to develop this report.

1. The U.S. Fish and Wildlife Service constructed, owned and operated the Miles City Hatchery from 1956 to 1983. All available drawings and records transmitted from the Service to the Department were reviewed and analyzed.

2. There have been many Montana Department of Fish, Wildlife and Parks employees who have had a significant involvement in the administration, development and refinement of the Montana Warmwater/Coolwater Fish Hatchery Study and the determination of goals, objectives and future needs. The following individuals have had a major involvement in the development of this study:

Mr. James Flynn	Director - Montana Department of Fish, Wildlife and Parks
Mr. Richard Johnson	Deputy Director Montana Dept. of Fish, Wildlife and Parks
Mr. Arthur Whitney	Fisheries Division Administrator
Mr. George Holton	Assistant Fisheries Division Administrator
Mr. Emmett Colley	Hatchery Bureau Chief
Mr. Allen Elser	Management Bureau Chief
Mr. Paul "Bud" Butterfield	Manager - Miles City State Fish Hatchery
Mr. Mike Rhodes	Assistant Manager - Miles City State Fish Hatchery
Mr. Keith Seaburg	Regional Coordinator - FWP
Mr. Phillip Stewart	Regional Fish Manager - FWP
Mr. Bill Weidenheft	Fort Peck Reservoir Biologist - FWP
Mr. Steve Joppa	Engineer - FWP

The following individuals with the U.S. Army Corps of Engineers were interviewed and/or provided significant information and assistance in the analysis and review of potential Fort Peck Reservoir Hatchery Sites.

Mr. Johnny Kuncheff	Area Engineer Montana Area Ft. Peck
Mr. Ronald Wallem	Project Maintenance and Construction Ft. Peck
Mr. Robert McInerney	Recreation Resource Management Ft. Peck
Mr. W.E. Woodford	Chief, Operation Division - Omaha District

Mr. L.S. Horihan	Chief, Hydrologic Engineering Branch - Omaha District
Dr. John Andersen	Limnologist - Hydrologic Engineering Branch Omaha District
Mr. Jim Opitz	Survey and Mapping Division, Omaha District
Mr. Arvid L. Thomsen	Chief, Planning Division, Omaha District
Mr. John Peta	Planning Division, Omaha District

Additional information of particular importance in the development of this study was obtained from:

Dr. Robert Bellows	Director, Fort Keogh U.S. Department of Agriculture, Range and Livestock Experiment Station
Mr. Robert Eidholt	Plant Engineer, Miles City Water Treatment Plant - Miles City, Montana
Mr. Robert Wagers	Manager, Blue Dog Lake State Fish Hatchery, Waubay, South Dakota
Mr. Pete White	Manager, Garrison National Fish Hatchery, Garrison Dam, North Dakota
Mr. Roger Copper	Manager, Gavins Point National Fish Hatchery, Yankton, South Dakota
Mr. Kirby Cottrell	Manager, Sand Ridge State Fish Hatchery, Manito, Illinois
Mr. Jim Walley	Department of Administration, Division of Architecture and Engineering.
Mr. Brent Magill	City Engineer, City of Glasgow
Mr. Manson Bailey,Jr.	Executive Director, Valley County Development Council
Mr. Marshall Fox	Acting Regional Engineer, U.S. Fish Wildlife Service, Denver

Field inspections of the Miles City State Fish Hatchery and Potential Fort Peck Reservoir Hatchery sites were conducted on February 24 - 27, 1984 by Mr. Thomas Johnson, Fisheries Biologist & Project Leader and Mr. Gary Wilken, Project Engineer to document existing conditions, and expansion potential of both sites. In addition to detailed interviews with involved personnel, an extensive series of photographs were taken during field inspections. The photographs will provide documentation of the existing conditions of various facilities at the time of the field surveys and will be used to illustrate and reference specific recommendations made in the report.

Public Meetings and Project Review Meetings

Date	Location & Purpose
Feb. 24 & 25, 1984	Miles City State Fish Hatchery Comprehensive Field Inspection and

	Comprehensive Field Inspection and Interviews
Feb. 26 & 27, 1984	Fort Peck Reservoir Comprehensive Field Inspection and Interviews
May 10, 1984	Miles City State Fish Hatchery Review of Preliminary Fish Production and Site Selection Data
June 21, 1984	Montana Department of Fish, Wildlife and Parks Central Office, Helena, Montana 75% Document Review
July 24, 1984	Hatchery Public Meeting - Elks Club, Glasgow, MT
July 25, 1984	Hatchery Public Meeting - Miles City Junior College, Miles City, MT
October 18, 1984	Miles City State Fish Hatchery Draft Final Report Review

The following staff members of Fisheries Design Group - Cochran and Wilken, Inc. have contributed to the preparation of this report and may be contacted regarding specific questions:

Mr. Thomas Johnson	Fisheries Biologist & Project Leader
Mr. Ken Ferjancic	Fisheries Biologist
Mr. Gary Wilken	Civil Engineer
Mr. Lincoln Cochran	Mechanical Engineer
Mr. Ed. Donahue	Civil Engineer
Mr. Melvin Peifer	Designer
Mrs. Cathy Peifer	Drafting
Mr. Gary Scott	Landscape Architect
Ms. Candice Woods	Secretary & Word Processing System Operator

SECTION II

SUMMARY AND RECOMMENDATIONS

After an in-depth examination of all of the factors influencing the selection of the proposed Montana Warm/Coolwater Fish Hatchery Project, it is recommended that the existing Miles City State Fish Hatchery be retained and that funds be appropriated for the major renovation and expansion of this facility.

It is estimated that the physical improvements to the hatchery necessary to meet the Department of Fish, Wildlife and Parks warmwater / coolwater fish production goals will entail an expenditure of funds for planning, design and construction in the range of $4.9 million dollars. This expenditure is based on completing all of the improvements outlined in this report in one (1) Construction Phase-which is the recommended alternative.

Specific details of the recommended program are detailed in this report.

SECTION III

Fish Production Objectives and Identification of Design Criteria for the Warmwater/Coolwater Hatchery

A. Species Production Requirements and Cultural Methods

1. General

The Montana Department of Fish, Wildlife and Parks has significantly expanded the fisheries management program for warmwater and coolwater fisheries in Montana reservoirs, impoundments and ponds. In order to adequately support this program, hatchery production of warmwater species (largemouth bass - LMB, smallmouth bass - SMB, channel catfish - CCF, white crappie - WCR and hybrid centrarchid sunfish) and coolwater species (walleye - WAE, northern pike -NP, and certain reservoir forage fish (Cisco)) must increase significantly to meet todays needs and future requirements.

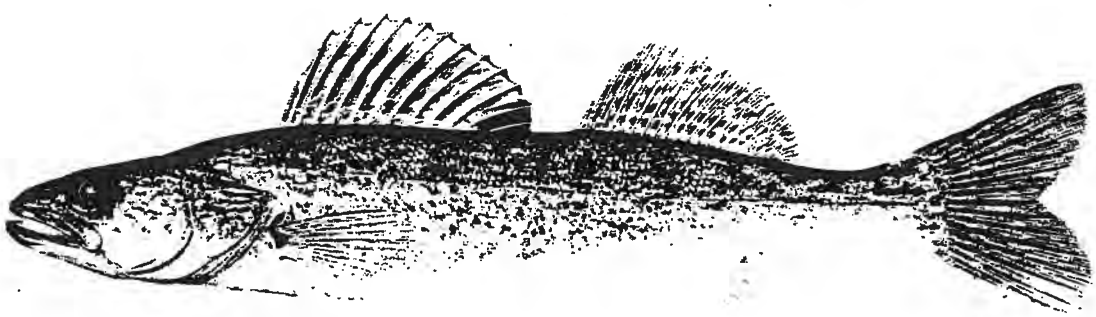
Department fisheries biologists have determined that the hatchery production of the following species, numbers and sizes is necessary to support statewide management programs.

Species	Size	Number
Walleye	Fry	42,000,000
Walleye	2" Fingerling	2,100,000
Northern Pike	Fry	5,000,000
Northern Pike	2" Fingerling	550,000
Largemouth Bass	1" Fingerling	500,000
Smallmouth Bass	1" Fingerling	500,000
White Crappie	1" Fingerling	300,000
Channel Catfish	2" Fingerling	22,000
Reservoir Forage Fish	1" Fingerlings & Fry	300,000

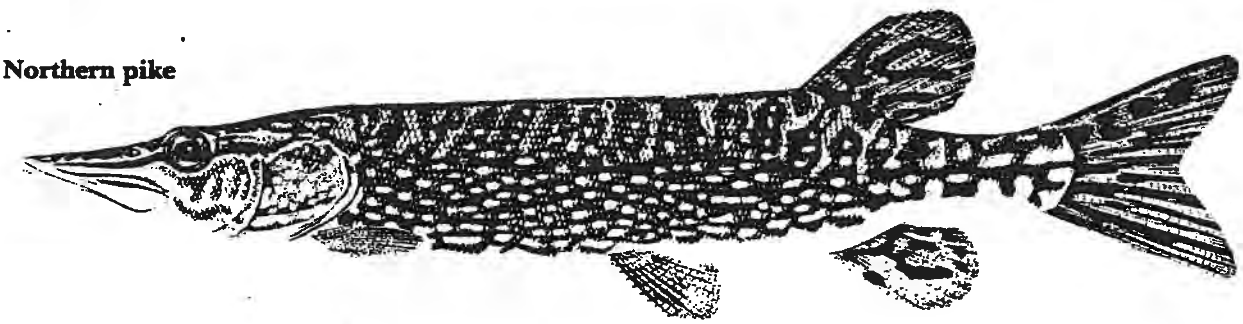
As in all state and federal fish production programs, the annual production requirements for a particular species size and number may fluctuate depending on management requirements. The objective of this study is to provide for the construction of a modern, state-of-the-art warmwater/coolwater hatchery with flexible fish production capability to meet Montana's present and future requirements. In addition to the production of species listed, rainbow trout distribution will also be carried out from the hatchery.

Warmwater and Coolwater Species cultural methods have been changing and improving for the last 50 year period. Within the last 20 years, there has been a significant effort in warm and coolwater fish culture to expand from the use of extensive pond culture methods into intensive (tank and raceway culture methods similar to those developed for trout and salmon production) or combinations of both. The culture of warmwater and coolwater species is continuously changing as improved artificial diets and

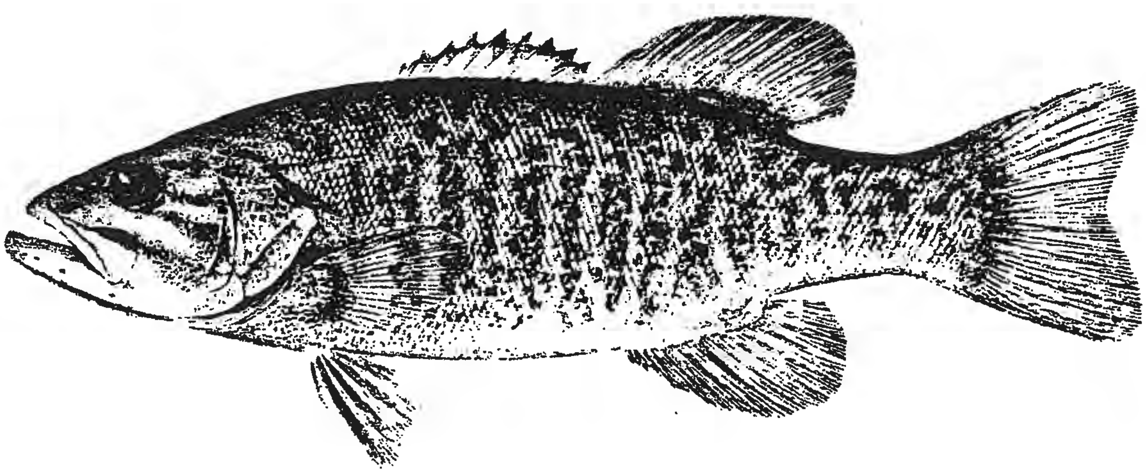
Walleye
Stizostedion vitreum (Mitchill)



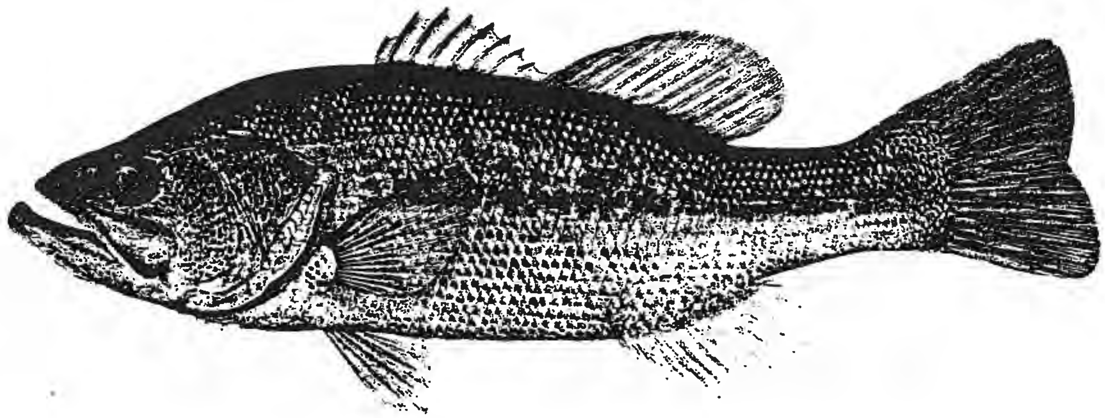
Northern pike



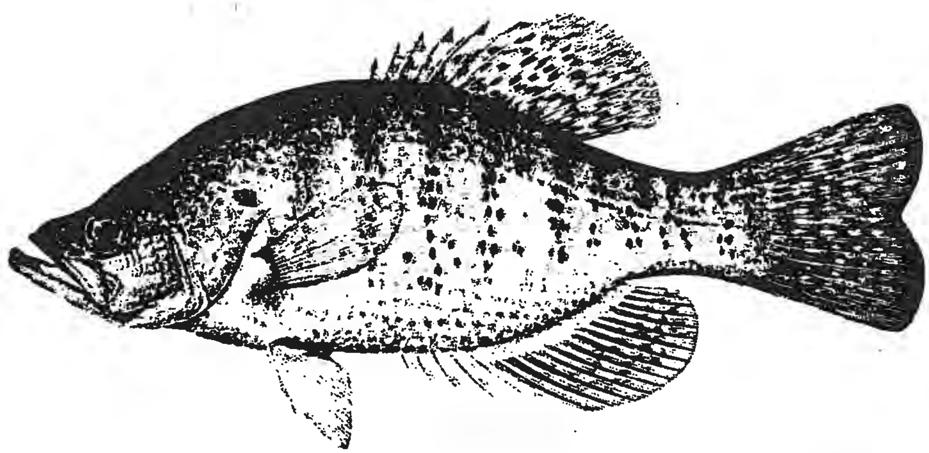
Smallmouth bass
Micropterus dolomieui Lacépède



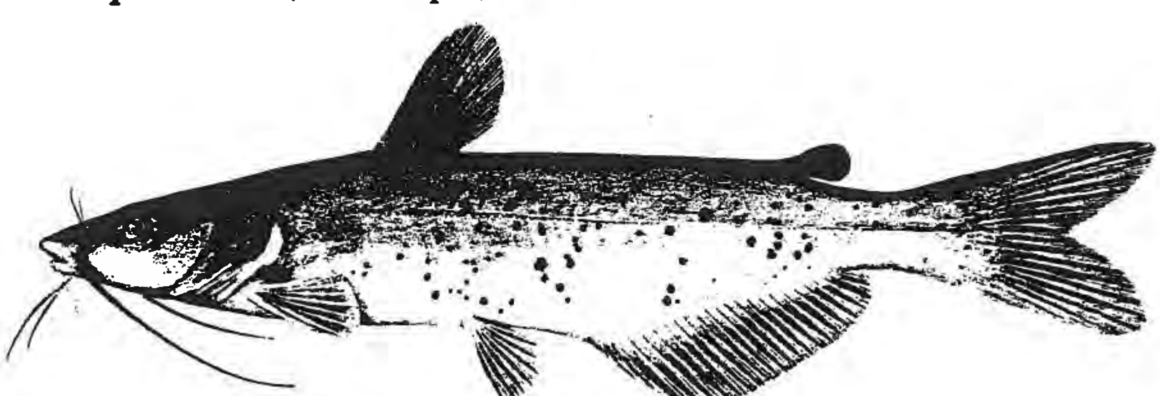
Largemouth bass
Micropterus salmoides (Lacépède)



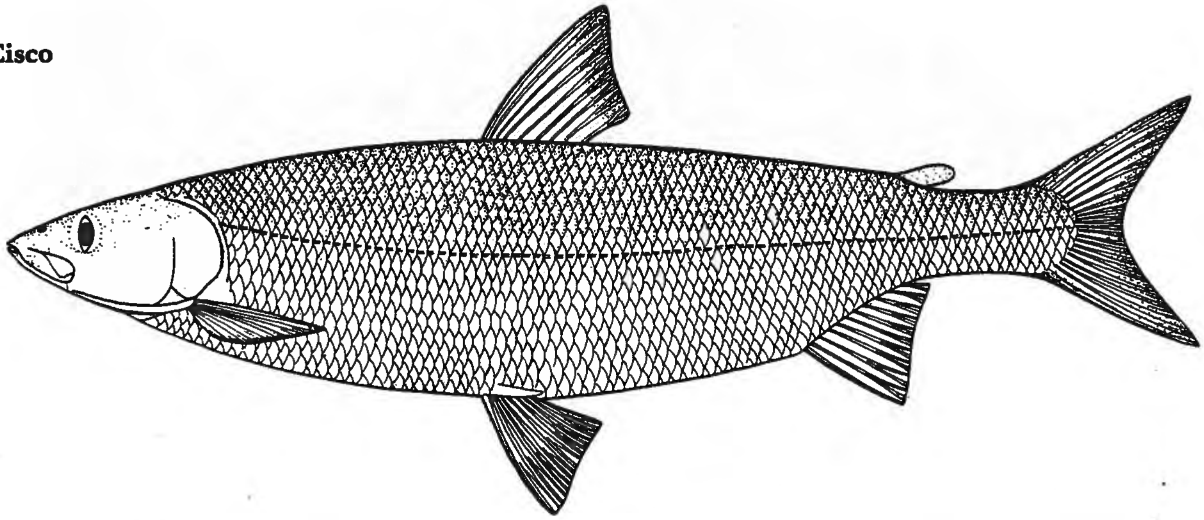
White crappie
Pomoxis annularis Rafinesque



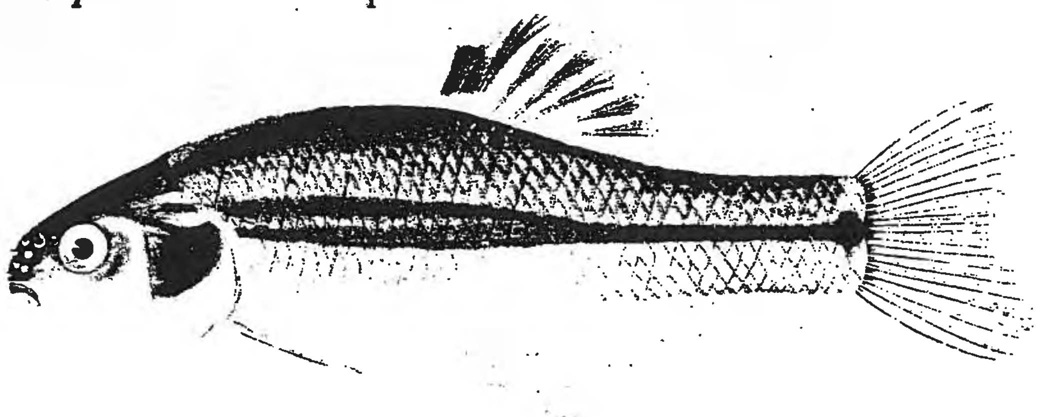
Channel catfish
Ictalurus punctatus (Rafinesque)



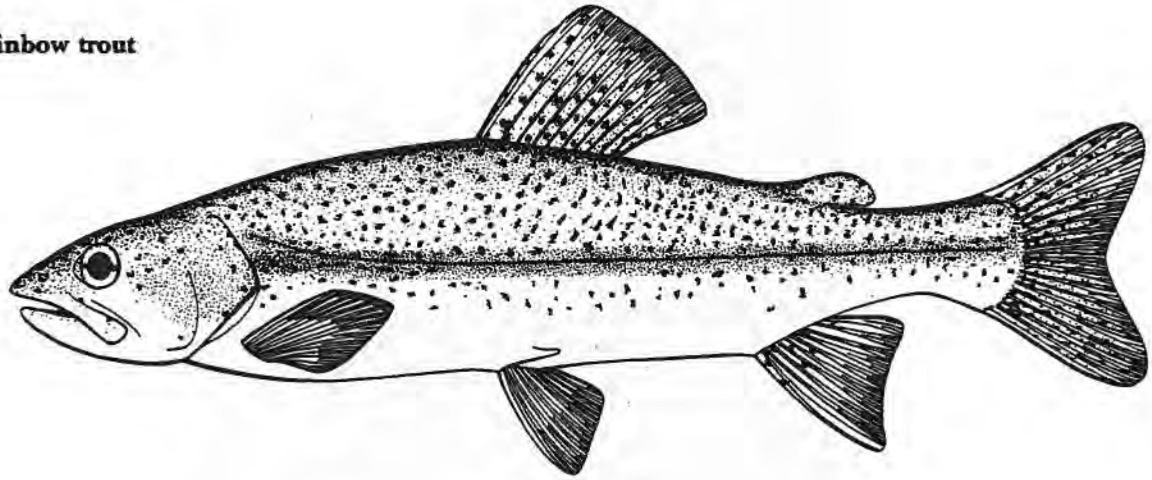
Cisco



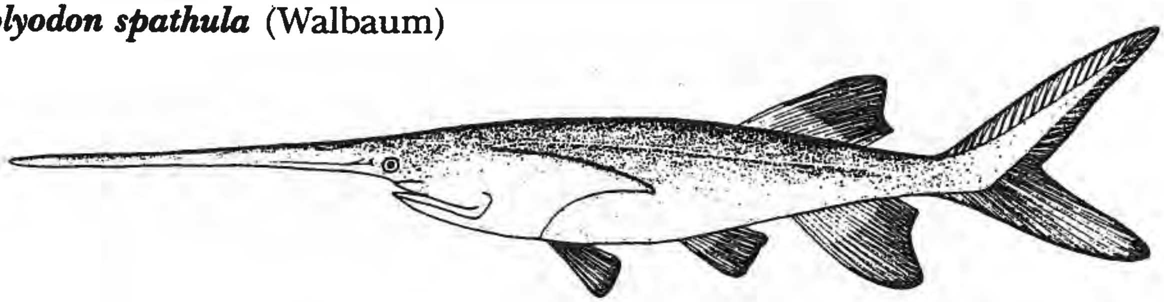
Fathead minnow
Pimephales promelas Rafinesque

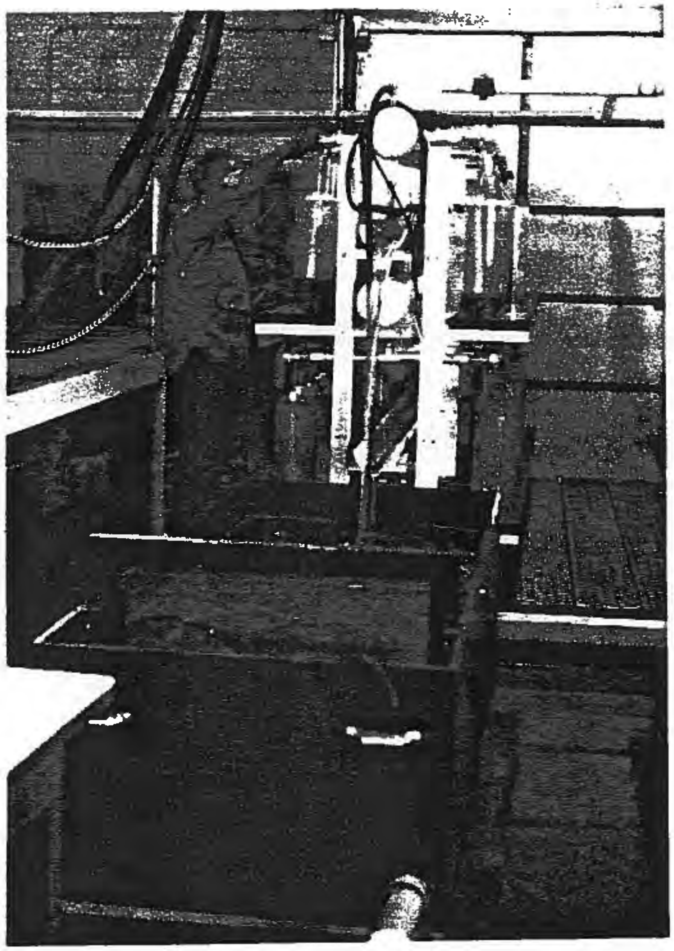


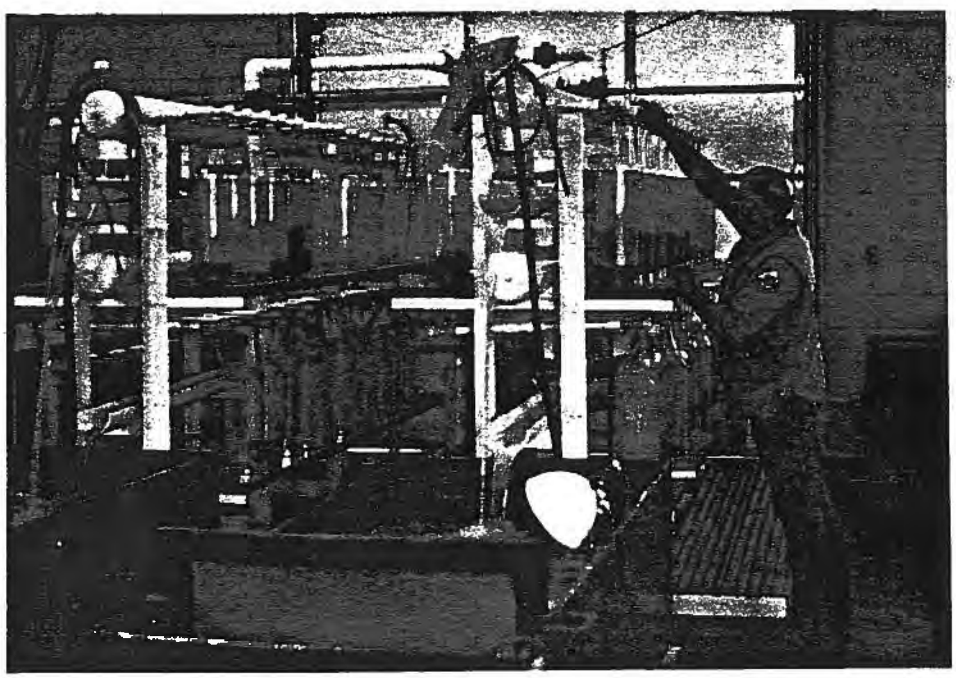
Rainbow trout



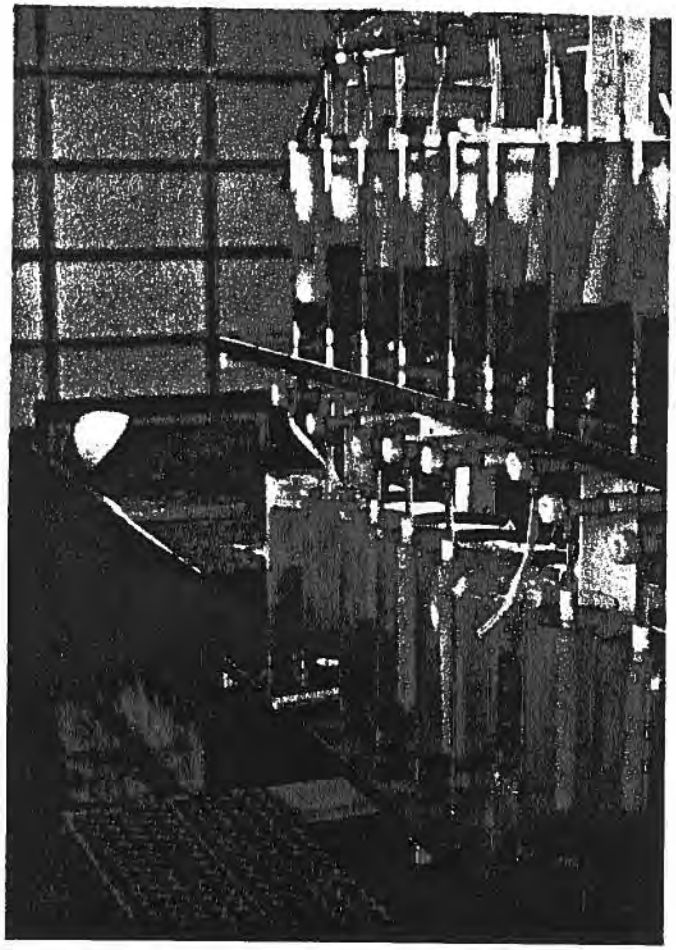
Paddlefish
Polyodon spathula (Walbaum)

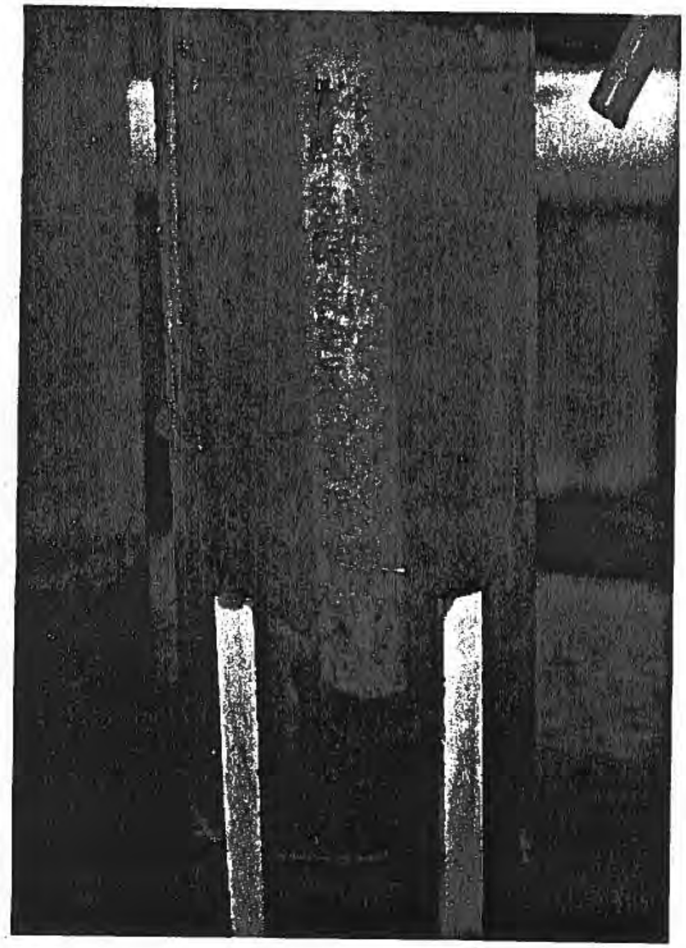






1984 WALLEYE HATCHING MILES CITY STATE FISH HATCHERY





1984 WALLEYE EGG INCUBATION AND HATCHING new culture techniques and equipment are developed and as biologists gain greater insights into the biological requirements of these fish. In the determination of proven cultural methods appropriate for the Montana Warmwater/Coolwater Hatchery, a variety of fish culture data sources have been reviewed and interviews with managers of similar state and federal hatcheries have been conducted. This report will not attempt to cite all individual references for cultural methods or production data. A complete listing of references used in this study is provided in the References Cited Section of the report.

2. Species Rearing Programs

Walleye (Stizostedion vitreum)

Walleye fry production shall be completed using standard jar hatching of eggs field collected from "wild" adult walleye during spawning runs. Adequate Holding Tank space within the building will be provided to "hold" adult walleye for ripening if necessary. In order to insure adequate supplies of green walleye eggs for support of the culture program, several different sources of adult walleye should be developed within Montana - preferably in different latitudes to permit progressive collection of adults and eggs during the spawning season.

Egg incubation shall take place in standard plastic 6" diameter McDonald hatching jars on multiple jar incubation racks equipped with several fiberglass fry catch tanks. Catch tanks shall be equipped with selectable tubes to direct fry to the desired catch tank. Fry catch tanks shall be furnished with small mesh (stainless steel) screens for retention of fry. Air service shall be provided to screens to prevent shell clogging. Egg incubation area shall provide sufficient room for fry bagging, boxing and loading to transport vehicles.

The water supply to the egg incubation system must provide a reliable supply of 58 degree F treated process water (i.e. filtered, ulltra-violet sterilized, heated water or any required combination of the three) for controlled egg incubation and hatching.

Walleye 2" fingerling production will be completed in extensive rearing ponds fertilized with chopped alfalfa hay to provide heavy zooplankton food production. Pond fertilization rates are normally 800 pounds/acre initially followed by 400 pounds per week during the rearing period. However, these fertilization levels may require adjustment depending upon zooplankton food production. Equipment to chop and spread baled alfalfa should be available to reduce the labor involved in pond fertilization.

Fingerling walleye will be harvested using either internal (inside pond) or external (common outside pond) fish harvest kettles using standard harvest seining techniques. Harvested walleye will be moved to fiberglass holding tanks in the main building for grading, and enumeration prior to shipment using insulated fish transportation tanks.

Rearing techniques and suitable artificial diets for providing intensive rearing of walleye fingerlings are rapidly improving. In the future, it appears that walleye fingerling rearing may involve a combination of extensive pond culture and intensive tank culture especially when fingerlings larger than 2" are needed for stockings. Start tanks, initial feeding troughs and automatic fish feeders will be provided in the hatchery building to provide for future intensive rearing programs.

Table 1 provides anticipated production schedules for walleye fry and fingerlings including egg requirements, fry and fingerling production estimates (length, weight, number), rearing unit requirements (type and total number) water flow and temperature requirements.

<u>Northern Pike</u> (Esox lucius)

Northern Pike fry production shall be completed using standard jar hatching of eggs field collected from northern pike similar to the method described for walleye. Adequate (preferably several different) sources of northern pike adults should be developed to insure that sufficient supplies of green eggs are available. Since northern pike are early spring spawners, spawn runs often occur under the ice or ice-out conditions making collection difficult.

Table 2 provides recommended production schedules for northern pike fry and fingerlings including egg requirements, fry and fingerling production estimates (length, weight, number), rearing unit requirements (type and total number) water flow and temperature requirements.

Intensive culture of northern pike in a production environment using the W-16 diet has been completed in Michigan, Pennsylvania and several other state and federal hatcheries. The design of the Montana Warmwater/Coolwater Hatchery should provide for both intensive and extensive rearing of northern pike using building start/holding tanks and outdoor production raceways as well as rearing ponds.

<u>Smallmouth Bass</u> (Micropterus dolomieui)

Smallmouth Bass fingerling production will be accomplished using a combination of proven extensive pond culture techniques and newly developed intensive spawning, egg incubation and initial rearing to swim-up fry techniques. Providing a method of controlling the spawning of smallmouth bass is particularly desirable since this species is notorious for abandoning spawning nests during spring cold fronts causing significant losses of eggs and fry. Due to the variability of Montana spring weather, smallmouth bass production can be dramatically influenced by cold

TABLE 1 REARING PROGRAM CRITERIA FOR WALLEYE

SPECIES: WALLEYE
SPAWNING METHOD: STRIPPING ADULTS — TEMP: 48-58 F
APPROX DATES: END APRIL- MID MAY

PRODUCTION

ANNUAL FRY PRODUCTION NUMBER:	42,000,000
FRY REQUIREMENT FOR FINGERLING PRODUCTION	4,200,000
ANNUAL TOTAL FRY REQUIREMENT	46,000,000

GREEN EGG REQUIREMENTS:	50%	60%	70%	80%
MILLIONS	92.4M	77M*	66M	58M
NUMBER OF EGGS PER QUART:		110,000		

INCUBATION JAR REQUIREMENTS	AT 2 QTS/JAR 300 JARS
TOTAL WATER REQUIREMENT	300 GPM AT 1GPM / JAR 150 GPM AT .5GPM /JAR
WATER TEMPERATURE	58F
INCUBATION TO HATCH (DAYS)	11.5 AT 300 DEGREE DAYS TO HATCH

FINGERLING PRODUCTION

ANNUAL FINGERLING PRODUCTION	2,100,000	
LENGTH: 2.0" WEIGHT LBS. 0.000239		#FISH/LB. 416 TOTAL LBS. 5039
REARING POND FRY STOCKING DENSITY/ACRE		100,000
FERTILIZATON METHOD	ALFALFA (CHOPPED)	400-800 LBS/WEEK
REARING PERIOD IN DAYS	21 TO 45	

FINGERLING HARVEST #/ACRE

SURVIVAL %	30%	40%	50%*	60%	70%
	30,000	40,000	50,000	60,000	70,000
# 1.5 A PONDS	47	35	28	24	20
# 1.0 A PONDS	70	53	42	35	30

HARVEST DATA

# OF 40 CUBIC FOOT HOLDING TANKS REQ./POND HARVESTED	3
HOLDING TANK VOLUME CUFT. /POND HARVESTED	120
HOLDING TANK INFLOW GPM	5 TO 20

* = RECOMMENDED FOR PLANNING PURPOSES

TABLE 2 REARING PROGRAM CRITERIA FOR NORTHERN PIKE

SPECIES: NORTHERN PIKE
SPAWNING METHOD: STRIPPING ADULTS TEMP: 39-45 F
APPROX DATES: APRIL

PRODUCTION

ANNUAL FRY PRODUCTION NUMBER:	5,000,000
FRY REQUIREMENT FOR FINGERLING PRODUCTION	1,200,000
ANNUAL TOTAL FRY REQUIREMENT	6,200,000

GREEN EGG REQUIREMENTS:	50%	60%	70%	80%
MILLIONS	12.4M	10.3M*	8.8M	7.75M
NUMBER OF EGGS PER QUART:		50,000		

INCUBATION JAR REQUIREMENTS	AT 2 QTS/JAR 103 JARS
TOTAL WATER REQUIREMENT	103 GPM AT 1GPM / JAR 52 GPM AT .5GPM /JAR
WATER TEMPERATURE	55-58F
INCUBATION TO HATCH (DAYS)	7.0 AT 180 DEGREE DAYS TO HATCH

FINGERLING PRODUCTION

ANNUAL FINGERLING PRODUCTION	550,000	
LENGTH: 2.0" WEIGHT LBS. 0.00159		#FISH/LB. 625 TOTAL LBS. 880
REARING POND FRY STOCKING DENSITY/ACRE		100,000
FERTILIZATON METHOD	ALFALFA (CHOPPED)	400-800 LBS/WEEK
REARING PERIOD IN DAYS	21 TO 45	

FINGERLING HARVEST #/ACRE

SURVIVAL %	30%	40%	50%*	60%	70%
	30,000	40,000	50,000	60,000	70,000
# 1.5 A PONDS	13	10	08	07	06
# 1.0 A PONDS	70	19	14	11	10

HARVEST DATA

# OF 40 CUBIC FOOT HOLDING TANKS REQ./POND HARVESTED	2
HOLDING TANK VOLUME CUFT. /POND HARVESTED	79.5
HOLDING TANK INFLOW GPM	5 TO 20

* = RECOMMENDED FOR PLANNING PURPOSES

fronts as was the case in 1984 (Bud Butterfield, personal communication). Holding smallmouth bass adults in holding tanks to suppress spawning until more stable spring weather and water temperatures will be used to prevent early spawning losses in the future.

Smallmouth bass fry collection has traditionally been a problem since the fry disperse from the nest after only a brief swim-up period. Location and observation of spawning nests in large ponds is often difficult due to wind and wave action, plankton blooms and turbidity. The portable nest spawning technique described by Hutson (1983) provides a simple method of collecting, enumerating and moving smallmouth fry from spawning ponds to fertilized zooplankton rearing ponds (Figure 1). The technique works well in spawning ponds with silt bottoms but does not work successfully in the present Miles City Hatchery ponds due to the amount of gravel in the pond bottoms and levee side slopes. One half acre elongated rectangular ponds with exposed plastic membrane liners will be provided as spawning ponds.

Recently, raceway spawning of smallmouth (and largemouth) bass has been demonstrated at several hatcheries using removable spawning substrates. In Illinois, at Sand Ridge State Fish Hatchery adhesive smallmouth eggs were removed from nesting box mock substate using the matrix-dissolving chemicals now used to separate channel catfish eggs. The eggs were incubated successfully in both jars and Heath vertical flow egg incubation units (with modified screens). Due to the controlled environment available in raceways (including adjustment of water temperatures, light, flow rates, etc.), it appears that controlled intensive spawning of smallmouth bass is feasible and offers potential to solve many of the identified spawning problems experienced with pond smallmouth culture.

Fingerling smallmouth production will be completed in rearing ponds fertilized with chopped alfalfa hay to provide a zooplankton food source. Facilities will be available to provide for intensive production of fingerling smallmouth using the newer artificial diets in the future. The benefits of maintaining smallmouth broodfish on artificial diets rather than on cultured forage fish justifies experimental intensive culture work with this fish alone.

Smallmouth broodfish will be initially obtained from both wild and hatchery reared fish. However, the goal is to establish groups of hatchery reared brood fish of Age III, IV and V for spawning with 1/3 replacement of brood fish occuring each year. Forage for brood stock maintenance is estimated at 5,000 to 7,000 pounds annually based upon the recommended 5.5 pounds of forage per pound of bass maintained. Fathead minnow forage will be used (or other suitable forage species). Security fencing for preventing theft of bass brood fish will be provided.

FIGURE 1 PORTABLE BASS SPAWNING BOX

TABLE 3 REARING PROGRAM CRITERIA FOR SMALLMOUTH BASS

SPECIES: SMALLMOUTH BASS
SPAWNING METHOD: POND &/OR RACEWAYS TEMP: 68-72 F
APPROX DATES: MAY- MID JUNE

AVG.# FRY / FEMALE : 4,000 ADULT STOCKING DENSITY #/A 100
TOTAL # OF ADULTS: 472 MIN.
SIZE OF SPAWNING POND: 0.5 ACRE TOTAL SPAWNING PONDS 8

PRODUCTION

FRY REQUIREMENT FOR FINGERLING PRODUCTION 787,000
ANNUAL TOTAL FRY REQUIREMENT 787,000

FOR INTENSIVE SPAWNING / HATCHING ONLY

GREEN EGG REQUIREMENTS:	60%
MILLIONS	1.31*
NUMBER OF EGGS PER QUART:	50,000
INCUBATION JAR REQUIREMENTS	AT 2 QTS/JAR 13 JARS
TOTAL WATER REQUIREMENT	13 GPM AT 1GPM / JAR 7.5GPM AT .5GPM /JAR
WATER TEMPERATURE	58-68F
INCUBATION TO HATCH (DAYS)	5.0 AT 140 DEGREE DAYS TO HATCH

FINGERLING PRODUCTION
ANNUAL FINGERLING PRODUCTION 500,000
LENGTH: 1.0" WEIGHT LBS. 0.001 #FISH/LB. 1,000
TOTAL LBS. 500
REARING POND FRY STOCKING DENSITY/ACRE 75,000
FERTILIZATON METHOD ALFALFA (CHOPPED) 400-800 LBS/WEEK
REARING PERIOD IN DAYS 21 TO 31

FINGERLING HARVEST #/ACRE

SURVIVAL %	30%	40%	50%*	60%	70%
	22,500	30,000	37,500	45,000	52,500
# 1.5 A PONDS	15	12	09	08	07
# 1.0 A PONDS	23	17	14	12	10

HARVEST DATA
OF 40 CUBIC FOOT HOLDING TANKS REQ./POND HARVESTED 2
HOLDING TANK VOLUME CUFT. /POND HARVESTED 75
HOLDING TANK INFLOW GPM 5 TO 20

Table 3 provides anticipated production schedules for smallmouth bass fingerlings, including brood fish requirements, fingerling production estimates (length, weight, number), rearing unit requirements (type and total number), water flow and temperature requirements.

Largemouth Bass (Micropterus salmoides)

Largemouth Bass fingerling production will be accomplished using a combination of proven extensive pond culture techniques and newly developed intensive spawning, egg incubation and initial rearing techniques similar to those discussed for smallmouth bass. Largemouth Bass culture suffers from many of the same problems previously discussed for smallmouth bass. The schooling nature of the largemouth bass fry generally simplifies fry collection and transfer from spawning ponds to rearing ponds when compared to smallmouth bass. However, the variability of spring weather, wind conditions and wave conditions, plankton levels and turbidity all influence the spawning of largemouth bass and observation of nests and collection of fry.

Largemouth spawning will be completed in 1/2 acre elongated plastic lined spawning ponds on portable (i.e. removable) spawning boxes. Normally, fry will be removed from these ponds by standard school seining techniques, however the recent removal of eggs and successful incubation in jars and/or Heath Vertical egg incubation units may also be used in the future.

Fingerling production to 1.0 inch fish can easily be accomplished in alfalfa fertilized spawning ponds. Should management needs require larger fingerlings than 2.5 to 3.0 inches then intensive culture feeding programs currently used for production of 4.0 to 6.0 inch fish should be used. Facilities for intensive feeding of largemouth bass will be provided.

Table 4 provides anticipated production schedules for largemouth bass fingerlings, including brood fish requirements, fingerling production estimates (length, weight, number), rearing unit requirements (type and total number), water flow and temperature requirements.

White Crappie (Pomoxis annularis)

White Crappie are colonial nest building sunfish that are only occasionally reared in warmwater hatcheries since mature adult fish are often stocked in lieu of fingerling crappie. Crappie spawning will be completed in extensive rearing ponds in a manner similar to that used for other sunfish such as bluegill and redear. "Wild" adult fish will be collected prior to spawning and placed into fertilized spawning ponds. Adult fish may be removed from the spawning ponds by seining or angling or left with the fingerlings until harvest.

TABLE 4 REARING PROGRAM CRITERIA FOR LARGEMOUTH BASS

SPECIES: LARGEMOUTH BASS
SPAWNING METHOD: POND &/OR RACEWAYS TEMP: 68-72 F
APPROX DATES: MID MAY- MID JUNE

AVG.# FRY / FEMALE : 4,000 ADULT STOCKING DENSITY #/A 100
TOTAL # OF ADULTS: 472 MIN.
SIZE OF SPAWNING POND: 0.5 ACRE TOTAL SPAWNING PONDS 8

PRODUCTION

FRY REQUIREMENT FOR FINGERLING PRODUCTION	787,000
ANNUAL TOTAL FRY REQUIREMENT	787,000

FOR INTENSIVE SPAWNING / HATCHING ONLY

GREEN EGG REQUIREMENTS:	60%
MILLIONS	1.31*
NUMBER OF EGGS PER QUART:	50,000
INCUBATION JAR REQUIREMENTS	AT 2 QTS/JAR 13 JARS
TOTAL WATER REQUIREMENT	13 GPM AT 1GPM / JAR 7.5GPM AT .5GPM /JAR
WATER TEMPERATURE	68-72F
INCUBATION TO HATCH (DAYS)	4.0 AT 140 DEGREE DAYS TO HATCH

FINGERLING PRODUCTION
ANNUAL FINGERLING PRODUCTION 500,000
LENGTH: 1.0" WEIGHT LBS. 0.001 #FISH/LB. 1,000
TOTAL LBS. 500
REARING POND FRY STOCKING DENSITY/ACRE 75,000
FERTILIZATON METHOD ALFALFA (CHOPPED) 400-800 LBS/WEEK
REARING PERIOD IN DAYS 21 TO 31

FINGERLING HARVEST #/ACRE

SURVIVAL %	30%	40%	50%*	60%	70%
	22,500	30,000	37,500	45,000	52,500
# 1.5 A PONDS	15	12	09	08	07
# 1.0 A PONDS	23	17	14	12	10

HARVEST DATA
OF 40 CUBIC FOOT HOLDING TANKS REQ./POND HARVESTED 2
HOLDING TANK VOLUME CUFT. /POND HARVESTED 75
HOLDING TANK INFLOW GPM 5 TO 20

No special spawning requirements are necessary, however, handling small 1" fingerling crappie is often difficult (the fish are very sensitive and die easily). Salt solutions, fish anesthetics and oxygen are often used to assist in crappie harvest and transfer.

Table 5 provides anticipated production schedules for white crappie fingerling production (length, weight, number) rearing unit requirements (type and total number), water flow and temperatures.

<u>Channel Catfish</u> (Ictalurus punctatus)

Channel catfish fingerling production (22,000-2" fingerlings) can be accomplished easily using eggs or fry obtained from other state or federal hatcheries. The maintenance of brood fish and development of spawning equipment is not justified at this level of channel catfish production. In addition, the spawning of channel catfish would likely take place in late June and July in Montana, and would move fingerling growth to 2" fish into September or October (Table 6).

Should the state significantly increase the channel catfish production program in the future to include larger numbers of fingerlings and/or the larger non-vulnerable (to predation) 8 inch plus fish now being produced by several hatcheries, the ponds, raceways and interior building features of the Montana Hatchery would permit the expansion of the catfish program.

<u>Reservoir Forage Species Production</u>

Reservoir forage fish production of species such as Cisco, shad or a variety of Notropis (minnow) species can be accomodated in the Montana Hatchery using rearing units and egg hatching equipment available for other sport fishes.

Cisco production was completed in 1984 using eggs obtained from outside sources (Canada and Minnesota). The timing of Cisco hatching to meet the needs of the reservoir stocking program can be better controlled using the heat pump system proposed for the building process water system. Using the heatpump, water may be heated or chilled to accelerate or suppress egg hatching. In 1984, Cisco hatching at Miles City Hatchery was faster than required due to the warmer well (55 degrees F) incubation water.

In addition to the production of reservoir forage species, the hatchery will require several thousand pounds of forage fish for the maintenance and development of hatchery reared largemouth and smallmouth bass brood fish. Fathead minnow production is probably the best choice for this forage requirement although golden shiner, goldfish, carp and a variety of other fish have been used to meet bass forage needs.

Fathead minnow production requires some type of cavity spawning structure. PVC or clay pipe or sheets of black plastic are often

TABLE 5 REARING PROGRAM CRITERIA FOR WHITE CRAPPIE

SPECIES: WHITE CRAPPIE
SPAWNING METHOD: POND TEMP: 60-68 F
APPROX DATES: MID MAY- MID JUNE

AVG.# FRY / FEMALE :25,000 ADULT STOCKING DENSITY #/A 100
TOTAL # OF ADULTS: 100 MIN.
SIZE OF SPAWNING POND: 1.0 ACRE TOTAL SPAWNING PONDS 1 - 2

PRODUCTION

FRY REQUIREMENT FOR FINGERLING PRODUCTION 1,250,000 AT 25% SURVIVAL
NOTE* FRY WILL NORMALLY REMAIN WITH THE ADULTS IN THE SPAWNING PONDS AND WILL NOT BE TRANSFERED TO SEPERATE REARING PONDS

FINGERLING PRODUCTION
ANNUAL FINGERLING PRODUCTION 300,000
LENGTH: 1.0" WEIGHT LBS. 0.003 #FISH/LB. 3,300
TOTAL LBS. 90
REARING POND FRY STOCKING DENSITY/ACRE 300,000
FERTILIZATON METHOD ALFALFA (CHOPPED) 400-800 LBS/WEEK
REARING PERIOD IN DAYS 31 TO 45

FINGERLING HARVEST #/ACRE

SURVIVAL %	25%	30%
HARVEST #/A	312,500	375,000
# 1.5 A PONDS	1	1
# 1.0 A PONDS	1	1

HARVEST DATA
OF 40 CUBIC FOOT HOLDING TANKS REQ./POND HARVESTED 4
HOLDING TANK VOLUME CUFT. /POND HARVESTED 180
HOLDING TANK INFLOW GPM 5 TO 20

* = RECOMMENDED FOR PLANNING PURPOSES

TABLE 6 REARING PROGRAM CRITERIA FOR CHANNEL CATFISH

SPECIES: CHANNEL CATFISH
SPAWNING METHOD: OBTAIN FRY FROM OUTSIDE SOURCE-TRADE
TEMP: 78-80 F
APPROX DATES: LATE JUNE- JULY

PRODUCTION

FRY REQUIREMENT FOR FINGERLING PRODUCTION 50,000 AT 50% SURVIVAL

FINGERLING PRODUCTION
ANNUAL FINGERLING PRODUCTION 22,000 2"
LENGTH: 2.0" WEIGHT LBS. 0.00239 #FISH/LB. 416
TOTAL LBS. 53
REARING POND FRY STOCKING DENSITY/ACRE 50,000
FERTILIZATON METHOD ALFALFA (CHOPPED) 400-800 LBS/WEEK OR USE ARTIFICIAL FOOD ENTIRELY

REARING PERIOD IN DAYS 45 TO 60

FINGERLING HARVEST #/ACRE

SURVIVAL %	50%
HARVEST #/A	25,000
1.0 A PONDS	1

HARVEST DATA
OF 40 CUBIC FOOT HOLDING TANKS REQ./POND HARVESTED 2
HOLDING TANK VOLUME CUFT. /POND HARVESTED 53
HOLDING TANK INFLOW GPM 5 TO 20

* = RECOMMENDED FOR PLANNING PURPOSES

TABLE 7 REARING PROGRAM CRITERIA FOR FATHEAD MINNOW FORAGE

SPECIES: FATHEAD MINNOW
SPAWNING METHOD: POND   TEMP: 60-65 F
APPROX DATES: MID MAY- MID JUNE

ADULT STOCKING DENSITY #/A 15,000-25,000
TOTAL # OF ADULTS: 250,000
SIZE OF SPAWNING POND: 1.0 ACRE   TOTAL SPAWNING PONDS 10

PRODUCTION

FINGERLING PRODUCTION 500,000 / ACRE AT 2" OR 1201 LBS/A
FRY MAY BE TRANSFERED TO SEPERATE REARING PONDS

FINGERLING PRODUCTION
NORMAL REARING PERIOD 45-70 DAYS
LENGTH: 2.0" WEIGHT LBS. 0.00239 #FISH/LB. 416
TOTAL PONDS = 10, TOTAL POUNDS = 12,010

FERTILIZATON METHOD   ALFALFA (CHOPPED) 400-800 LBS/WEEK
AND ARTIFICIAL FEEDS FED AT 2% OF BODY WT. / DAY

NOTE: FATHEAD FORAGE PONDS WILL BE HARVESTED AND FORAGE INTRODUCED TO LARGEMOUTH & SMALLMOUTH BASS AS REQUIRED TO KEEP FISH IN GOOD CONDITION.

* = RECOMMENDED FOR PLANNING PURPOSES

TABLE 8 REARING PROGRAM CRITERIA FOR CISCO RESEROIR FORAGE

SPECIES: CISCO
SPAWNING METHOD: JAR INCUBATION- TEMP: 35-41 F
APPROX DATES: DEC-JAN-FEB
CISCO EGGS ARE OBTAINED FROM WILD COLLECTED ADULTS OR FROM TRADES WITH OTHER AGENCIES

EGG INCUBATION (DAYS) 110 TO 125 DAYS

NOTE: FRY WILL BE COLLECTED AND STOCKED DIRECTLY INTO RESERVOIRS FOR GROWTH. FRY REPORTEDLY CAN SURVIVE UP TO 18 DAYS BEFORE REQUIRING ACTIVE PLANKTON FEEDING. EGG HATCHING CAN BE ACCELERATED BY USING WARMER EGG INCUBATION WATER TO SPEED DEVELOPMENT OR CHILLED WATER TO SLOW DEVELOPMENT
CONSIDERABLE CULTURAL FLEXIBILITY SHALL BE AVAILABLE TO PRODUCE OTHER FORAGE SPECIES AS REQUIRED (IE. SPOTTAIL SHINER, OTHER SHAD, OTHER MINNOW SPECIES, CARP, GOLDFISH ETC.)

used to provide a place for egg deposition. The black plastic method provides a method to move eggs to minnow production ponds by moving sheets of plastic upon which eggs have been layed. This method permits assessment of spawning success by hatchery personnel. Forage is essential to the bass program. Backup sources of forage should be available via purchase from outside minnow dealers. The artificial feeding program for brood stock maintenance previously discussed should be investigated.

B. Hatchery Design Criteria

1. <u>Rearing Unit Requirements</u>

Rearing Unit needs were determined by summarizing the individual species production requirements presented in Tables 1 thru 8. Fish rearing unit requirements (i.e. # of jars, start tanks, ponds and raceways) were developed for the Montana Warmwater/Coolwater Hatchery using "demonstrated" fish production values from state and federal hatcheries and fisheries literature guidelines.

Projected monthly rearing unit utilization by species is given in Table 9. Water supply requirements for each rearing unit were developed by interviews with Department personnel and established criteria.

The following number and type of fish rearing units are required to meet the identified production goals:

a. 4-Jar Incubation Racks with 100 McDonald Jars per Rack. Each rack to be equipped with 2-rectangular fiberglass fry catch tanks (8 fry catch tanks total). Rectangular fry catch tank dimensions of 10' X 2' X 2' (or 40 cubic feet) are recommended. Stainless steel fry screens shall be provided.
b. 32-Fiberglass Start/Holding Tanks. Suggested start tank dimensions are: 24 rectangular tanks 10' X 2' X 2' (40 cubic feet/tank) and 8 circular tanks diameter 6 feet X 2.5' deep (75.6 cubic feet/tank). Total start/hatchery tank volume = 1525 cubic feet. Aluminum screens and flow baffles shall be provided.
c. 16-Fiberglass Initial Feeding Troughs. Suggested size 10' X 1' X 0.66', or 6.6 cubic feet/tank. Total Trough Volume = 105.6 cubic feet.
d. 13-1/2 acre exposed membrane lined (synthetic plastic liner) extensive spawning ponds. Total surface acreage = 6.5 acres; Volume = 29.3 acre feet. Pond outlet structures and kettles shall have aluminum screens.
e. Earthen extensive rearing ponds totaling a minimum of 48 surface acres. Individual pond size should be 1.0 or 1.5 surface acres or a combination of both sizes. Ponds should have uniform size and volume. Pond outlet structures and harvest structures shall be equipped with perforated aluminum plate screens. Rearing ponds of varying

[redacted]

JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
TENSIVE ...ING UNITS	PONDS	INTENSIVE REARING UNITS	PONDS	INTENSIVE REARING UNITS	PONDS	INTENSIVE REARING UNITS	PONDS	INTENSIVE REARING UNITS	PONDS	INTENSIVE REARING UNITS	PONDS	INTENSIVE REARING UNITS	PONDS
...NGERLING HARVEST ...START TANKS	FINGERLING REARING 42 ACRES	FINGERLING HARVEST IN START TANKS											
HARVEST ...NGERLINGS ...START TANKS													
	FINGERLING REARING 14 ACRES	HARVEST FINGERLINGS INTO START TANKS	FINGERLING REARING 14 ACRES		BROOD STOCK HOLDING 2 ACRES		BROOD STOCK HOLDING 2 ACRES		BROOD STOCK HOLDING 2 ACRES				
	SPAWNING 8½ ACRES PONDS		FINGERLING REARING 14 ACRES	HARVEST FINGERLINGS	FINGERLING REARING 14 ACRES		BROOD STOCK HOLDING 2 ACRES		BROOD STOCK HOLDING 2 ACRES				
	FINGERLING REARING 2 ACRES	HARVEST FINGERLINGS INTO START TANKS											
...TAIN CCF FRY FROM OUTSIDE SOURCE		INITIAL REARING OF FRY TO FEEDING STAGE	FINGERLING REARING 1 ACRE POND		FINGERLING REARING 1 ACRE POND	HARVEST FINGERLINGS INTO START TANKS							
	FORAGE REARING		FORAGE REARING HARVEST FORAGE BEGIN BASS FEEDING		FORAGE REARING & BASS FEEDING		FORAGE REARING AND BASS FEEDING		FORAGE REARING AND BASS FEEDING				
										OBTAIN EYED EGGS FROM OUTSIDE SOURCE 100 JARS @ 10000 AT 35°-41°F		EGG INCUBATION 100 JARS @	
						HOLDING & DISTRIBUTION OF START TANKS & RACEWAYS TROUT AS REQUIRED		HOLDING & DISTRIBUTION OF TROUT IN START TANKS AND RACEWAYS AS REQUIRED		HOLDING & DISTRIBUTION OF TROUT AS REQUIRED			
	FINGERLING REARING		FINGERLING REARING		FINGERLING REARING	FINGERLINGS HARVEST & DISTRIBUTION	FINGERLING REARING						

TABLE 9.1 RECOMMENDED WATER SUPPLY FOR THE MONTANA WARMWATER/COOLWATER HATCHERY AND DATA FOR REARING UNITS.

INTENSIVE REARING UNIT	# OF UNITS	RECOM. FLOW @	TOTAL	UNIT DIMENSIONS	VOLUME CUBIC FEET	VOLUME GALLONS
HATCHING JARS	400	1 gpm	400	6' x 18¼"	0.76	5.68
OLD				12.6' x 3' x 3'	113.4	848
START/HOLDING TANKS NEW	16	25 gpm	400	10.8' x 3 x 3'	97.2	727
START/HOLDING TANKS CIRCULAR	6	25 gpm	400	10.0' x 2' x 2'	40.0	299
REARING TANKS INITIAL	8	25 gpm	200	6'0 x 3'	75.2	562
FEED TROUGHS CONCRETE	16	5 gpm	80	10' x 1' x 0.66'	6.6	49.3
RACEWAYS	8	269- 538-	2,152 4,304	60' x 6' x 3'	1080	8,078
		TOTAL=1480 max. gpm				

REARING PONDS & RESERVIOURS		SURFACE ACRES @	TOTAL SURFACE ACRES	VOLUME ACRE FEET @	TOTAL VOLUME ACRE FEET	AVERAGE DEPTH FEET	TOTAL GROUP FILLING TIME AT 3,000 gpm	FILLING TIME AT 1,000 gpm
1.5 ACRE REARING POND	21	1.5	31.5	6.75	141.8	4.5'	11.0 DAYS	32.0 DAYS
1.0 ACRE REARING POND SPAWNING	15	1.0	15.0	6.75	67.5	4.5.'	5.0	15.2
3.0 ACRE REARING POND	2	3.0	6.0	13.5	27.0	4.5'	2.0	6.1
UPPER SUPPLY RESERVOIR	1	3.0	3.0	15	15	5.0'	1.1	3.4
LOWER SUPPLY RESERVOIR	1	12.0	12.0	60	60	5.0'	4.5'	13.5
0.5 ACRE LINED SPAWNING POND	13	0.5	6.5	2.25	29.25	4.5'	2.2	6.6
SEDIMENTATION CHANNEL	1	0.25	0.25	1.25	1.25	5.0'	---	
1.5 WASTEWATER LAGOON	1	1.5	1.5	6.75	6.75*	4.5'	---	
			75 acres		341.8 acre feet		28.5 days	76.8 days
			59 acres of rearing ponds					

RECOMMENDED WATER PUMPING CAPACITY 3,000 to 4,000 gpm.

@ = RECOMMENDED
* NOT INCLUDED IN TOTAL

and irregular size and volume should <u>not</u> be built. Total rearing pond volume will be approximately 216 acre feet.

f. A combined solar warming/water storage reservoir should be constructed. The reservoir should have a surface acreage of at least 15 acres and should provide a storage volume of at least 75 acre feet (average depth 5 feet).

g. Eight (8)-60' X 6' X 3' (Volume = 1080 cubic feet) concrete production raceways shall be constructed. These production units shall be constructed in 2 tiers: 2 pair of upper tier raceways and 2 pair of lower tier units providing for water reuse. Paved 14' wide access roads shall be provided around the perimeter of each raceway. Raceways shall be equipped with modern aluminum screens, flow distribution baffles and walkways. Total raceway volume = 8,640 cubic feet.

Rearing Unit Density (pounds per cubic foot of rearing volume) and Flow Index (pounds per gallon per minute inflow) for each of the rearing units are presented in Appendix G. These tables should be used as a <u>technical reference only</u> to guide the hatchery staff determining the fish carrying capacity of the rearing units.

2. <u>Water Supply Requirements</u>

Water supply requirements were determined for the Montana Warmwater/Coolwater Hatchery based upon established criteria for rearing units discussed in Piper, etal. 1982 and through discussions with Department personnel. The following basic design criteria was used:

a. Jar Incubation Water Supply Headers shall be capable of providing up to 1 gpm per jar of filtered, ultraviolet, sterilized, heated (or chilled) process water (or any combination thereof). In addition, direct river or reservoir water shall be supplied to the jar incubation system. Total flow requirement = 400 gpm.

b. Initial Feed Troughs shall be provided with 3.2 gpm each (R=4). Total flow requirement = 52 gpm. Treated process water and river or supply reservoir water inlets shall be provided to each trough.

c. Start/Holding Tanks shall be provided with the following design flows: Rectangular units (40 cu. ft.) shall be supplied with 20 gpm each (R=4). Total Flow requirement = 480 gpm. Circular Units - 6 ft. diameter shall be supplied with 35 gpm each (R=4). Total Flow requirement = 282 gpm. All tanks will be equipped with treated process water and river/reservoir supply lines.

d. Production Raceways supply piping should be designed to provide design flows up to 538 gpm/raceway (R=4) or a Total Flow Requirment of 4,304 gpm. Normally, raceways shall operate with full serial reuse in the lower tiers, reducing the inflow requirement to 2,152 gpm. Exchange rates for warmwater and coolwater species may range from less than 1 up to 3 per hour. To permit the station to effectively handle trout for additional rearing or distribution, we suggest the design inflow of R=4 be designed for. Both direct river (pumped) and supply reservoir (gravity) supply lines will be provided to the raceways. A provision in the raceway supply piping system shall be made to permit reuse of treated process water from the main hatchery building.

e. Pond Water Supply design shall provide for overall filling of the hatchery in 21 days. Individual pond filling of any pond should be provided in 24 to 36 hours.

Recommended pond water supply to provide filling of 48 surface acres of large rearing ponds (1.0 & 1.5 surface acre, 4.5 feet average depth or 48 X 4.5' = 216 acre feet) and 6.5 surface acres of small rearing ponds (0.5 surface acre 4.5 feet average depth = or 6.5 X 4.5' = 29.3 acre feet). Total rearing pond volume of 245.3 acre feet is required (not including evaporation and ground seepage). Pond filling in 21 days will require pumping capacity of 2,650 gpm. System design should provide water supply capacity in the range of 3500 gpm to accomodate hatchery building and pond supply needs.

Total Hatchery Water Supply Requirement

Total water supply requirement for the hatchery is presented in Table 9.1. Monthly flow projections indicate that a water supply system in the range of 2,500 gpm to 4,000 gpm is required.

Process Water Treatment System Requirements

A process water treatment system capable of providing filtration, ultraviolet sterilization and heating (or chilling) of at least 500 gpm is required to meet incubation, initial fry feeding and brood stock holding needs. The interconnecting piping of the treated water system components should permit any combination of treatment methods desired. A water to water electric heat pump capable of heating (or chilling) process water a maximum of 10 degrees F is recommended due to the dual heating or chilling capability and efficient energy utilization. Plate 8 illustrates a typical process water treatment system, combined packed column aerator/degasser-supply headbox and heat pump/heat recovery sump for Miles City Hatchery. This sytem is absolutely essential to provide the required flexibility in egg incubation initial fry feeding and broodstock holding for the fish production program.

Specific details of all water suupply system piping and drains should be carefully coordinated with Department hatchery staff during the final design phase of the Montana Hatchery Project to insure that all requirements are addressed.

Low Pressure Air System

A low pressure air system capable of providing 5 psi air to all rearing units in the main hatchery building for screen cleaning and supplemental aeration shall be provided. Air generation shall be provided via low pressure air blowers to be located in a remote blower building (due to noise).

3. Hatchery Buildings and Related Support Facility Requirements

Based upon the identified fish production program requirements and our understanding of Department hatchery operational needs, the following facility requirements are recommended:

a. A main hatchery building (9,800 +/- square feet) to include Offices, Visitor Displays, Incubation and Start/Holding Tanks Room, Mechanical Room for Process Water Treatment System, Shop, Food Preparation Area and Crew Support Facilities.

b. Low Pressure Air Blower House and Generator Building (600 square feet) to provide isolation of equipment from the main hatchery building (due to high noise levels).

c. An equipment storage building of at least 4,000 square feet. The building will provide additional shop working area as well as equipment storage. A pre-engineered heated and insulated metal building is recommended.

d. Security Fencing around the entire hatchery complex is recommended. Minimally, security fencing around bass broodstock ponds and raceways will be provided to discourage vandalism.

e. Three residences (1400 to 1500 square feet) with garage are recommended.

f. Paving around the main hatchery building, storage building raceways, residences and visitor parking is strongly recommended. All pond access roads shall be compacted aggregate surfaces.

SECTION IV

Site Selection Criteria

A. General Description of the Fort Peck Reservoir Site and Miles City State Fish Hatchery Site

1. Fort Peck Reservoir Site

Figures 2 and 3.

Fort Peck Dam and Reservoir is located 18 miles southeast of Glasgow, Montana. Fort Peck reservoir is located at Missouri River Mile 1771.5 and was the first of 6 Missouri River Main Stem Reservoirs constructed (Figure 4). The dam represents one of the longest and oldest hydraulic earth fill dams in the world. The reservoir is 134 miles long with 1,520 miles of shoreline at normal operating pool of 2246 MSL (240,000 acres).

Based upon field inspections and discussions with Mr. Johnny Kuncheff, Montana Area Engineer; Mr. Ron Wallem, Head of Project Maintenance and Construction; and Mr. Bob McInerney, Head of Project Recreation and Resource Management, U.S. Army Corps of Engineers (COE), several potential hatchery sites at Fort Peck Reservoir were investigated and analyzed.

Plate 1 shows the location of potential hatchery sites A, B and C located downstream (i.e. in the tailwater area) of Fort Peck Dam. Areas A, B and C were analyzed with respect to their ability to provide approximately 100 acres of land area necessary for hatchery development, potential to provide gravity flow water supply from the dam, topography, flood protection and overall compatibility with existing Corps of Engineer reservoir operations.

Area B

Area B (located adjacent to the dredge cut pond) provides approximately 50 acres of project land for hatchery development. An additional 50 acres of private land would be required for hatchery development. Gravity water supply from the #1 Unit Intake Tube would require over 12,000 feet of main water supply pipe. Due to the distance from the dam and the required purchase of private land, Area B is not recommended for hatchery siting. Hatchery water supply could be pumped from the dredge cut pond, however, this option is not recommended due to operational costs associated with water pumping. Area B is shown in Figure 5.

Area C

Area C (located along the left bank of Missouri River channel) provides approximately 70 acres of project land for hatchery development. Private land acquisition of 30 acres (shown on Plate 1) would be required for hatchery development. Gravity

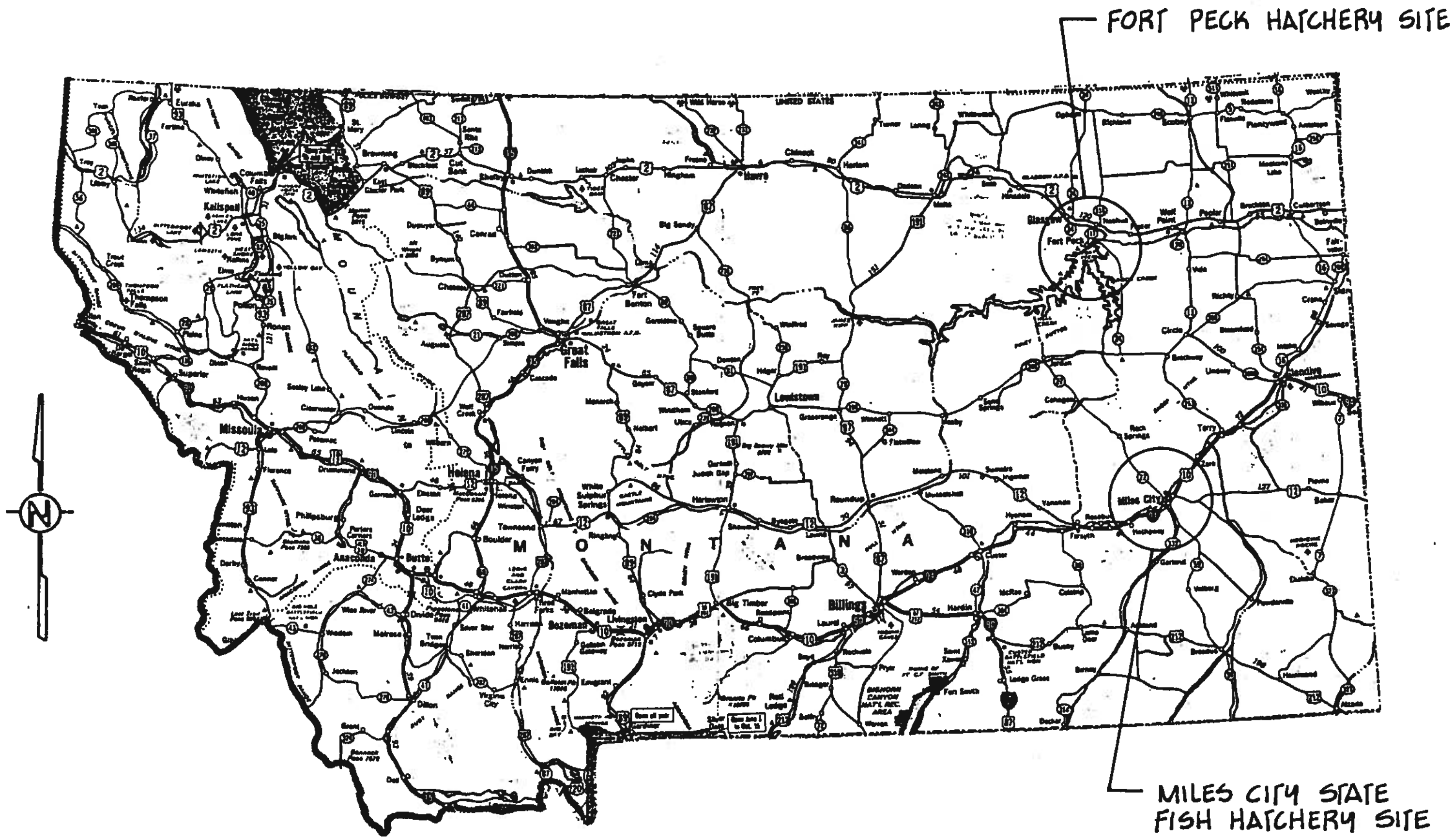


FIGURE # I-A

HATCHERY SITE LOCATION MAP

MONTANA WARM/COOL WATER
FISH HATCHERY STUDY

Fisheries Design Group	DATE 9/28/84

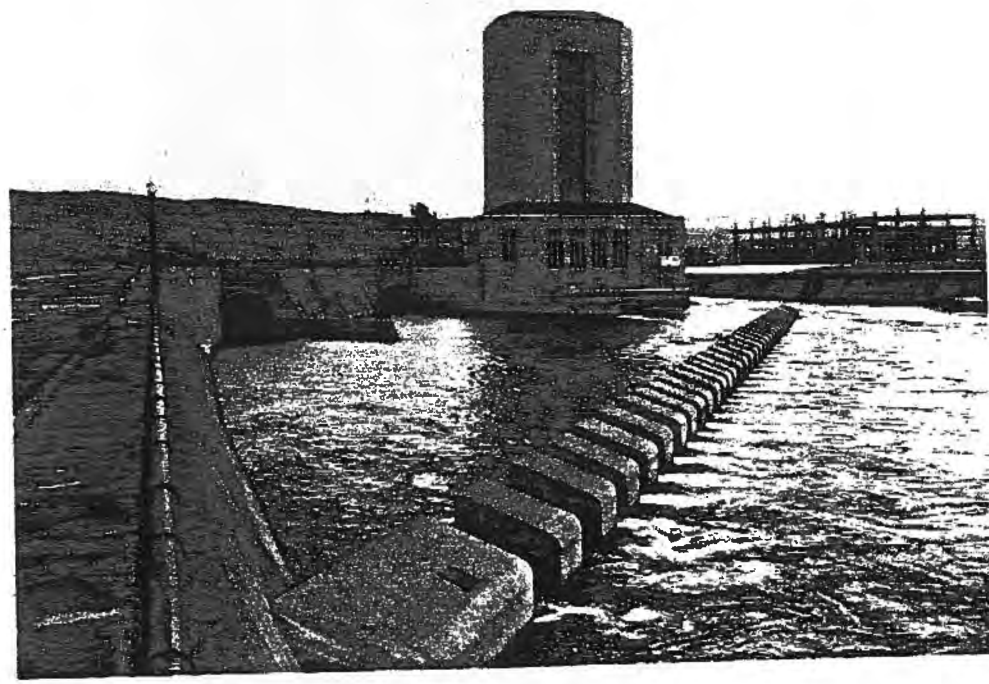
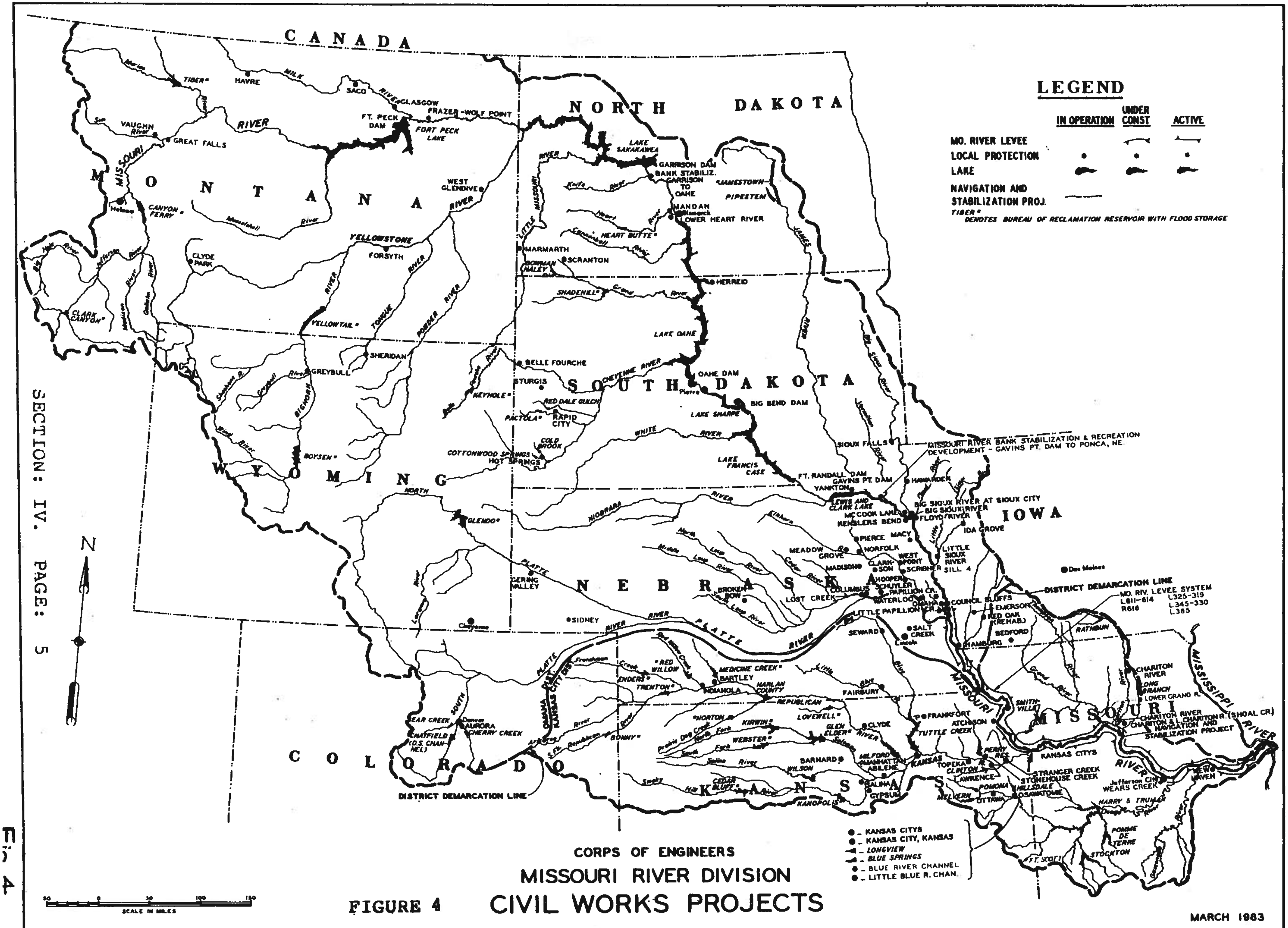
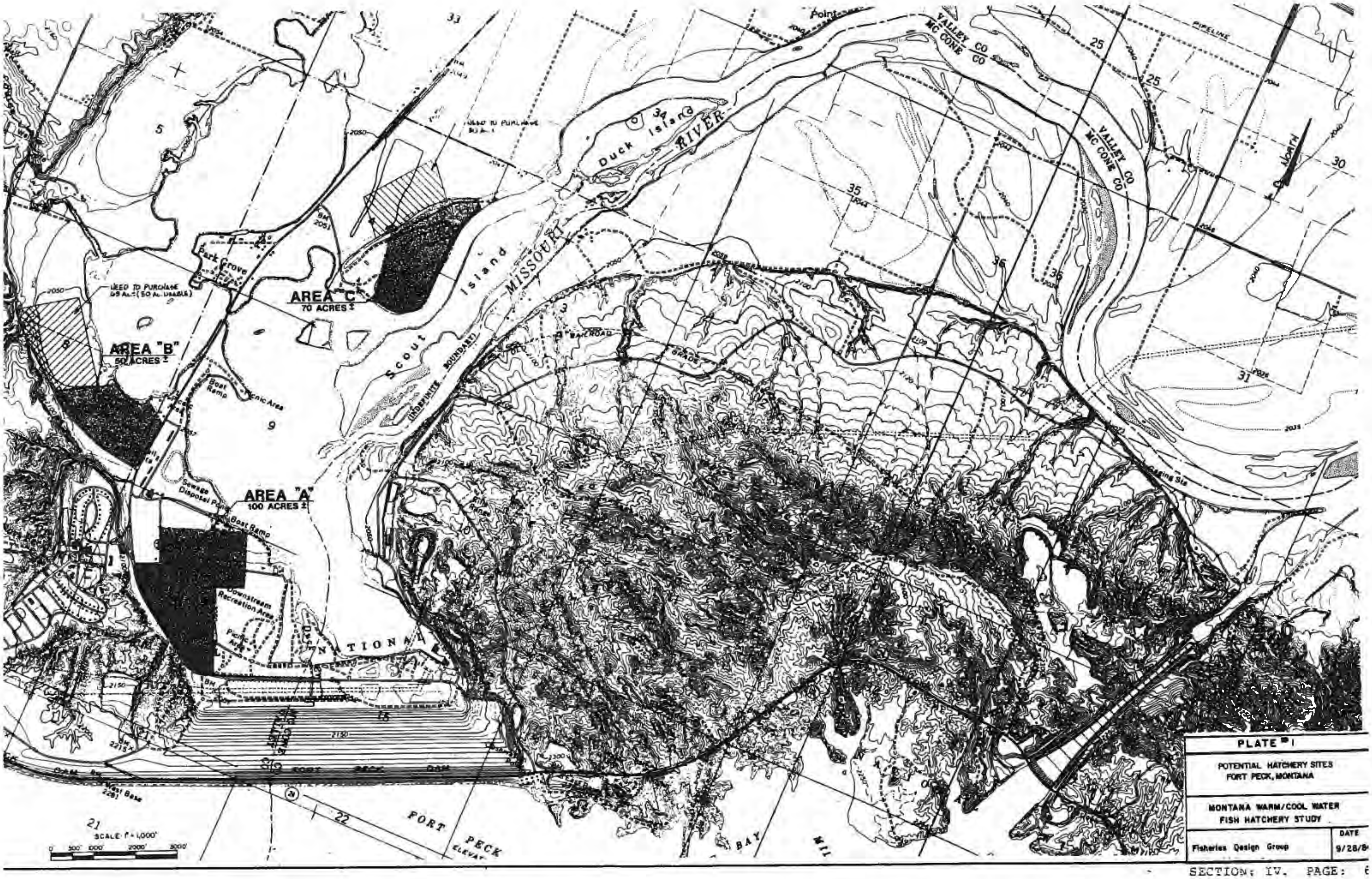


FIGURE 3 FORT PECK PROJECT SIGN & POWERHOUSE



CORPS OF ENGINEERS
MISSOURI RIVER DIVISION
FIGURE 4 CIVIL WORKS PROJECTS

Fig 4


AREA "A"
100 ACRES ±
AREA "B"
50 ACRES ±
AREA "C"
70 ACRES ±
NEED TO PURCHASE
MISSOURI
RIVER
Duck Island
Scout Island
Park Grove
Boat Ramp
Picnic Area
Sewage Disposal Pond
Boat Ramp
Downstream Recreation Area
Picnic Area
VALLEY CO
MC CONE CO
VALLEY CO
MC CONE CO
PIPELINE
NORTH
RAILROAD
GRADE
FORT PECK DAM
FORT PECK
BAY
SCALE 1" = 1,000'
0 500 1000 2000 3000
PLATE #1
POTENTIAL HATCHERY SITES
FORT PECK, MONTANA
MONTANA WARM/COOL WATER
FISH HATCHERY STUDY
DATE
Fisheries Design Group

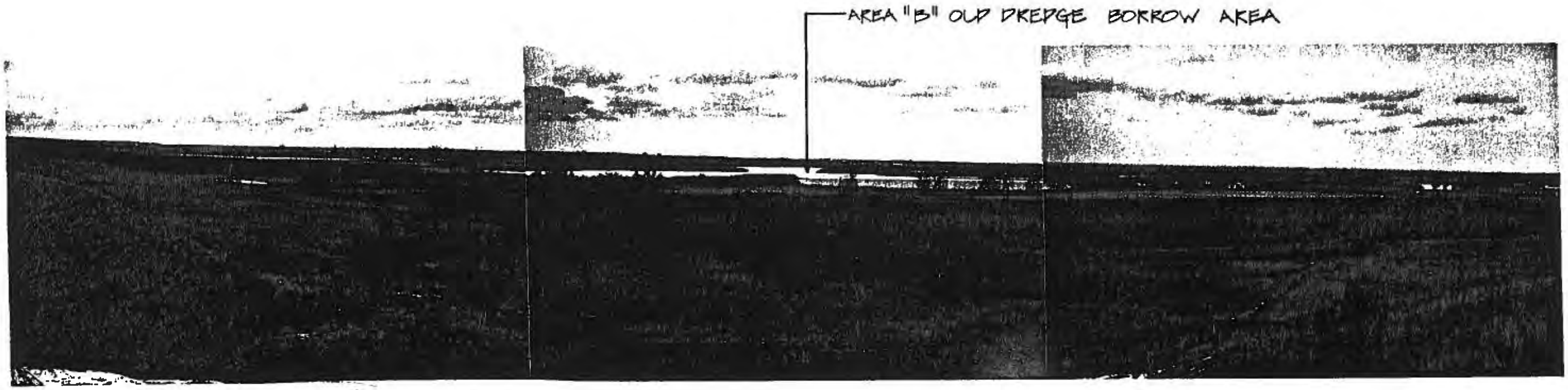


FIGURE 5 AREA B POTENTIAL HATCHERY SITE FORT PECK

water supply from the #1 Unit Intake Tube would require over 11,000 feet of main water supply pipe and would require expensive pipe line crossing of the Missouri River. Area C could be adversely impacted by the (proposed) construction of the Corps of Engineers Re-Regulation Dam and high discharges from the dam control works. Similar to the reasons discussed for Area B, Area C development is not recommended. General location of Area C is shown in Figure 6.

Area A

Area A (located along the left bank of the Missouri River channel) immediately downstream of the dam is the preferred Fort Peck Hatchery Site. This location was suggested as a possible hatchery site in the 1946 Corps of Engineers Master Recreation Development Plan for Montana.

Area A provides the required 100 acres required for hatchery development and can provide the desired gravity flow water supply line (approximately 6,000 feet) from the #1 Unit Intake Tube.

Figures 7 and 8 show the location and general topography and characteristics of Area A. Figure 9 illustrates the routing of the new Fort Peck Water Treatment Plant Supply Line from the #1 Unit Intake Tube to the Plant.

Figure 10 illustrates the area below the west side of the dam (southwest of the town of Fort Peck). This area was also considered as a potential hatchery site, but would require the construction of a separate reservoir water intake structure and long drainage ditch to the tailwater area. Further consideration was not given to this area.

2. <u>Miles City State Fish Hatchery Site</u>

Operation of the Miles City State Fish Hatchery was assumed by MDFWP under the provisions of a 30-year lease agreement (Appendix A) from the United States Department of the Interior, Fish and Wildlife Service on March 31, 1983. The hatchery was constructed by the U.S. Fish and Wildlife Service and was operated by that agency from 1958 - 1983.

The hatchery is located 1 mile north of Interstate 94 in Custer County, Montana. Plate 3. Distance to Miles City is approximately 1 1/2 miles to the northeast. The hatchery is bordered to the south and east by the Fort Keogh U.S. Department of Agriculture Range and Livestock Experiment Station. Northern boundry of the hatchery is Spotted Eagle Lake (Figure 11), a City Operated Recreation Area. Western boundry is formed by Branum Lake, a public fishing lake built and owned by the Department, now operated as a forage production lake as a part of the hatchery complex. The Miles City Hatchery includes 168.22 acres of land and 40 acres of land associated with Branum Lake.

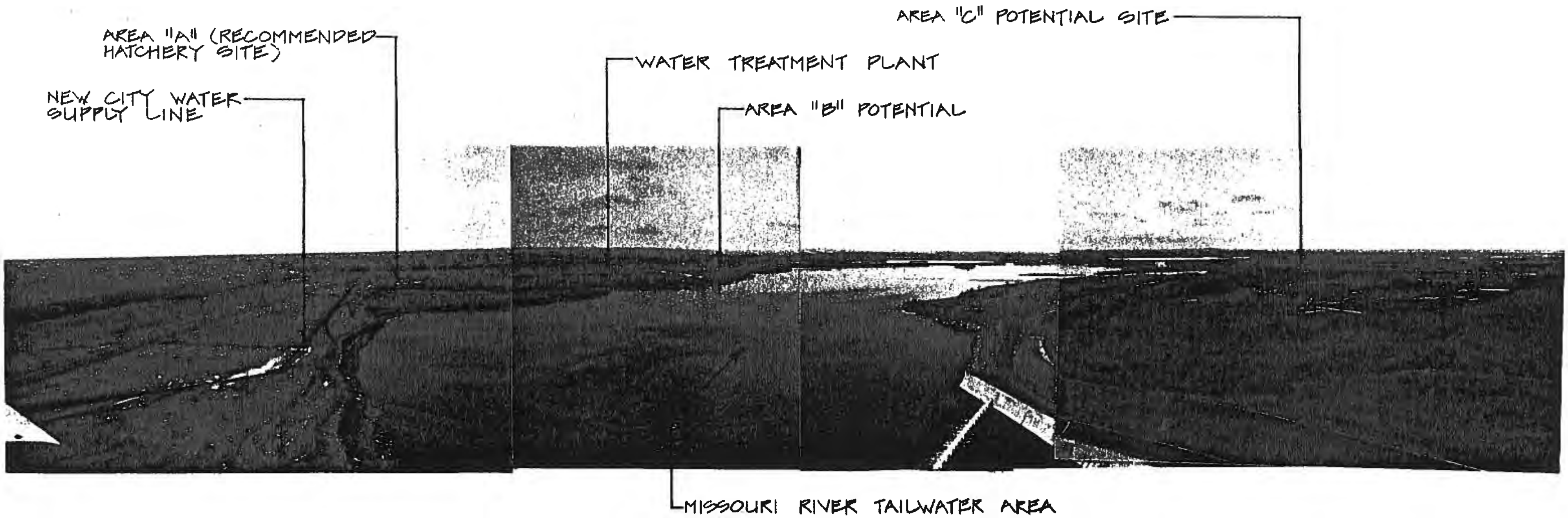


FIGURE 6 AREA C POTENTIAL HATCHERY SITE FORT PECK

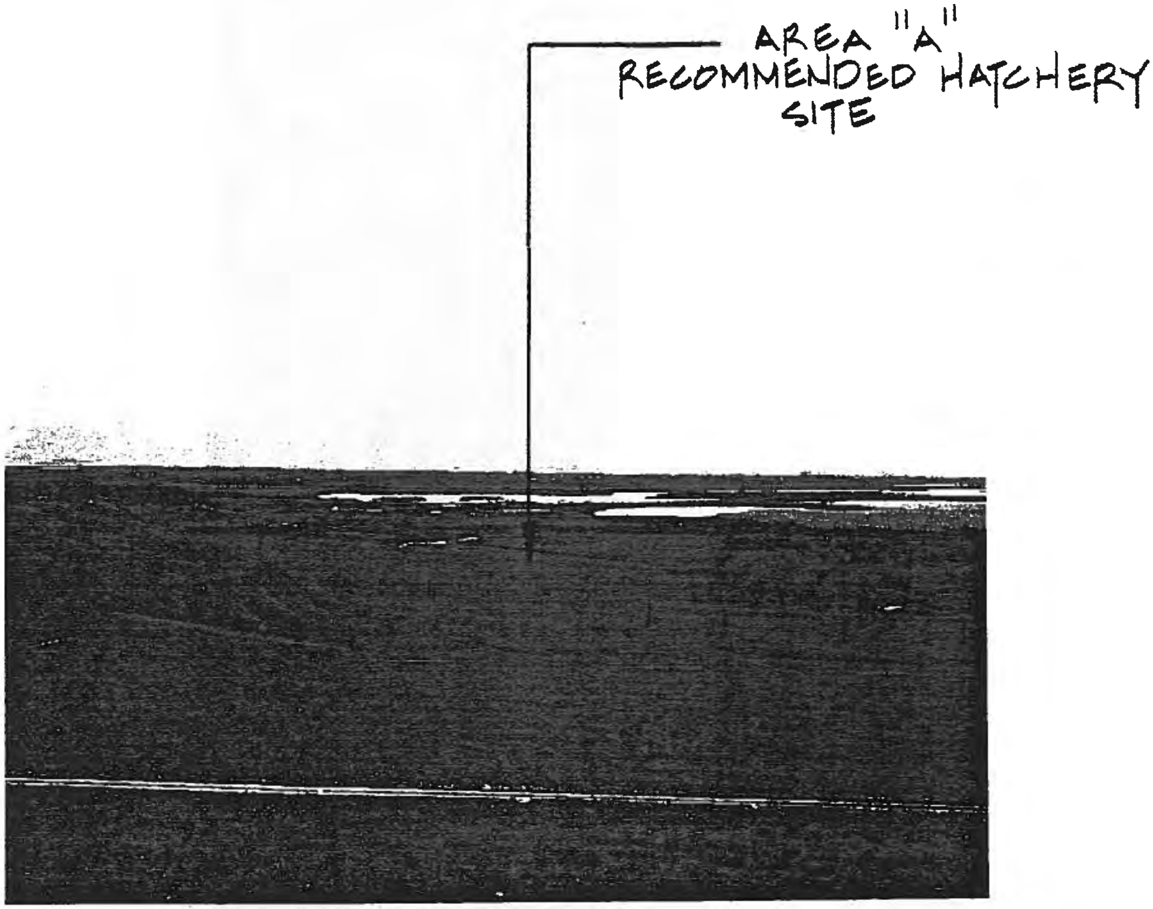


FIGURE 7 AREA A POTENTIAL HATCHERY SITE FORT PECK NORTHWEST VIEW

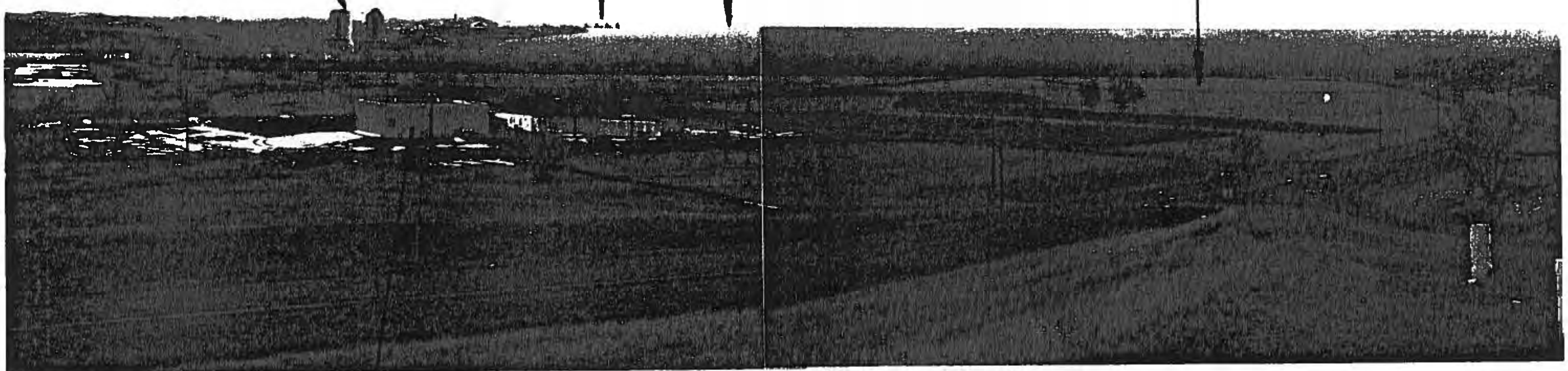


FIGURE 8 AREA A SOUTHEAST VIEW TOWARD DAM

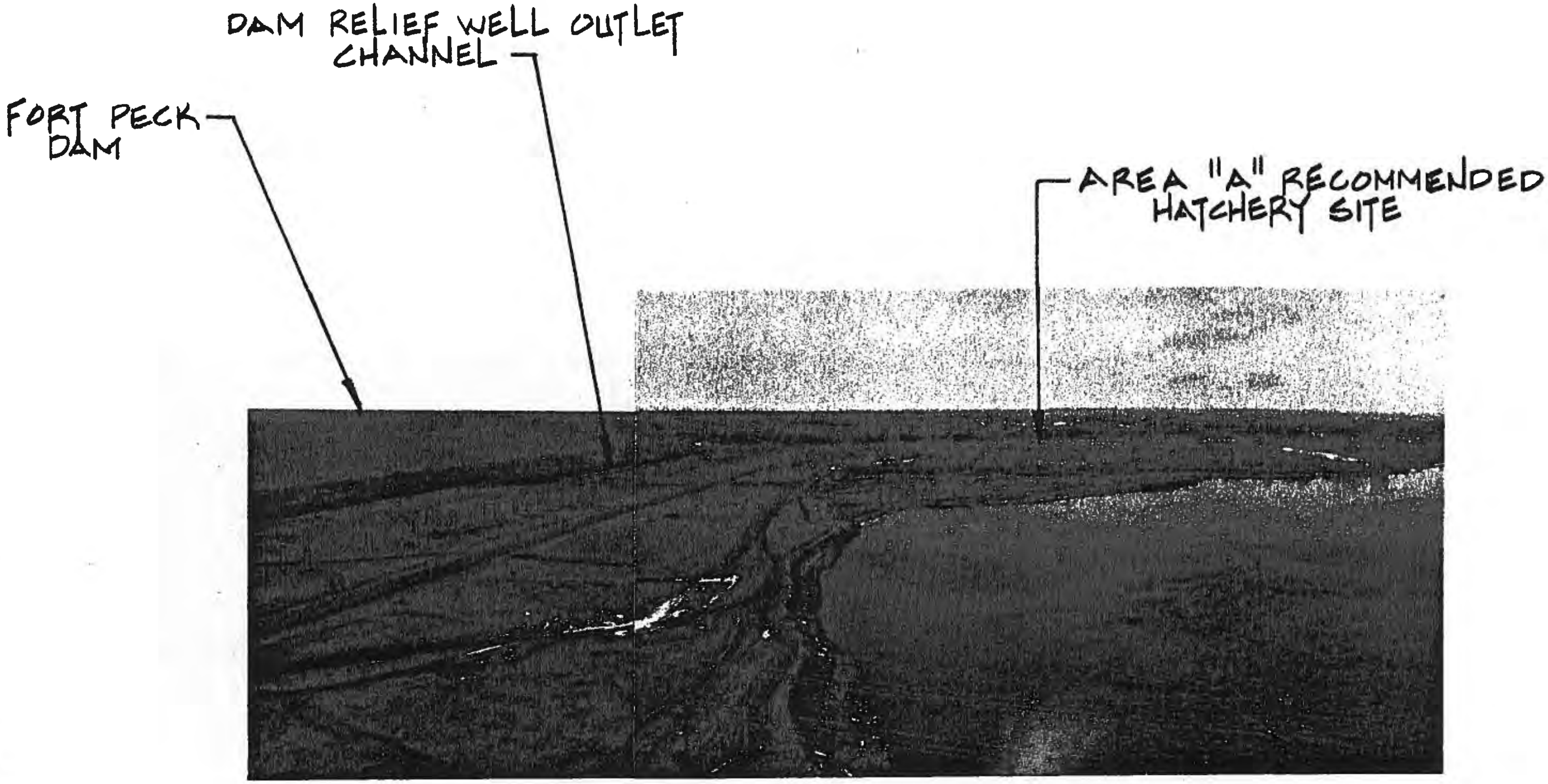


FIGURE 9 **AREA A FORT PECK WATER SUPPLY LINE ROUTING**

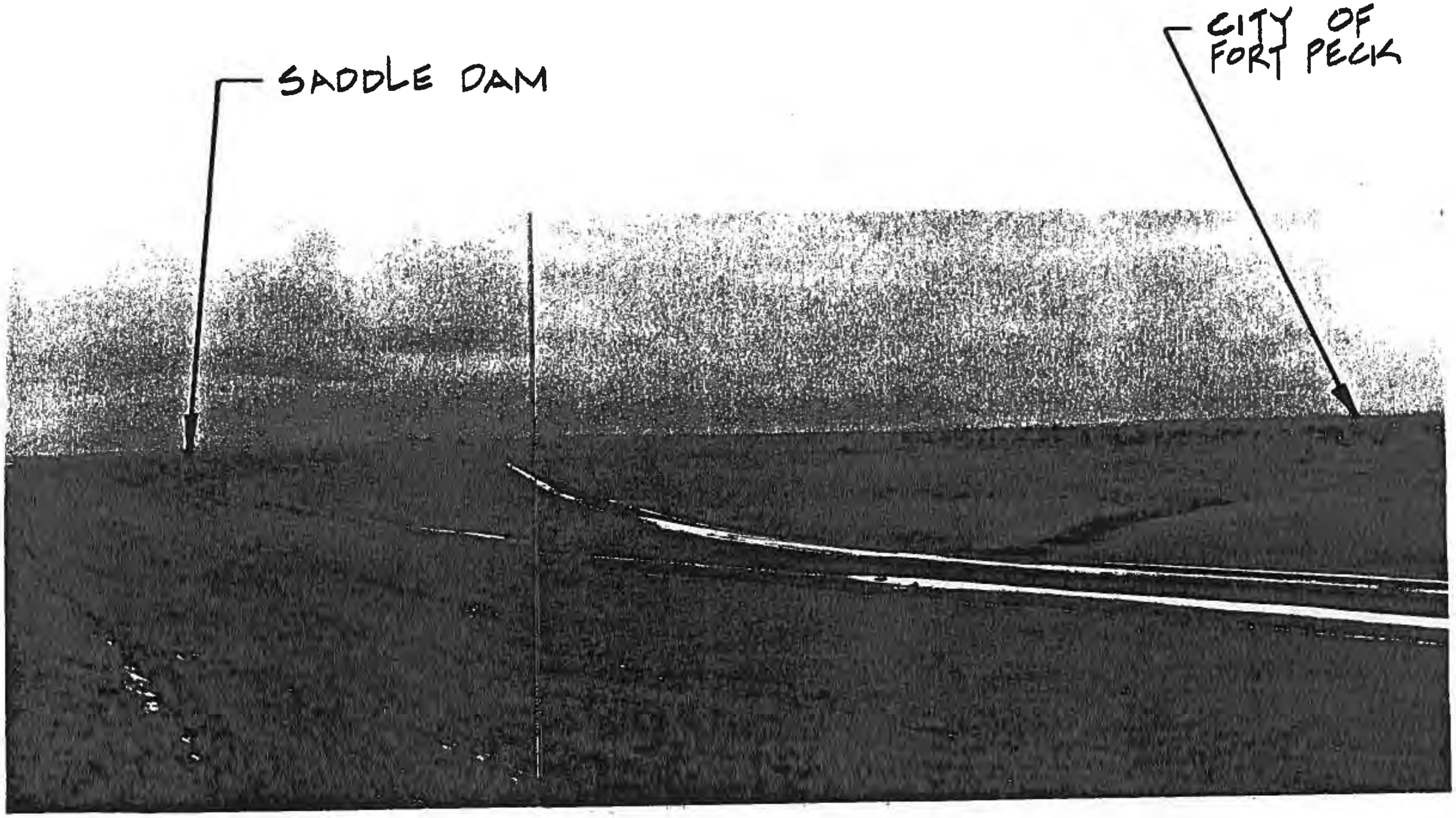


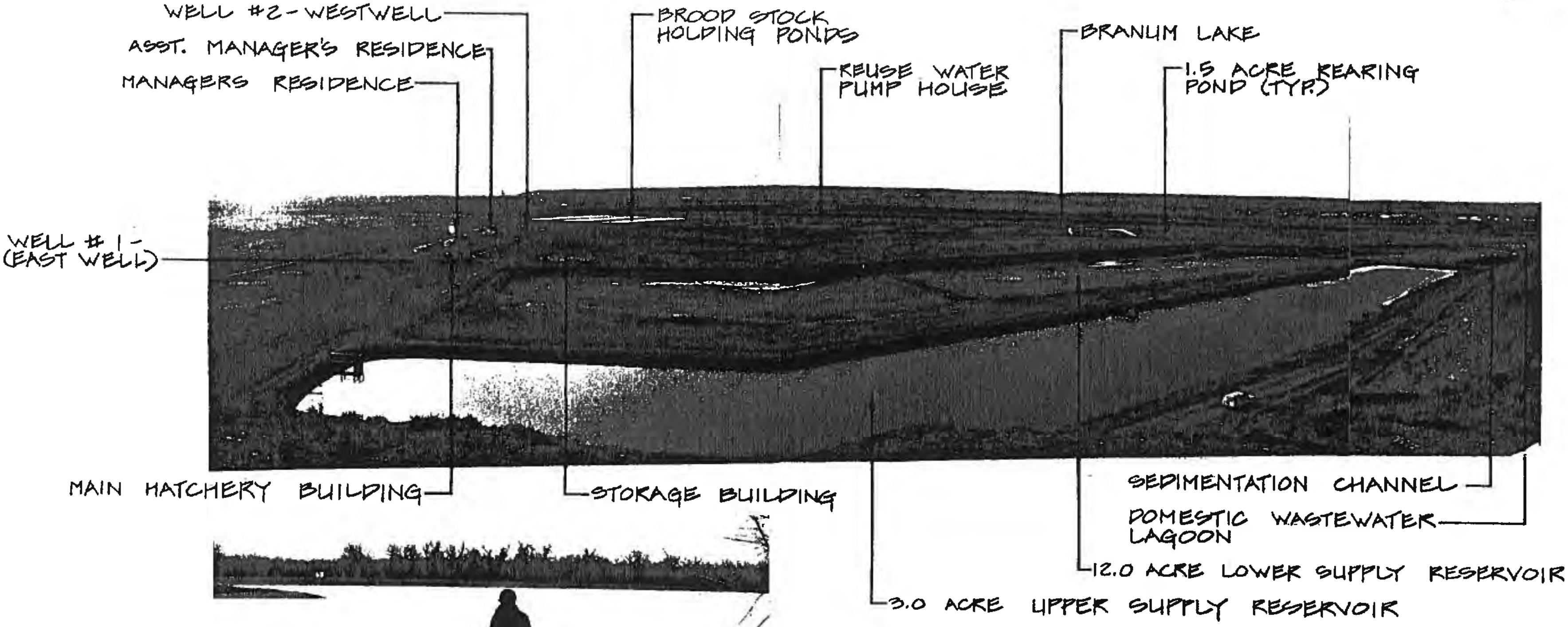
FIGURE 10 SITE WEST SIDE OF DAM (SOUTHWEST OF TOWN OF FORT PECK)

PLATE # 3

MILES CITY AREA TOPOGRAPHY AND HATCHERY SITE

MONTANA WARM/COOL WATER FISH HATCHERY STUDY

Fisheries Design Group	DATE 9/28/84



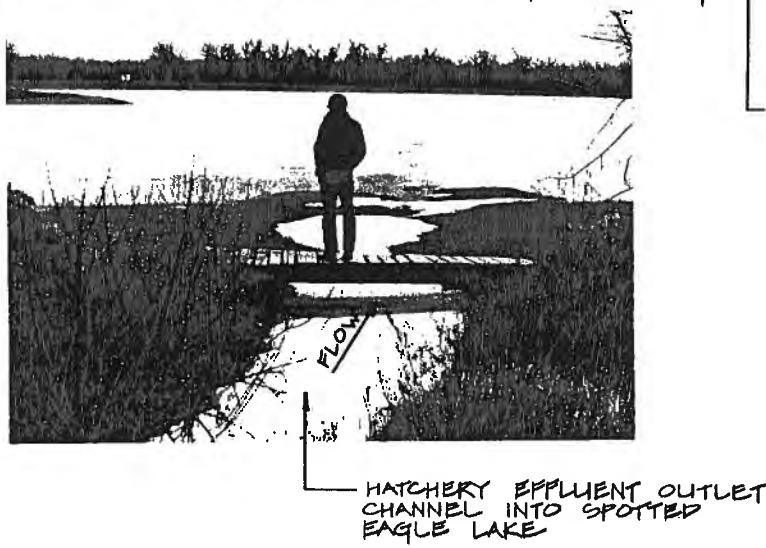


FIGURE 11 MILES CITY SFH OVERVIEW AND SPOTTED EAGLE LAKE

Plate 4 shows the general layout and components of the hatchery complex. Tables 10 and 11 (USFWS Real Property Inventory Forms) provide date of construction and initial cost of all major components of the Miles City Hatchery.

The following description and figures characterize the existing Miles City Hatchery.

Main Hatchery Building

The main hatchery building is a 4,636 sq. ft. structure (122' X 38') completed in 1959 at a cost of $175,000. The building provides office area, food preparation/storage area, visitor display, aquarium room, garage/shop area and combined start tank/egg incubation room with vehicle drive-thru corridor. Concrete start/holding tanks (16) are located on 2 separate levels of the start tank room. General condition of the main hatchery building is good. Figures 12, 13 and 14 show the exterior of the main building and Figures 15, 16 and 17 illustrate the interior condition of the building. The main building is heated by gas forced air furnace and gas space heaters, Figure 18.

Flammable Storage Building and Underground Gasoline Storage Tank

The 120 square foot brick flammable storage building (Figure 19) was constructed in 1959 at a cost of $6,000.00. A 1,000 gallon steel underground storage tank is available for fuel storage. Condition of existing equipment is good.

Garage/Storage Building

The frame, unheated garage storage building (1,848 square feet) was constructed in 1960 at a reported cost of $11,094 (Figure 20). Condition of the garage is good, however, additional equipment storage area is needed (Figure 21).

Hatchery Residences

Two 1,600 square foot frame residences with concrete basements were completed in 1959 at a cost of $19,000 each (Figure 22). Generally, condition of the residences is good, due to the repair painting and renovative work completed by Department hatchery personnel. The garage slab-on-grade floor is cracked and damaged in both garages and should be replaced. Landscaping and lawn repair is needed at both residences. A third residence originally constructed by the USFWS was sold and removed from the hatchery property.

Sewage Lift Station and Lagoon

The domestic sewage lift station and 0.54 acre lagoon was installed in 1970 at a cost of $19,409 (Figure 23). The system has generally performed well under the present loading.

PLATE # 4	
MILES CITY AERIAL PHOTO. & YELLOWSTONE RIVER WATER SUPPLY	
MONTANA WARM/COOL WATER FISH HATCHERY STUDY	
Fisheries Design Group	DATE 9/28/84

Fish and Wildlife Service
Division of Realty

TABLE 10

REAL PROPERTY INVENTORY OF OTHER STRUCTURES AND FACILITIES

Unit: Miles City NFH
State: Montana
Division:
County: Custer
Designation: 1-FWS-493
Date: 09-30-81

Inventory Record							Disposal Record			
1 Prop. No.	2 Tract Desig.	3 *Structures & Facilities	4 Description Construction & Size	5 Date Built	6 Cost	Code	7 Date Excess	8 Appraisal Value	9 Date Disposal	10 Sale Price
11	1	Gas Storage	Steel, 1,000 gal.	1959	800	40				
12	1	Water Storage	Concrete, 12,000 gal.	1959	Est 3,500	71				
13	1	Pipeline T.R.	Asb. Cem., 14" x 2,900'	1960	Est 26,000	71				
14	1	Ponds (8)	1.5 acre ponds	1958	Est 75,000	80				
15	1	Ponds (5)	1.5 acre ponds	1960	Est 51,625	80				
16	1	Ponds (2)	3.0 acre ponds	1958	30,000	80				
17	1	Upper Reservoir	3 acres	1958	Est 10,000	71				
18	1	Lower Reservoir	11 acres	1958	Est 20,000	71				
19	1	Supply Lines	Asb. Cem.	1958	Est 50,000	71				
20	1	Sewage System	Lift station and lagoon .54 acre	1970	Est 19,409	71				
21	1	Settling Channel	Settling channel .32 acre	1970	3,572	80				
22	TM	Tongue River Intake Structure	Intake Structure	1970	9,396	80				
26	1	Sewage System	Lift Sta. & Lagoon .54 Acre	1970	19,409	71				
27	1	Settling Channel	.32 Acre	1970	3,572	80				
28	TM	Intake Structure	Tongue River	1970	9,396	80				

*Structures & Facilities, i.e.: Bridge, canal, control structure, dam, dike, fence, gauging station, pond

Fish and Wildlife Service
Division of Realty

TABLE 1

REAL PROPERTY INVENTORY OF BUILDINGS

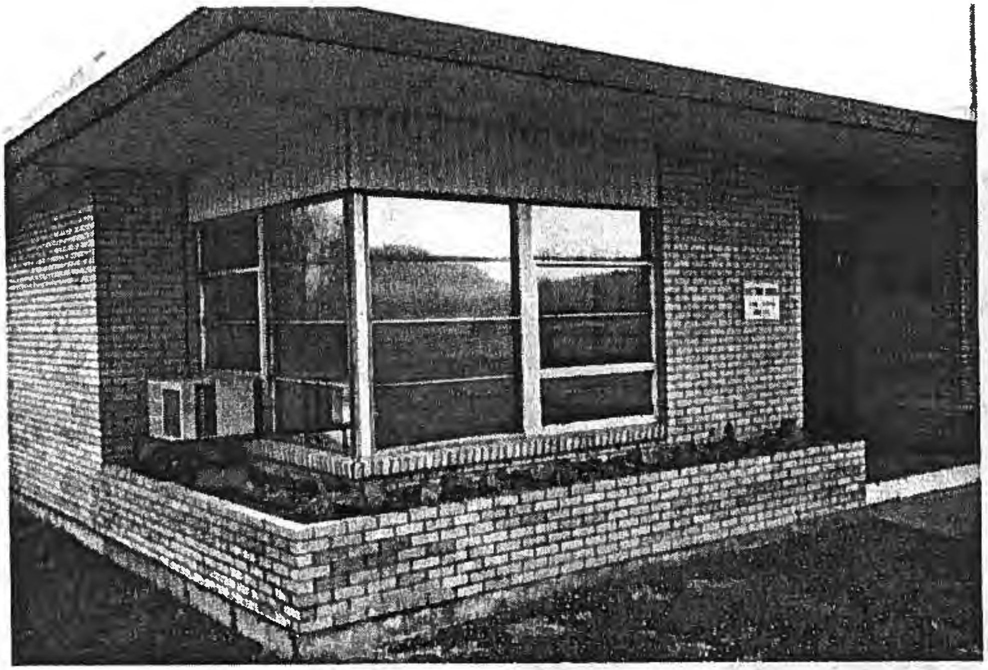
Unit: Miles City NFH
State: Montana

Division:
County: Custer

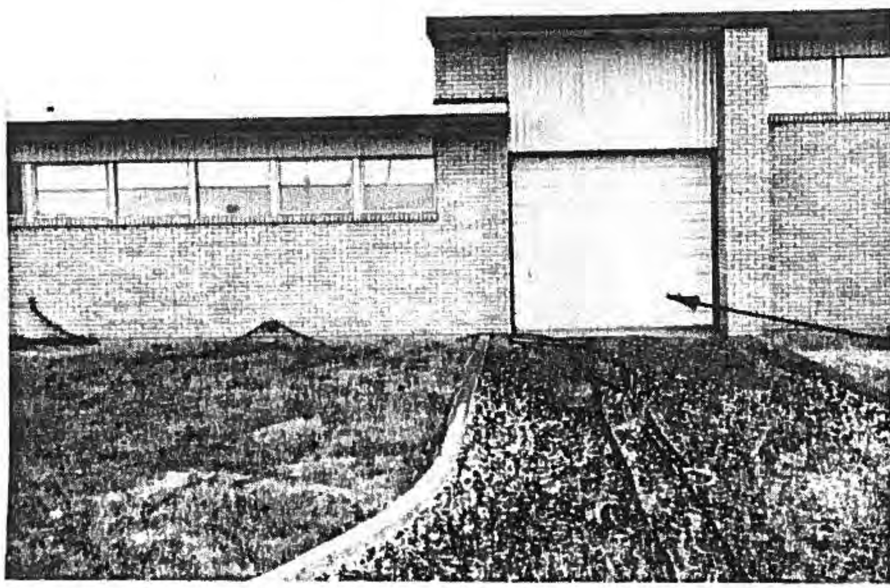
Designation: 1-FWS-493
Date: 09-30-81

INVENTORY RECORD | DISPOSAL RECORD

Prop. No.	Tract Desig.	Use	Type of Construction	Date Acquired	No. Rooms	Space Sq.Ft.	% Occupied	Cost	Code	Date Excess	Appr. Value	Disposal Date	Sale Price
	1	Resid.	Frame	1959		1,600	100	19,000	30				
				Reported to Energy		2472 gsf		Est					
	1	Resid.	Frame	1959		1,600	100	19,000	30				
				Reported to Energy		2472 gsf		Est					
	1	Hatchery /Office	Brick	1959		4,636	100	175,000	80				
	1	Oil Hse	Brick	1959		120	100	6,000 Est	40				
	1	Sump house	Steel	1958		80	100	6,000 Est	80				
	1	E. Well House	Brick	1958		80	100	6,000 Est	80				
	1	W. Well House	Brick	1958		80	100	6,000 Est	80				
	1	Garage	Frame	1960		1,848	100	11,094 Est	40				
0	1	T. River Pump House	Steel	1960		48	100	4,800 Est	80				



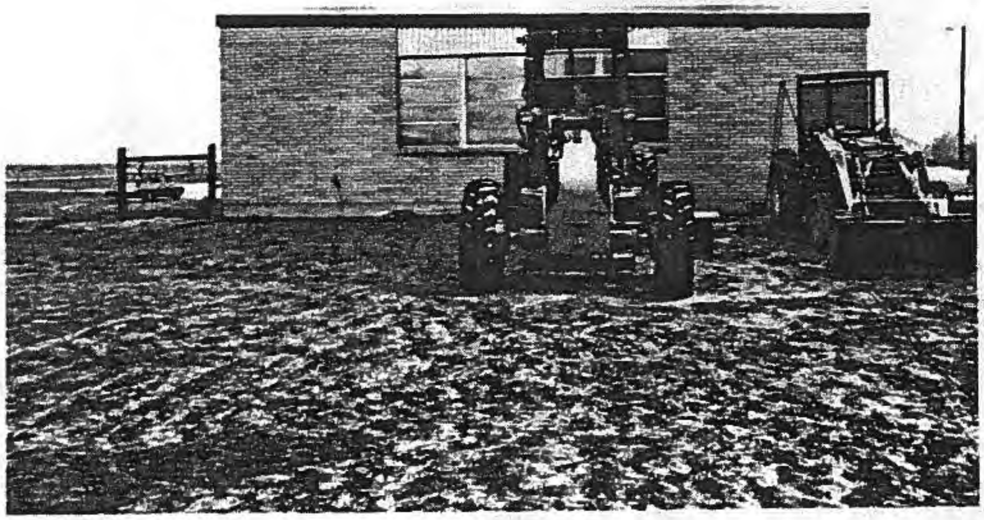
FRONT ENTRANCE



FRONT DRIVE THRU ENTRANCE

FIGURE 12

MILES CITY SFH - MAIN BUILDING EXTERIOR (SOUTH VIEW)



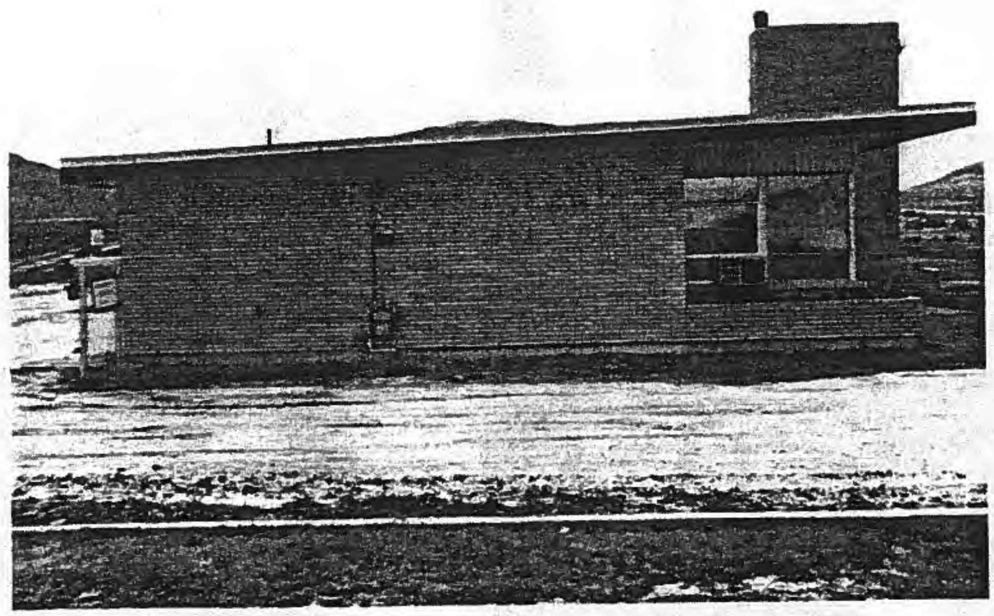


FIGURE 13 MILES CITY SFH - MAIN BUILDING EXTERIOR (EAST & WEST VIEW)

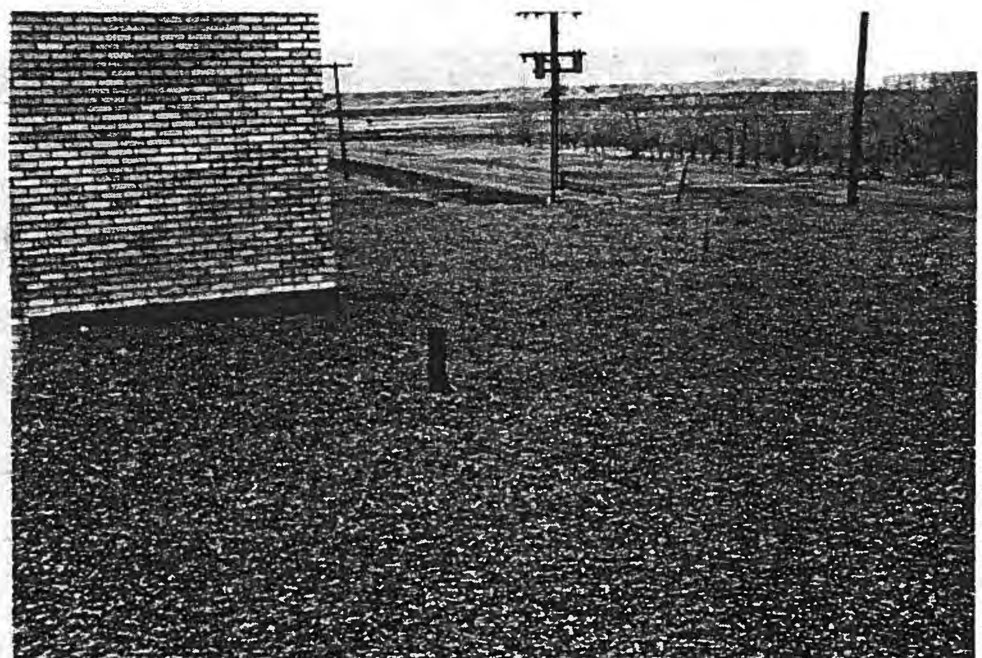
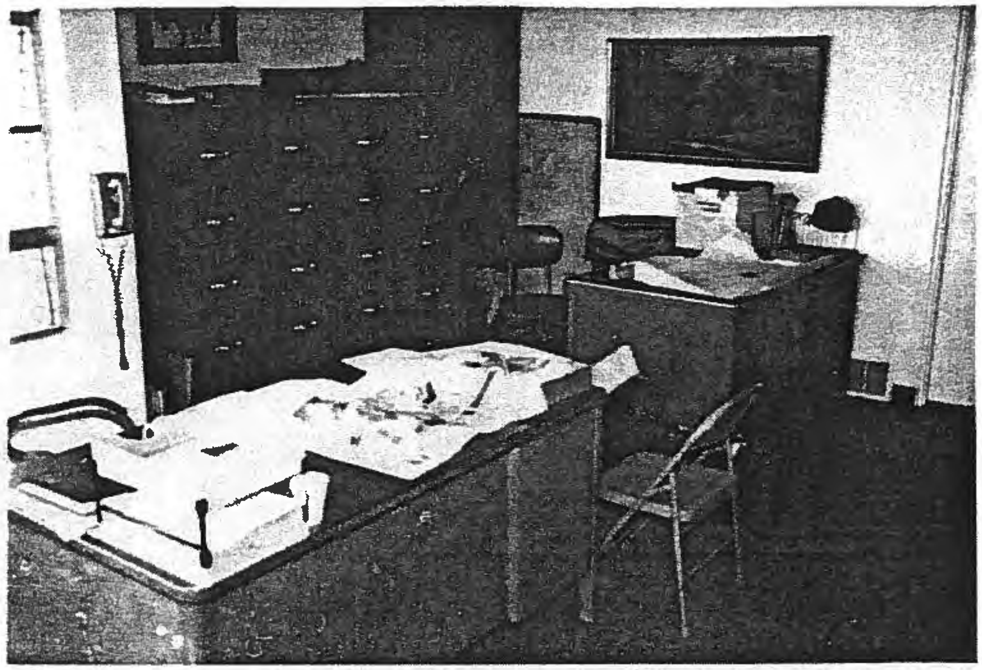


FIGURE 14 MILES CITY SFH - MAIN BUILDING EXTERIOR (NORTH VIEW & ROOF)



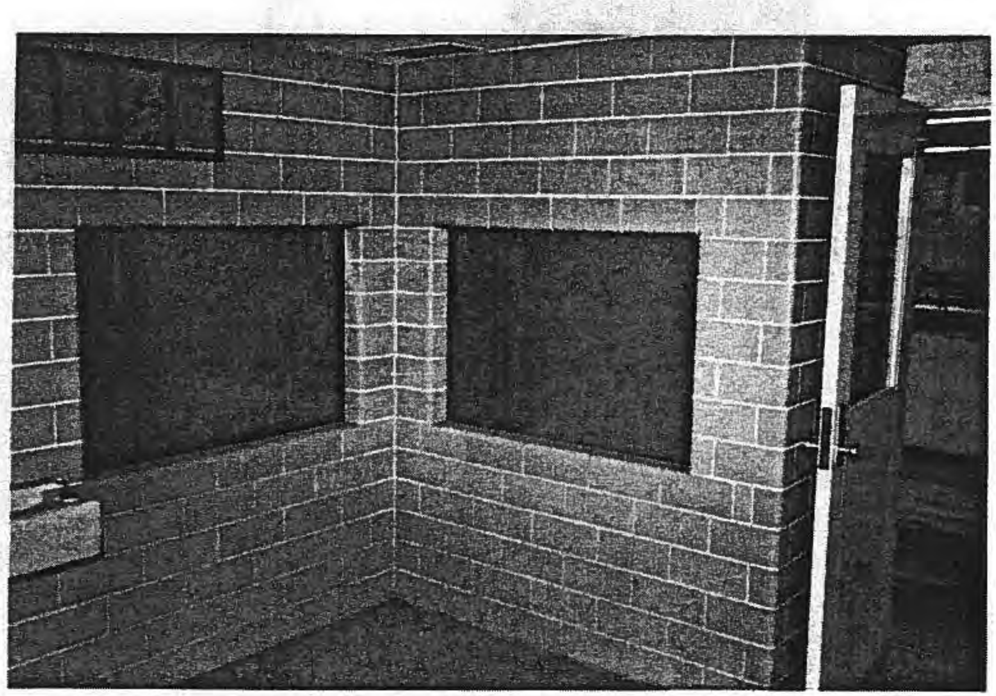
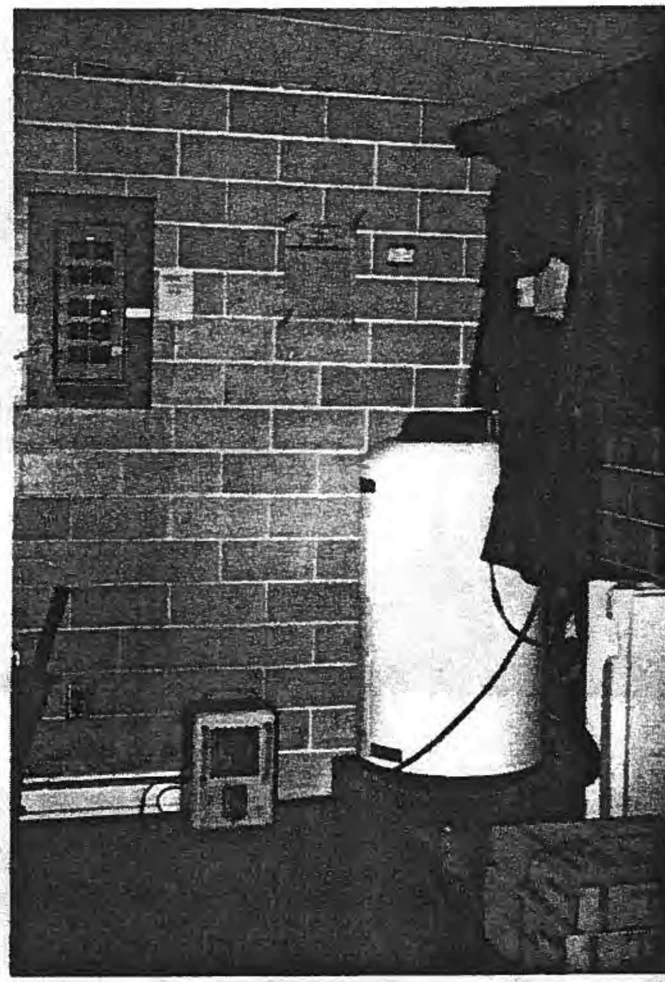


FIGURE 15 MILES CITY SFH - MAIN BUILDING INTERIOR (OFFICE & VISITOR AQUARIUM)



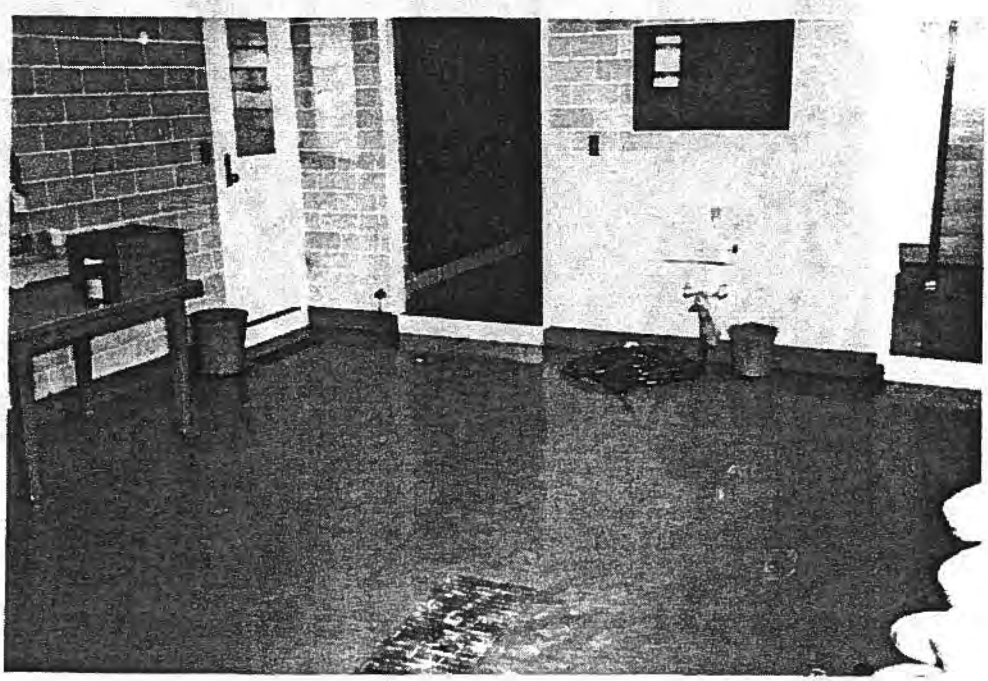


FIGURE 16 MILES CITY SFH - MAIN BUILDING INTERIOR (CREW ROOM & FOOD PREP. ROOM)

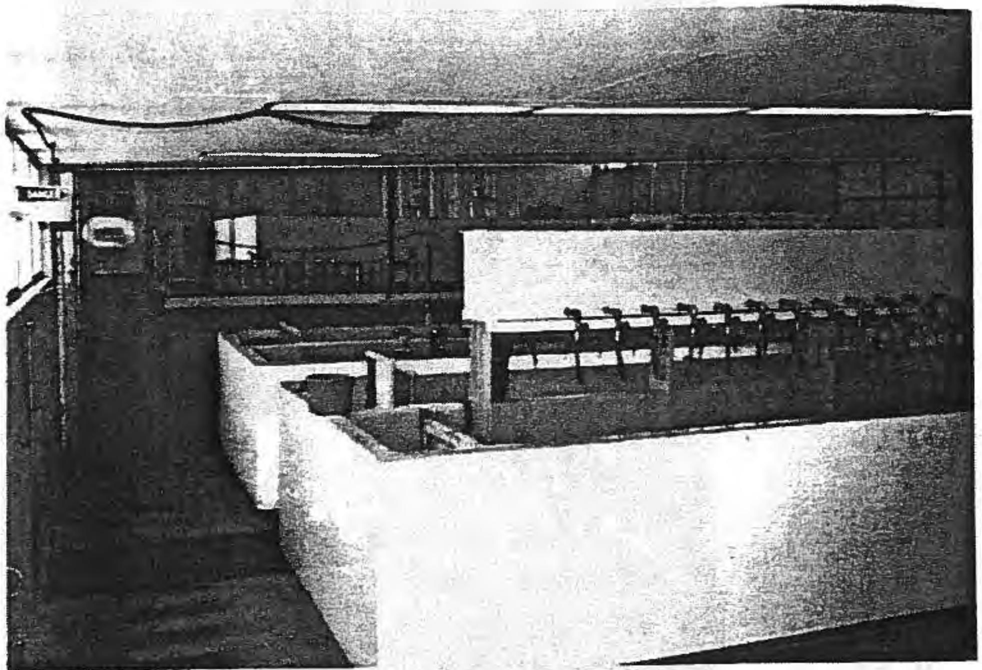


FIGURE 17 MILES CITY SFH - MAIN BUILDING - START TANK ROOM & SHOP

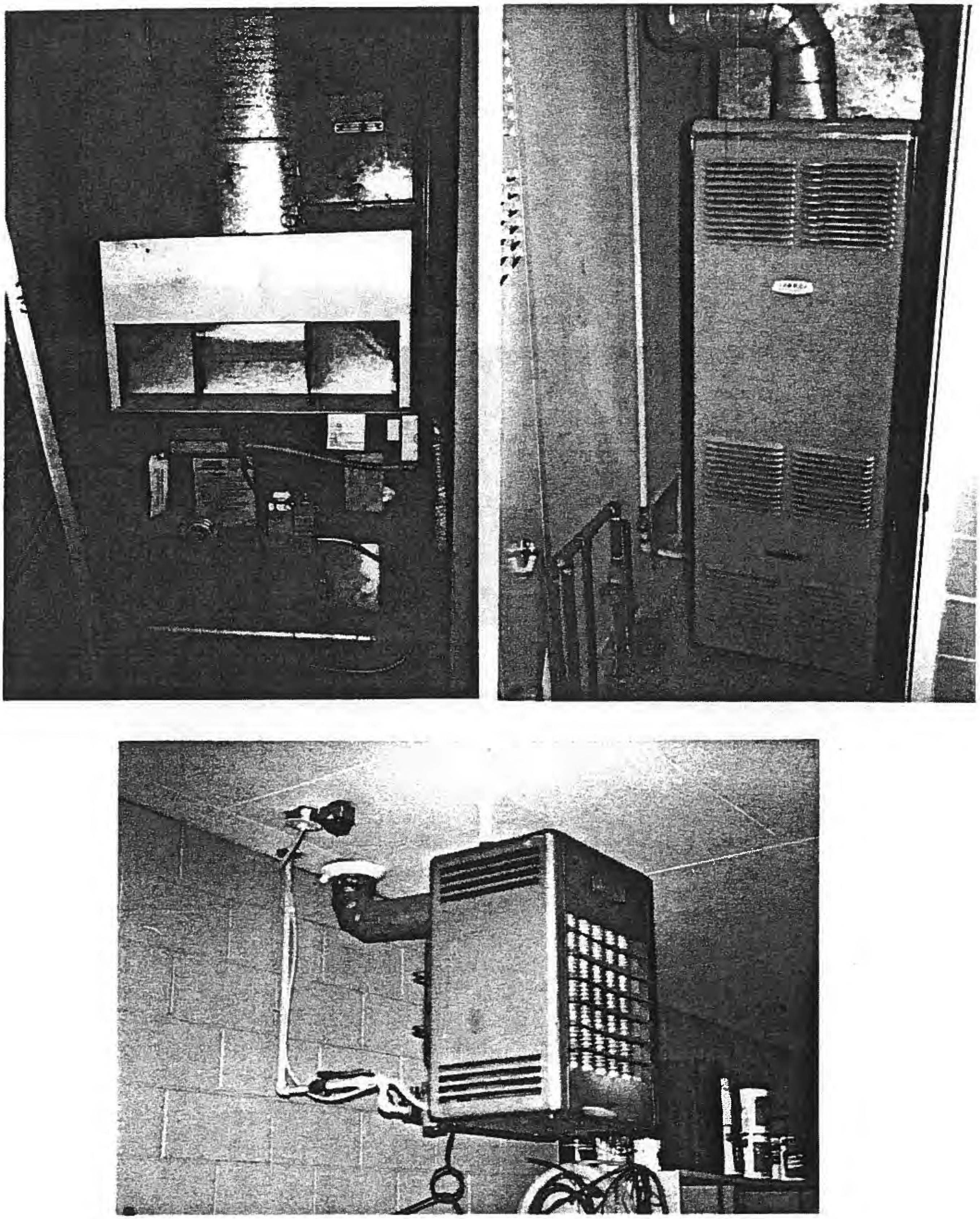


FIGURE 18 MILES CITY SFH - MAIN BUILDING - GAS FURNACE & GAS UNIT HEATERS

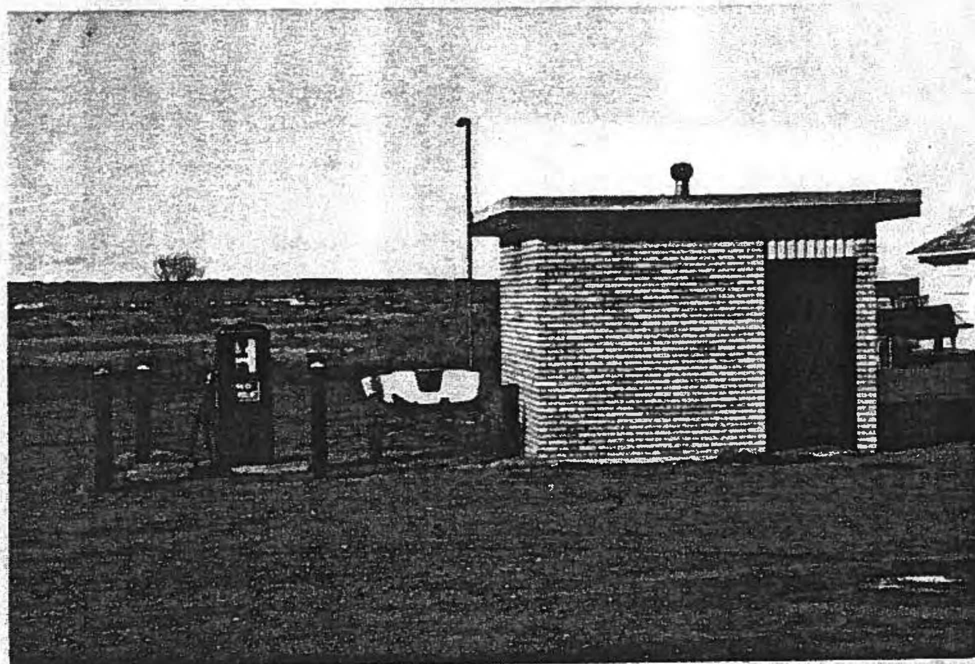


FIGURE 19 FLAMMABLE STORAGE BUILDING & FUEL STORAGE

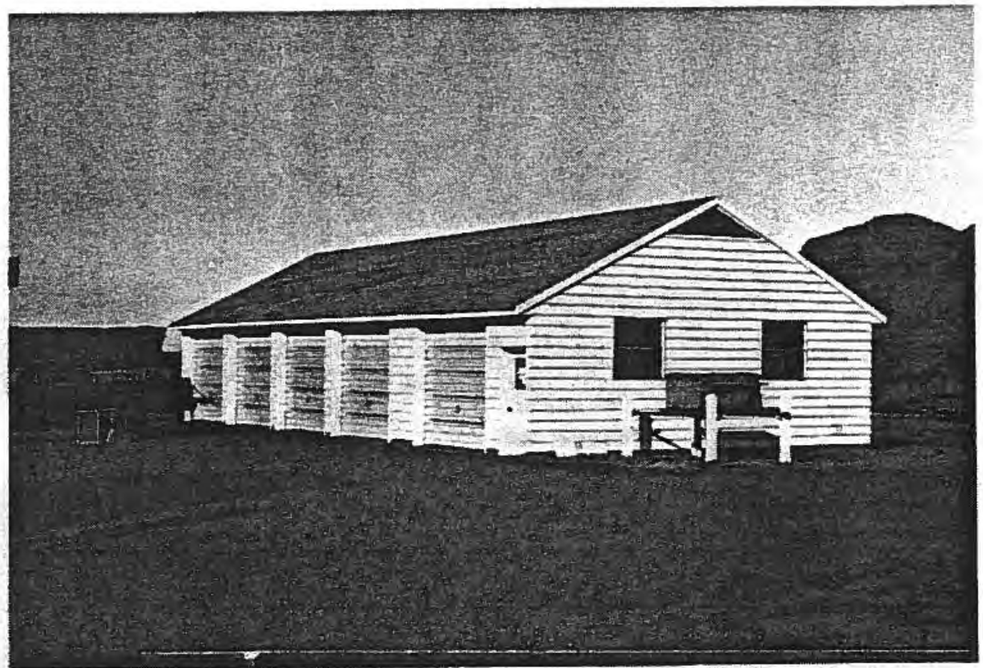


FIGURE 20 GARAGE/STORAGE BUILDING (NORTHEAST VIEW)

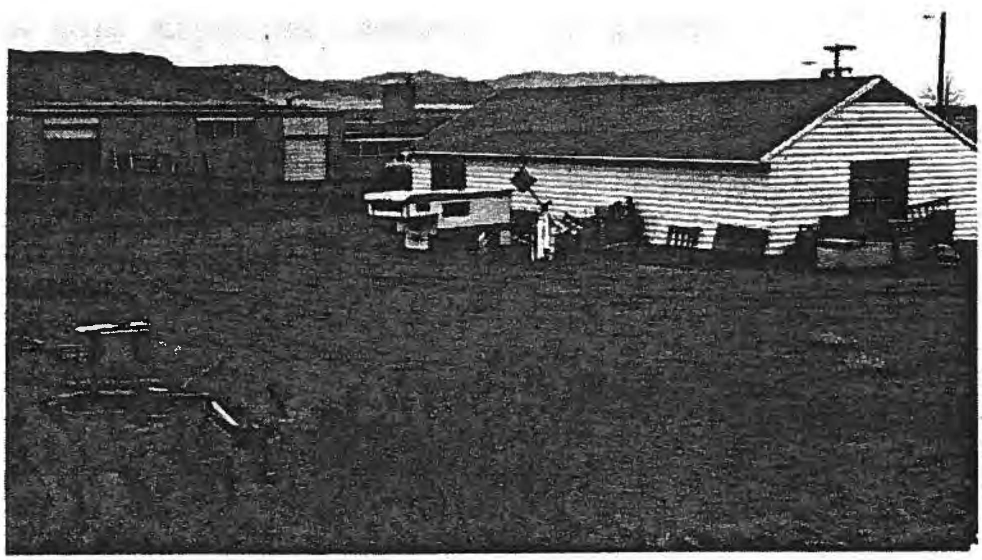
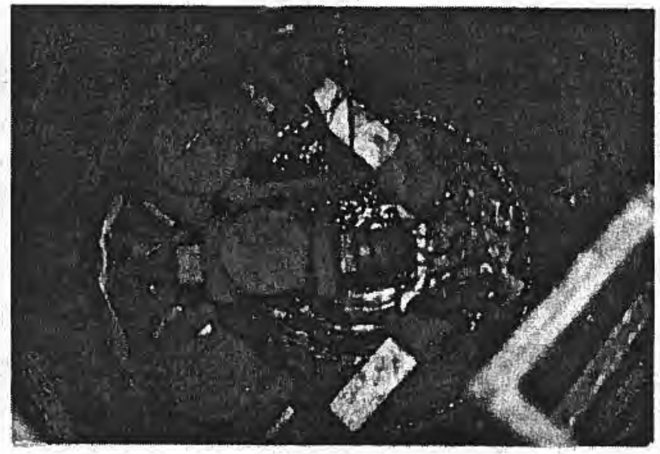
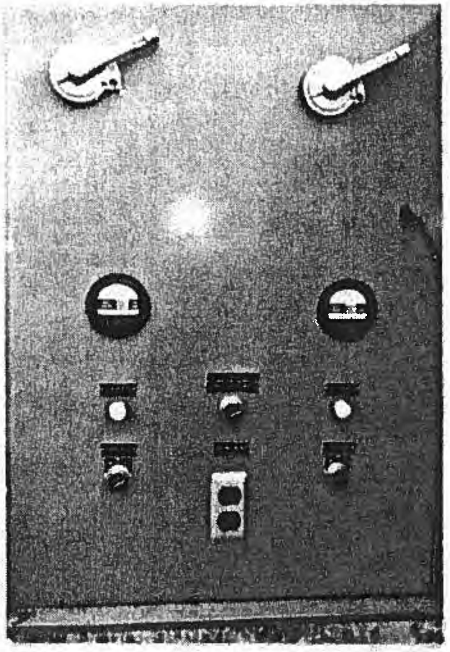


FIGURE 21 GARAGE/STORAGE BUILDING (SOUTHEAST VIEW)

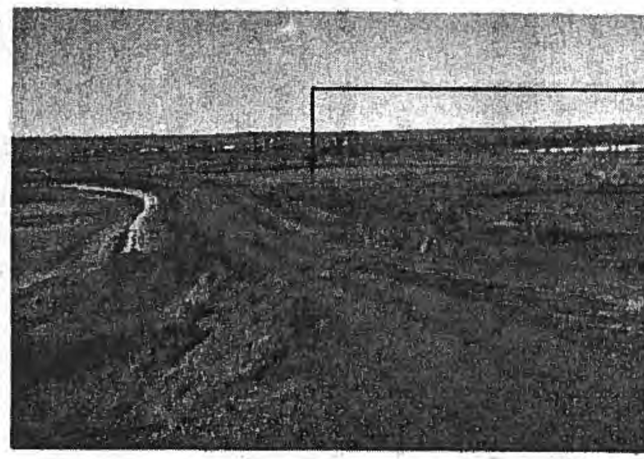
FIGURE 22 HATCHERY RESIDENCE WITH BASEMENT (TYPICAL)

DOMESTIC WASTEWATER LIFT STATION PUMPS & PIPING





DOMESTIC WASTEWATER LIFT STATION PUMP CONTROL PANEL



FENCED WASTEWATER LAGOON

FIGURE 23 **DOMESTIC WASTEWATER SYSTEM - LIFT STATION AND LAGOON**

Domestic Water Supply System

The domestic water supply system consists of a 49 gpm East Well #2 (Figure 24) and brick well house constructed in 1958 and a 12,000 gallon buried storage tank located on the "camelsback" to provide gravity flow to the hatchery building (Figure 25). The control portion of the domestic system that provides "automatic" filling of the storage tank (via stop/start of the well) is not functioning and needs repair. The domestic water system also provides supply to the fire water system (Figure 26) and can be used to supply limited amounts of water to the hatchery building rearing water system.

Hatchery Water Supply System

The components of the hatchery water supply system consisting of the Tongue River pump station, sedimentation pond, upper and lower water supply reservoirs, water recirculation (i.e. reuse) pump station, 120 gpm West well #2, 49 gpm East well #1, hatchery building, 15 rearing ponds, Branum Lake and all associated drain and supply lines are shown on Plate #5.

The Tongue River pumping station consisting of river intake structure, Corrugated Metal Pump House, 1,000 gpm 15-horsepower 440 volt main pump, 3-horsepower priming pump and related power meter controls and power distribution equipment are shown in Figures 27, 28, 29 and 30. The existing Tongue River Pumping System has suffered from low and shifting channel river conditions, sediment pumping and wear on pump components. Periodic yearly maintenance is required to keep the system functioning correctly.

Water pumped from the Tongue River pump station is conveyed to a 0.32 surface acre sedimentation channel for solids settling. Sediment must be removed from the channel periodically. From the sedimentation channel water may be directed into the 3.0 surface acre uppper supply reservoir or 12.0 surface acre lower supply reservoir via concrete outlet structures equipped with sluice gates (Figure 31 and 32).

The upper (3.0 acre) and lower (12.0) supply reservoirs provides important water supply storage, solar water warming, secondary sedimentation removal and zooplankton food production functions. Generally, the condition of the supply reservoirs is good. Repair to concrete outlet structures, screens and basin grading is required periodically. Repair of an electric centrifugal booster pump from the 12 acre reservoir to the main hatchery building is also needed (Figures 33, 34, 35 and 36). The upper and lower reservoir was constructed in 1958 at a reported cost of $30,000.

The water recirculation (i.e. reuse) pump station provides the capability to reuse pond drainage water and hatchery building

#2 WELL

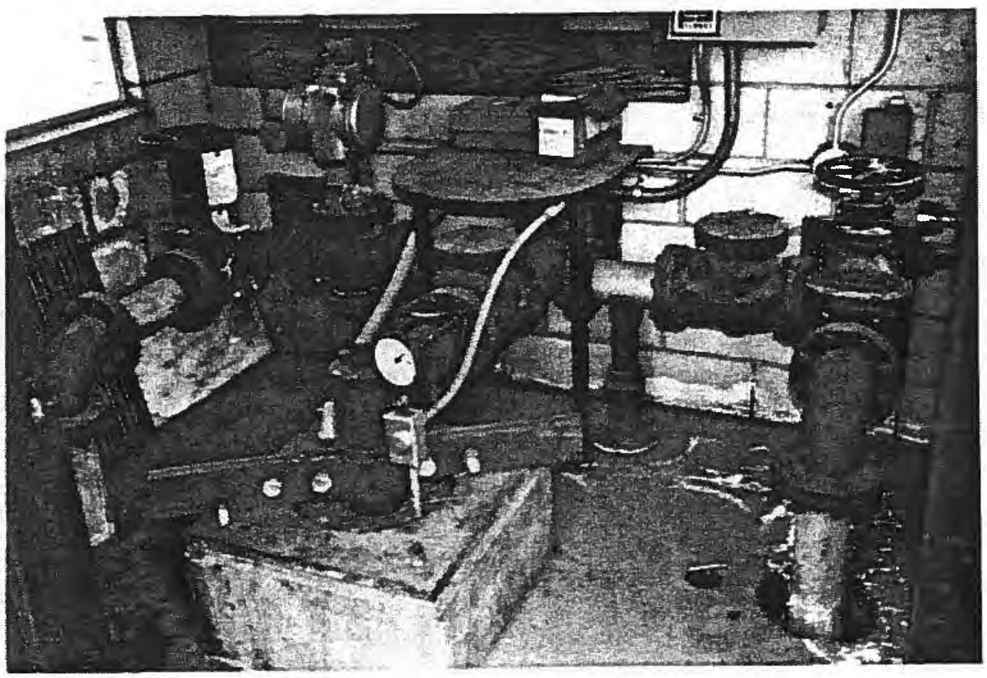


FIGURE 24   DOMESTIC WATER SYSTEM - EAST WELL #2 (49GPM)

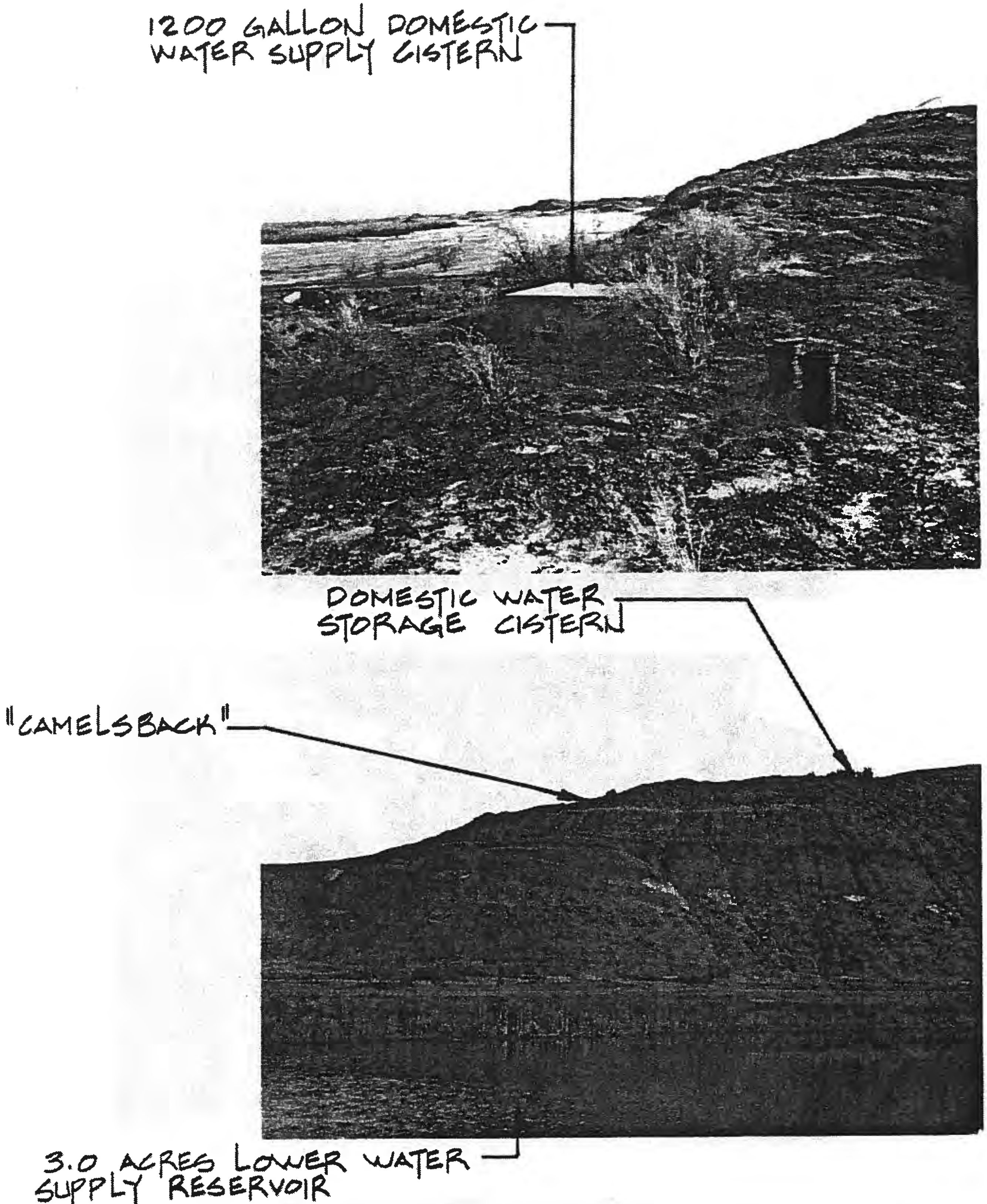


FIGURE 25 DOMESTIC WATER STORAGE TANK ON "CAMELSBACK"

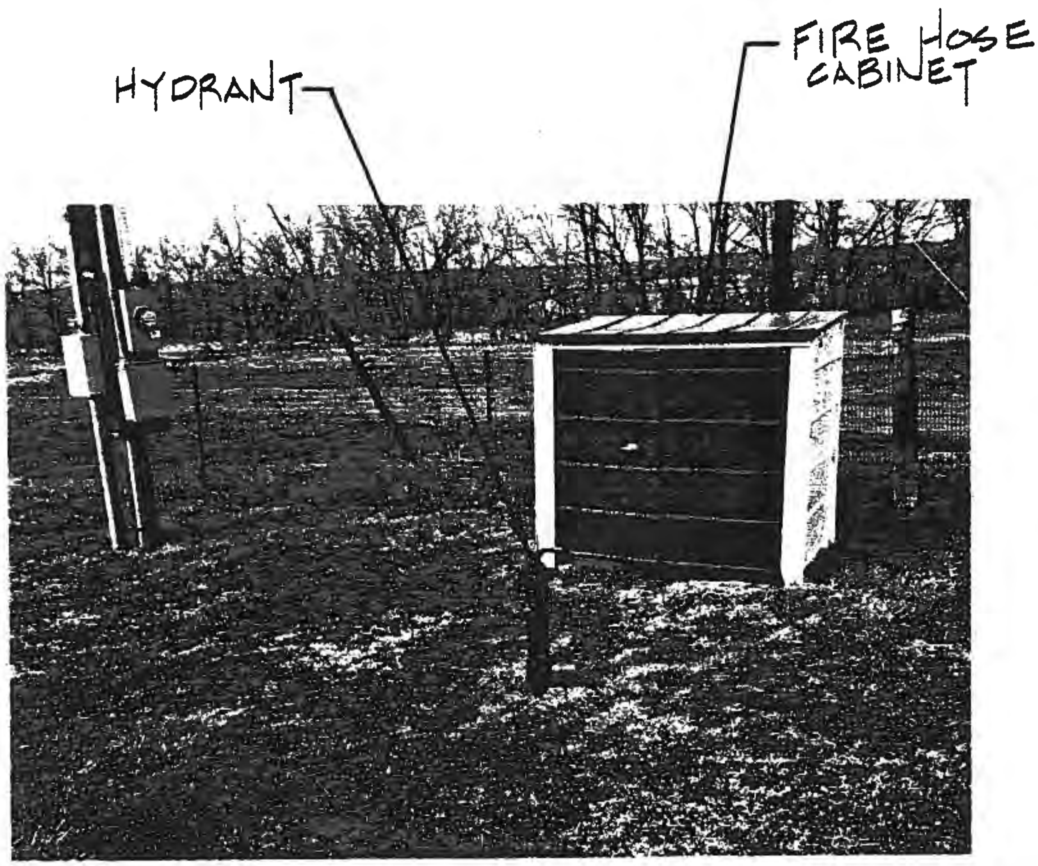


FIGURE 26 FIRE WATER SYSTEM

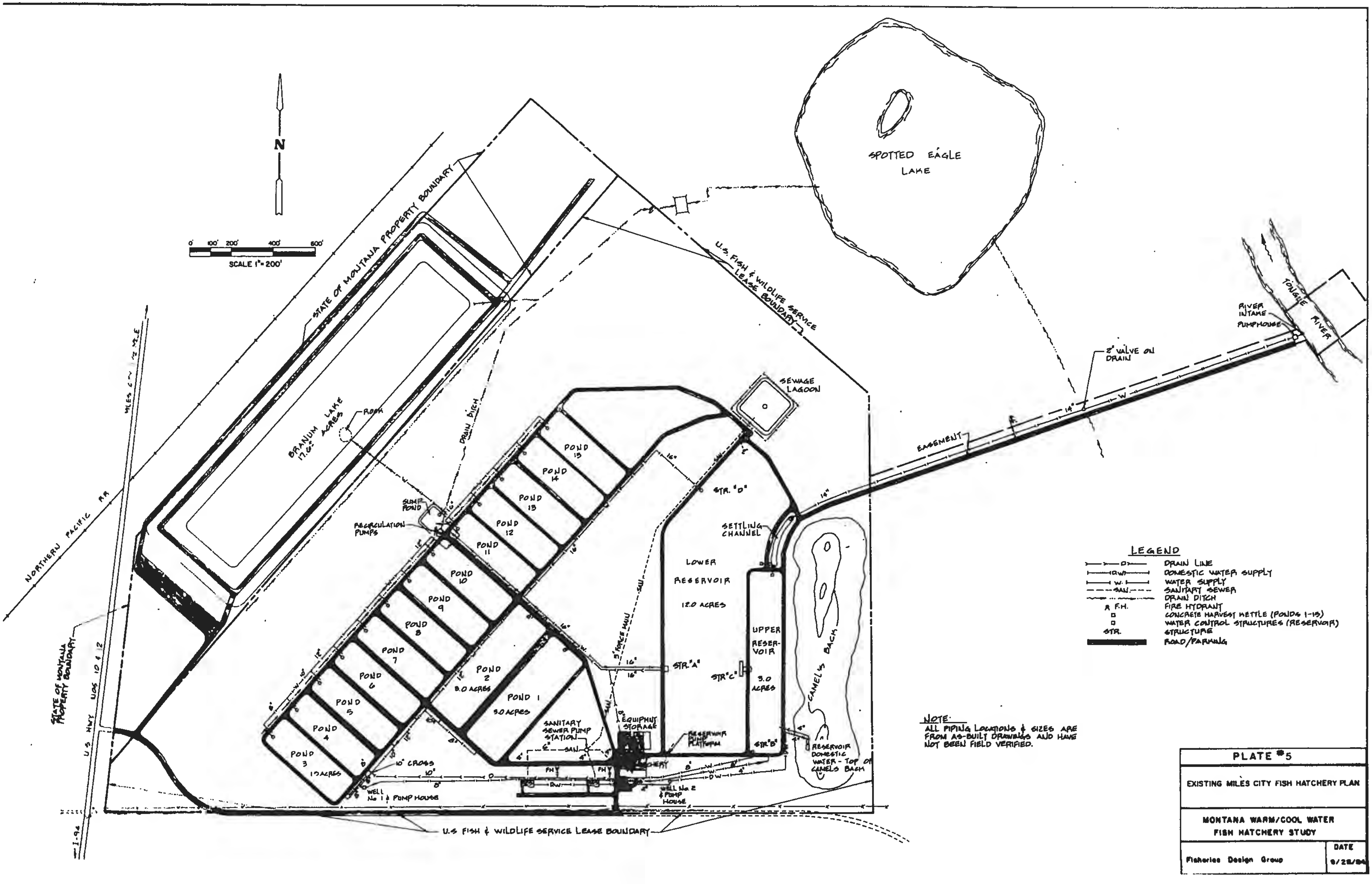


PLATE #5

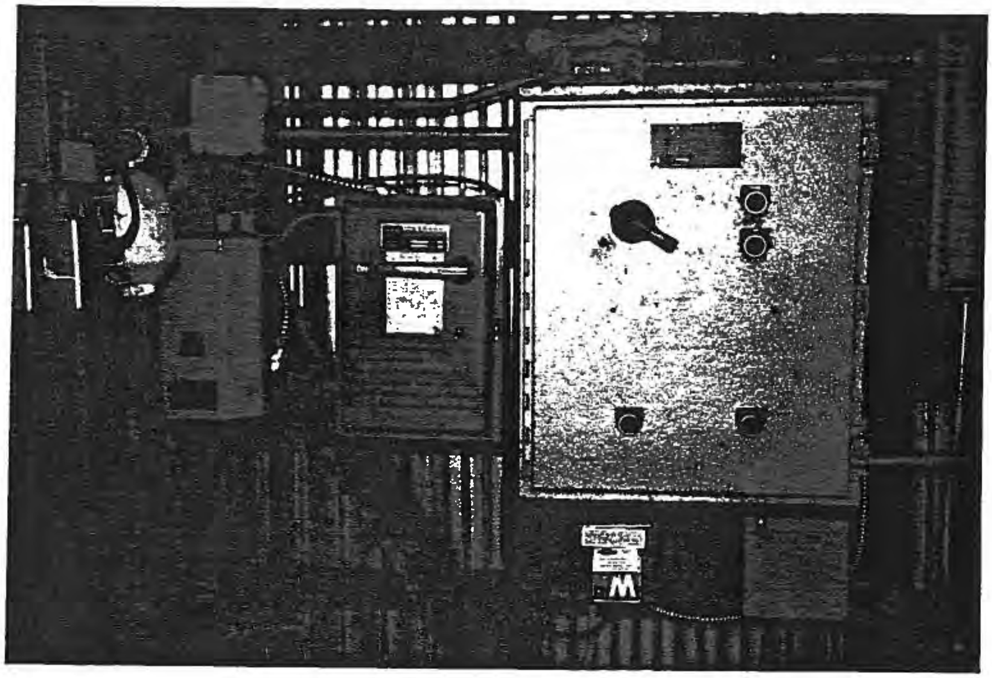
EXISTING MILES CITY FISH HATCHERY PLAN

MONTANA WARM/COOL WATER FISH HATCHERY STUDY

Fisheries Design Group

DATE 9/28/84

FIGURE 27 TONGUE RIVER PUMP STATION BUILDING & MAIN PUMP



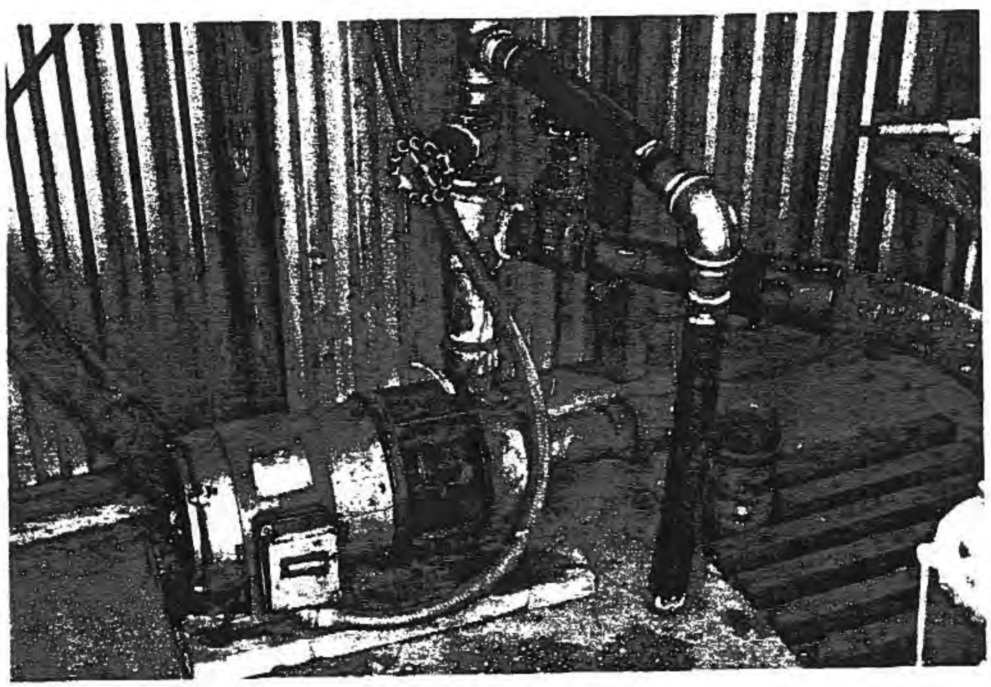


FIGURE 28 TONGUE RIVER PUMP STATION - PUMP CONTROLS & PRIMING PUMP

FIGURE 29 TONGUE RIVER INTAKE STRUCTURE & RIVER (SUMMER)

FIGURE 30 TONGUE RIVER INTAKE STRUCTURE & RIVER (WINTER)

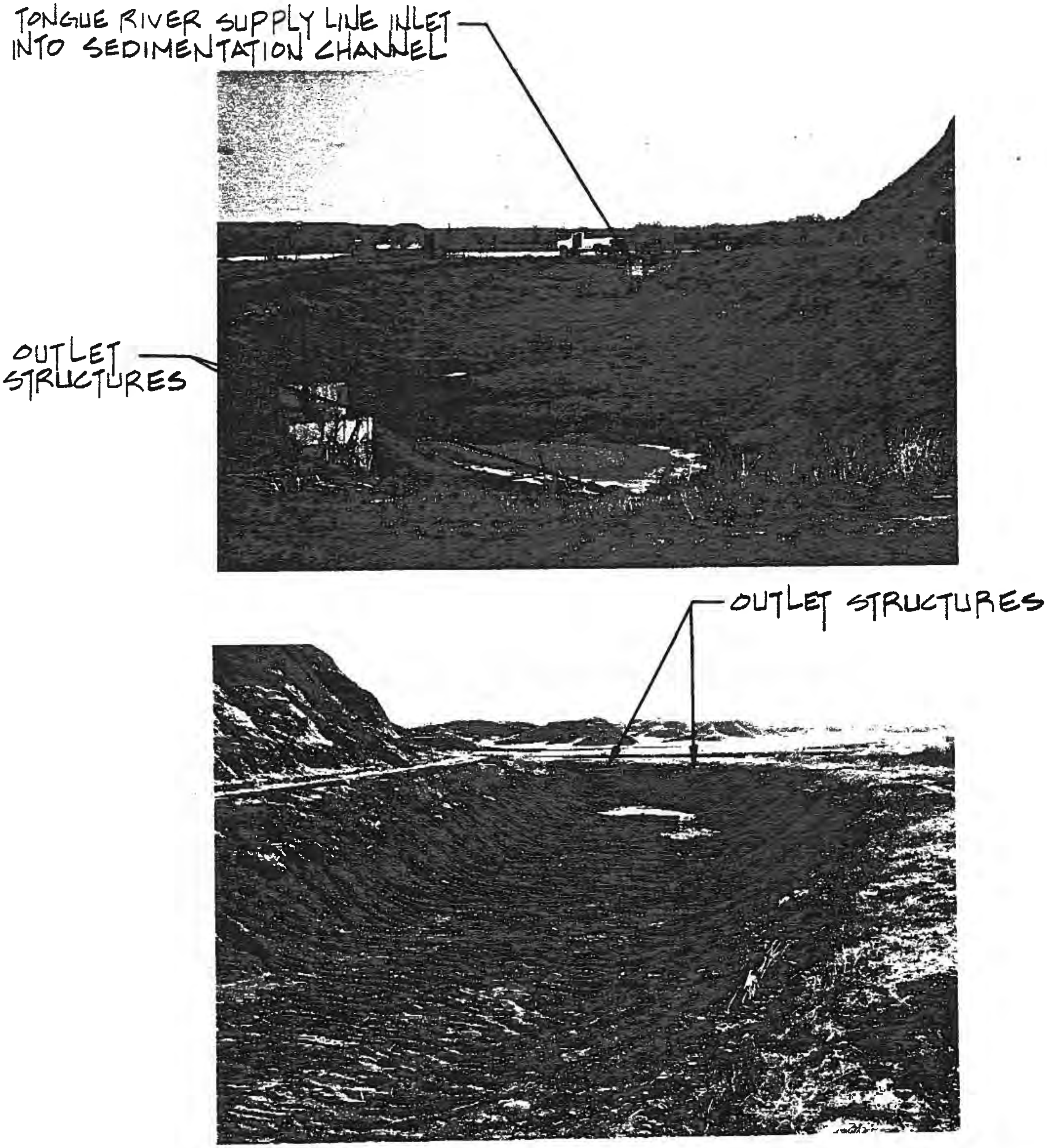


FIGURE 31 SEDIMENTATION CHANNEL AND VIEW AFTER DREDGING

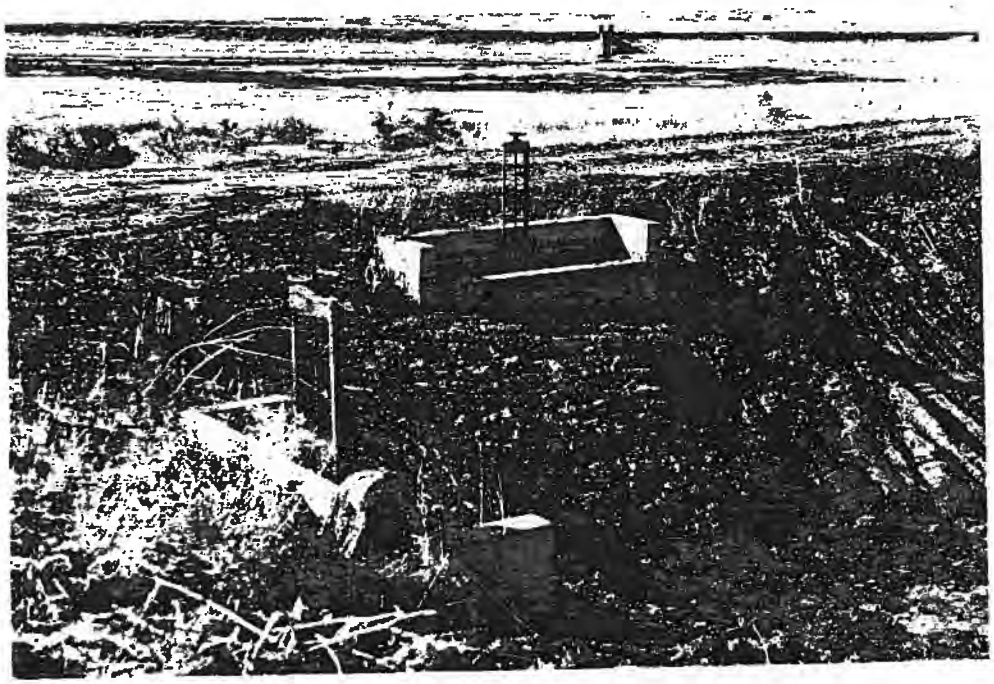


FIGURE 32 SEDIMENTATION CHANNEL WATER INLET AND OUTLET CONTROL STRUCTURES

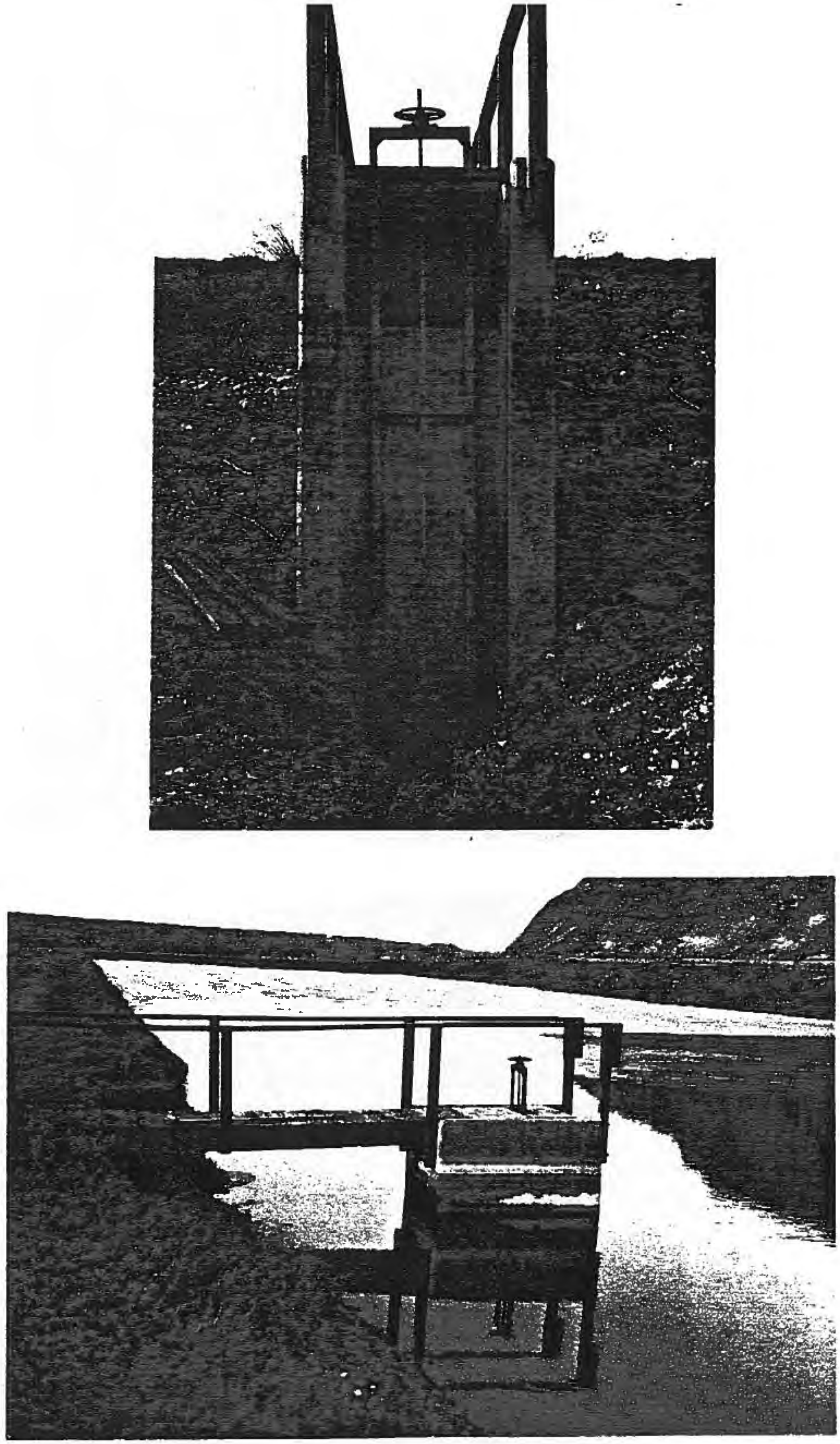
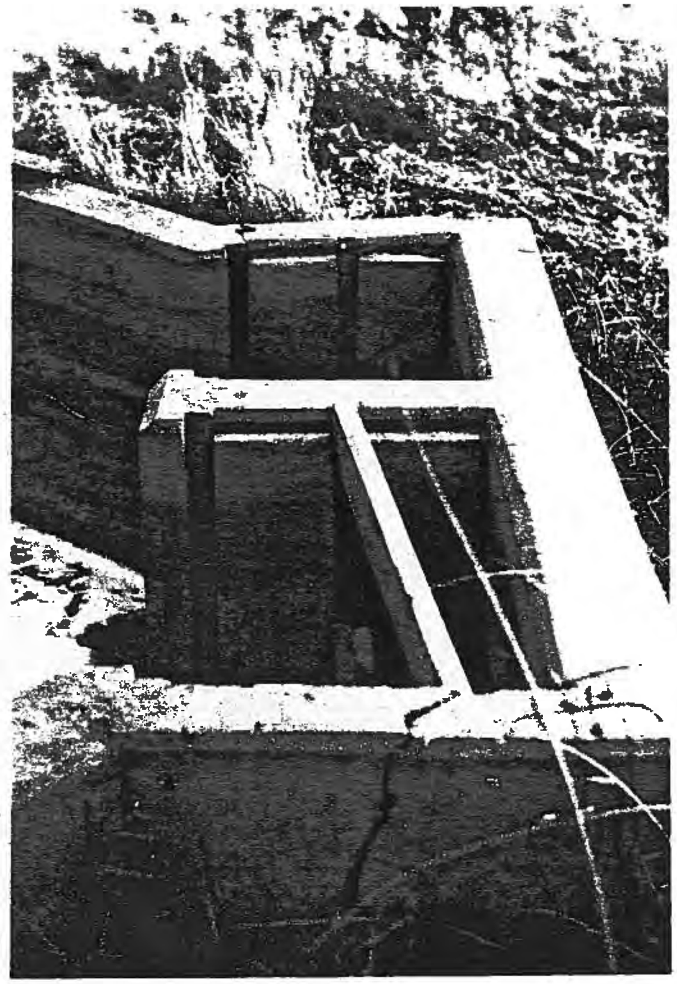


FIGURE 33 UPPER SUPPLY RESERVOIR OUTLET STRUCTURE



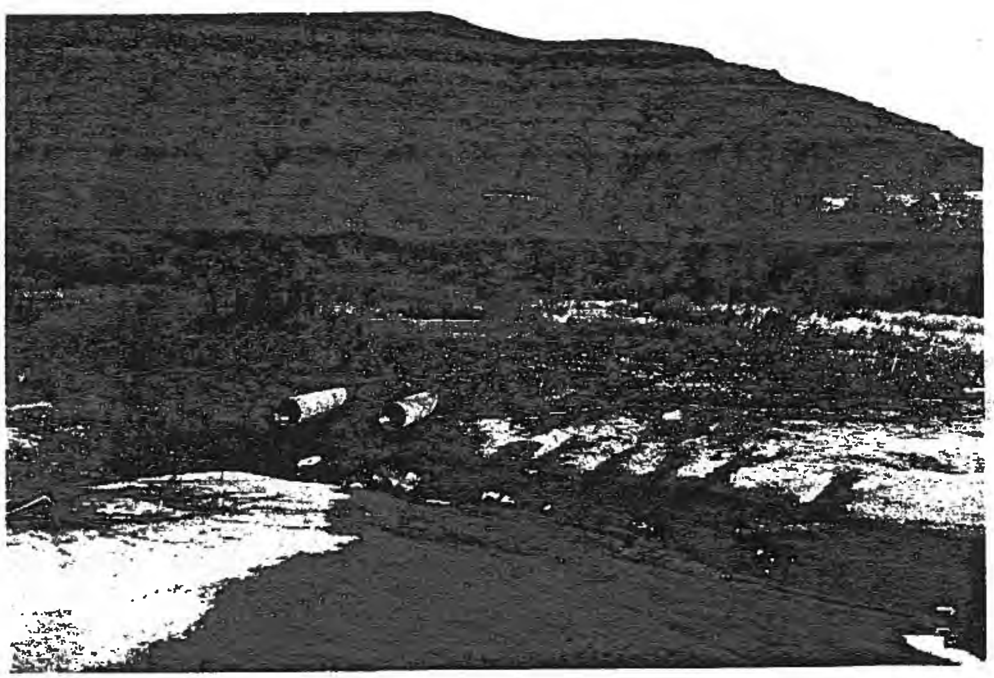


FIGURE 34 UPPER TO LOWER RESERVOIR OUTLET STRUCTURE AND DRAINS

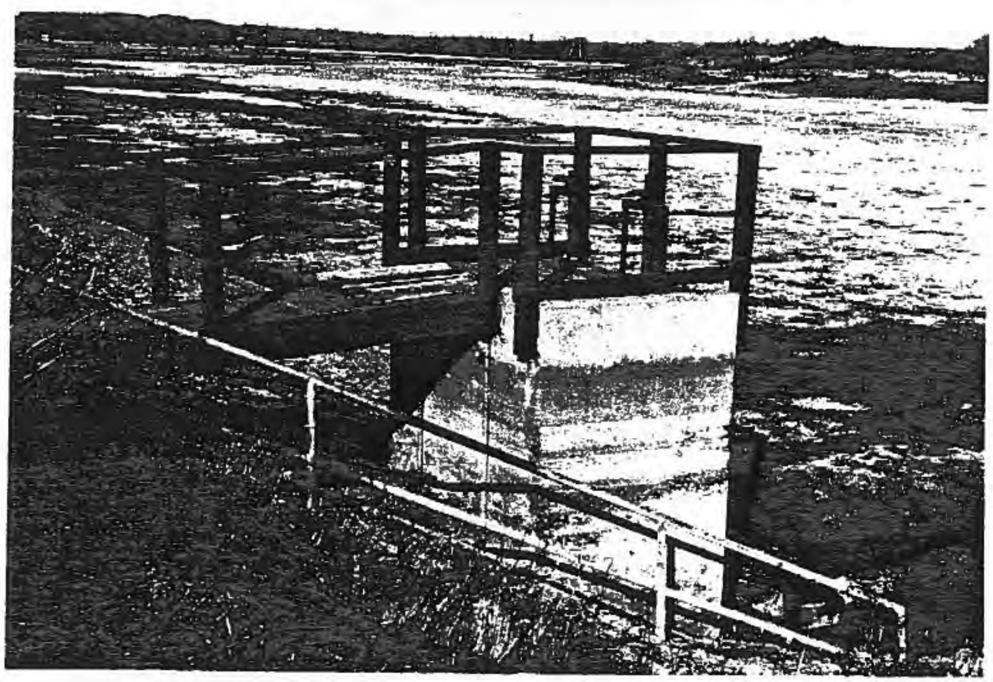


FIGURE 35 LOWER SUPPLY RESERVOIR OUTLET STRUCTURE

FIGURE 36 LOWER RESERVOIR TO BUILDING BOOSTER PUMP

overflow water for re-filling rearing ponds, the 12 acre lower supply reservoir and (optionally) Branum Lake. Pumping is provided by 2-1500 gpm 20-horsepower 220 volt 3-phase turbine pumps and a 3-horsepower, 225 gpm turbine pump. Components of a Healey-Ruff Water Level Control System are present in the reuse pump station but not presently functional. Pond drainage water is transferred from the ponds to the reuse pump station via open earthen drainage ditches. Static screens located at the inlet of pump station remove algae and large debris but are difficult to keep clean by manual cleaning. Periodic cleaning (sediment removal) of the earthen basin leading to the reuse pump station inlet is necessary as is re-building and maintenance of turbine pumps. Water not re-circulated may be directed to Spotted Eagle Lake (for lake filling) via open drainage ditch. Figures 37, 38, 39 and 40 show the major components of the reuse water pump station.

The #1 West Well is a 6" diameter, 120 gpm submersible turbine pump mounted in a 12" diameter casing. Well depth is 300 feet. The well is equipped with a 20-horsepower 220-volt, 3-phase motor and is located in a 6' X 8' brick pump house where the pump and control systems are located. In addition to supplying well water to the main hatchery building, the 55 degree F well water may also be used to fill and maintain brood stock holding ponds #3 and #4 which are equipped with metal cone aeration units for winter pond aeration and de-icing. Ponds #3 and #4 may also reuse building overflow water for filling and de-icing. Paddle-type pond aeration units powered from the #1 Well House are used to maintain required dissolved oxygen levels for brood stock during severe winter conditions. Figures 41 and 42 illustrate the existing equipment.

Existing rearing ponds consist of two-3 surface acre and thirteen-1.5 surface acre earthen rearing ponds. Ponds are equipped with concrete control structures for standard harvest screens and sluice gates. A concrete interior (i.e. inside pond) kettle with side inlet notches is available for fish harvest. Pond water supply inlets are located at the kettle and shallow end of the pond. Side slopes of the rearing ponds are equipped with cobble size riprap for erosion control. Pond bottoms require annual re-grading and discing. Sediment must be removed from kettles annually. Metal kettle stairs have deteriorated on most of the ponds and need replacement. Generally, supply piping and the outlet structures are in good condition due to recent intensive maintenance work completed by hatchery personnel. Screens are in fair to poor condition and should be upgraded to modern perforated aluminum plate screens with aluminum frames. Figures 43, 44, 45 and 46 illustrate the characteristics and condition of the rearing ponds. Pond roads are in fair to good condition, but require additional gravel and compaction.

Branum Lake is a 20-acre Department owned public fishing lake that has been operated by the hatchery for bass forage fish production. Generally, the lake and its inlet and outlet

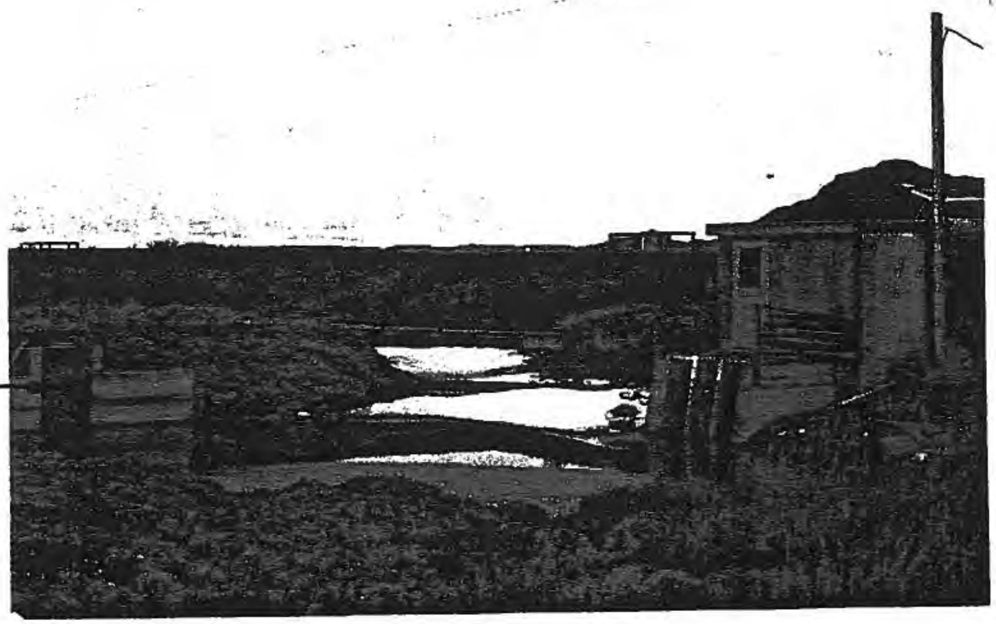
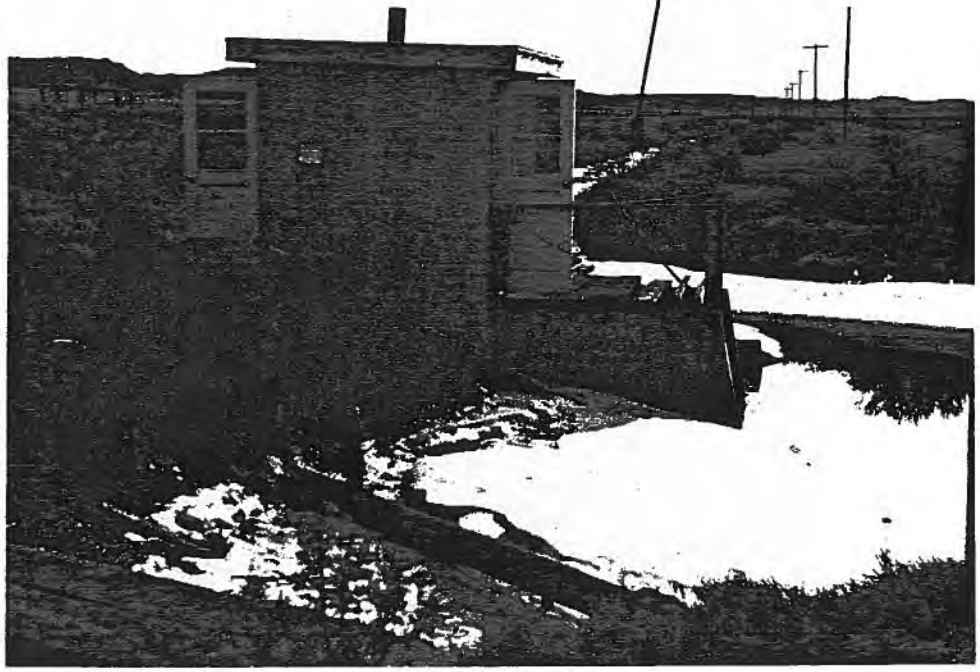


FIGURE 37 REUSE WATER PUMP STATION, INTAKE SCREEN & SUMP OUTLET CONTROL STRUCTURE



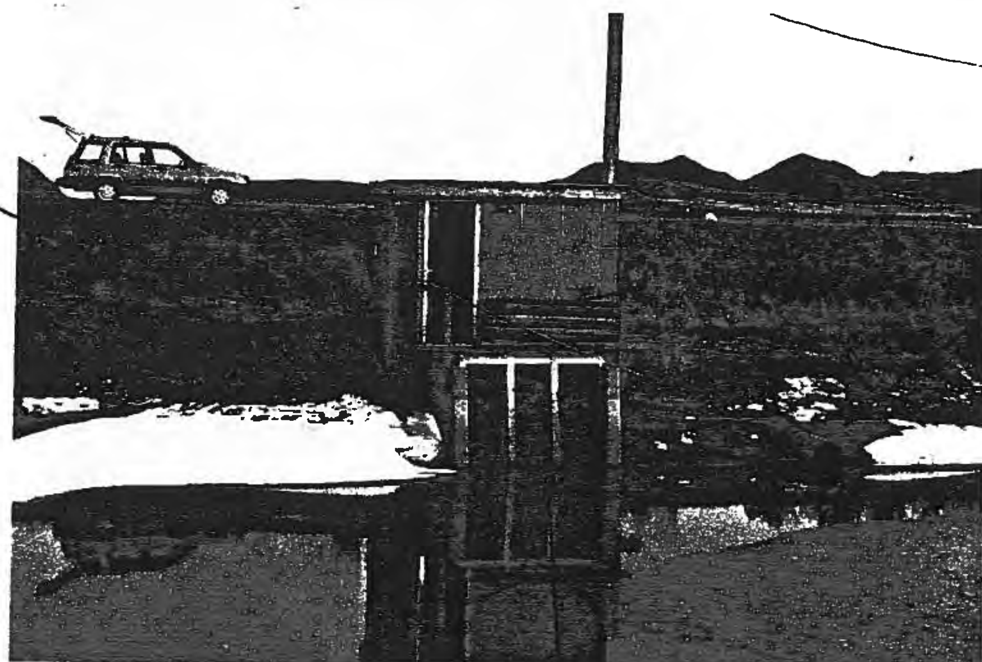


FIGURE 38 REUSE PUMP STATION, REUSE SUPPLY LINE TO BRANUM LAKE & DRAINAGE DITCH

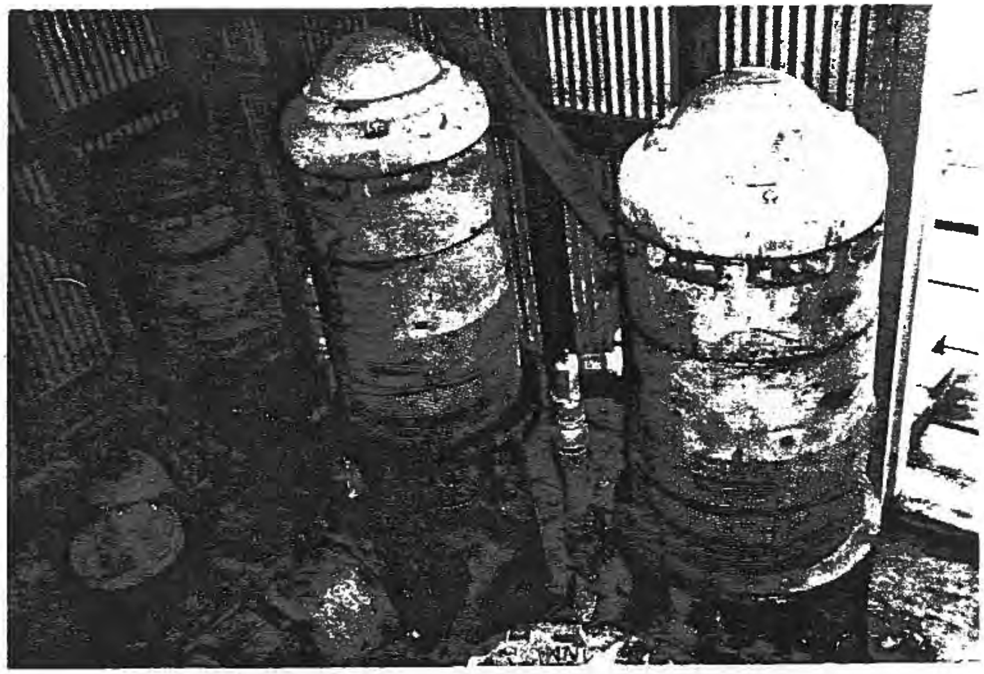


FIGURE 39 REUSE WATER PUMPS AND PUMP CHECK VALVES

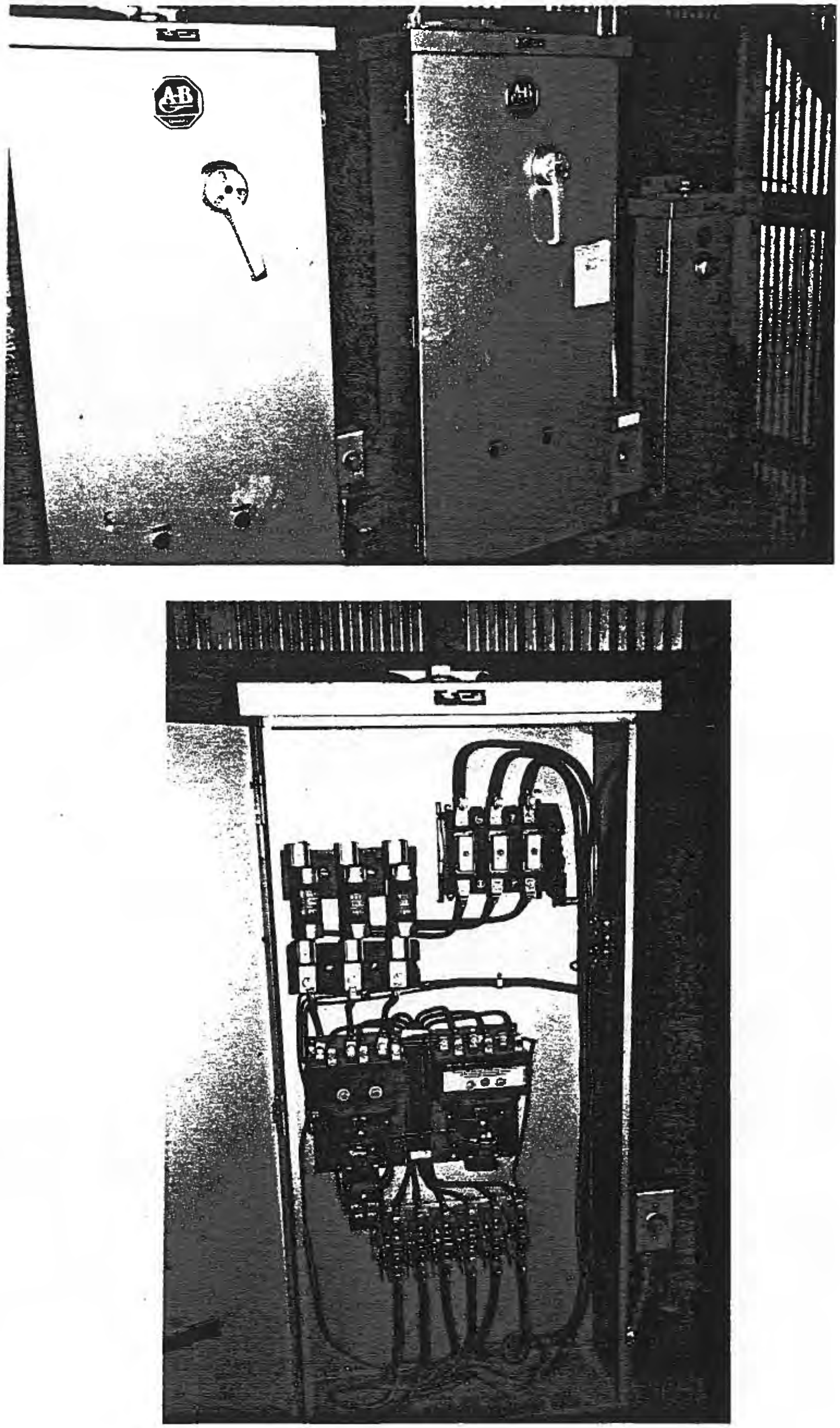


FIGURE 40   REUSE WATER PUMP CONTROLS

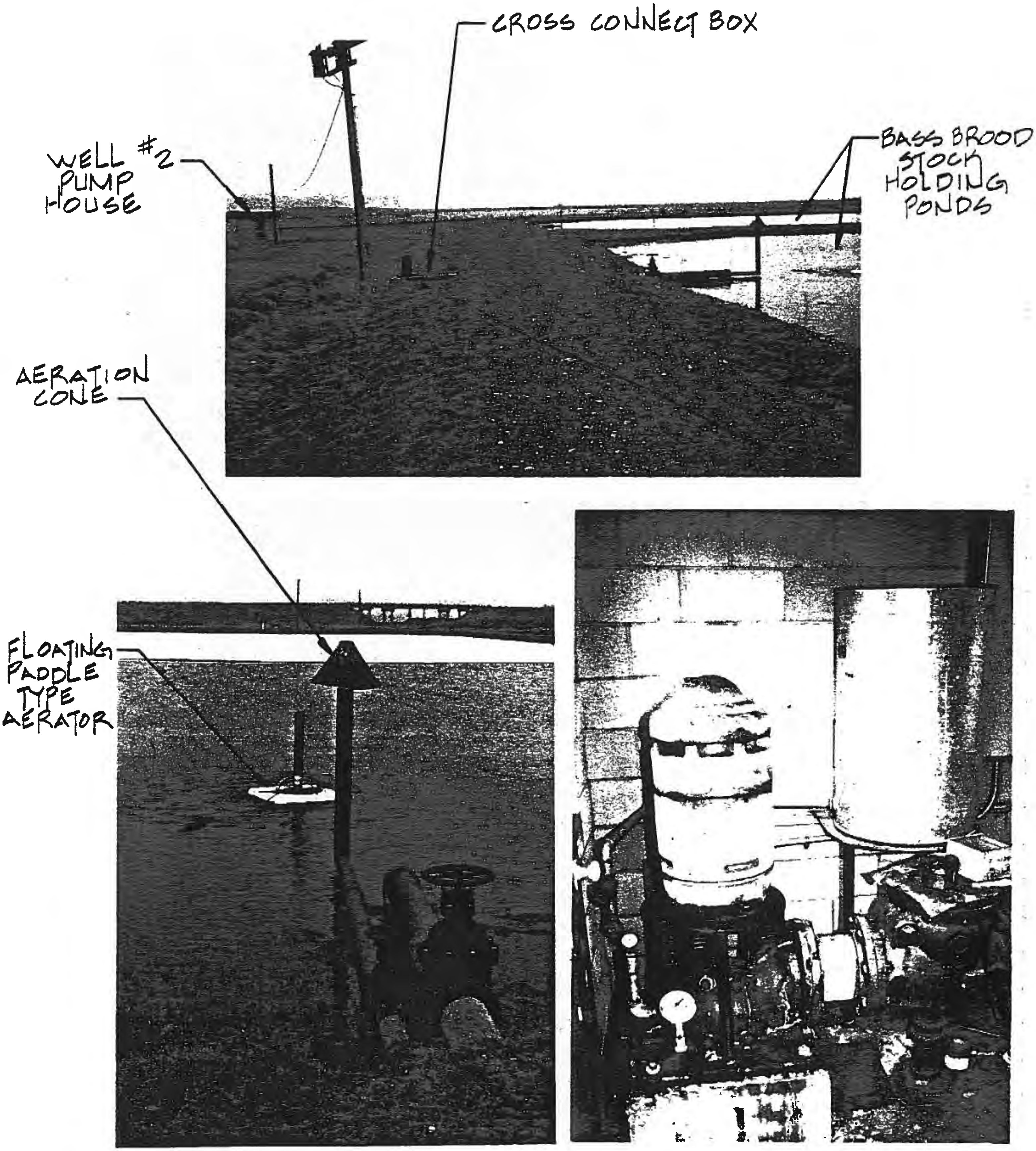
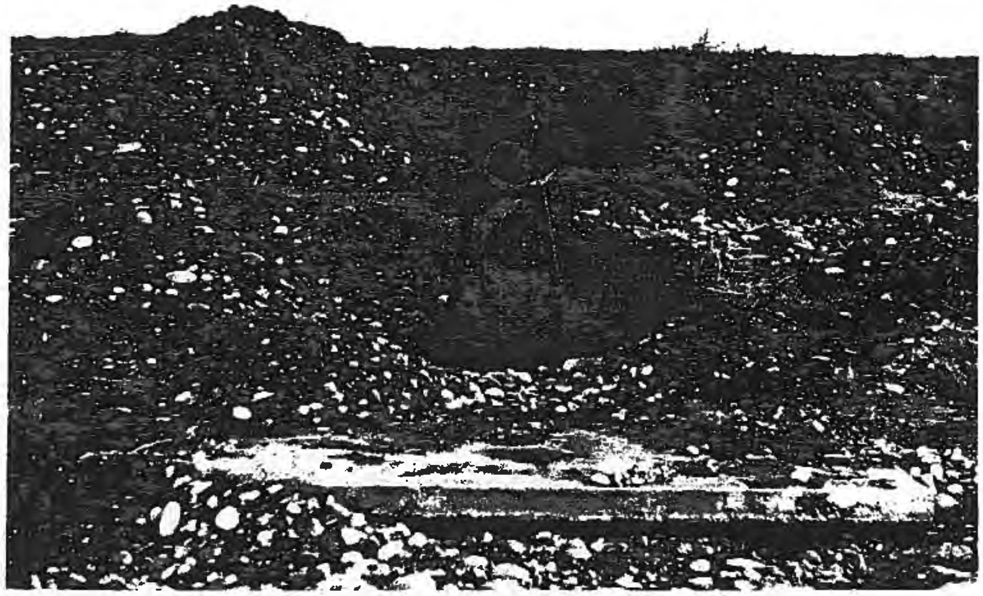


FIGURE 41 WELL #2 INLET SUPPLY LINE, AERATION CONE & WINTER AERATION DEVICE IN BASS BROOD STOCK HOLDING PONDS #3 & #4



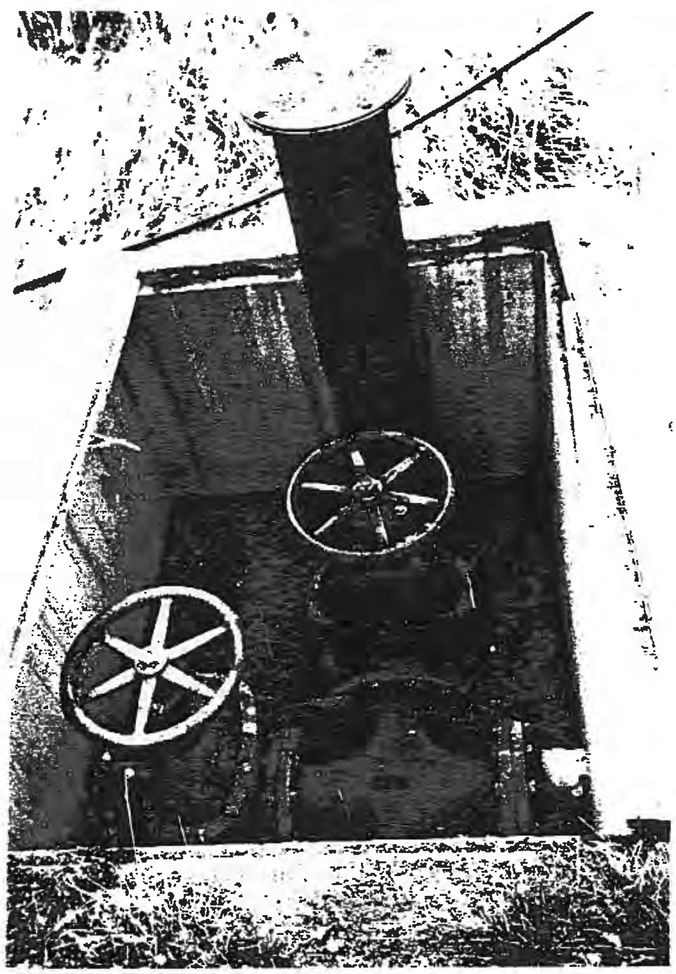


FIGURE 42 REARING POND SHALLOW END WATER SUPPLY INLET AND SPLASH PAD & WEST WELL #1 CROSS CONNECT VALVE BOX

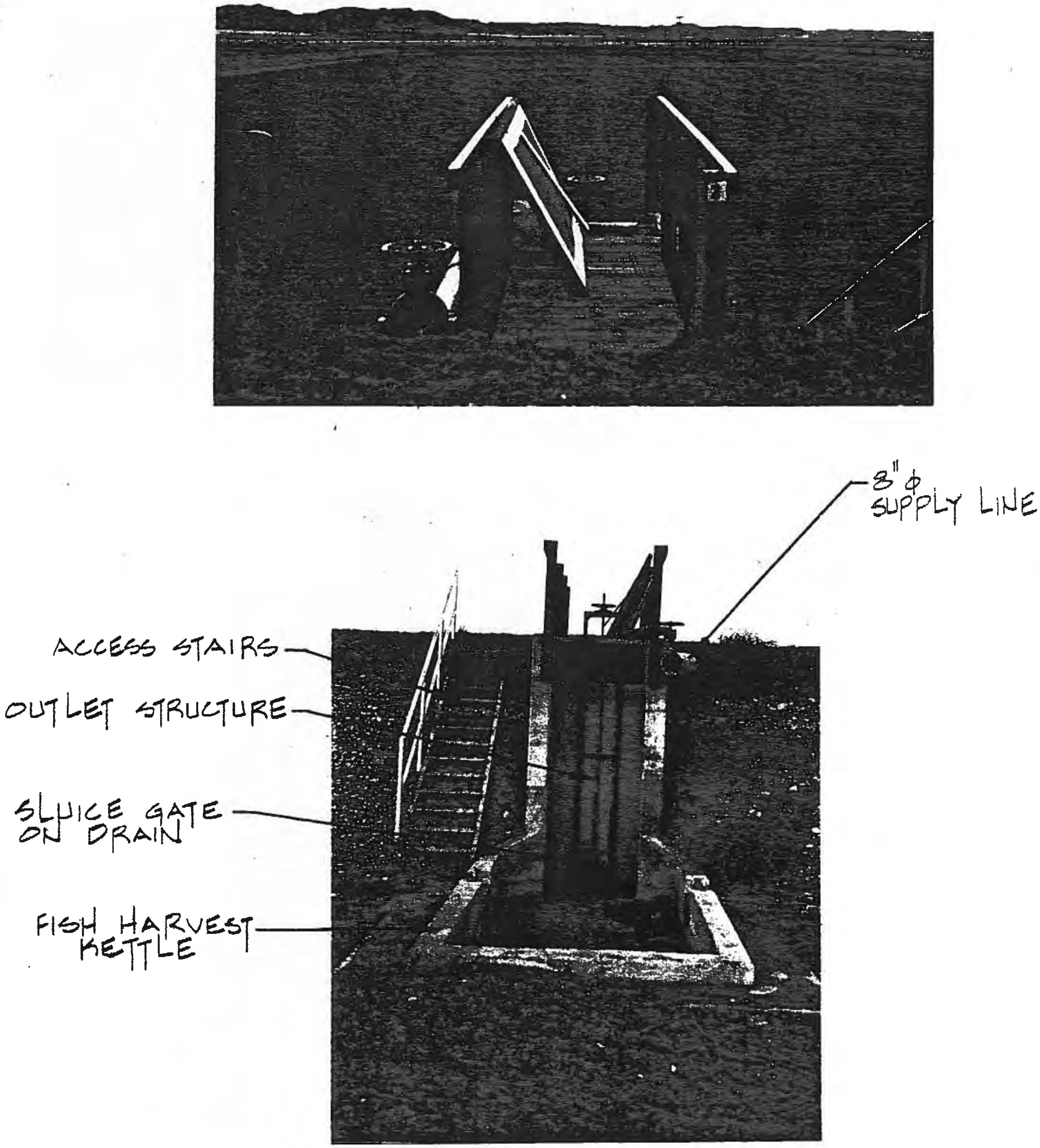


FIGURE 43 3-ACRE REARING PONDS (#1 & #2), HARVEST KETTLE & OUTLET STRUCTURE

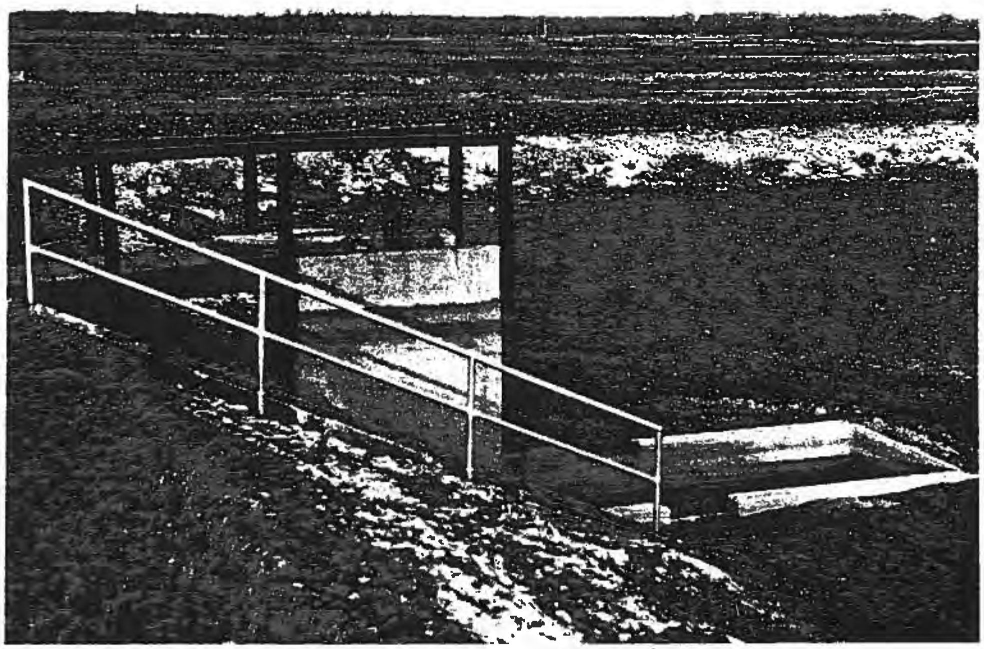


FIGURE 44   1.5-ACRE REARING PONDS (#3-#15), HARVEST KETTLE AND OUTLET STRUCTURE

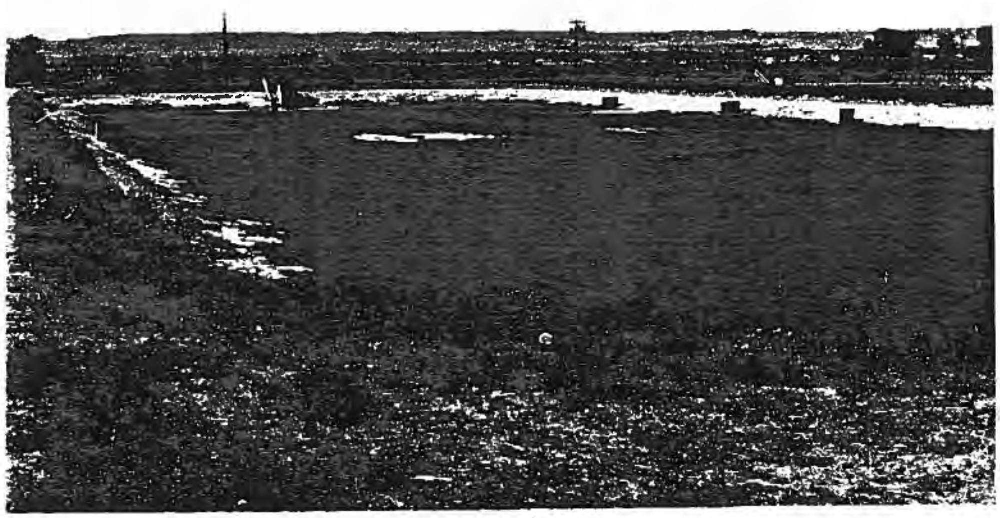


FIGURE 45 "GREEN" RYE GRASS FERTILIZER CROP IN 1.5-ACRE PONDS

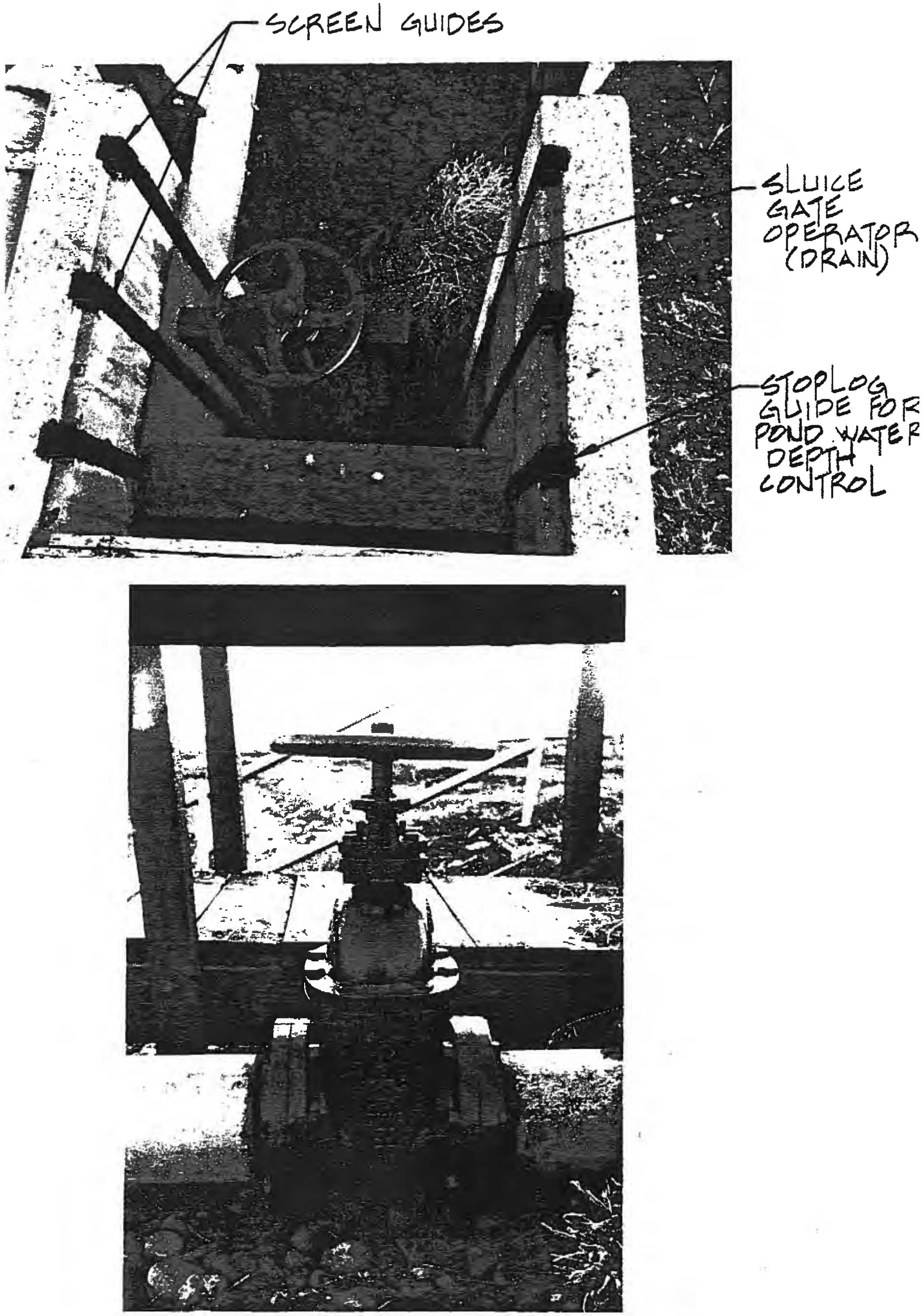


FIGURE 46 OUTLET STRUCTURE SCREEN GUIDES, SLUICE GATE AND VALVE MAINTENANCE PAINTING

structures are in poor condition as are the levee access roads (Figures 47, 48, and 49).

Generally, the existing exterior hatchery piping system is in good condition. One exception to this are transite concrete drain lines leading from the ponds to the drainage ditch. In several locations drain lines have settled and concrete energy dissipation pads have cracked, shifted and eroded away from ditch bank (Figure 50).

B. Climate and Its Impact Upon Fish Production

Climatological data obtained from the National Climatic Date Center (Appendix B) for the period of 1943 to 1982 for Miles City and Glasgow, Montana have been reviewed. The data reviewed indicates that the Miles City Area has a significantly more moderate climate than the Fort Peck Area. Monthly normal, mean and extreme temperatures (for the 39 year reporting period) indicate that the Miles City Area is generally 3 to 4 degrees F warmer than the Fort Peck Location (Table 12).

Climate has a major impact upon a warmwater/coolwater hatchery production program due to its relationship to water temperature and fish growth. Spawning of smallmouth bass and largemouth bass is particularly influenced by "unpredictable" swings in Spring weather. Cold fronts cause adults to abandon nests with dramatic losses in fry production. Fingerling rearing is also influenced by water temperature. Cooler temperatures reduce fish growth rates and zooplankton production. Solar warming of hatchery water supplies also reduces the amount of heat required to insure correct egg incubation water temperatures. This is a major factor at the potential Fort Peck Hatchery site due to the extremely cold supply water temperatures (38 F - 44 F) in April, May and June during main egg incubation period when 55 F - 58 F is required.

The Miles City location has a definite climatological advantage over the Fort Peck location.

C. Hatchery Water Supply Quality and Quantity

Water Quality

Analysis of water quality data obtained from the United States Gèological Survey (U.S.G.S.) Corps of Engineers, Miles City Water Treatment Plant, U.S. Fish and Wildlife Service-Miles City Hatchery Water Quality Study has been completed for the Tongue River, Yellowstone River at Miles City and Fort Peck (tailwater release). Data has been compared to accepted hatchery water supply desirable water quality parameters (Table 13). Generally, the Fort Peck water supply has dissolved nitrogen, fluoride,

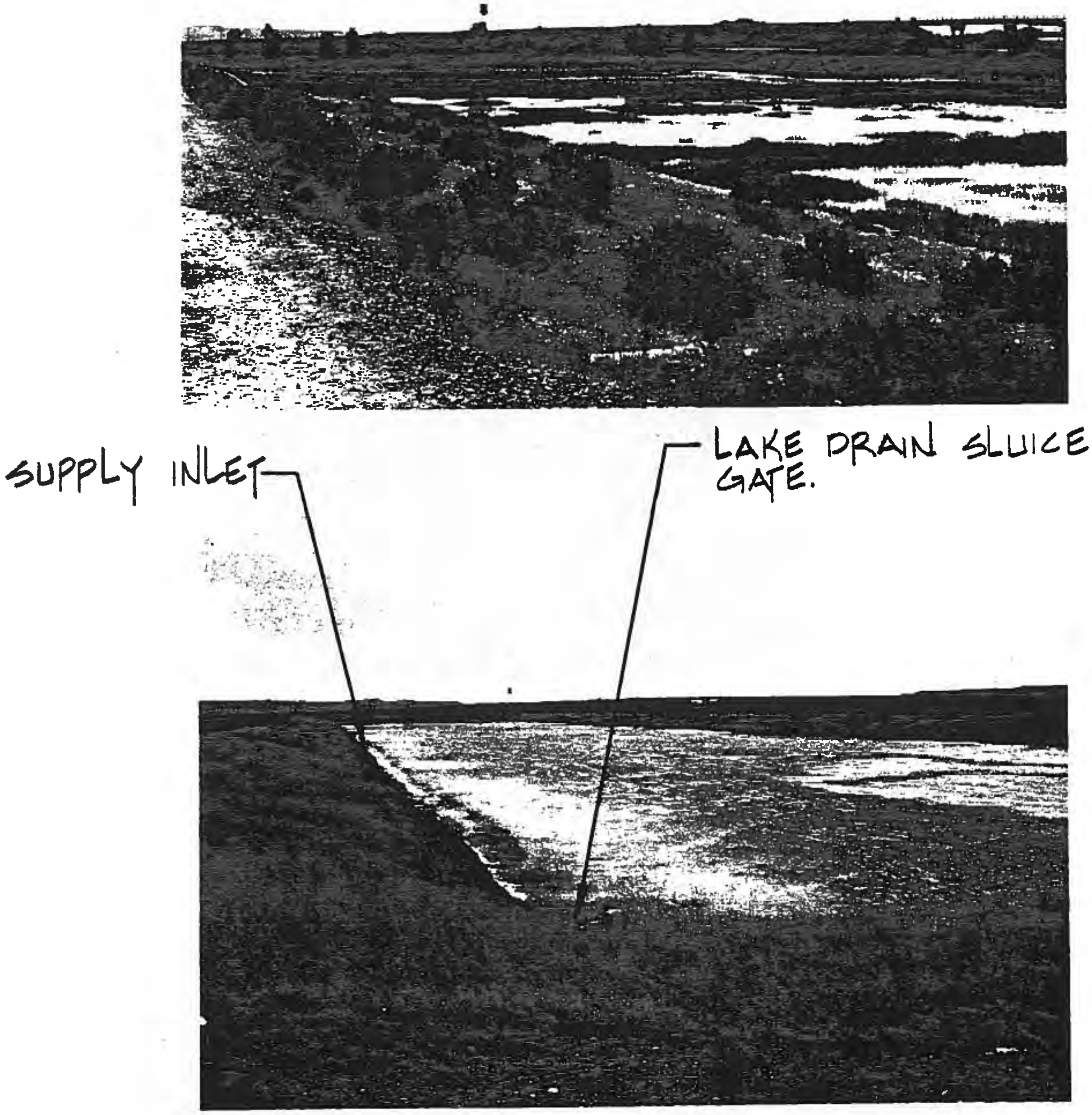


FIGURE 47 BRANUM LAKE (USED AS FORAGE PRODUCTION POND)

BRANUM LAKE
INLET SUPPLY LINE
FROM REUSE PUMP
STATION

FIGURE 48 BRANUM LAKE INLET SUPPLY LINE AND LEVEE ROAD

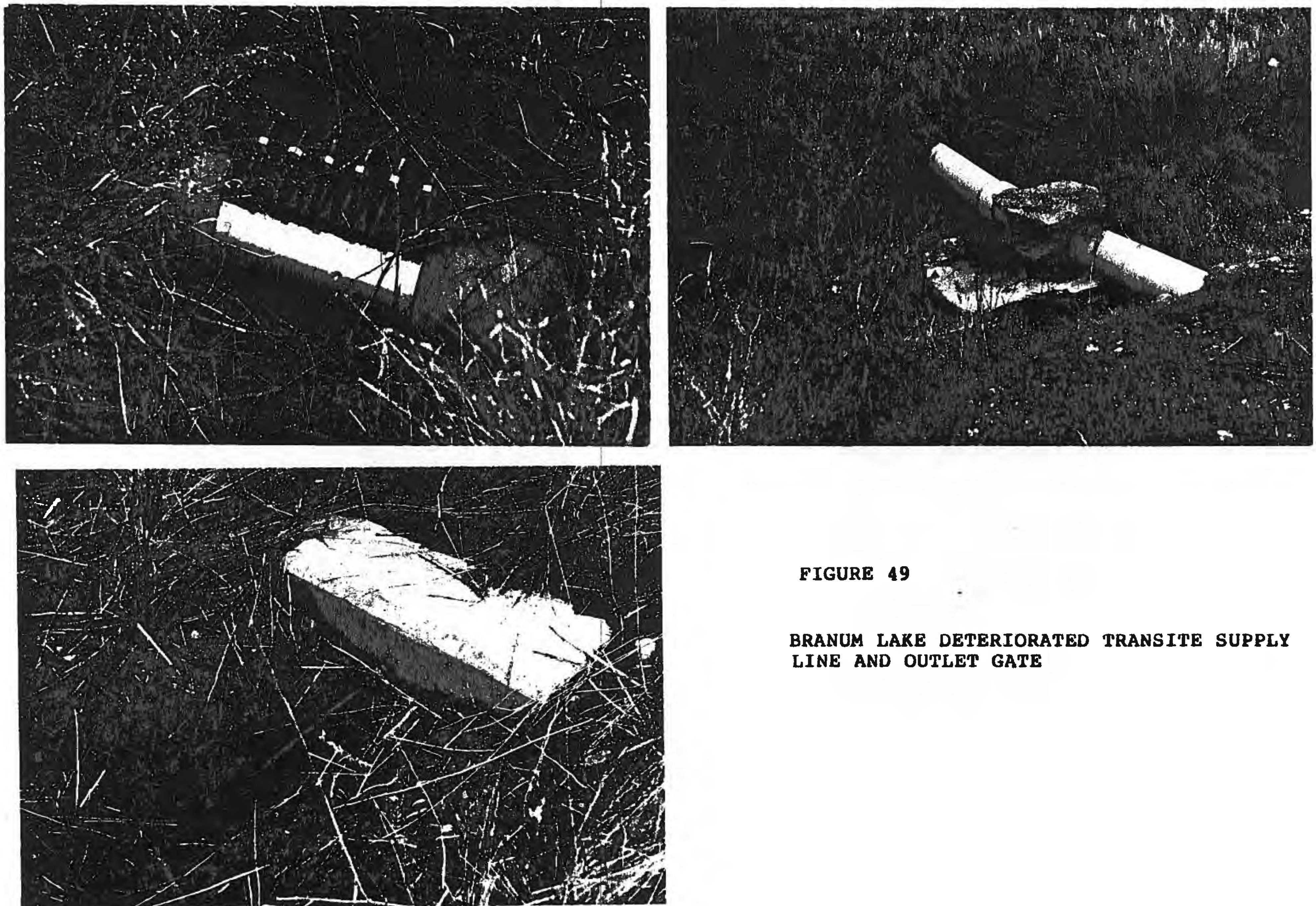
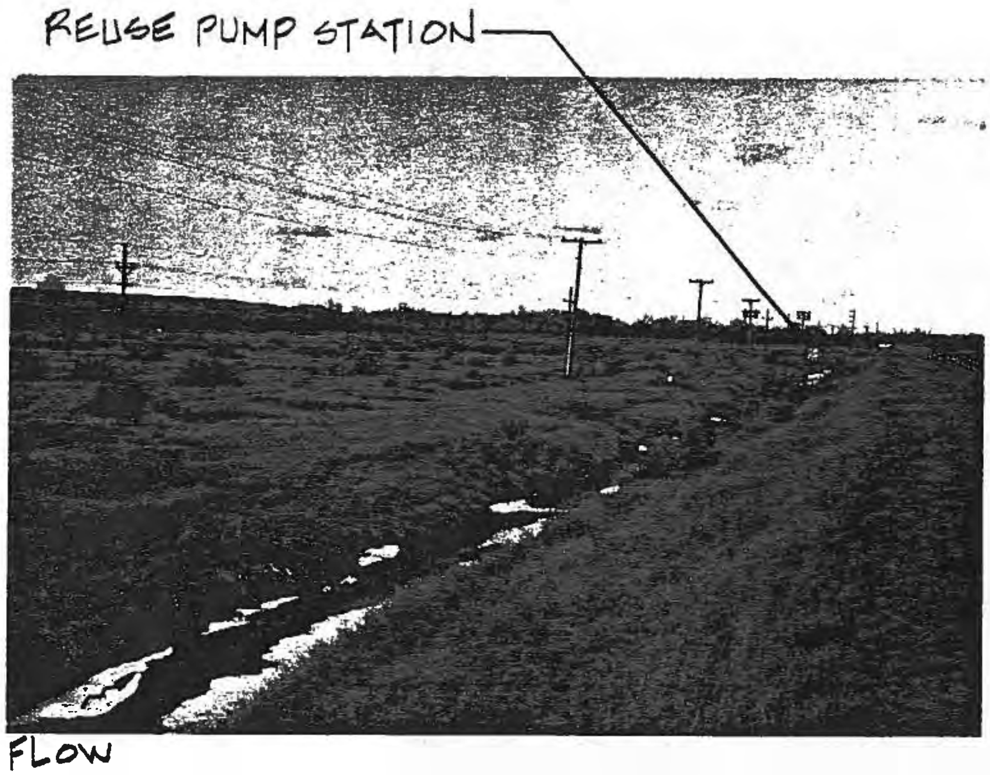


FIGURE 49

BRANUM LAKE DETERIORATED TRANSITE SUPPLY LINE AND OUTLET GATE



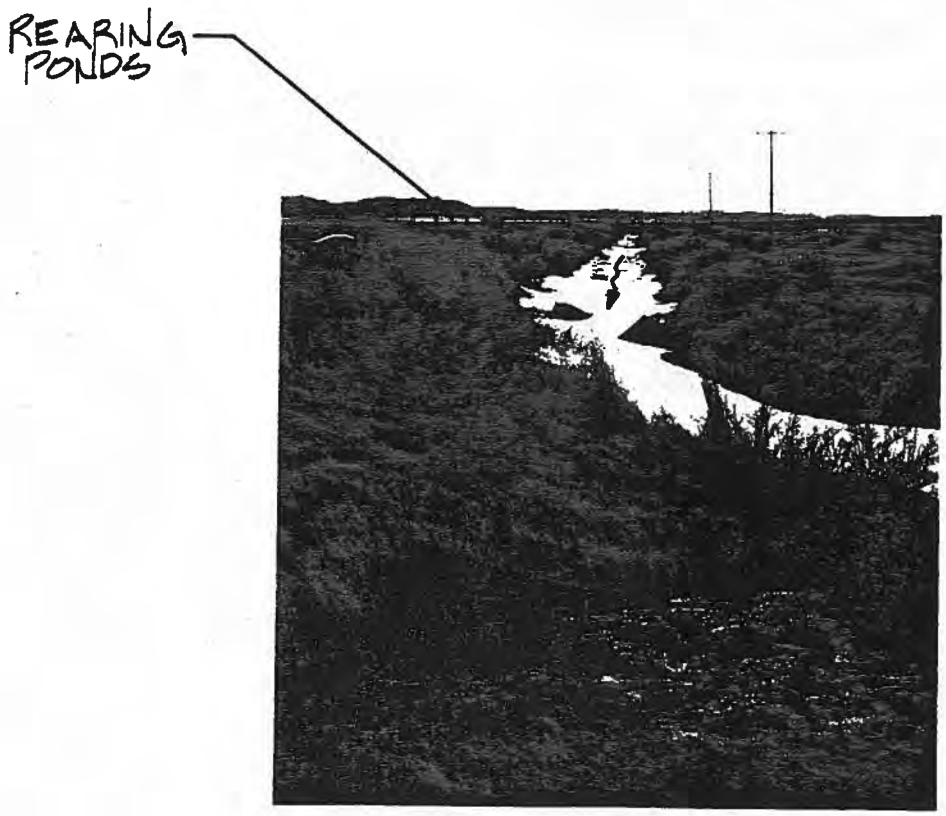


FIGURE 50 DETERIORATED POND DRAINAGE DITCH, POND DRAIN LINES AND ENERGY DISSIPATORS

TABLE 12

COMPARISON OF AIR AND WATER TEMPERATURES FOR THE FORT PECK AND MILES CITY HATCHERY SITES

	Fort Peck Air	Fort Peck Max. Min.	Miles City Air	Miles City Max. Min.	Fort Peck Water		Miles City Tongue River Water		Miles City Yellowstone River Water	
January	9.1	19.2 -1.0	15.1	25.5 4.7	33.0		32.0		33.8	
February	15.7	26.2 5.1	21.3	32.2 10.4	33.0		33.0		34.7	
March	26.9	37.8 16.0	31.5	42.8 20.1	33.8		44.6		44.6	
April	43.5	55.8 31.2	45.5	57.9 33.1	38.0		52.7		53.6	
May	55.0	67.7 42.2	56.5	69.0 44.0	41.0		57.2		57.0	
June	63.5	76.1 50.8	65.5	78.1 52.8	44.6		66.0		61.7	
July	71.1	85.3 56.8	74.4	88.8 60.0	46.4		76.2		72.5	
August	69.4	83.7 55.0	72.3	86.8 57.8	48.9		74.3		73.4	
September	57.8	71.4 44.1	60.5	74.2 46.7	50.0		63.5		64.4	
October	46.5	59.5 33.5	48.6	61.5 35.7	51.8		48.2		50.7	
November	29.3	39.9 18.7	32.1	42.8 21.4	46.4		38.0		40.1	
December	16.8	26.7 6.9	22.0	32.1 11.9	38.0		32.0		32.0	
Annual Mean	42.0	54.1 29.9	45.4	57.6 33.2	35.1	51.8 33.0	47.5	84.0 32.0	51.8	82.4 32.0
#days <32 F	96		78							
#days < 0 F	59		44							
Degree Days Base 65 F	Heating 8969 Cooling 465		Heating 7889 Cooling 776							

TABLE 12 (continued)

Precipitation in./yr.	10.8"	13.9"

Data Source: National Climatic Data Center
U.S. Army Corps of Engineers - Omaha District
U.S. Geological Survey

TABLE 13 N.D.=NO DATA

HATCHERY WATER QUALITY STANDARDS COMPARISON FOR FORT PECK AND MILES CITY HATCHERY SITES

Parameter	U.S. EPA Hatchery Standard	Outside Recommended Limits	Fort Peck	Tongue River	Yellow-stone River
Alkalinity(asCaCO)	>20mg/l		250-270 150-160	140-480 110-280	86-250 82-439
Aluminum Al	<.01 mg/l		N.D.	N.D.	N.D.
Ammonia NH	<.02 mg/l	(occasional)	.02-.63	0.-.35	0.06-.7
Arsenic As	5.0 mg/l		.003	.002	.002
Barium Ba	.0005 mg/l		0.100	.100	.100
Cadmium Cd	.005 mg/l		0	.001	.001
Calcium Ca	>.52 mg/l		56-62	31-77	18-80
Chlorine Cl gas	.003 mg/l		N.D.	N.D.	N.D.
Chromium Cr	.03 mg/l		.010	.010	.010
Carbon dioxide CO g	1.5 mg/l		N.D.	N.D.	N.D.
Copper Cu	.03mg/l		0.006	.005	.013
Dissolved Oxygen D.O.	>5mg/l 75% sat.		8.6-14.0	8.3-14.1	8.6-12.8
Fluoride F	<0.5mg/l		.6-.7	.1-.5	0.4
Hydrogen Cyanide HCN	<0.005 mg/l		N.D.	N.D.	N.D.
Hydrogen sulfide H S	<0.003 mg/l		N.D.	N.D.	N.D.
Iron fe	<0.1 mg/l		.190	0.010	.01-.18
Lead Pb	<0.02 mg/l		.004	0.003	.004
Magnesium Mg	<15 mg/l	26	28-61	9.0-58	
Manganese Mn	<.01 mg/l		0.010	0.20-0.12	.02-.27
Mercury Hg	<.2 mg/l	0.002	0.0001	.001	
Nitrogen N gas	<103% super sat.		120%>	N.D.	N.D.
Nitrate NO	<1.0 mg/l		0.44	0-.17	.09-.43
Nitrite NO	<1.0 mg/l		"	"	"
Nickel Ni	<.01 mg/l		0.002	.003	.019
PCB (polychlorinated biphenyls)	.002 mg/l		N.D.	N.D.	N.D.
pH range of	6.7-8.6	8.3-8.5	7.8-8.4	7.1-8.7	
Potassium K	<5.0 mg/l		3.5-4.2	3.3-6.5	3.9-7.7
Salinity (parts per thousand)	<5 ppt	N.D.	N.D.	N.D.	
Selenium Se	<.01 mg/l		0.001	0	.001
Silver Ag	<.003 mg/l		0	0	.001
Sodium Na	1	54-63	18-130	22-81	
Sulfur S	<1.0 mg/l		N.D.	N.D.	N.D.
Sulphate SO	<50 mg/l	190-230	74-410	130-260	
Total Dissolved Solids TDS	<400 mg/l		437-498	216-846	4-611
Total Suspended Solids TSS	<80 mg/l (concern)	problem	Not a Incubation (Data needed)	Filtration of In- Water (Data needed)	
Uranium U	<.1 mg/l	N.D.	N.D.	N.D.	

Vanadium V	<.1 mg/l	N.D.	N.D.	N.D.	
Zinc Zn	0.005 mg/l		.030	.005	.062
Ziconium Z	0.1 mg/l	N.D.	N.D.	N.D.	
Conductivity		734	872	551-980	
Turbidity JTU		0.5-13	1.6-240	4.1-410	

iron, magnesium, sulfate and total dissolved solids that (sometimes) exceed recommended limits. Tongue and Yellowstone River water quality has fluoride, iron, magnesium, sulfate, potassium, sodium, total dissolved solids, and total suspended solids that (sometimes) exceed recommended limits. Potentially, supersaturated nitrogen levels at Fort Peck and high suspended solids load during high river stages on the Tongue River and Yellowstone River, are the most troublesome. These "exceedances" can be controlled at reasonable cost at either the Fort Peck or Miles City location with the proper equipment. Water quality rating is approximately equal at both sites with no major advantage or disadvantage to either site.

Water Quantity

Hatchery water quantity in the range of 2,500 gpm to 4,000 gpm flow is required to effectively operate the desired future fish production program (see Section III).

The enhancement of the present Tongue River Water Supply Pumping Station or installation of a new Yellowstone River Supply System (or combination of both) is needed to insure the proper quantity of water to operate the Miles City Station at the desired level of production. The existing Tongue River System cannot supply the amount of water needed without major upgrading. In addition, the existing 650 acre foot water rights permit for the Tongue River (Appendix C) would need significant expansion. The Department has, via transfer, obtained a 3,650 acre foot/year water right on the Yellowstone River (Appendix C). Cost estimates for both systems have been prepared and are included in Section VII of this report. Annual re-occuring pumping cost in the range of $10,000 to $20,000 are expected for operation.

The Fort Peck location provides the opportunity to utilize a gravity flow supply system with no re-occuring pumping costs. The Corps of Engineers has reviewed a tentative request for peak water supply demand in the range of 2,500 to 4,000 gpm. The Corps of Engineers indicates that a main tap of the #1 Unit 24' diameter supply lines to provide that amount of water is potentially available without causing significant head loss to the generation units. Unfortunately, the heating requirement of the cold 200 foot deep Fort Peck main intake offsets the no pumping costs due to gravity flow. The Fort Peck location has an advantage in water quantity (availability) over the Miles City location.

D. Land Base: (Space Ownership, Acquisition, Soils & Topography

The space requirement for development of the desired hatchery production ponds and hatchery complex is approximately 100 acres. Review of potential Fort Peck Hatchery Sites has revealed that only the downstream tailwater area site (Site A) is large enough for the hatchery (without private land acquisition required at Site B). Elevation at Site C is too low and could be impacted severely by high river conditions or possible construction of the COE re-regulation dam. The acquisition of private land would also be required at Site C. If the hatchery was constructed at Fort Peck Area A, future expansion potential would be limited due to the location of the City water treatment plant and downstream recreation area. Hatchery construction at Area A will require relocation of the City water supply line and golf course and will have an impact to potential visitor traffic movement in the downstream recreation area. The Corps of Engineers tentatively supports the use of Area A for the hatchery. Soils and topography at Area A at Fort Peck appear to be suitable for hatchery construction.

Miles City Hatchery has approximately 168 acres within the original USFWS boundary and 41 acres in the state owned Branum Lake Area. Future expansion (beyond that necessary for the expanded production program) is possible if the Tongue River Railroad Development Project does not severely impact the hatchery. Acquisition of land from the USDA, Fort Keogh Research Center may be possible if additional future expansion is undertaken. The recent Federal Court Injunction against the Tongue River Railroad Development Project may "tie up" the project indefinitely. The final outcome of the railroad project and its potential adverse impacts to the Miles City location should be determined before committing state capital construction dollars to expansion if possible. Acquisition of the hatchery from the U.S. Fish and Wildlife Service is also necessary before any expansion program is undertaken. The purchase cost (if any) of the hatchery from the Federal government may have an impact on the future construction of the Montana Warmwater/Coolwater Hatchery System. Based upon acquisition of other National Hatcheries closed recently, we assume the hatchery can be obtained via legislative action.

The Miles City Site, in our opinion, has an advantage in the land base category over Fort Peck (pending outcome of the railroad development and COE re-regulation dam projects).

E. Effluent Treatment Requirements

Domestic wastewater and tank cleaning wastes will be treated in hatchery lagoon systems at either location. Since production poundages are well under the 100,000 pound/year limit for fish hatcheries set by the Federal EPA, and the fact that the planned expansion is essentially extensive rearing ponds, no hatchery wastewater treatment appears to be required. Retention of the hatchery wastewater and overflow water at both locations is recommended in a 1.5 acre retention pond for settling. Discussions with the Montana Department of Health and Environmental Services indicates that "solids settling" is the only required form of wastewater treatment currently used at the State and Federal Hatcheries producing coldwater species (i.e. trout and salmon) in Montana. We recommend that a retention pond (1.5 acres) be available to provide solids settling of pond drainage water prior to discharge. All filter backwash water, hatchery start/holding tank cleaning effluent and floor drain wastewater will be treated in the hatchery domestic wastewater treatment lagoon system. Warmwater/coolwater hatcheries (traditionally) have not come under the stricter effluent standards as the flow-thru intensive trout hatcheries, since the ponds tend to "buffer" the wastewater treatment requirement. In our opinion, both sites are equal in this regard.

F. Energy and Communications Source and Requirements

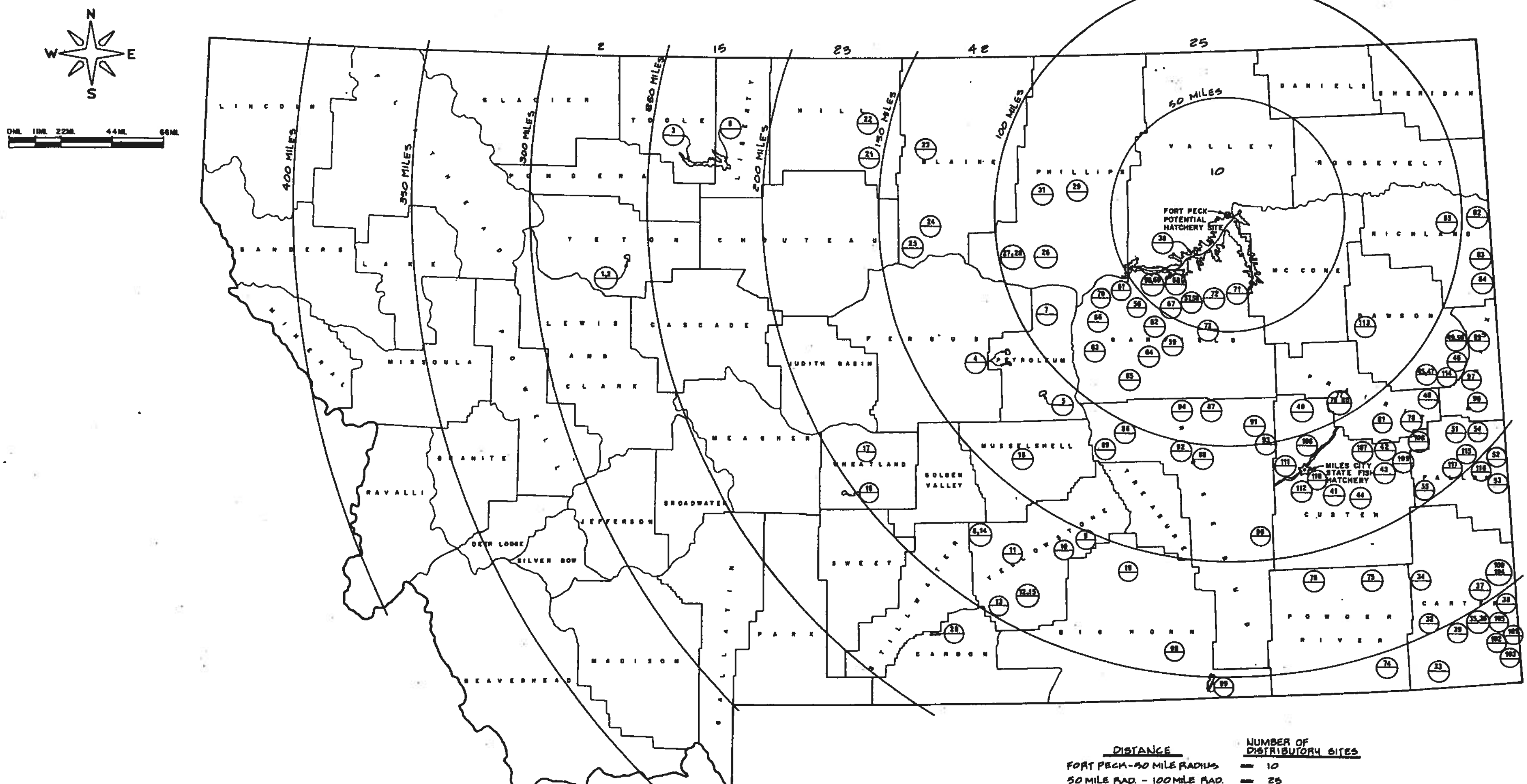
Electrical energy availability is equal at both locations. Electrical costs are approximately equal at both locations under the standard commercial rates. If the Western Area Power Administration would provide "reduced rate" power to the State of Montana, this might favor the Fort Peck Location (our initial contacts with WAPA do not appear to indicate a willingness to provide reduced rate power). Telecommunication services are also equal at both sites. Commercial services of electricity and communication services are available at both the Fort Peck and Miles City Hatchery locations for meeting the proposed Warmwater/Coolwater Hatchery Project requirements. Natural gas is available at the Miles City Hatchery Site and is not available at the Fort Peck location.

G. Distribution Distance for Fish Stocking

Radius maps from the Fort Peck location and Miles City location have been prepared to reflect the 1983 Fish Planting Program (Plates 10 and 11). Using the 117 stocking requests to reservoirs and ponds listed in the 1983 Fish Planting Program, (Appendix D) the number of stockings shown in 50 mile radius increments are shown. Using the 1983 data, 94% of all stockings are within a 200 mile radius from Miles City and 85% from the Fort Peck Location. Interstate Air Transportation of eggs and fry via major commercial airlines is easiest out of Billings. Intrastate air transportation out of Glasgow or Miles City are approximately equal. Some stockings of Noxon Rapids Reservoir (not shown in 1983) in Northwestern Montana involve long travel distances of 400 to 700 miles one way and are difficult to accomplish from either site. Trout distribution of fish reared at Lewistown Hatchery is approximately equal from both the Fort Peck and Miles City Hatchery Sites. The Miles City Hatchery appears to have a slight advantage over the Fort Peck Location in the fish distribution category.

H. Hatchery Accessibility Relative to Brood Fish Sources and Commercial Transportation Systems

Based upon our analysis of brood fish collection locations, both hatchery sites appear to be equal in this category. Collections in Medicine Lake, Nelson Reservoir, Fresno Reservoir, Fort Peck Reservoir favor the Fort Peck site. Collections made in the southern reservoirs like the Tongue River Reservoir and Big Horn Lake favor Miles City. Walleye egg collections in the



MONTANA STATE MAP

COUNTY BOUNDARIES

DISTANCE	NUMBER OF DISTRIBUTORY SITES
FORT PECK - 50 MILE RADIUS	10
50 MILE RAD. - 100 MILE RAD.	25
100 MILE RAD. - 150 MILE RAD.	42
150 MILE RAD. - 200 MILE RAD.	23
200 MILE RAD. - 250 MILE RAD.	15
250 MILE RAD. - 300 MILE RAD.	2

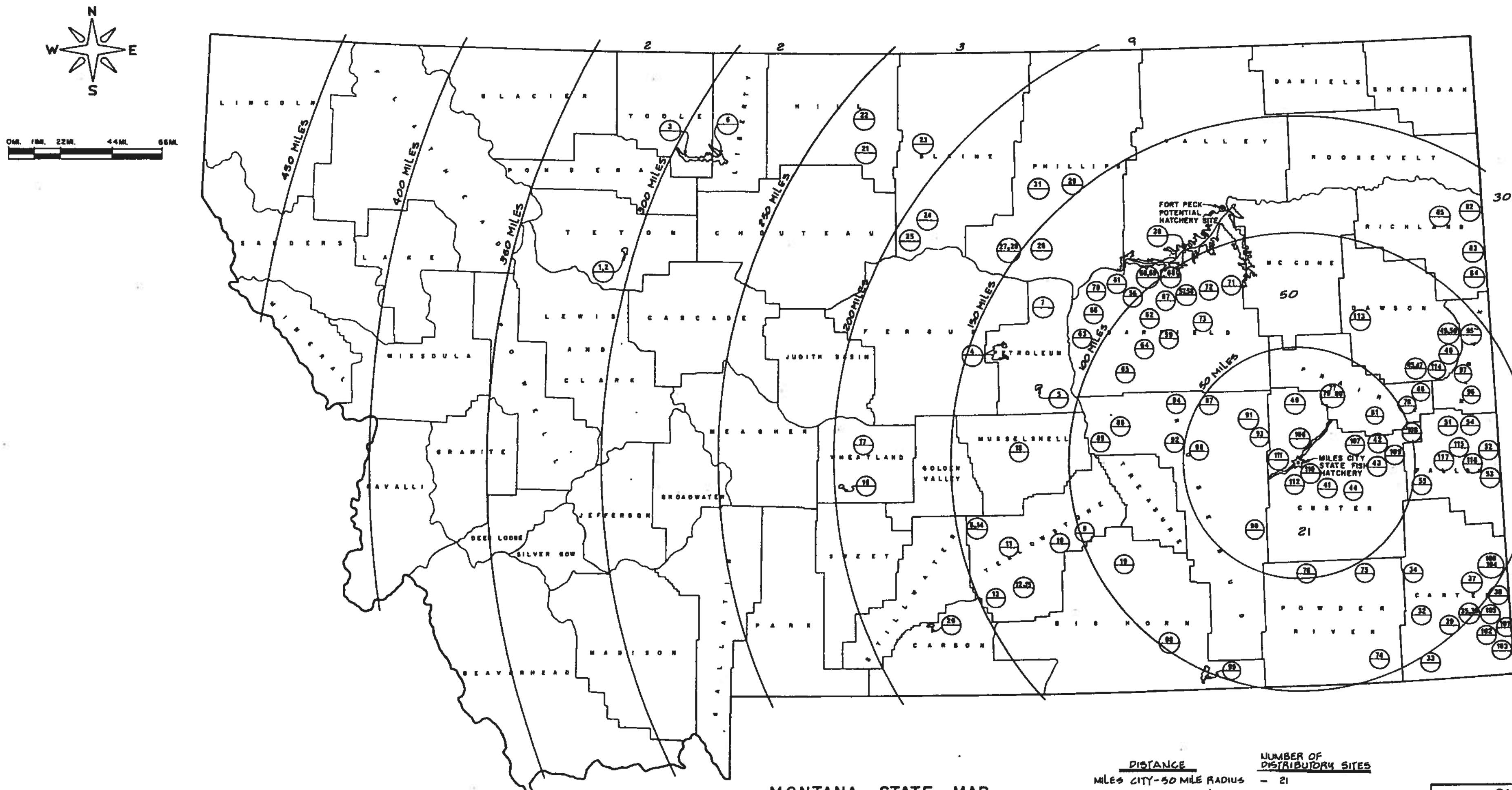
PLATE # 6

DISTRIBUTION DISTANCE FOR FISH STOCKING FROM FORT PECK HATCHERY SITE

MONTANA WARM/COOL WATER FISH HATCHERY STUDY

Fisheries Design Group

DATE 9/28/84



MONTANA STATE MAP

COUNTY BOUNDARIES

DISTANCE	NUMBER OF DISTRIBUTORY SITES
MILES CITY - 50 MILE RADIUS	- 21
50 MILE RAD. - 100 MILE RAD	- 50
100 MILE RAD. - 150 MILE RAD.	- 30
150 MILE RAD. - 200 MILE RAD	- 9
200 MILE RAD. - 250 MILE RAD	- 3
250 MILE RAD - 300 MILE RAD	- 2
300 MILE RAD. - 350 MILE RAD	- 2

PLATE # 7

DISTRIBUTION DISTANCE FOR FISH STOCKING FROM MILES CITY HATCHERY SITE

MONTANA WARM/COOL WATER FISH HATCHERY STUDY

Fisheries Design Group

DATE 9/28/84

Yellowstone River at Intake are approximately the same distance from both hatchery sites, although road access is easier to Miles City via Interstate 94. The availability of Interstate 94 simplifies interstate egg shipments. Due to large size of the State of Montana, we strongly recommend that several sources of brood fish collection sites be developed. This provides flexibility in the timing of brood fish collection and permits greater latitude in meeting production requirements due to the "unpredictable" biological factors involved (i.e. poor spawning, climate conditions, collection problems, etc.). Fisheries managers should cooperate with the hatchery staff in developing strong populations of brood fish that are collectable for support of the hatchery program.

I. Site Problems

Four principle areas of concern (unknowns) still exist and require reasonable answers before any final decisions are made regarding actual design and construction of the new warmwater/coolwater hatchery:

Fort Peck Site

1. Resolution of the proposed COE Re-Regulation Power Dam Project and its impacts to the Fort Peck Area A Site. This project does not appear to be moving forward rapidly; the cost/benefit ratio may not warrant its construction.

2. Full support and cooperation between the U.S. Army Corps of Engineers and Montana Department of Fish, Wildlife and Parks in the development, construction and operation of a hatchery at the Fort Peck location is necessary. The Corps of Engineers has been very helpful in development of this study and does support the concept of locating the hatchery at the Fort Peck Location. In our opinion, the COE would fully support the project at the Fort Peck location.

Miles City Site

3. Resolution of the proposed Tongue River Railroad Project and its impacts to the existing Miles City State Fish Hatchery. Due to the recent Federal Injunction of the Tongue River Railroad Development Project and questionable construction benefits of the project, we recommend that the Department move forward with the Miles City Hatchery expansion project identified in this report.

4. Title acquisition of the Miles City State Fish Hatchery from the U.S. Fish and Wildlife Service. This requirement can best be addressed by the combined legislative efforts of the Department, Governor's Office and Montana Legislators.

J. Site Comparison Matrix Table

Table 14, a Site Selection Comparison of the Miles City and Fort Peck hatchery Sites has been prepared to reflect the overall rating of Site Specific Paramters A through H. In addition to items A through H, the factor of initial construction cost, Item I (due to its importance in any hatchery construction program) has also been included. Based upon simple "unweighted" rating system of the site specific parameters, the Miles City Hatchery location was rated higher (2.25 vs. 1.75) when compared to the Fort Peck location. The issue of cold water temperatures at the Fort Peck location vs. limited availability of the Tongue River Water supply are very important factors. The use of the Yellowstone river as an additional water supply at the Miles City Hatchery provides a viable construction alternative to the need for high quality water in sufficient quantity to support the expanded production program. The problem of cold rearing water temperatrues at the Fort Peck location is difficult to address in an operationally cost effective manner. The reoccuring cost of mechanical water heating makes the use of the Fort Peck Reservoir water supply very prohibitive.

Item I, overall construction cost comparison (see Section VII) of 5.1 million for the expansion of the existing Miles City Hatchery compared to 6.7 million (see Section VII) for the construction of a new hatchery complex at the Fort Peck location is, of course, the bottom line that must be addressed by the Department on the development of the Montana Warmwater/Coolwater Hatchery Program.

K. Public Review Meetings

The summarized findings of the Site Selection Phase of this study were presented to the public by Director James Flynn on July 23, 1983 at the Elks Club, Glasgow, Montana and July 24, 1984 at the Miles City Junior College, Miles City, Montana. Both Public Meetings were well attended at both locations. Questions of primary interest centered around:

1. Water Quality and Quantity from the Tongue River at Miles City and "rumors" of past-operational problems.

2. Possible gravity flow water supply in lieu of pumping from the Yellowstone River at Miles City.

3. Equitable comparison of the Fort Peck location site selection parameters to the Miles City parameters.

4. Questions of construction cost and overall project funding.

At the completion of both Public Meetings, Director Flynn invited the public to submit any written comments, questions or concerns regarding the Montana Warmwater/Coolwater Hatchery Study to the Department. As of October 1, 1984, no written responses were received.

L. Site Selection Recommendation

TABLE 14

MONTANA WARMWATER/COOLWATER FISH HATCHERY STUDY SITE SELECTION COMPARISON OF THE MILES CITY AND FORT PECK HATCHERY LOCATIONS

Site Selection Item	Miles City State Fish Hatchery	Potential Hatchery Site and Fort Peck Reservoir
Fish Production Parameters		
Rearing Pond Acreage approx. 54 acres	2	2
Water Supply (Flow Required) 2,500 to 4,000 gpm	2	2
Site Specific Parameters		
A. Climate	3	1
B. Water Quality	2	2
Water Quantity	1	3
C. Land Base: (Space, Ownership, Acquisition, Soils, Topography)	3	1
D. Effluent Treatment Requirements	2	2
E. Energy and Communications	2	2
F. Fish Distribution	3	1
G. Brood Fish Collection	2	2
H. Site Problem/Concerns	2	2
I. Initial Construction Cost	3	1
TOTAL AVG.	AVG. = 2.25	AVG. = 1.75

SITE RATING SYSTEM:

3 = site advantage
2 = sites equal
1 = site disadvantage

Based on analysis of site selection parameters, initial construction and operational costs and demonstrated successful fish culture production program for warm and coolwater species at the Miles City Fish Hatchery, it is recommended that the Montana Department of Fish, Wildlife and Parks select the Miles City Hatchery as the site for development of the Montana Warmwater/Coolwater Hatchery Program.

SECTION V

Environmental Impacts Associated with Hatchery Construction and Site Development

A. Water Withdrawal and Water Rights

1. Fort Peck Reservoir Withdrawal

The U.S. Army Corps of Engineers has given tentative approval to the withdrawal of 2,500 gpm from the #1 Unit Intake Tube at the Fort Peck Reservoir Location. Corps of Engineers requirements for Intake Unit #1 maintenance and repairs could impact the operation of a hatchery at Fort Peck (although this is not considered to be a major negative factor). All reservoir withdrawal of water from Fort Peck Reservoir via the #1 Unit would be regulated (and approved) by the Omaha District and higher COE authorities.

2. Miles City Hatchery-Tongue River Water Withdrawal and Water Rights

Tongue River pumping during the irrigation season (May-September) is limited by existing Water Right of 650 acre feet purchased from the Tongue River Water Users Association. An increase water supply requirement from the Tongue River during the irrigation season (above the 650 acre feet authorization) would require a modification in the existing water right. Note: under the recommended plan, an increase in the Tongue River Water Right will not be necessary.

3. Miles City Hatchery - Yellowstone River Water Withdrawal and Water Right

Provisional Permit 15530-S42KJ (Montana Department of Natural Resources - Water Rights Division for Yellowstone River Water Withdrawal in the amount of 3,650 acre feet per year at a rate of 10 CFS or 4,480 gpm is a valid right; a post-1973 right) that must be updated with a DNR Form 608 or extended by letter to the DNR. Filing of this water right will be required to pursue the recommended development of the Yellowstone River water supply system to Miles City Hatchery).

2. Easements and Cooperative Operational Requirements

Fort Peck Site

Development of the Fort Peck Area A Hatchery Site would require:

1. Approval from the Montana Area and Omaha District U.S. Army Corps of Engineers (and higher Missouri River Division authority) before the use of project lands could be formally authorized. The State of Montana through the Montana Department of Fish, Wildlife and Parks would negotiate a formal agreement with the Omaha District to accomplish hatchery construction on the project.

   Tentatively, the COE supports the construction of the hatchery at the Fort Peck Area A, using water available from the #1 Intake Tube.

2. Relocation of the new City of Fort Peck Water Supply Line through Area A would be necessary to construct a hatchery at Area A. COE approval and adherence to COE requirements would be required to relocate the water line to the new water treatment plant (this work can be accomplished without major service interruption). Other possible relocation requirements and/or impacts may include the three-hole golf "course" in the COE tailwater recreation area.

3. Hatchery Construction and Operation at Fort Peck Reservoir would require full cooperation between the Department and COE. Based upon Garrison Dam and Gavins Point National Fish Hatchery Operation, the Omaha District would cooperate in the operation of the proposed Montana State Hatchery at Fort Peck.

4. Installation of new electrical service to the hatchery site from the powerhouse to the hatchery site would require COE and Western Area Power Administration approval and easements. Proposed electrical routing would be similar to the water supply line.

<u>Miles City Hatchery Site</u>

Development of the Miles City Hatchery Site would require the following easements and cooperative agreements.

5. Yellowstone River Supply Line Construction Easements from the City of Miles City, Montana. Fort Keogh U.S. Department of Agriculture, Montana Department of Transportation and Burlington Northern Railroad.

6. Electrical Power Line Construction Easements to the Yellowstone River Pump Station.

7. Construction Easement to provide for construction of a new Yellowstone River Pump Station and Inlet Structure from Fort Keogh or agreement to install and operate hatchery pumps from the existing Miles City Water Treatment Plant River Intake (this would be the

preferred method). Use of the Treatment Plant Intake Structures with new hatchery supply pump(s) would require cooperation between the Department and City.

8. Continued cooperation with the City of Miles City regarding operation of Spotted Eagle Lake and the pond drainage water routing.

9. Road use easements/agreements during construction.

c. Permit Requirements

The following permits will be required.

1. Corps of Engineers Section 10/404 Permit (river intakes/outlets).

2. Montana Department of Fish, Wildlife and Parks Stream Bed Preservation Permit (river intake & outlets).

3. Montana Department of Health and Environmental Sciences Discharge Permit and Quarterly Sampling of Suspended Solids. BOD and Discharge Volume (CFS).

SECTION VI

Preliminary Engineering & Architectural Hatchery Design

A. Conceptual Hatchery Plan - Ft. Peck

The conceptual layout of the warm/coolwater hatchery analyzed at Ft. Peck Reservoir is shown on Plate 2, "Ft. Peck - Area A Layout". As discussed earlier, other hatchery locations downstream of the Ft. Peck dam were eliminated from further consideration due to several reasons (too far from dam for water supply, area not large enough for hatchery site, elevation too low, etc. - see Plate 1 for other hatchery site locations).

The basic hatchery consists of the following components:

1. Water supply from the Ft. Peck Power Plant to the hatchery site.

2. A solar pond for heating water and storage prior to use in the hatchery.

3. An aeration/degassing and process water treatment system.

4. A main hatchery building for egg incubation, fry rearing and various other production oriented functions, as well as room for storage, offices, shop area, and visitor information.

5. Support facilities such as storage buildings and staff residences.

6. Site work and utilities including drainage, roads, parking, site security & lighting, electrical, communications, domestic water and wastewater, production overflow and waste retention.

7. Spawning and rearing pond and associated supply and drain piping and concrete water control and harvest kettles.

8. Intensive culture concrete production raceways and associated supply and drain piping.

B. Recommended Ft. Peck Hatchery Construction Items, Design Requirements, and Estimated Construction Costs

1. Land Requirements - As discussed in earlier sections the amount of land required for this hatchery is dependent upon the production level goals, pond loading requirements, and pond layout. It has been determined that approximately 32-one and one-half acre ponds and 13-half acre ponds, as well as hatchery building, residences and support facilites are required to meet the production goals of the Department. At Ft. Peck it was also determined that a shallow solar heating pond would be required to pre-heat the production water prior to filling ponds, but more importantly, prior to mechanically heating the water for use in

the hatchery building for egg incubation and fry rearing. A pond area of approximatley 15 acres was chosen more for the layout of the Area A topography than because of optimum size. A pond in the size range of ten to thirty acres is normally used in this type of application based on the availability of land.

Therefore, based on the extensive pond size requirements, the need for a solar heating pond and the necessary support facilities the criteria of a hatchery site containing a minimum of 100 acres was established. The land needed to be relatively flat, or gently sloping from the water supply side to the water discharge side to provide for gravity water flow throughout the hatchery. The lower elevations should not be susceptible to flooding or highwater since that condition would cause back-up of drain lines in the hatchery. Area A appeared to be the only site that met all of the land requirements and still provided economical gravity flow from the water source at the power plant.

The following discussion will summarize the various design requirements and/or considerations for the individual construction items and hatchery system components identified above and on Plate 2. In addition the estimated probable cost of the items will be discussed as summarized in Section VII, "Cost Estimate".

2. Water Supply - One of the most attractive aspects of the Ft. Peck Hatchery site is the large volume of high quality water available via gravity-flow directly downstream of the Ft. Peck Dam. In order to insure that no pumping of water is required it will be necessary to tap one of the power plant's penstocks to provide the head pressure created by the water surface of the impounded water. See Appendix E for a May 4, 1984 letter to the Corps of Engineers, Omaha District regarding the availability of a water tap at the Power plant. The Corp's response dated August 7, 1984 (also in Appendix E) indicates the following:

> "Because your request is one of a number of similar requests to tap various Corps penstocks, we are seeking general policy guidance concerning this matter from our Division office. In the meantime, we offer the following comments. The tap located on Tunnel #1 would be sufficient to supply both the fish hatchery and the City of Glasgow at the withdrawal rates determined by your office and the city. We must note, as we have in the past to Glasgow city officials, that this supply could not be guaranteed at all times because of the necessity to dewater the tunnels for maintenance and inspections. A description of the outage requirements is included as enclosure 2. In addition, a water storage contract would have to be set up to define the water withdrawal amounts and charges and the operation and maintenance requirements."

Further design requirements indicate that water demands for the hatchery will vary from 2,500 gallons per minute to a peak of

4,000 gpm if filling of the rearing ponds in a short period of time is required. If the ponds can be filled more gradually flows in the 2,500 gpm range are acceptable.

Based on the flow ranges that cannot be finalized at this preliminary stage and without an in-depth analysis of the full impact of the City of Glasgow Water Supply Project (which appears to be delayed at the time of this report) a supply line in the eight to twelve inch range will be required. For cost estimating purposes a twelve-inch water supply line from the No. 1 Penstock along the general route shown on Plate 2 to the solar pond, as well as a by-pass straight to the hatchery building was used.

A joint tap or other interior valving and piping was estimated at $50,000. This number is obviously impossible to determine until other unknown parameters have been established. The water supply line was estimated to cost $30.00 per lineal foot, with the total distance of supply piping estimated to be 9,000 feet.

3. <u>Solar Pond/Supply Reservoir</u> - As discussed in previous sections the benefits of the Ft. Peck site (water quantity) are balanced against the extremely cold temperature of the reservoir water at the 200 foot water intake depth. In order to "pre-heat" this water prior to mechanical heating to the required temperature a solar pond/supply reservoir was schematically designed. This pond will serve two purposes. First, depending upon the time of year, the hatchery building production water temperature requirements, and the volume of "warmer" water needed the solar pond will elevate the water temperature from a few degrees to approximately ten degrees above normal intake water temperature. Secondly, it will provide a small volume (67.5 Acre feet) buffer for critical water needs during any short period shutdown of the water source.

Due to the topographic and horizontal limitations of the Ft. Peck site the pond was designed in an irregular shape that provides approximately 15 surface acres of water. The "perched" pond (a pond with levees around all four sides with pond bottom at existing grade) is schematically designed with a 4.5 foot average water depth and 1.5 foot freeboard (six foot overall levee height). Based on a visual analysis of existing earth embankment construction in the area but without the benefit of current soils data and analysis the levees were schematically designed with a twelve foot top width and 3:1 side-slopes. Eighteen-inch thick riprap is to be provided for full side-slope erosion protection. A pump station was also included in schematic design since it does not appear that there will be enough head differential between the pond and the estimated maximum 1,200 gpm to the building.

For estimating purposes 25,000 cubic yards of earth embankment (at $3.00/cy) and 4,600 cubic yards of riprap (at $15/cy) as well as $75,000 for a 1,200 gpm pump station were used.

4. Aeration/Degassing and Process Water Treatment System - The process water that will be used within the hatchery for egg incubation and fry rearing will be aerated and/or degassed, filtered for sediment removal, sterilized by ultraviolet radiation, and elevated in temperature by a water-to-water heat pump. The water treatment requirements will be similar in size and layout to those at the Miles City facilty. Plate 8 shows a schematic layout for the treatment system at Miles City.

The volume of water to be treated will obviously impact both the initial construction cost as well as the operating and maintenance costs of the facility. For estimating purposes the following rates of treatment and associated initial costs are as follows:

A. Degassing/Aeration and Filtration System - Up to 500 gpm - $250,000
B. Ultra-violet sterilization - Up to 500 gpm - $20,000
C. Water heating - Up to 500 gpm from 38 F to 60 F - $76,000

The need for a process water treatment system capable of providing water filtration, ultra-violet sterilization and heating or chilling has been discussed in Section III of this report. The system would consist of (automatic) rapid sand pressure filters, ultra-violet water sterilization unit (Aquafine Corporation recommended) and a electric water to water heat pump system capable of heating (or chilling) process water. System design shall provide 500 gallons per minute treatment capacity. Figure 51 illustrates this type of process water treatment equipment. Aeration and degassing of hatchery water will be completed in packed column aeration.

Figure 52 shows one of the main 24 foot diameter intake tubes at the Fort Peck Powerhouse that would be tapped to provide water supply. Water quality of the Fort Peck Reservoir release is very good. Figure 53 shows Cisco forage egg incubation and hatching successfully completed at the powerhouse in 1984. High iron levels exist in the Fort Peck dam relief well flow making use of this water for hatchery supply not recommended (Figure 54).

5. Main Hatchery Building - Based on the space requirements for production raceways, incubation racks, offices, storage, restrooms, visitor information, shop area, water treatment equipment and mechanical room it is recommended that a hatchery building approximatley 10,000 square feet (84' X 120') be considered. Due to the amount of sophisticated plumbing, high quality concrete finishing and other non-standard construction requirements a unit price of $65.00 per square foot has been established to cover the building and all furnishings and equipment except for the water treatment equipment discussed in Item 4, above. In addition to the building cost two associated costs have been included in the hatchery building estimate. An emergency electrical generation system for key production and

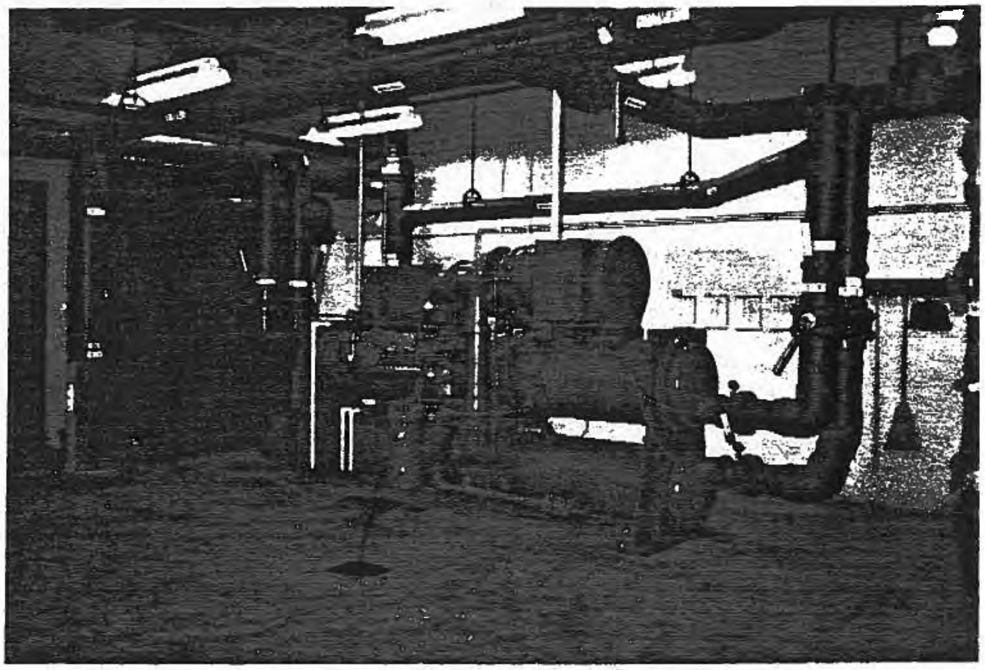
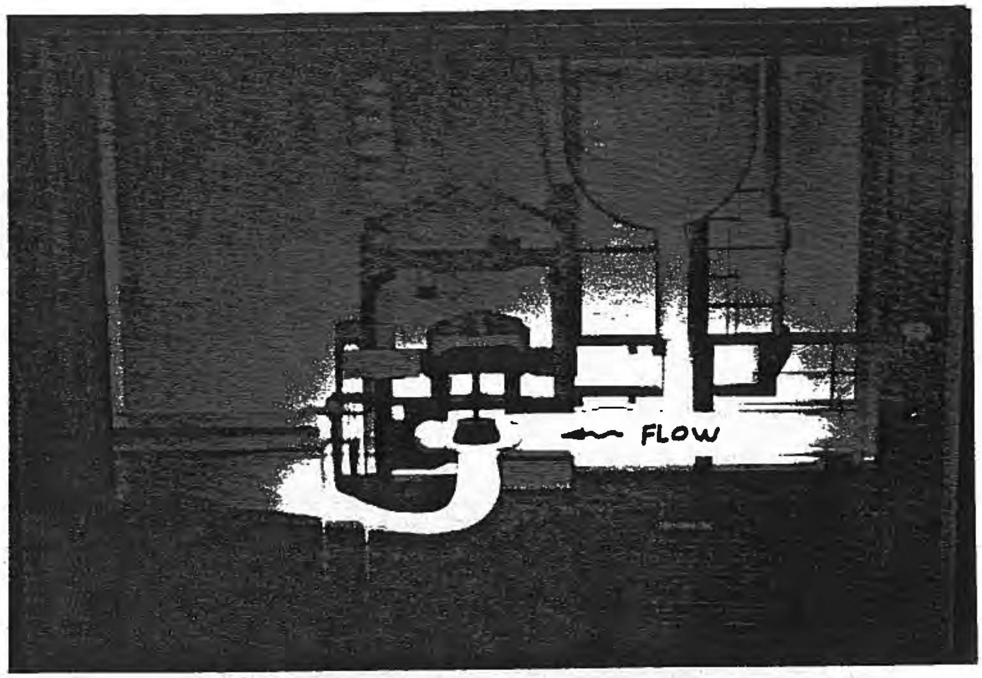


FIGURE 51 HEAT PUMP



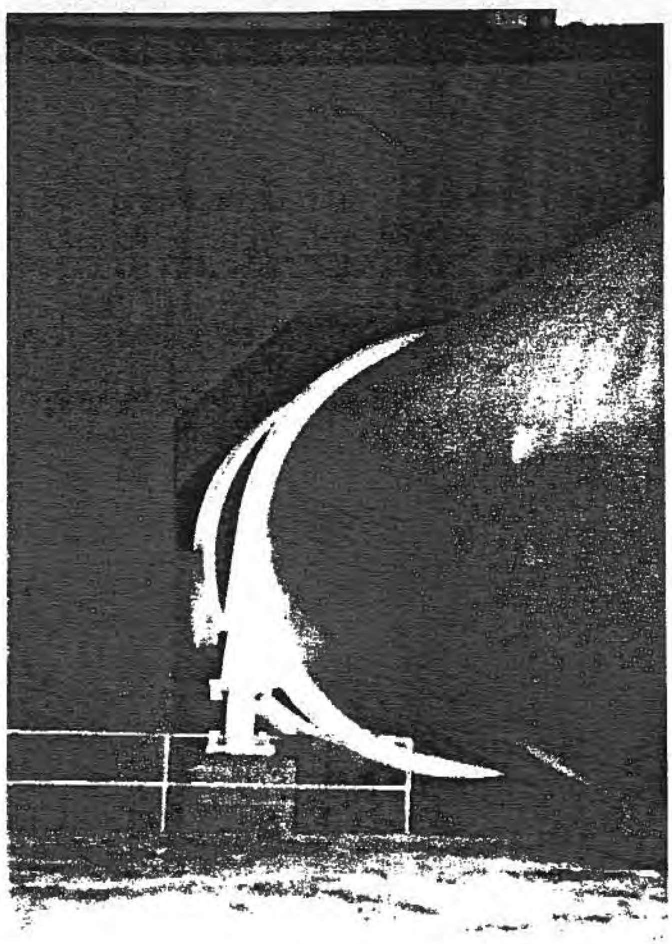


FIGURE 52 MAIN 24' DIAMETER INTAKE TUBE AT FORT PECK POWERHOUSE

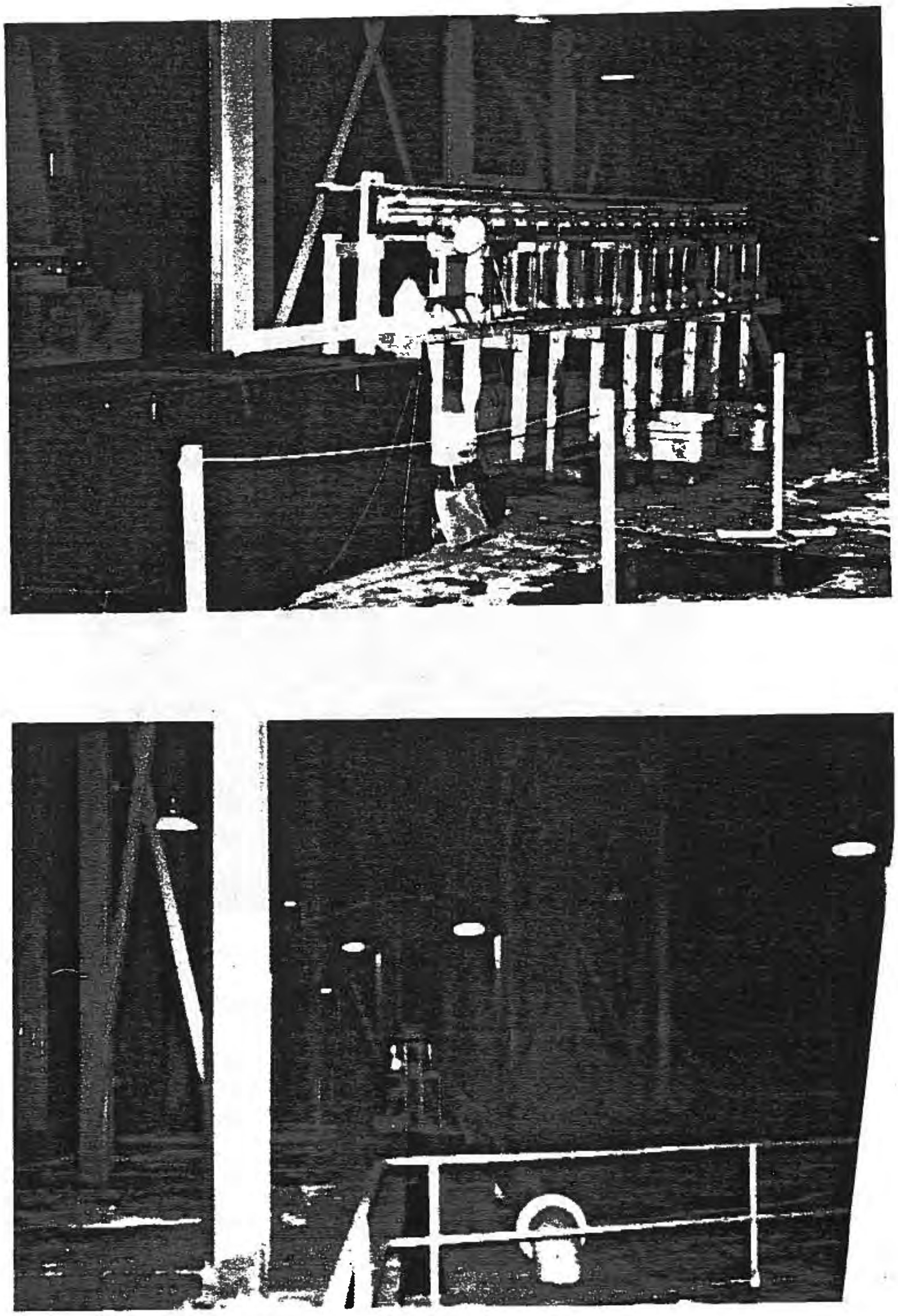


FIGURE 53 CISCO RESERVOIR FORAGE EGG INCUBATION AND HATCHING AT FT. PECK POWERHOUSE

FIGURE 54 DAM RELIEF WELL SHOWING HIGH IRON LEVELS

support systems is estimated to cost $80,000. In addition, since visitor information and education is an important function in any government-operated hatchery a lump sum amount of $15,000 has been established for visitor-oriented displays and information boards. Expenditures of this magnitude are well-justified for at least two reasons. First, it serves to provide the ultimate user/owner of the facility what the purpose of the hatchery and the fisheries management system is attempting to accomplish. Secondly, a well-designed display and visitor-orientation program will allow for more self-education and/or tour and drastically reduces the amount of time that hatchery staff personnel must allocate to visitors.

6. Support Facilities - The main support buildings required to efficiently and economically operate a hatchery of this size are a storage building for materials, nets, screens, piping and vehicles and residences for on-site living by hatchery personnel. The storage building is proposed to be approximately 4,000 square feet (40 X 100) with overhead doors and concrete floor but no heat or bathroom facilities. A unit price of $15.00 per square foot was established to reflect the type of facility required.

It is the policy of the Department to provide on-site residential units for key hatchery staff and their families. A hatchery of this size normally would include housing for three staff members. Typical housing should include three bedrooms, a basement if site conditions allow, and at least a one car garage. Floor space, exclusive of the garage should be approximately 1,500 square feet, similar to the residence at Miles City. A unit price of $60,000 per residence (approximately $40/SF) has been used for this facility. This price includes all utility hook-ups to five feet outside the building units.

7. Sitework and Utilities - The Ft. Peck-Area A site requires modification to at least two existing site features. A new ten-inch diameter water main ws installed in 1983 from the power plant to the municipal water treatment plant and traverses through the proposed site. The relocation of this line is estimated at $15.00 per lineal foot for the 3,200 lineal feet affected. A major surface water drainage ditch also is located in the area of the future ponds. In order to relocate approximately 2,600 lineal feet of ditch, approximately 7,000 cubic yards of earth at an estimated unit price of $3.00/cy is required.

Additional site work at Ft. Peck is to provide new primary power from the generation plant to the site and electrical distribution and security lighting within the hatchery site. At this stage of schematic design each of these items was estimated at a lump sum figure of $100,000.

Water for domestic use in the residences and hatchery building can be provided from the nearby municipal water treatment plant. Likewise, domestic wastewater from these facilities can be pumped to the municipal wastewater treatment plant. The Corps of Engineers, owner and operator of these facilities, indicate in their August 7, 1984 letter (see Appendix E) that connection to their facilities would not be a major complication. For estimating purposes, water service was set at $10,000 and sewage hook-up and pump station at $20,000.

A paved entrance road and parking lot as well as pit-run gravel access roads around all ponds and the solar pond/storage reservoir has been schematically designed on Plate 2. A total of 16,500 cubic yards of gravel and 1,000 tons of hotmix pavement (asphaltic concrete) have been estimated at $12.00/cy and $35.00/ton, respectively.

For security from predators and vandalism as well as safety for the general public it is recommended that the entire hatchery site be fenced with six foot high chain-link fencing material. It is estimated that approximately 10,000 lineal feet at $10.00/L.F. will be required.

A 1.5 acre retention/wastewater lagoon has been located to retain/settle overflow water from raceways and/or cleaning wastes from raceways and ponds, if required by Regulatory Agencies. A lump sum cost of $50,000 has been estimated to complete this facility.

8. <u>Spawning and Rearing Ponds</u> - It has been determined that approximately 13-one-half acre spawning ponds and 32-one and one-half acre rearing ponds will be required to provide the facilities necessary to meet the Department's ultimate production goals. These extensive ponds will be similar to the existing ponds at Miles City.

Included in the design of these ponds will be twelve foot (interior) and sixteen foot (exterior) levee tops with slopes in the 2:1 to 3:1 range depending upon soil conditions. Each pond will be riprapped for erosion control for the entire interior-slope. For preliminary design it has been estimated that 4,000 cubic yards of earthwork will be required for construction of each pond. Twelve inch thick riprap (using four-inch cobble) on approximately 13.5 feet of exposed side slope requires approximately 600 cubic yards of riprap for each pond. Pit run gravel to cover the levee top has been discussed in Item 7 above. Unit prices of $3/cy for earthwork and $15/cy for riprap have been used for estimating.

In addition, each pond will be provided two-valved water supplies from a looped-supply line. Supply line is estimated to be in the eight to ten inch diameter range at a unit cost of $15/LF. Drain lines for reuse or discharge are estimated to be in the 24 inch diameter size-range and $30/LF in-place cost-range. Each rearing pond will include a concrete water control structure equipped with wooden stop-logs, fish screens, and sluice or slide gate for dewatering. The structure can be used for internal fish harvesting or fish may be piped to an external kettle common to several (or all) the ponds for harvesting at one centralized structure. It is estimated that each concrete harvest kettle will cost approximately $6,000.

The only major difference in the spawning ponds and the rearing ponds besides the size (0.5 and 1.5 acres) is that the spawning pond will be lined with plastic membrane liner. The purpose of the liner from a bioengineering standpoint is discussed more fully in Section III, A. The unit price for the liner material in-place is estimated at $0.50 per square foot.

9. Concrete Raceways - Intensive culture concrete production raceways approximately six feet wide, sixty feet long and four feet high will be located near the hatchery building in four-double units (8 total raceways). Bioengineering criteria and justification for intensive raceways is discussed in Section III, A. Due to the various embedded items in the concrete for spawning cubicle hooks, screen and baffle guides, stoplogs and overflow weirs and piping the unit price per cubic yard of in-place concrete is set at $350.00. Miscellaneous supply and drain piping will also be provided to these raceways.

This concludes the major construction items, design requirements, and associated estimated construction costs for Ft. Peck Area A.

C. Conceptual Hatchery Plan - Miles City

The conceptual layout of the renovation/expansion of the existing Miles City State Fish Hatchery is shown on Plates 6-8. The existing hatchery components have been analyzed for function and serviceability and recommended rehabilitation and expansion have been designed to make use of the existing systems. The basic hatchery expansion and rehabilitation consists of the following components:

1. Subdividing Branum Lake into 15-one acre rearing ponds.

2. Adding six 1.5 acre rearing ponds similar to and adjacent to the existing thirteen 1.5 acre ponds.

3. Thirteen 0.5 acre spawning ponds and associated supply and drain piping and concrete water control and harvest kettles.

4. Water supply system from the Yellowstone River, with intake structure and pump station to the existing storage reservoir, replace the existing Tongue River intake/pump station, and groundwater well system.

5. An aeration/degassing and process water treatment system.

6. A main hatchery building addition for egg incubation, fry rearing and various other production oriented functions, as well

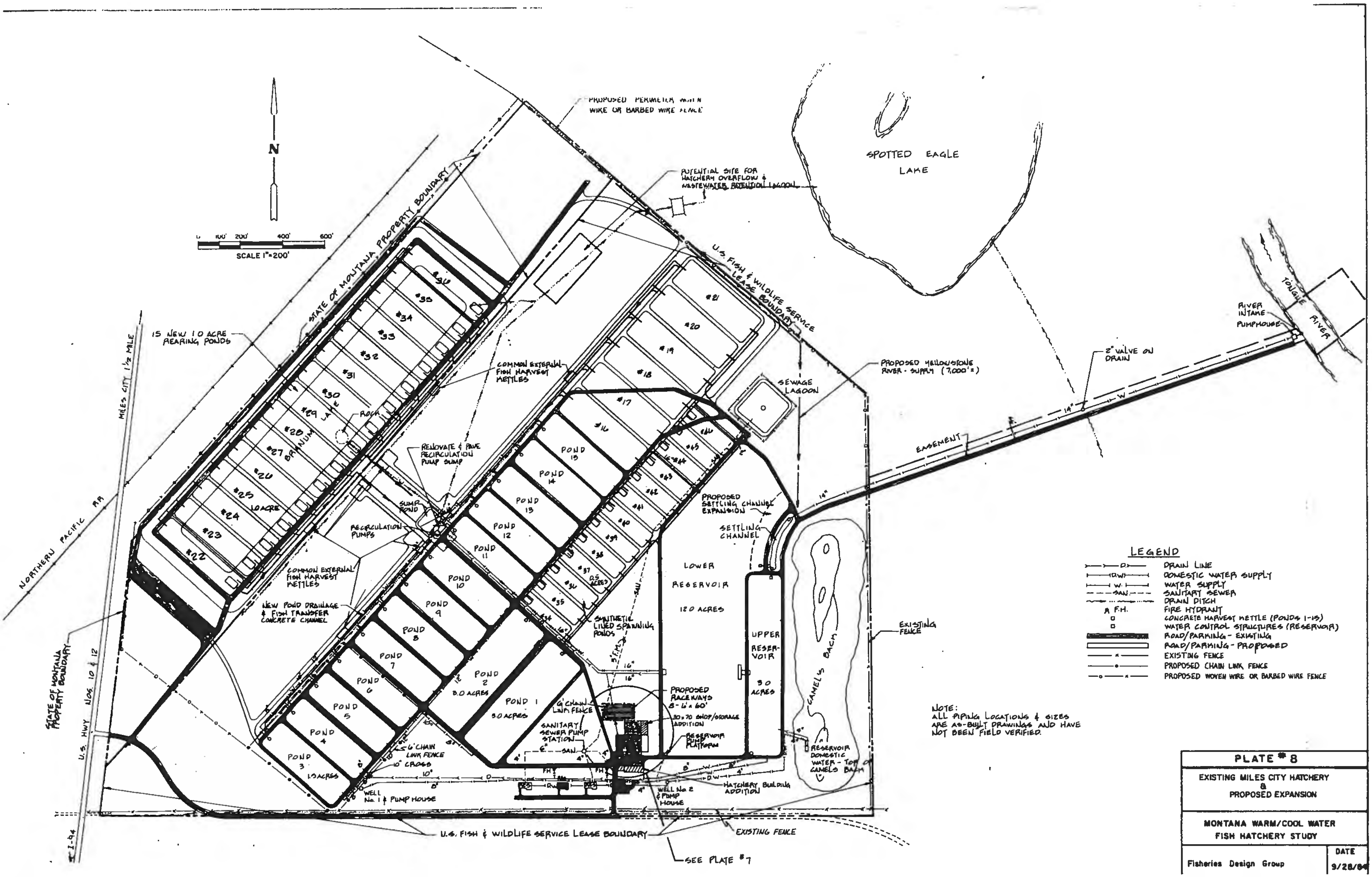
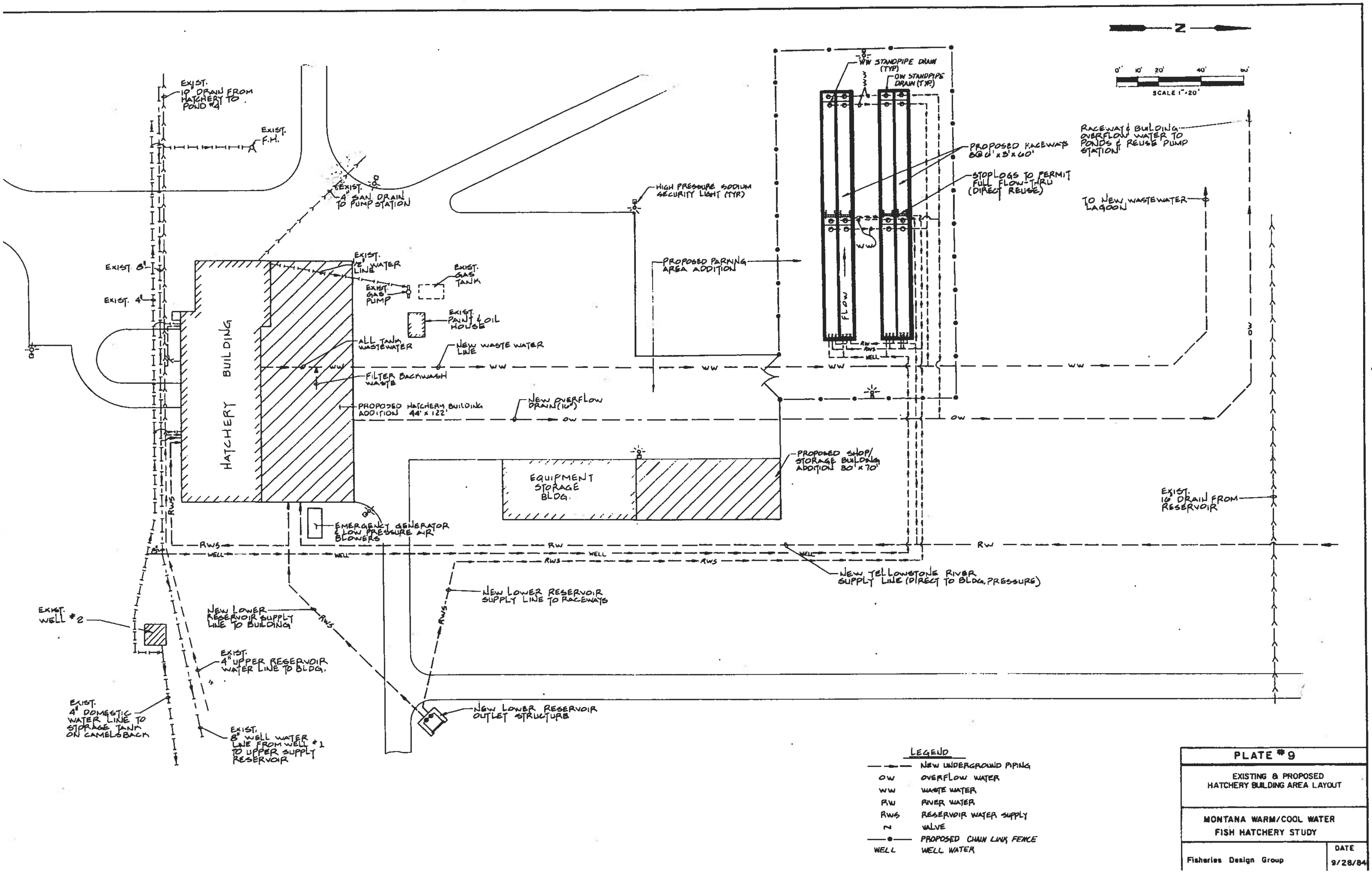


PLATE # 8
EXISTING MILES CITY HATCHERY & PROPOSED EXPANSION
MONTANA WARM/COOL WATER FISH HATCHERY STUDY
Fisheries Design Group
DATE 9/26/84
SCALE 1"=200'
N
SPOTTED EAGLE LAKE
TONGUE RIVER
RIVER INTAKE PUMPHOUSE
2" VALVE ON DRAIN
EASEMENT
PROPOSED YELLOWSTONE RIVER - SUPPLY (7,000'±)
POTENTIAL SITE FOR HATCHERY OVERFLOW & WASTEWATER RETENTION LAGOON
PROPOSED PERIMETER WOVEN WIRE OR BARBED WIRE FENCE
STATE OF MONTANA PROPERTY BOUNDARY
U.S. FISH & WILDLIFE SERVICE LEASE BOUNDARY
15 NEW 10 ACRE REARING PONDS
COMMON EXTERNAL FISH HARVEST KETTLES
RENOVATE & PAVE RECIRCULATION PUMP SUMP
SUMP POND
RECIRCULATION PUMPS
NEW POND DRAINAGE & FISH TRANSFER CONCRETE CHANNEL
SEWAGE LAGOON
PROPOSED SETTLING CHANNEL EXPANSION
SETTLING CHANNEL
LOWER RESERVOIR 120 ACRES
UPPER RESERVOIR 30 ACRES
SYNTHETIC LINED SPAWNING PONDS
PROPOSED RACEWAYS 8 - 6' x 60'
30 x 70 SHOP/STORAGE ADDITION
RESERVOIR PUMP PLATFORM
6' CHAIN LINK FENCE
SANITARY SEWER PUMP STATION
HATCHERY BUILDING ADDITION
WELL No 2 & PUMP HOUSE
WELL No 1 & PUMP HOUSE
6' CHAIN LINK FENCE
10" CROSS
RESERVOIR DOMESTIC WATER - TOP OF CAMELS BACK
CAMELS BACK
EXISTING FENCE
NORTHERN PACIFIC RR
MILES CITY 1½ MILE
U.S. HWY NOS. 10 & 12
I-94
SEE PLATE #7
POND 1 3.0 ACRES
POND 2 3.0 ACRES
POND 3 1.0 ACRES
POND 4
POND 5
POND 6
POND 7
POND 8
POND 9
POND 10
POND 11
POND 12
POND 13
POND 14
POND 15
#16 #17 #18 #19 #20 #21
#22 #23 #24 #25 #26 #27 #28 #29 #30 #31 #32 #33 #34 #35 #36
10 ACRE
0.5 ACRES
LEGEND
DRAIN LINE
DOMESTIC WATER SUPPLY
WATER SUPPLY
SANITARY SEWER
DRAIN DITCH
FIRE HYDRANT
CONCRETE HARVEST KETTLE (PONDS 1-15)
WATER CONTROL STRUCTURES (RESERVOIR)
ROAD/PARKING - EXISTING
ROAD/PARKING - PROPOSED
EXISTING FENCE
PROPOSED CHAIN LINK FENCE
PROPOSED WOVEN WIRE OR BARBED WIRE FENCE
NOTE: ALL PIPING LOCATIONS & SIZES ARE AS-BUILT DRAWINGS AND HAVE NOT BEEN FIELD VERIFIED.



Z
SCALE 1"=20'
EXIST. 10" DRAIN FROM HATCHERY TO POND #4
EXIST. F.H.
EXIST. 4" SAN DRAIN TO PUMP STATION
EXIST. 8"
EXIST. 4"
EXIST. 1/2" WATER LINE
EXIST. GAS TANK
EXIST. GAS PUMP
EXIST. PAINT & OIL HOUSE
HATCHERY BUILDING
ALL TANK WASTEWATER
NEW WASTE WATER LINE
FILTER BACKWASH WASTE
PROPOSED HATCHERY BUILDING ADDITION 44' x 122'
NEW OVERFLOW DRAIN (16")
HIGH PRESSURE SODIUM SECURITY LIGHT (TYP)
PROPOSED PARKING AREA ADDITION
WW STANDPIPE DRAIN (TYP)
OW STANDPIPE DRAIN (TYP)
PROPOSED RACEWAYS 8@6'x3'x60'
STOPLOGS TO PERMIT FULL FLOW-THRU (DIRECT REUSE)
FLOW
RACEWAY & BUILDING OVERFLOW WATER TO PONDS & REUSE PUMP STATION
TO NEW WASTEWATER LAGOON
EQUIPMENT STORAGE BLDG.
PROPOSED SHOP/STORAGE BUILDING ADDITION 80' x 70'
EMERGENCY GENERATOR & LOW PRESSURE AIR BLOWERS
EXIST. 16" DRAIN FROM RESERVOIR
NEW YELLOWSTONE RIVER SUPPLY LINE (DIRECT TO BLDG. PRESSURE)
NEW LOWER RESERVOIR SUPPLY LINE TO RACEWAYS
NEW LOWER RESERVOIR SUPPLY LINE TO BUILDING
EXIST. WELL #2
EXIST. 4" UPPER RESERVOIR WATER LINE TO BLDG.
EXIST. 4" DOMESTIC WATER LINE TO STORAGE TANK ON CAMELSBACK
EXIST. 8" WELL WATER LINE FROM WELL #1 TO UPPER SUPPLY RESERVOIR
NEW LOWER RESERVOIR OUTLET STRUCTURE
LEGEND
NEW UNDERGROUND PIPING
OW OVERFLOW WATER
WW WASTE WATER
RW RIVER WATER
RWS RESERVOIR WATER SUPPLY
VALVE
PROPOSED CHAIN LINK FENCE
WELL WELL WATER
PLATE #9
EXISTING & PROPOSED HATCHERY BUILDING AREA LAYOUT
MONTANA WARM/COOL WATER FISH HATCHERY STUDY
Fisheries Design Group
DATE 9/28/84

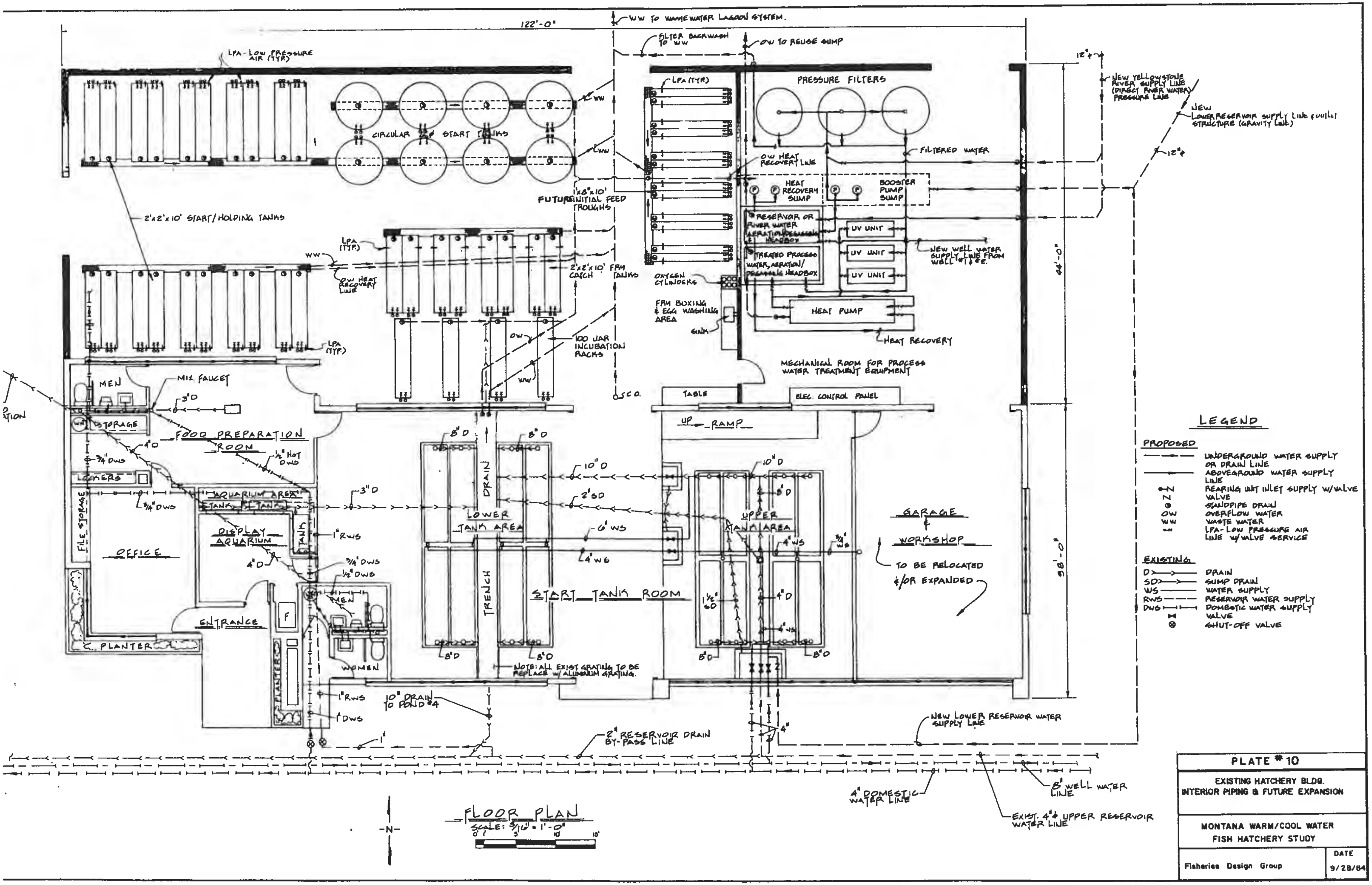


PLATE #10

EXISTING HATCHERY BLDG.
INTERIOR PIPING & FUTURE EXPANSION

MONTANA WARM/COOL WATER
FISH HATCHERY STUDY

Fisheries Design Group

DATE 9/28/84

as expansion of storage area, offices, shop area, and visitor information area.

7. Sitework and utilities including roads, parking, site security and lighting, landscaping/irrigation, and production overflow and waste retention.

8. Intensive culture concrete production raceways and associated supply and drain piping.

9. Support facilities such as storage buildings, staff residence rehabilitation and the addition of one residence.

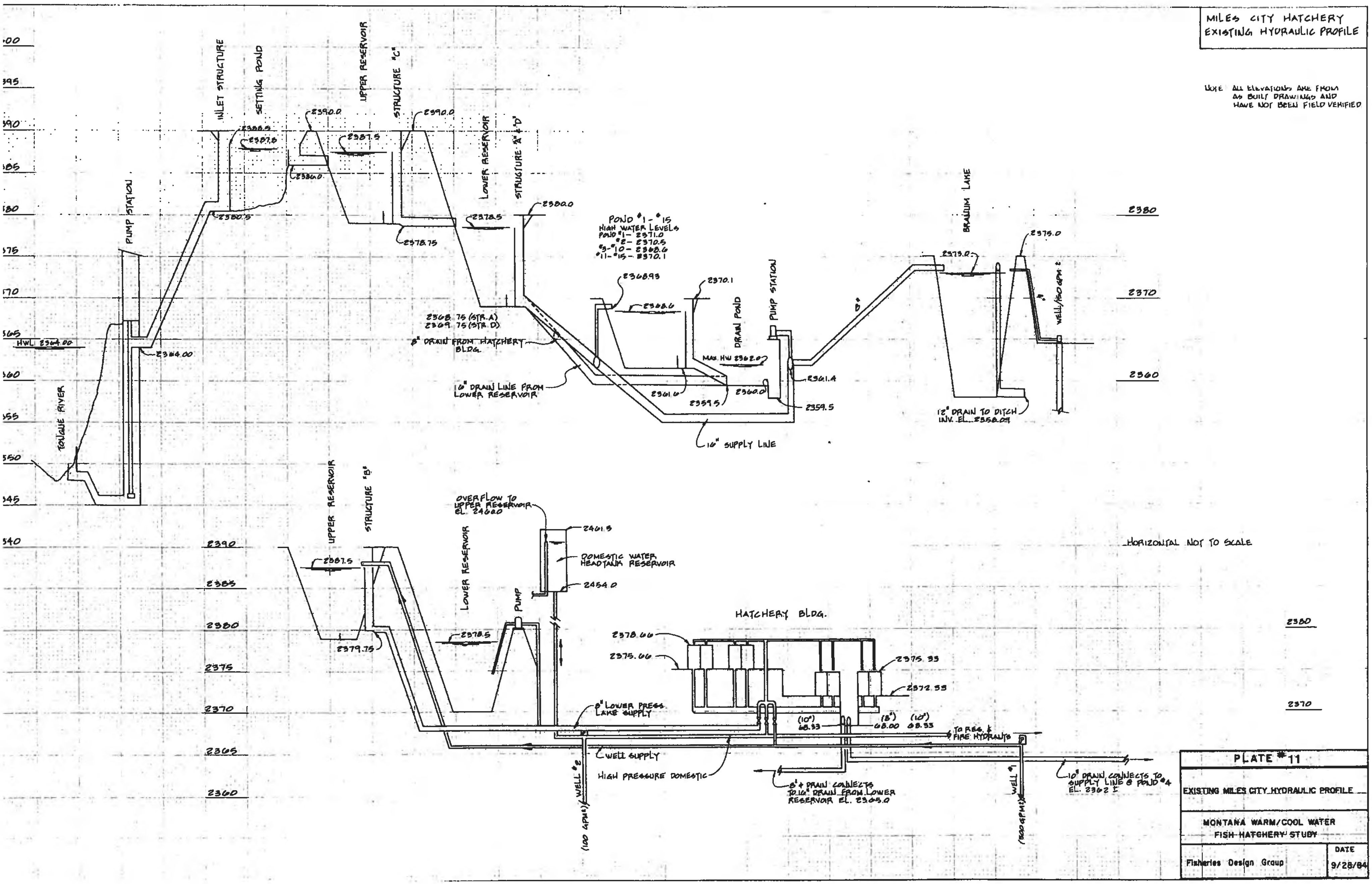
D. Recommended Miles City Hatchery Rehab/Expansion Construction Items, Design Requirements, and Estimated Construction Costs

1. Land Requirements - As discussed previously the existing USFWS hatchery property contains 168 acres, and the Branum Lake area an additional 40 acres. The proposed expansion can all be accomplished within the existing boundaries, with marginal area remaining for even further future expansion.

The following discussion will summarize the various design requirements and/or considerations for the individual construction components identified above and on Plate 6. In addition, the probable cost of the items will be discussed as summarized in Section VII, "Cost Estimate".

2. Branum Lake - This "perched" Lake which depends upon its water from the reuse pump station is recommended to be subdivided into 15 one-acre rearing ponds similar to the existing 1.5 acre ponds. During the design process it must be determined whether it will be beneficial to raise the bottom of the Branum Lake ponds high enough to gravity drain back to the reuse pump station. If this is desired, the pond bottom elevation will need to be raised approximately five (5) feet. If the pond bottoms are not raised, it will not be possible to reuse this water through the existing reuse pump station. The design of the ponds will be similar to those discussed at Ft. Peck with 16 foot perimeter levee tops and 12' interior levees. Side slopes will be between 2:1 and 3:1 and will be protected with twelve inch thickness of 4" cobble riprap. Levee surfaces will be covered with compacted pit run gravel. Water supply will be furnished to both ends of the pond with a looped network, suppy line eight inches to ten inches in diameter. Drain (and/or reuse) lined concrete channel will be provided. Internal concrete kettles as well as an external centralized kettle will be constructed.

Earthwork is estimted at 60,000 cubic yards (at $3/cy), riprap at 8,250 cubic yards (at $8/cy), water supply piping 5,300 lineal feet (at $15/LF), drain/reuse channel at 2,600 lineal feet (at $25/LF), and the 15 internal kettles are estimated to cost $6,000 each, and 4 external kettles at $4,000 each.


MILES CITY HATCHERY
EXISTING HYDRAULIC PROFILE
NOTE: ALL ELEVATIONS ARE FROM AS BUILT DRAWINGS AND HAVE NOT BEEN FIELD VERIFIED
TONGUE RIVER
PUMP STATION
INLET STRUCTURE
SETTING POND
UPPER RESERVOIR
STRUCTURE "C"
LOWER RESERVOIR
STRUCTURE "A" & "D"
POND #1 - #15
HIGH WATER LEVELS
DRAIN POND
PUMP STATION
BRAULUM LAKE
HWL 2364.00
2364.00
2380.5
2388.5
2387.0
2386.0
2390.0
2387.5
2390.0
2378.75
2378.5
2380.0
2368.75 (STR. A)
2369.75 (STR. D)
8" DRAIN FROM HATCHERY BLDG.
16" DRAIN LINE FROM LOWER RESERVOIR
16" SUPPLY LINE
2368.93
2368.6
2370.1
MAX HW 2362.0
2361.6
2359.5
2360.0
2361.4
2359.5
2373.0
2375.0
12" DRAIN TO DITCH
HORIZONTAL NOT TO SCALE
UPPER RESERVOIR
STRUCTURE "B"
LOWER RESERVOIR
PUMP
OVERFLOW TO UPPER RESERVOIR
2461.5
DOMESTIC WATER HEADTANK RESERVOIR
2454.0
HATCHERY BLDG.
2387.5
2379.75
2378.5
2378.66
2375.66
2375.33
2372.33
8" LOWER PRESS. LAKE SUPPLY
WELL SUPPLY
HIGH PRESSURE DOMESTIC
8" DRAIN CONNECTS TO 16" DRAIN FROM LOWER RESERVOIR EL. 2363.0
TO RES. & FIRE HYDRANTS
10" DRAIN CONNECTS TO SUPPLY LINE @ POND #4
WELL #2
WELL #1
PLATE #11
EXISTING MILES CITY HYDRAULIC PROFILE
MONTANA WARM/COOL WATER FISH HATCHERY STUDY
Fisheries Design Group
DATE
9/28/84

3. Rearing and Spawning Ponds - In addition to the subdivision of Branum Lake, it is proposed that six additional 1.5 acre rearing ponds and thirteen 0.5 acres spawning ponds be added at Miles City. These ponds would be similar in design as those existing and those proposed for Branum Lake. The exception would be that the smaller spawning ponds will be lined with a synthetic plastic liner on the bottom and sideslopes as was discussed at the Ft. Peck Site (see Section VI, B.8).

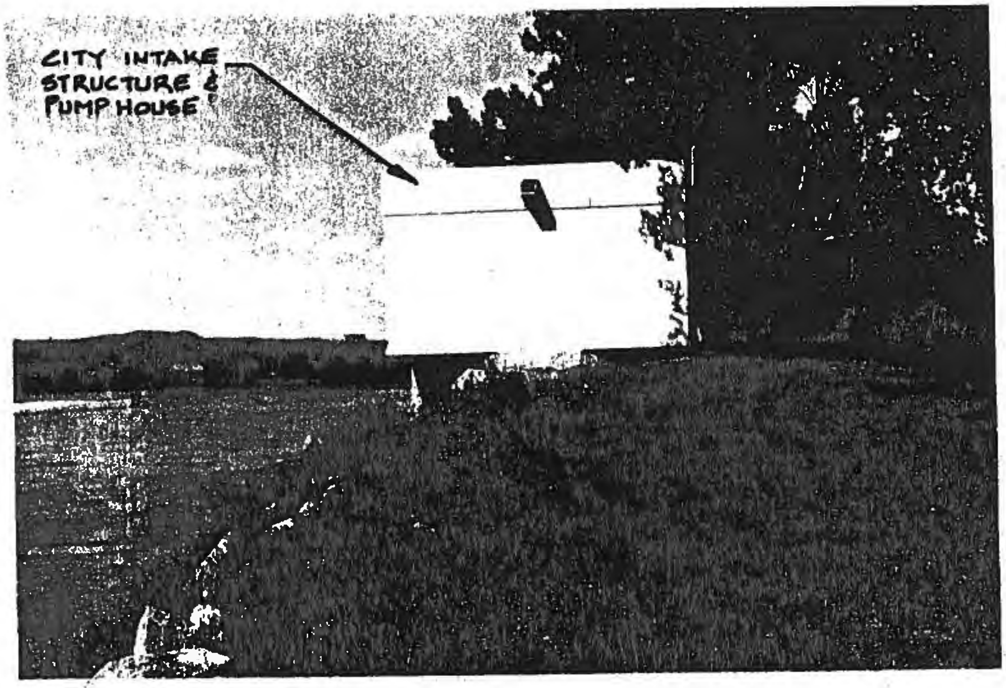
4. Water Supply

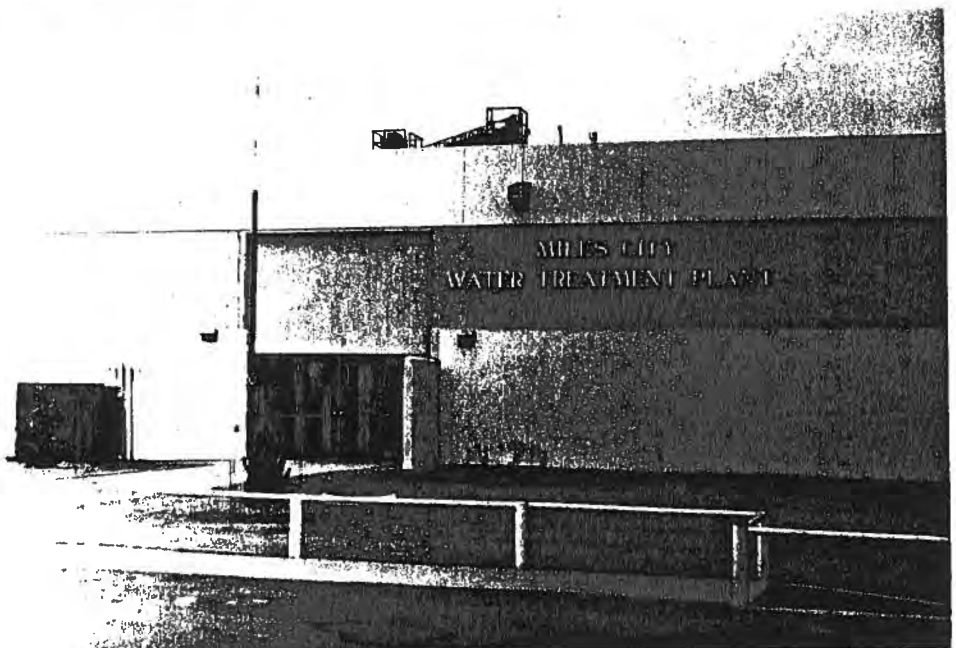
A. Yellowstone River Supply System: A Yellowstone River supply system providing flows up to 4,000 gpm is recommended. Two options for this system are available, (1) construct a new river intake, screen system, pump station and pipeline to the hatchery or (2) utilize the existing Miles City Water Treatment Plant River Intake. Plate 4 illustrates the possible location of both a new river intake and utilization of the Miles City River Intake and suggested supply pipeline routing to the hatchery. Figures 55, 56, and 57 illustrate the character of Yellowstone River at the Miles City Treatment Plant, the Intake Structure, Existing City Supply Pumps and Location for future pump expansion. No screening is currently available at the Miles City Intake Silo and moss entrainment from moss fragments apparently released during upstream discharges from Yellowtail Reservoir is a pump maintenance problem often clogging pump intakes. Installation of screening for moss and fish removal is recommended. The plant operator/engineer has expressed a willingness to cooperate with the Department in this regard, however, formal approval by the City Council is necessary.

Figures 58, 59, and 60 illustrate the irrigation system, Yellowstone River intake, tangential static intake screen, and pumps currently used to supply water to Fort Keogh. Moss clogging was also mentioned as a maintenance problem at this intake station.

Figures 61, 62, 63 and 64 illustrate the ground condition along the proposed Yellowstone Pipeline routing to the hatchery. The intake/pump station is estimated to cost $200,000 and the supply line approximately $372,000 (7,000 lineal feet at $36/LF and $120,000 for road and railroad boring/jacking installation.

B. Tongue River Supply System: The existing Tongue River Water Supply System has been discussed in Section IV of this report. We recommend maintaining the Tongue River System in the future to provide pumping flexibility should a problem with the Yellowstone System occur. The shifting nature of the Tongue River Channel has caused intake maintenance problems in the past and channel control dikes were proposed to improve this situation. However, broken concrete was used in 1984 to complete this work was not approved fill material and was removed (Figure 65). Quarry stone should be obtained and used to construct the channel dikes in the





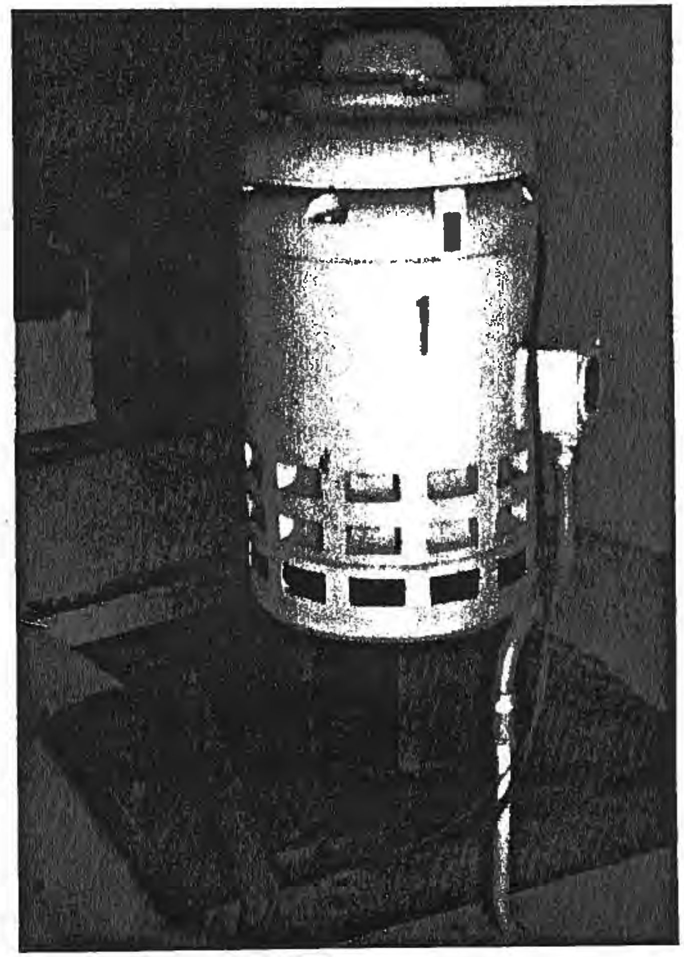


FIGURE 55

MILES CITY WATER TREATMENT PLANT AND
YELLOWSTONE RIVER INTAKE

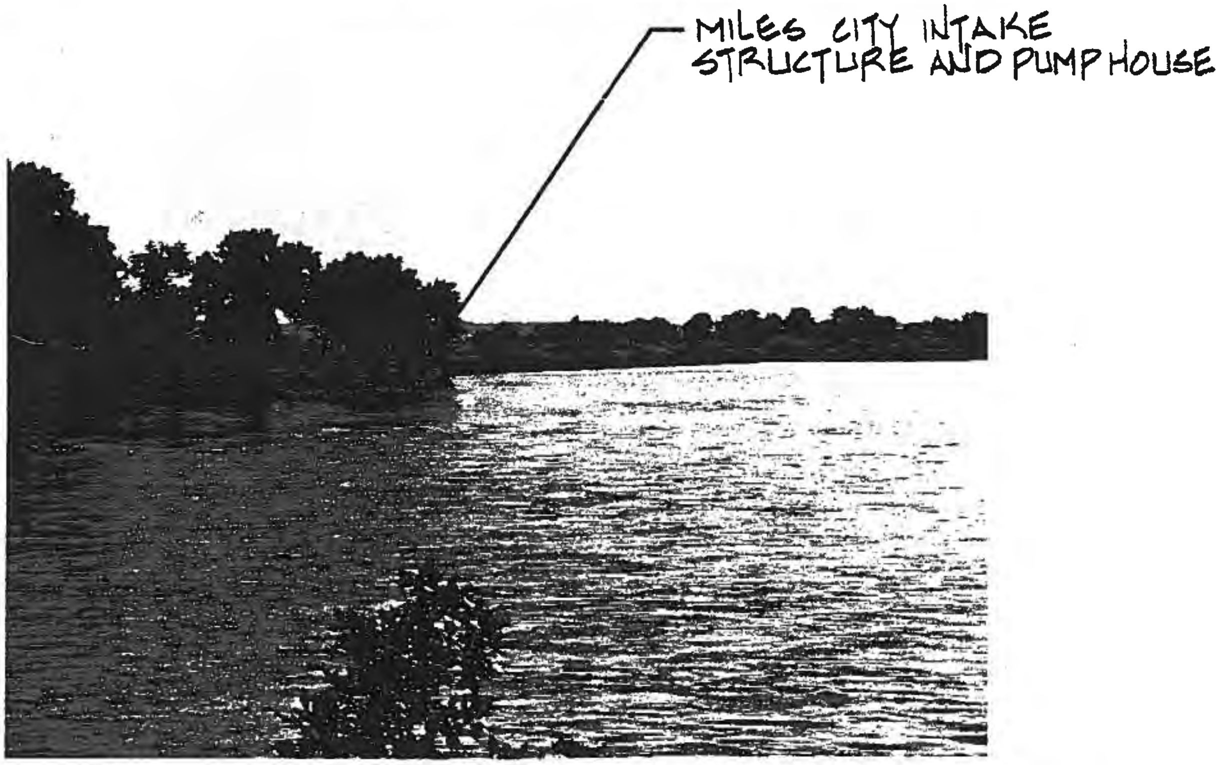
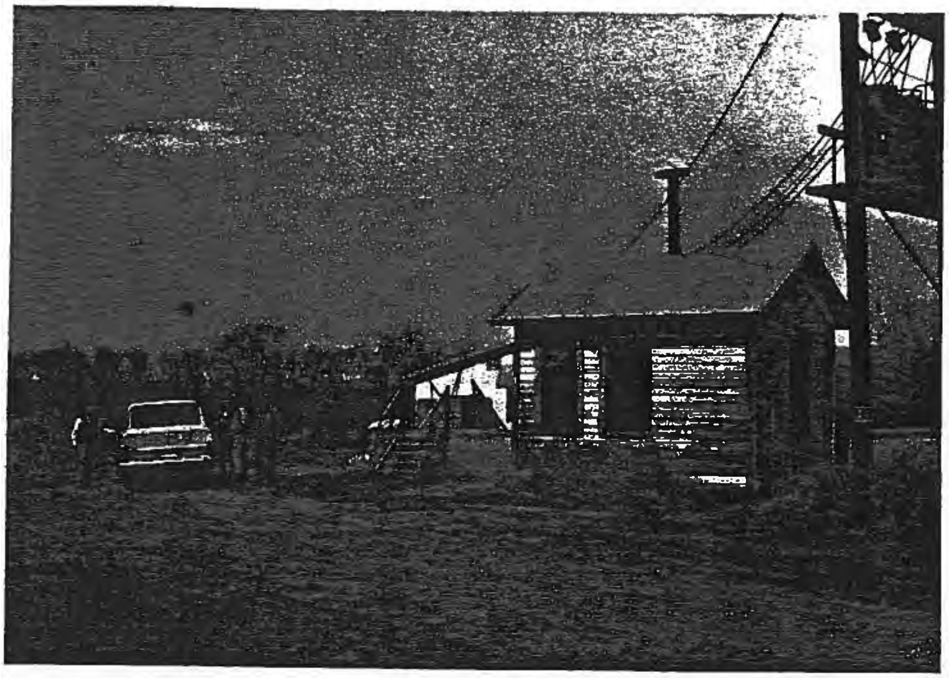


FIGURE 56 **YELLOWSTONE RIVER UPSTREAM & DOWNSTREAM OF MILES CITY TREATMENT PLANT INTAKE**



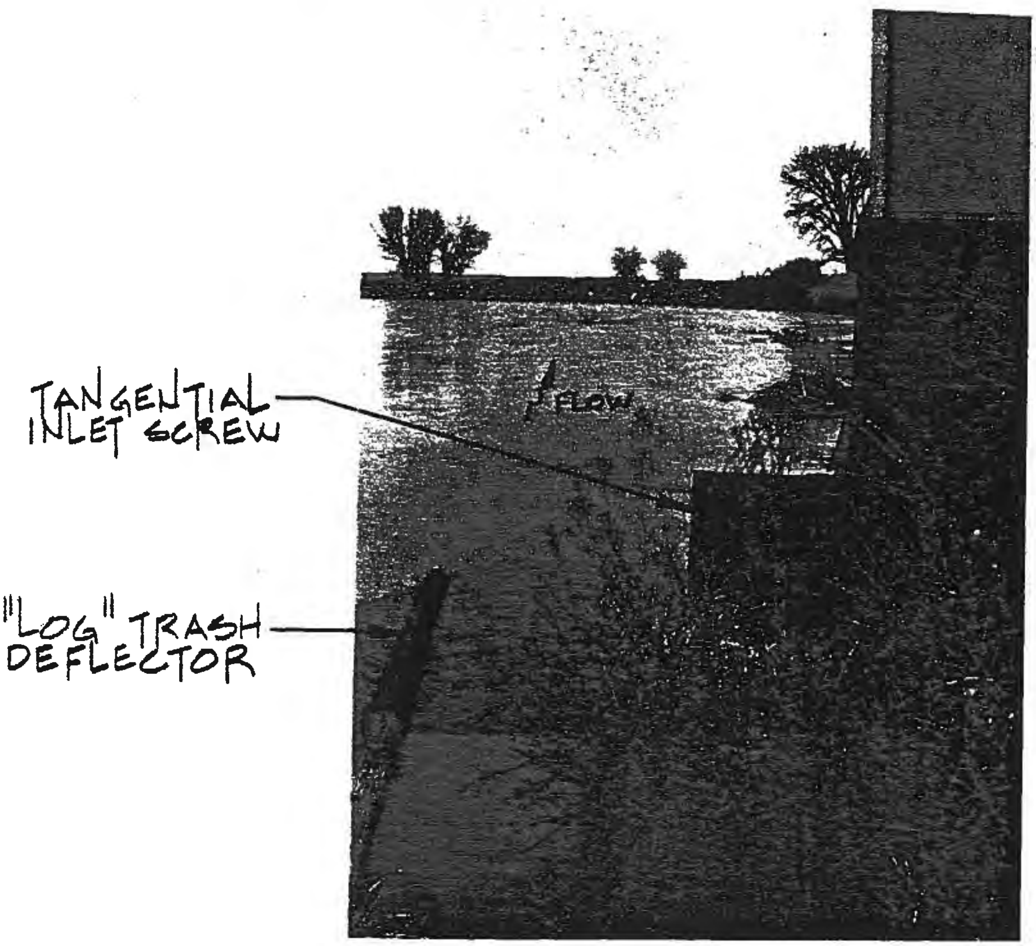
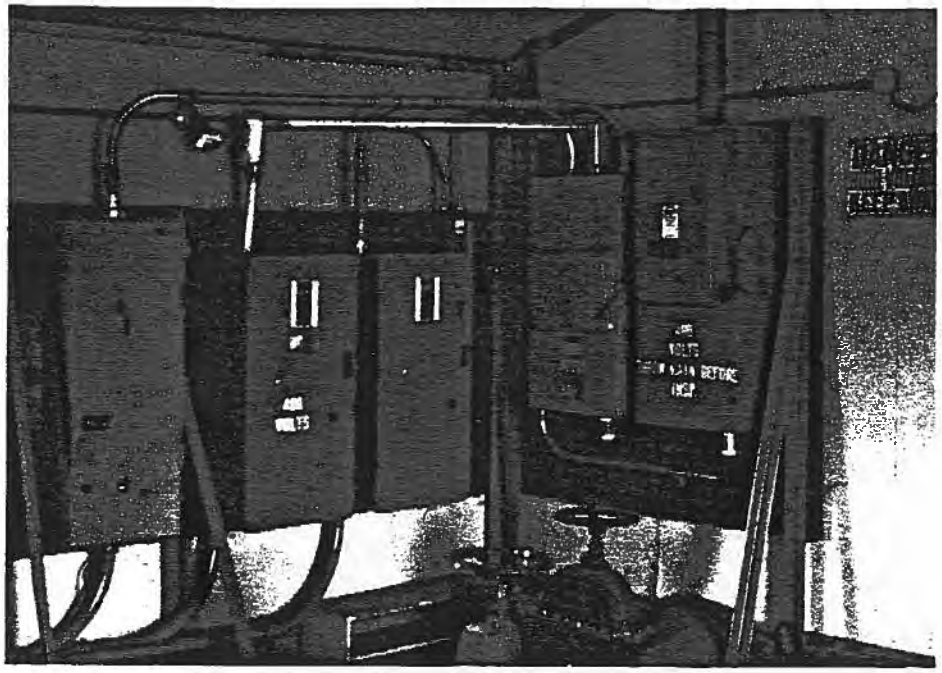


FIGURE 57 FORT KEOGH USDA - YELLOWSTONE RIVER INTAKE SCREEN & PUMP HOUSE



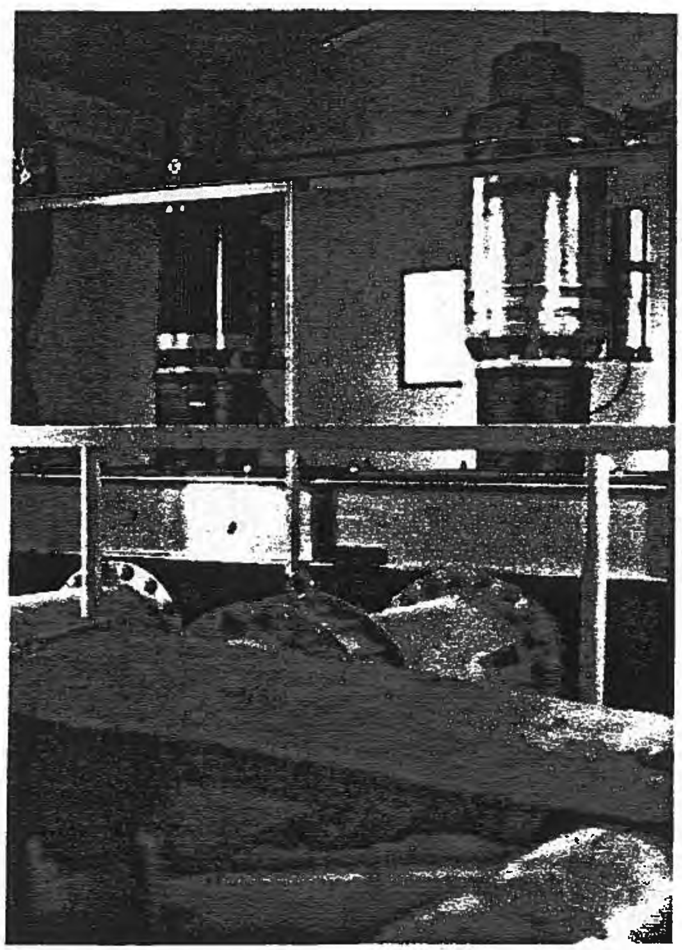


FIGURE 58 USDA IRRIGATION SYSTEM SUPPLY PUMPS & CONTROLS

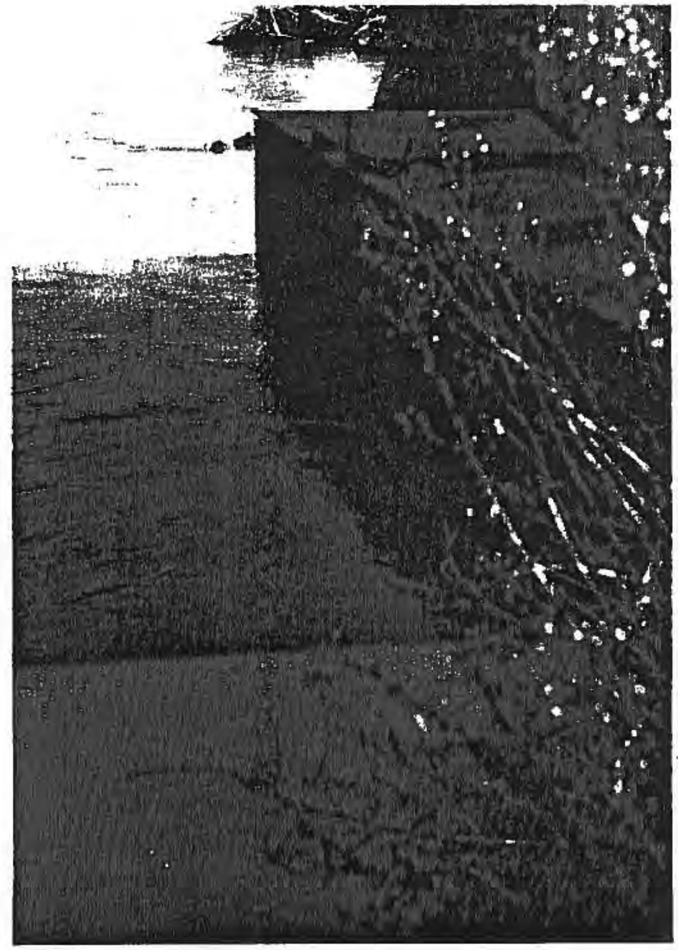


FIGURE 59

USDA IRRIGATION SYSTEM INTAKE STATIC SCREEN & YELLOWSTONE RIVER

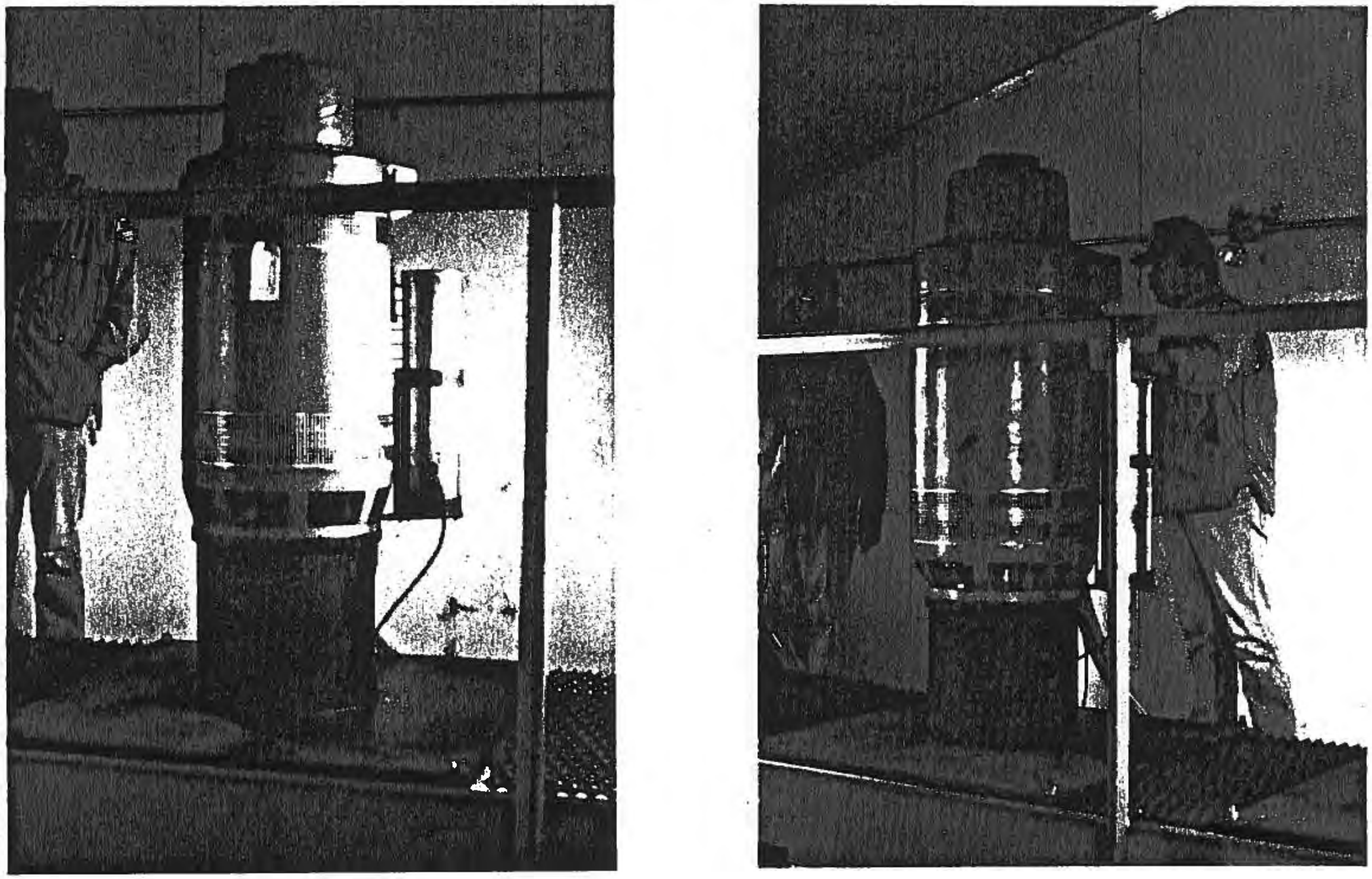


FIGURE 60 USDA IRRIGATION SYSTEM SUPPLY PUMP & PUMP MOUNTING

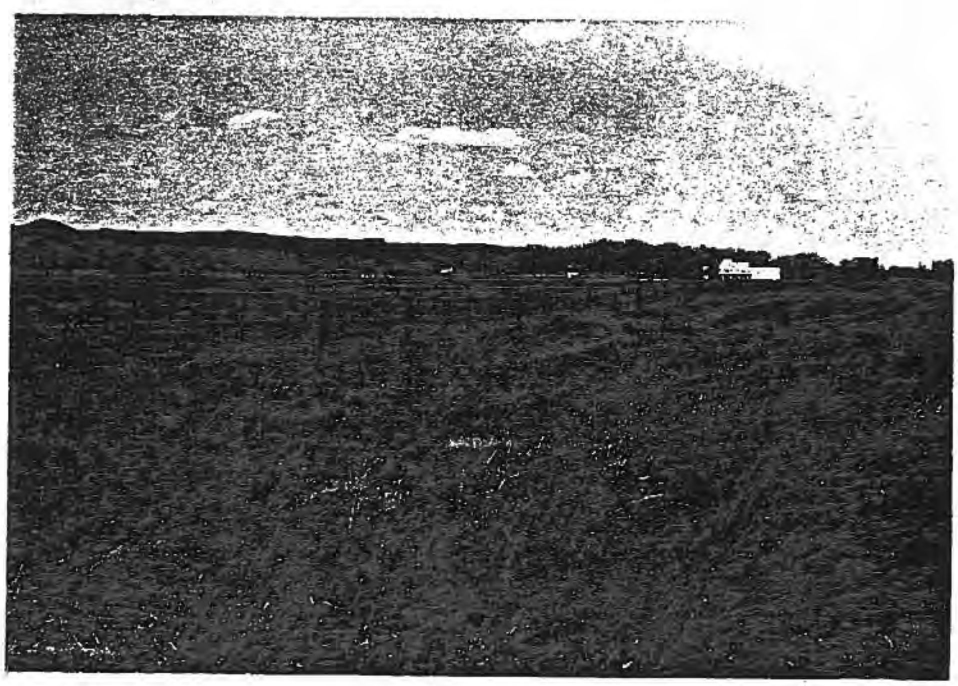


FIGURE 61 ROUTING YELLOWSTONE RIVER PIPELINE RENDERING PLANT TO MILES CITY TREATMENT PLANT ALONG ABANDONED RAILROAD

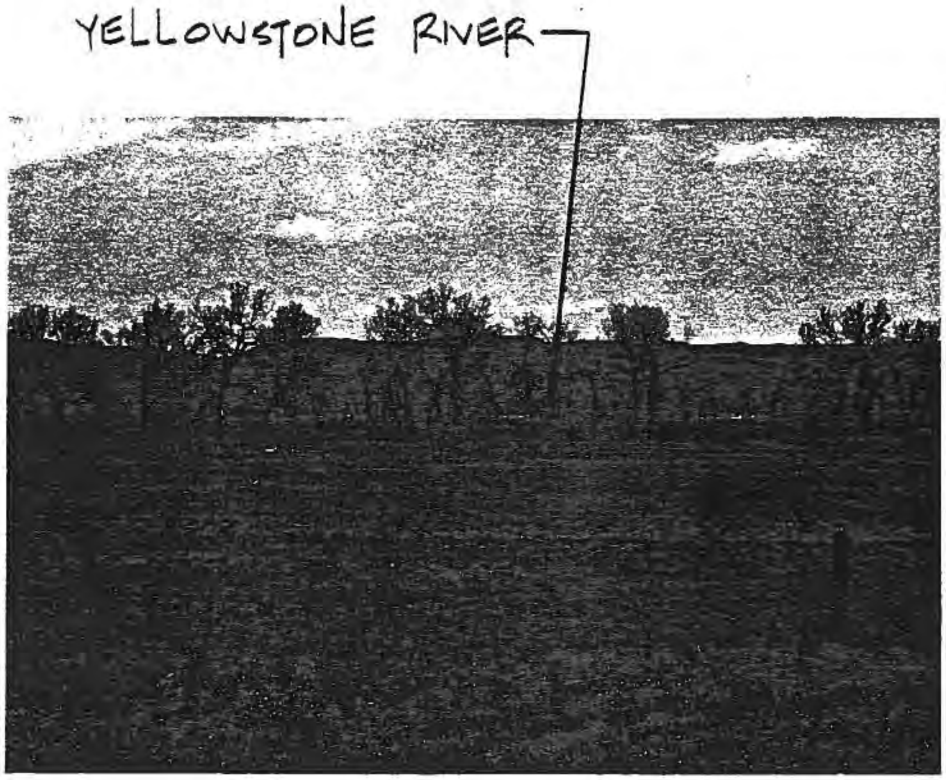


FIGURE 62 RIGHT-OF-WAY (VIEW NORTHEAST)
ROUTING YELLOWSTONE RIVER PIPELINE -
RENDERING PLANT ACRES FORT KEOGH USDA
PROPERTY TO YELLOWSTONE RIVER (NEW INTAKE
SITES)

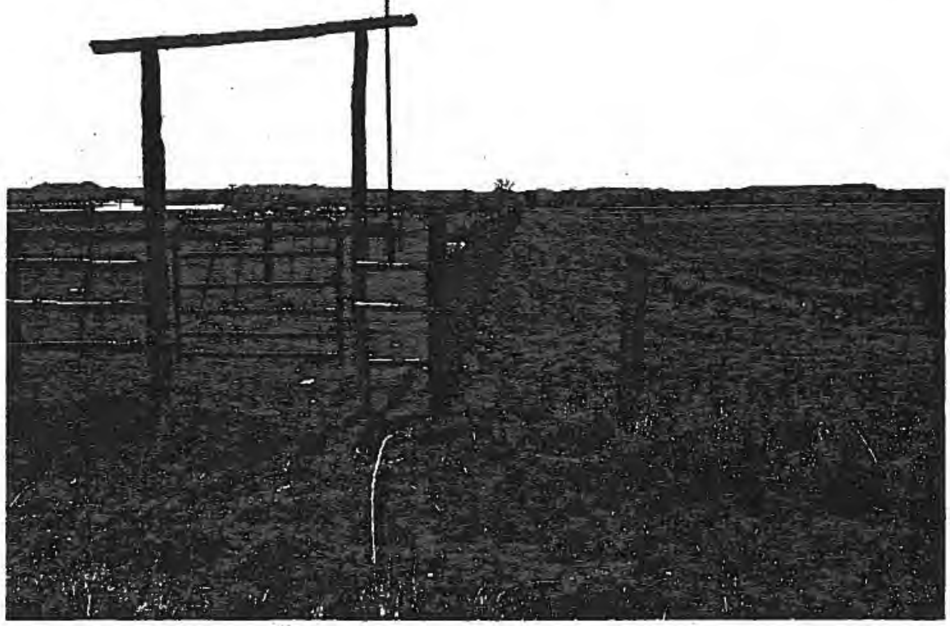


FIGURE 63 ROUTING YELLOWSTONE RIVER PIPELINE FROM RENDING PLANT ALONG BRIDAL PATH TO U.S. ROUTE 12 (VIEW SOUTHEAST & VIEW NORTHWEST)

FIGURE 64 ROUTING YELLOWSTONE RIVER PIPELINE FROM U.S. ROUTE 12 TO BURLINGTON NORTHERN RAILROAD (VIEW SOUTHEAST)

FIGURE 65 UNAPPROVED BROKEN CONCRETE FILL - TONGUE RIVER INTAKE CHANNEL CONTROL SITES

future. Pump replacement and other minor enhancements to the pump station were included in the cost estimate. Figure 66 illustrates the difference in suspended solids load of the Tongue River compared to the Yellowstone River at the confluences. The use of the sedimentation pond in the future is recommended and will require periodic maintenance.

Rehabilitation of the intake/pump station is estimated to cost $75,000.

C. Well Water Supply System: The existing 120 gpm West Well #1 and 49 gpm East Well #2 provide 54-55 F water for fish rearing and domestic purposes. We recommend that both wells be maintained and upgraded in the future program. The warm 55 F water will provide an excellent source of heat for the treated process water system heat pump for early spring northern pike and walleye egg incubation. Cost estimates of $50,000 reflects desired upgrading of these facilities including repair of the domestic water control system (currently not functional).

D. Reuse Pump Station: Rehabilitation of the existing reuse sump and pump station and pumps is estimated at $83,000.

5. <u>Aeration/Degassing and Process Water Treatment System</u> - See Plate 8 for proposed layout. The design parameters are similar to those discussed at the Ft. Peck site (see Section VI, B.4) except that the water heating requirements will be to heat up to 500 gpm from 5 degrees to 10 degrees temperature rise at an estimated cost of $60,000. Ultra-violet sterilization and filtration system construction costs are similar to Ft. Peck.

6. <u>Main Hatchery Building</u> - The existing and proposed layout of the hatchery building are shown on Plate 8. The layout is conceptual only and is intended to show the additional process, equipment and functions recommended for the hatchery building. The design phase should address actual space allocation, necessary functional and structural modification to the existing building to allow for better compatibility with the added space, and the overall program and production goals to be accomplished within the building.

Funds up to $20.00 per square foot for the existing 4,000 square foot building ($80,000) has been allocated for modification to piping and valves, repairing raceways and trench drains, new aluminum grates, higher efficiency building heat system and/or office air-conditioning, and better insulated windows.

An emergency electrical generator system ($80,000) and visitor information/education facilities ($15,000) associated with the hatchery building will be similar in magnitude and scope as those discussed at Ft. Peck in Section VI, B.5.

Section VI, D.10 will discuss the specific recommendations for additional fish production rearing units in the hatchery addition

FIGURE 66 CONFLUENCE OF TONGUE RIVER AND YELLOWSTONE RIVER - NOTE: TURBIDITY PLUME FROM THE TONGUE RIVER LEFT SIDE OF FIGURE

including egg incubation and fry catch tank, initial rearing troughs, circular and/or rectangular rearing tanks, as well as rearing ponds and harvest kettles and production raceways outside the hatchery building.

A unit price of $65.00 per square foot has been estimated for the building expansion and the fisheries production equipment. Water treatment equipment costs are estimated separately.

7. <u>Sitework and Utilities</u> - Domestic water and wastewater treatment systems appear to be adequate at the Miles City facility and no major expansion or modification is recommended. Additional site lighting is recommended for security and safety. A lump sum of $20,000 has been allocated for this purpose. Security fencing (six foot chain link) is recommended around the broad ponds and the concrete raceway complex. Public safety and the prevention of vandalism are the main reasons for adding the fencing. It is estimated that 2,900 lineal feet (at $10/LF) is required for the site fencing. Additional perimeter fencing (woven-wire or three strand barbed wire) will be added to the west, north and east boundaries. Approximately 6,800 lineal feet (at $4/LF) is necessary to complete the perimeter fencing.

It is recommended that $20,000 be allocated for lawn irrigation equipment and landscaping to provide a more appealing appearance to the hatchery and residence area. Further site improvement recommendations include adding base course gravel to the existing entrance road, hatchery building parking lot and residences drive and surfacing with a hot mix (asphaltic concrete) pavement. This paved surface will provide for less dust in the building/residence area and will greatly enhance snow removal and all-weather traffic movement. It is estimated that 1,200 cubic yards of pit run gravel (at $6/cy) and 1,400 tons (8,000 square yards) of hot mix material (at $35/ton) will be required to complete this proposed paving.

As at Ft. Peck it is recommended that all new pond levees be surfaced with pit run gravel (6 to 9 inches thick) and that all existing levees be re-surfaced with 4 to 6 inches of gravel. It is estimated that 17,000 cubic yards (at $6/cy) will be required.

8. <u>Concrete raceways</u> - Intensive culture concrete production raceways approximately six feet wide, sixty feet long and four feet high will be located near the hatchery building in four-double units (8 total raceways). Bioengineering criteria and justification for intensive raceways is discussed in Section III, A. Due to the various embedded items in the concrete for spawning cubicle hooks, screen and baffle guides, stoplogs and overflow weirs and piping the unit price per cubic yard of in-place concrete is set at $350.00. Miscellaneous supply and drain piping will also be provided to these raceways.

9. <u>Support Facilities</u> - It is recommended that an expansion of the existing 28' X 66' storage building with a 2,100 square foot

addition be completed to provide additional storage space for materials, nets, screens, piping and vehicles. Overhead doors and concrete floors but no heat or bathroom facilities will be included. A unit price of $15.00 per square foot was established to reflect the type of facility required.

As discussed at Ft. Peck it is desirable to provide three residential units at a hatchery of this size. It is recommended that a third residence be constructed at the site where a USFWS house was previously located. A house of the same design as the existing homes should be built. The existing residences are approximately 1,300 square feet of living space (plus basement) and 350 square feet of garage. It is estimated that a residence of ths size would cost approximately $60,000. In addition it is recommended that $10,000 be allocated for energy efficiency improvements at each of the two existing residences. Possible improvements include modifications to furnace, insulation, windows, roof, carpet and other energy related items.

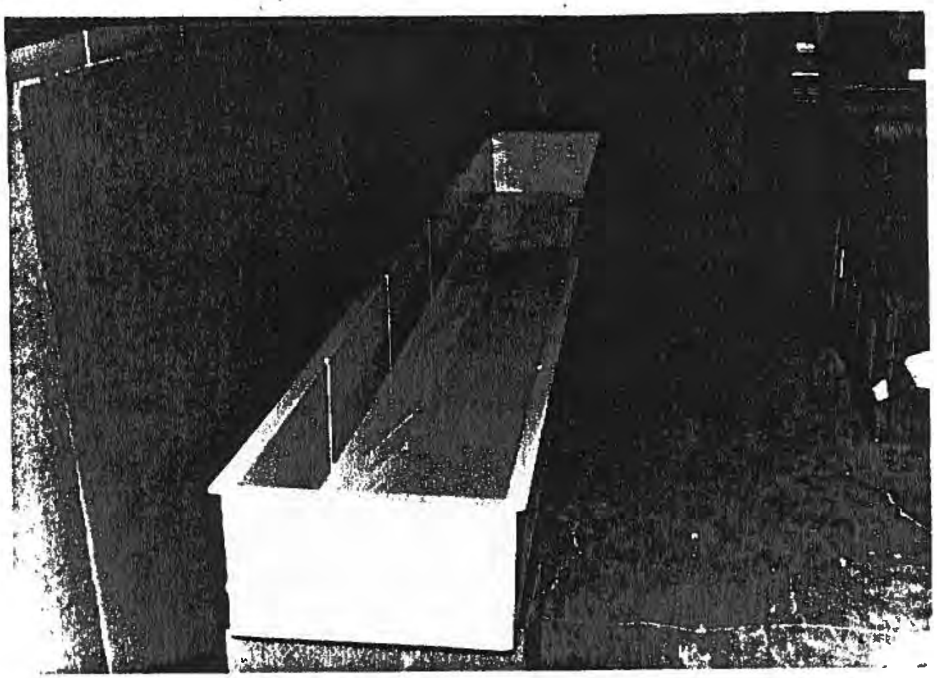
10. <u>Fish Production Rearing Units</u> - A suggested layout of fish rearing units and new water supply and drains is shown on Plate 8. The layout of equipment provides drive-in vehicle access into the rooms to permit easy unloading/loading of fish and eggs. We suggest that fiberglass modular tanks be used for the start/holding tanks, circular tanks and initial feed troughs to allow simple movement and re-configuration of the start tank room to best meet program requirements or future innovations in fish culture. Typical fiberglass rearing units are shown in Figure 67. Rearing unit supply piping and drains, valves and standpipes should be PVC (polyvinyl chloride) pipe to permit future modification. Since the layout of fish culture equipment is one of personal preference, during final design, modifications and enhancements to the basic layout proposed in Plate 8 are expected. In addition, repairs to the existing start tanks, supply piping, rusted floor trench grates, tank screens and other related items should be completed. The Department hatchery staff has completed many repairs and enhancements to the existing equipment. Items not completed should be identified for inclusion in final design. Cost estimate includes funding necesary for repairs to the existing main hatchery building. (Figures 68 and 69 illustrate some needed repair items.

Details of raceway design and pond kettle design are items that will be completed in final design including items such as screens, flow distribution baffles, stoplogs, catwalks, standpipes and other related features.

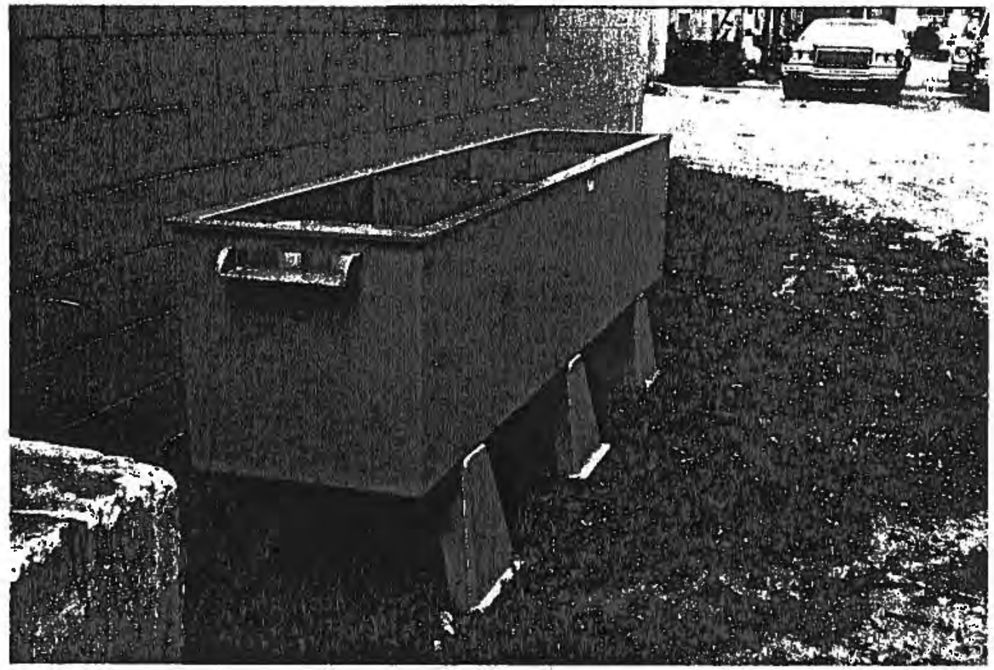
11. <u>Special Hatchery Equipment Requirements</u>

In addition to identified new construction items, several types of equipment are recommended for purchase:

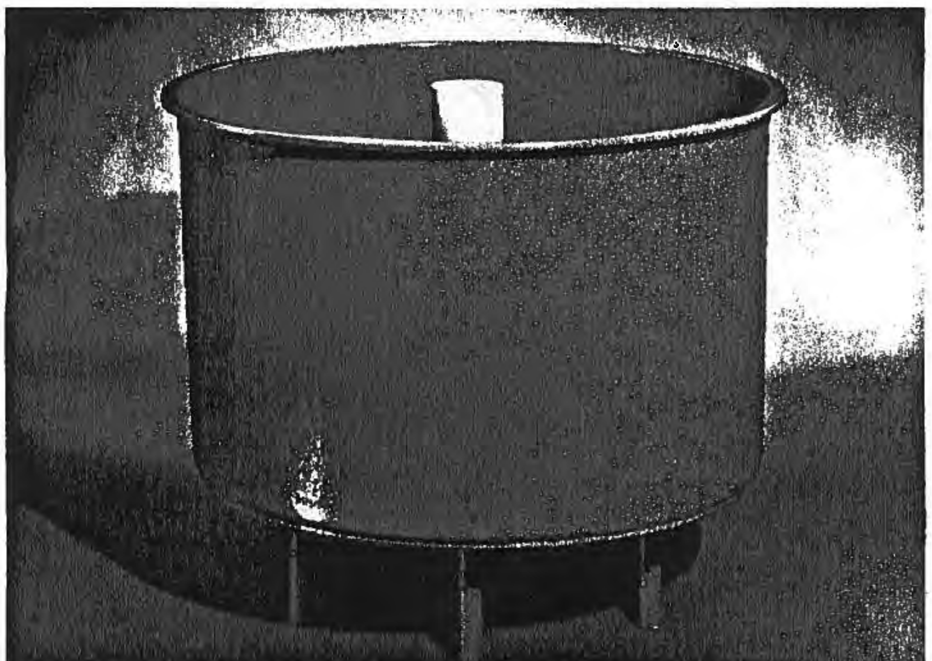
1. Sixteen (16) of the Start/Holding Tanks and the 16 Initial Feed Troughs should be equipped with programmable automatic fish



INITIAL FEEDING TROUGH



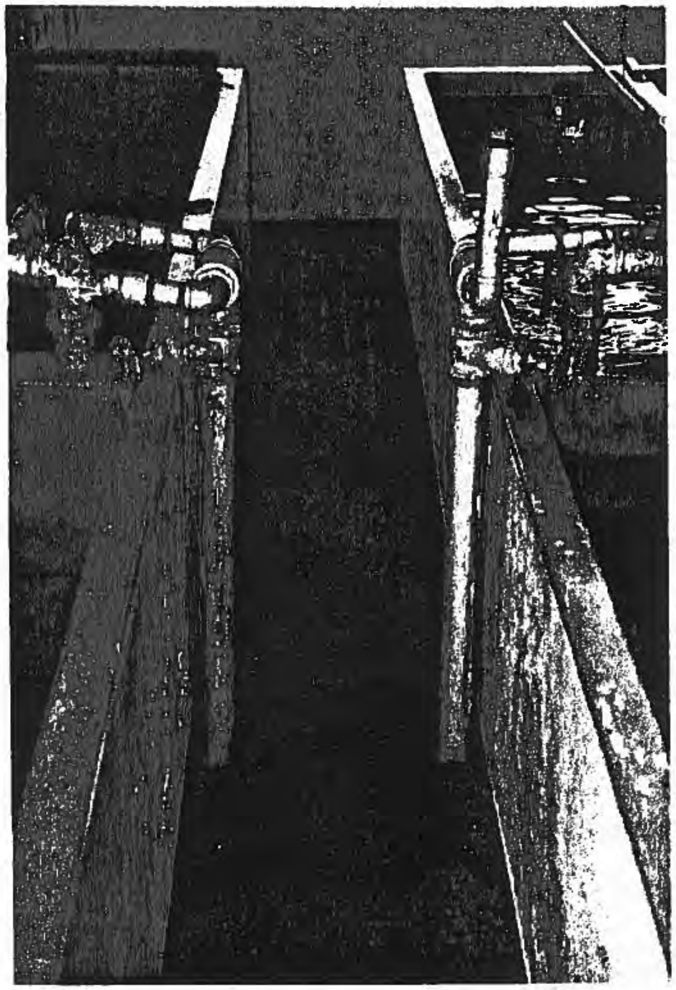
RECTANGULAR START/HOLDING TANK



CIRCULAR REARING TANK

FIGURE 67

FIBERGLASS START/HOLDING TANK, INITIAL FEED TROUGH & CIRCULAR TANK



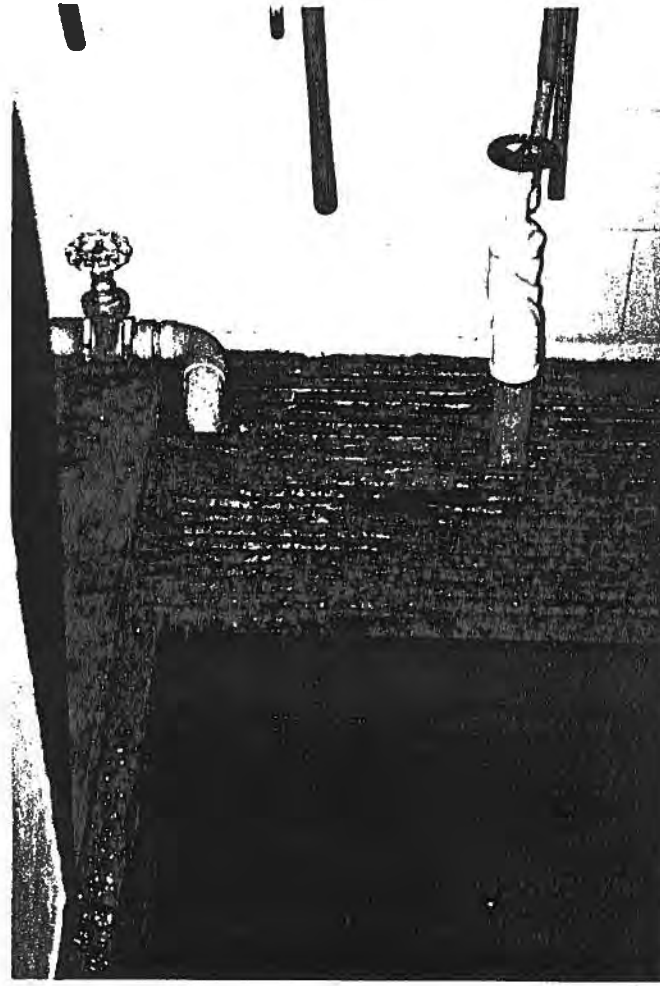
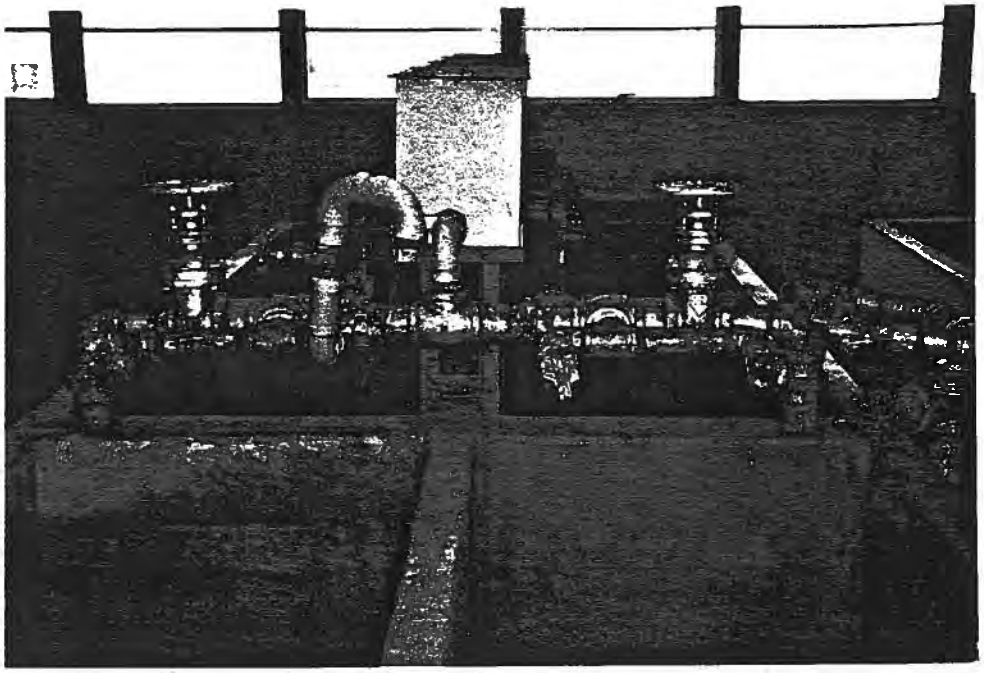


FIGURE 68 NEEDED TRENCH GRATE REPLACEMENT AND START TANK REFINISHING



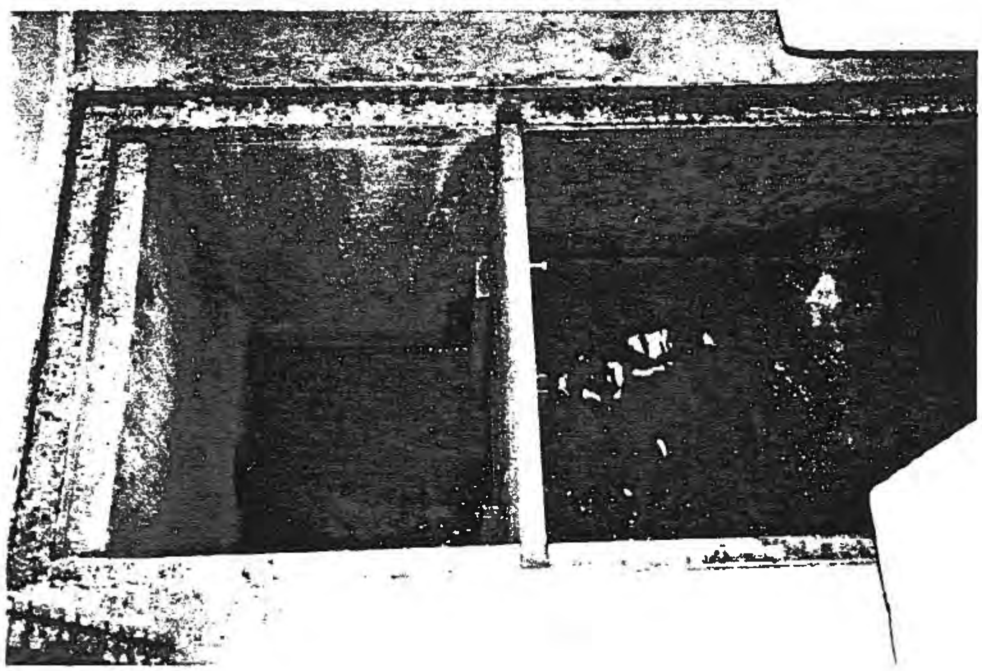


FIGURE 69 NEEDED SUPPLY LINE AND VALVE REPLACEMENT AND TRENCH DRAIN UPGRADING

feeders. The 24" or 48" AFS24 or AFS48 Sweeney Trough Feeder are recommended with 2-AFT1-QA quartz automatic timer/controllers. Cost = $8,000.00.

2. Automatic or Demand Type Pond Feeders and DFT-Q Time & Rechargeable Dry Battery System (if automatic). Cost = $3,100.00.

3. Perforated Aluminum Plate Screens for Kettles, Pond Outlet Structures and Existing Start Tanks. Cost = included in estimate.

4. Fish Transportation Tank and Trailer (for bumper hitch mounting). A 250 to 300 gallon Insulated Fiberglass or Insulated Aluminum Fish Transportation Tank with compartments complete with 12 volt aerators, oxygen diffuser system, 6" diameter quick release outlets and fish transfer hose shall be mounted on a suitable low-boy type trailer for hatchery use. Estimated cost = $5,000.00 complete

5. Fish Transportation Truck and Transportation Tank. A larger diesel fish transportation truck (1-ton flatbed) with a 250 to 300 gallon multi-compartment, fiberglass transportation tank unit (complete with 12 volt aerators, oxygen diffuser system, 6" diameter quick release outlets and fish transfer hose) is also recommended for transporting brood fish and large loads of fingerlings for distribution. Cost Estimated at $25,000.00 complete. The truck would also be used to transport fertilizer feed or chemicals (with the tank removed).

SECTION VII - A.

Cost Estimates

A. Cost Estimate Format

The purpose of the preliminary cost estimate provided in this study is two-fold. First the estimate will serve to compare the initial cost of construction at both the Ft. Peck and the Miles City proposed locations. In order to assign meaningful and/or relative cost of these two similar facilities it is imperative that the method of determining the various quantities and units of work at both locations is consistent. Once quantities have been established the various factors that will impact the contractors bid must be analyzed including:

1) Volume of various components of work: Items such as earth embankment, riprap erosion control, plastic synthetic pond liner, roadway base and surfacing are normally provided at smaller unit prices as the quantity increases since fixed mobilization, overhead and administrative costs can be allocated over a larger number of units.

2) Location of material sources: Cost of items such as concrete, riprap, gravel and asphaltic concrete surface are often dramatically effected by their availability to a specific construction location. One time mobilization costs for earthmoving equipment or delivery of pump, filters, etc. are not greatly impacted by distance variations of one to eight hours travel time. However, materials that must be delivered by truck for each unit can have a wide variation in costs due to travel delivery time.

3) Soils/Water/Climate: The quality and physical parameter of the soil can have a large impact on the overall cost of a project. Soils that require extra compaction requirements or specialized structural foundations are obviously more expensive than average to good soil. The amount of surface (pond, river or overland drainage) water or ground (near rivers) water encountered or expected to be encountered can impact the cost of the project. The length of the construction season and the type of work (inside work which can proceed during inclement weather) will also impact the overall construction costs.

The analysis of the two project locations and overall estimated quantities identify the following:

1. Although the Ft. Peck site is farther from a regional source of building supplies than Miles City (18 miles versus 2 miles) that factor is balanced by the increased quantities involved in the construction of Ft. Peck. Therefore, generally the unit prices for most items were identical at both locations.

2. Based on disucssions with Montana Department of Fish, Wildlife and Parks engineering personnel, it was determined that the unit cost of aggregate items (riprap and gravel) were approximately twice as expensive at Ft. Peck versus Miles City. Unit prices at Ft. Peck for riprap was set at $15.00 per cubic yard and gravel at $12.00 per cubic yard compared to $8.00 and $6.00 for Miles City.

3. Since no soils information was readily available for either site all estimated unit prices are based on similar soils/water condition, and that the soil is fairly common for the area. This appears to be a realistic assumption based on the existence and performance of ponds at Miles City and of the wastewater treatment plant and old swimming pool at Ft. Peck. It is important that soils information is documented and analyzed early in the design phase of the construction project.

The second purpose of the cost estimate is to provide budgeting and funding appropriation direction to the Department for upcoming Legislative action. In providing this information, several items need to be highlighted for further consideration and/or action.

1. All quantities and unit prices are estimated conservatively to cover unknown or undetermined design elements. For example, no valves or fittings have been estimated for the water supply piping, however the quantity of piping and the unit price have been rounded off upward to cover this design phase element.

2. There is an item titled "10% Contingency/Adjustment due to the Preliminary Nature of the Estimate" which is added to the construction cost subtotal. This item is included to reflect the fact that this Preliminary Design Report is not refined enough to include all the incidental construction requirements that will be defined in the Design Development Phase of the project. All major components and units of work have been identified except for additional parameter requirements due to Regulatory Agency mandates that cannot be identified in this preliminary planning stage. Examples of additional construction-related regulatory requirement might be the Tongue and/or Yellowstone River Intake systems, hatchery production wastewater treatment requirements, etc.

3. Planning, Design & Construction Engineering Fees are included in the project cost and obviously subject to operating procedures, availability of State personnel and contract negotiations between the State and the consulting engineering firm.

    1. The design fee has been estimated on a sliding scale as a percentage of the overall construction costs

and degree of difficulty. This cost ranges from 7.2% for Miles City to 7.4% for Ft. Peck.

2. Surveying - Aerial topography should be flown and mapped over the entire hatchery property and water supply line easements and plotted to a scale of one inch equals one hundred feet and to one foot contour intervals. If possible, this work should be scheduled and completed <u>prior</u> to the design phase.

3. Soil Borings - As discussed above, detailed soils information will be required at either hatchery location. As shown in the correspondence with the Fish & Wildlife Service in the Appendix E, soils data may be available at the Denver Engineering Center for Ft. Peck and at the Corps of Engineers Office in Omaha. If a file search does not produce the needed information then soils investigation and analysis will be required as one of the first steps of design development.

4. Construction Inspection - It is recommended that full-time construction inspection be provided for this project either by state personnel or by the consulting engineer. Preliminary estimates indicate the following construction time will be required:

A. Ft. Peck: 18 months
B. Miles City: 15 months

The length of reasonable construction period must be addressed more fully during the design phase. The most cost effective time to begin construction is at the beginning of the construction season (April-May) so that as little interruption as possible due to winter shutdown is necessary.

5. Construction Materials Testing - This is an important control function that can either be completed with State personnel and laboratories and/or independent testing labs. Items to be tested during construction include earthwork compaction, concrete strength, air entrainment, and slump, structural steel strength, water and drainline leakage tests, pond and/or synthetic liner leakage tests, etc. The quantity and types of testing (and subsequent testing costs) must be addressed in the design phase.

6. Operations & Maintenance Manual - This is a very important document that is normally prepared by the design engineer as an additional services above and beyond the design/construction phase. Items included in a typical O & M Manual consists of all major aspects of the hatchery system operation and the relationships to the fish production program.

The manual should present the operation and maintenance of each of the "systems" of the hatchery including detailed instructions on the operational modes of each of the fish rearing units. Most O & M Manuals are bound in a three-ring binder with a complete index tabbing system for easy location and reference of manual sections. Emergency system operating instructions and procedures should be clearly indicated for each of the "systems" in the hatchery. The manual should present instructions and procedures in narrative form, figures (graphic plans), labeled photographs and tables. A manual will clearly illustrate the important fish cultural and mechanical aspects of the operation and maintenance of the Fish Hatchery.

Major features to be covered should be:

(a) Water supply systems to the building and ponds;
(b) Fish production systems;
(c) Wastewater systems;
(d) Supplemental water systems;
(e) Identification of all mechanical aspects.

Cost of the Manual depends on the depth and detail requirements of the Owner and are negotiable with the consulting firm.

With this narrative explanation of the Cost Estimate Format and the discussion of Preliminary design concepts in Section VI the following Preliminary Cost Estimate Form should be easier to interpret and understand.

SECTION VII - B.1

MONTANA WARMWATER - COOLWATER
FISH HATCHERY STUDY

September 28, 1984

Fort Peck State Fish Hatchery
New Development
Summary Cost Estimate
(Full Scope)

ITEM	TOTAL COST
1. 1.5 Ac Ponds (32)	$1,179,000
2. 0.5 Ac Ponds (13)	441,000
3. Solar Pond	219,000
4. Water Supply System	666,000
5. Main Hatchery Building	745,000
6. Concrete Raceways	100,000
7. Hatchery Support Bldgs. & Residences	240,000
8. Sitework	700,000
	$4,290,000
+ 10% Contingency/Adjustment Due to Preliminary Nature of Estimate	$ 429,000
Subtotal	$4,719,000
+ 10% Construction Contingency	$ 471,900
1984 CONSTRUCTION GRAND TOTAL	$5,190,900
1. Engineering Design Fee	$ 400,000
2. Reimbursables:	
a. Surveying	8,000
b. Soil Borings	12,000
c. Construction Inspection-Full Time (18 months)	70,000
d. Construction Material Testing	30,000
3. Operations & Maintenance Manual	50,000
Planning, Design & Construction Engineering Subtotal	$ 570,000
1984 PROJECT TOTAL	$5,760,900
+ 112% Cost escalation to 1986 Construction Season	$6,452,200
For Preliminary Project Budget (Option 1) Use	$6,500,000

Itemized Cost Estimate

ITEM		# UNITS	UNIT MEAS.	INSTALLED COST/UNIT	TOTAL COST
1.	1.5 Ac. Ponds (32)				
a.	Earthwork Excavation: 4,000 cy/pond X 32	128,000	c.y.	$ 3.00	$ 384,000
b.	Concrete Kettles	32	ea.	6,000.00	192,000
c.	Riprap-12" X 4" cobble on 13.5' side slope-600 cy/pond X 32	19,200	c.y.	15.00	288,000
d.	Supply Line - both ends & looped	11,000	L.F.	15.00	165,000
e.	Drain Lines - 24" dia. +/-	5,000	L.F.	30.00	150,000
					$1,179,000
2.	0.5 Ac. Ponds (13)				
a.	Earth excavation: 2,000 cy/pond X 13	26,000	c.y.	3.00	78,000
b.	Concrete Kettle	13	ea.	6,000.00	78,000
c.	Plastic Membrane Liner- 30,000 SF/pond X 13	390,000	s.f.	0.50	195,000
d.	Supply Line	2,000	l.f.	15.00	30,000
e.	Drain Lines-24" dia. +/-	2,000	l.f.	30.00	60,000
					$ 441,000
3.	Solar Pond-15 Ac., 6' levee, 12' top, 4' water lined.				
a.	Earth Exc. (1.20 Compaction Factor)	25,000	c.y.	3.00	$ 75,000
b.	Riprap - 18" deep	4,600	c.y.	15.00	69,000
c.	Pump Station-1,200 gpm to Bldg.	1	l.s.	75,000.00	75,000
					$ 219,000
4.	Water Supply System				
a.	Powerhouse Intake Tap	1	l.s.	50,000.00	$ 50,000
b.	Supply Line-from Power House 12" dia. +/-	9,000	l.f.	30.00	270,000
c.	Filtration System	1	l.s.	250,000.00	250,000
d.	Ultra-violet Sterilization-500 gpm to Bldg.	1	l.s.	20,000.00	20,000
e.	Water Heating	1	l.s.	76,000.00	76,000
					$ 666,000

5.	a. Main Hatchery Building (approx. 84' X 120')	10,000	s.f.	65.00	650,000
	b. Emergency Generator System	1	ea.	80,000.00	80,000
	c. Visitor Information & Education	1	ea.	15,000.00	15,000
					$ 745,000
6.	Concrete Raceways-8 at				
	a. 6' X 60' X 4' high (8" walls)-22 CY/ Raceway X 8	176	c.y.	350.00	$ 61,600
	b. Miscellaneous Piping				38,400
					$ 100,000
7.	Hatchery Support Buildings & Residences				
	a. Equipment Storage Bldg. 40 x 100	4,000	s.f.	15.00	$ 60,000
	b. Residenes - including all utility hook-ups to 5' outside building Furnished. Approx. 1,500 SF	3	l.s.	60,000.00	180,000
					$ 240,000
8.	Sitework				
	a. Site Electrical	1	l.s.	100,000.00	$ 100,000
	b. New Primary from Power Plant 8,500 +/- LF	1	l.s.	100,000.00	100,000
	c. Domestic Water Hook-up	1	l.s.	10,000.00	10,000
	d. Domestic Sewer Hook-up	1	l.s.	20,000.00	20,000
	e. Relocation of existing City Water Main (10" dia.)	3,200	l.f.	15.00	48,000
	f. Fencing-6' Chainlink	10,000	l.f.	10.00	100,000
	g. Retention Lagoon	1	l.s.	50,000.00	50,000
	h. Relocate Drainage Ditch 2,600 LF	7,000	c.y.	3.00	21,000
	i. Gravel Entrance Road & Parking Lot-Pit Run Gravel-9" comp. thickness	4,500	c.y.	12.00	54,000
	j. Hot Mix Pavement- 3" thick-9,000 SY	1,500	T	35.00	53,000
	k. Pond & Reservoir- Gravel Access Roads- Pit Run Gravel (33,000 LF X 12')-9" comp. thickness	12,000	c.y.	12.00	144,000

	$ 700,000
Items #1-8 Subtotal	$4,290,000
+ 10% Contingency/Adjustment Due to Prelim. Nature of Estimate	$ 429,000
Subtotal	$4,719,000
+ 10% Bidding & Construction Change Order Contingency	$ 471,900
CONSTRUCTION GRAND TOTAL	$5,190,900
A. Engineering Design Fee	$ 400,000
B. Reimbursables	
1. Surveying	$ 8,000
2. Soils Borings	12,000
3. Construction Inspection-Full Time (18 months +/-)	70,000
4. Construction Materials Testing	30,000
C. Operations & Maintenance Manual	50,000
Planning, Design & Construction Engineering Subtotal	$ 570,000
1984 PROJECT TOTAL	$5,760,900
+ 112% Cost Escalation to 1986 Construction Season	$6,452,200
For Preliminary Project Budget Use	$6,500,000

END OF FT. PECK ESTIMATE

MONTANA WARMWATER-COOLWATER
FISH HATCHERY STUDY
SEPTEMBER 28, 1984

Miles City State Fish Hatchery
Expansion & Rehabilitation
Summary Cost Estimate

ITEM		TOTAL COST
1.	Branum Lake Ponds - 1.0 Ac. (15)	$ 496,500
2.	1.5 Ac. Ponds (6)	245,800
3.	0.5 Ac. Ponds (13)	390,000
4.	Water Supply System	1,110,000
5.	Main Hatchery Building	524,000
6.	Concrete raceways	100,000
7.	Hatchery Support Bldgs. & Residences	111,500
8.	Sitework	255,400
		$3,233,200
+	10% Contingency/Adjustment Due to Prelim. Nature of Estimate	$ 323,300
	Subtotal	$3,556,500
+	10% Construction Contingency	$ 355,700
	1984 CONSTRUCTION GRAND TOTAL	$3,912,200
1.	Engineering Design Fee	$ 300,000
2.	Reimbursables	
	a. Surveying	$ 4,000
	b. Soil Borings	6,000
	c. Construction Inspection (15 months)	50,000
	d. Construction Materials Testing	30,000
3.	Operations & Maintenance Manual	$ 50,000
	Planning, Design & Construction Engineering Subtotal	$ 440,000
	1984 PROJECT TOTAL	$4,352,200
+	112% Cost Escalation to 1986 Construction Season	$4,874,500
	For Preliminary Project Budget Use	$4,900,000

Itemized Cost Estimate
Option One (Full Scope)

ITEM		# UNITS	UNIT MEAS.	INSTALLED COST/UNIT	TOTAL COST
1.	Branum Lake (15)				
	a. Earth Excavation	60,000	c.y.	$ 3.00	$180,000
	b. Concrete Kettles	15	ea.	6,000.00	90,000
	c. Riprap-12" X 4" cobble on 13.5' side slope-550 CY/ Pond X 15	8,250	c.y.	8.00	66,000
	d. Supply Line-Both ends & looped	5,300	l.f.	15.00	79,500
	e. Drain & Reuse Lined Concrete Channel	2,600	l.f.	25.00	65,000
	f. External Kettles	4	ea.	4,000.00	16,000
					$496,500
2.	1.5 Ac. Ponds (6)				
	a. Earth excavation - 3,000 CY/pond x 6	18,000	c.y.	3.00	54,000
	b. Concrete Kettles	6	ea.	6,000.00	36,000
	c. Riprap-12" X 4" Cobble on 13.5' side slope-600 cy/pond X 6	3,600	c.y.	8.00	28,800
	d. Supply Line-Both ends & looped	2,400	l.f.	15.00	36,000
	e. Drain & Reuse Lined Concrete Channel	3,000	l.f.	25.00	75,000
	f. External Kettles	4	ea.	4,000.00	16,000
					$245,800
3.	0.5 Ac. Ponds (13)				
	a. Earth excavation 1,000 cy X 13	13,000	c.y.	3.00	39,000
	b. Concrete Kettles	13	ea.	6,000.00	78,000
	c. Plastic Membrane Liner-30,000 SF/pond X 13	390,000	s.f.	0.50	195,000
	d. Supply Line	2,600	l.f.	15.00	39,000
	e. Drain Lines	1,300	l.f.	30.00	39,000
					$390,000
4.	Water Supply System				
	a. Tongue River Intake	1	l.s.	75,000.00	75,000
	b. Filtration System	1	l.s.	250,000.00	250,000
	c. Ultra-violet Sterilization-500 gpm to Bldg.	1	l.s.	20,000.00	20,000
	d. Water Heating	1	l.s.	60,000.00	60,000
	e. Reuse Sump & Pump				

	House				
	1. 50'X50'X6'X8" thick	132	c.y.	250.00	33,000
	2. Pump House & Pumps (3)	1	l.s.	50,000.00	50,000
f.	Well Improvements & Expansion	1	l.s.	50,000.00	50,000
g.	Yellowstone River Intake & Pumps-2/1000 gpm	1	l.s.	200,000.00	200,000
h.	Yellowstone River Supply - 16" dia.				
	1. 7,000 l.f.	7,000	l.f.	36.00	252,000
	2. Road & R.R.- Jacking	300	l.f.	400.00	120,000
					$1,110,000
5.	**Main Hatchery Building**				
a.	44' x 122' addition on North	5,368	s.f.	65.00	$349,000
b.	Rehab existing building	4,000	s.f.	20.00	80,000
c.	Emergency Generator System	1	ea.	80,000.00	80,000
d.	Visitor Information & Education	1	ea.	15,000.00	15,000
					$524,000
6.	**~~Concrete raceways - 8/~~**				
a.	6'X60'X4' (8" walls) - 22 CY/Raceway X 8	176	c.y.	350.00	61,600
b.	Miscellaneous Piping				38,400
					$100,000
7.	**Hatchery Support Buildings & Residences**				
a.	Addition to Storage Garage 28' X 75'	2,100	s.f.	15.00	31,500
b.	Residence Improve-ments - General	2	ea.	10,000.00	20,000
c.	3rd Residence	1	ea.	60,000.00	60,000
					$111,500
8.	**Sitework**				
a.	Gravel Entrance Road & Parking Lot (4") Pit Run Gravel	1,200	c.y.	6.00	7,200
b.	3" Hot Mix Pavement 8,000 SY	1,400	T	35.00	50,000
c.	Pond Access Roads - Pit Run Gravel - 12' wide X 42,000 LF/total 9" thick-new 4"-6" thick-existing	17,000	c.y.	6.00	102,000
d.	Fencing 6' Chain				

Link:Broodpond & Raceways)	2,900	LF	10.00	29,000
Perimeter Fencing (Woven wire)	6,800	LF	4.00	27,200
e. Site Electrical & Lighting	1	LS	20,000.00	20,000
f. Lawn Irrigation System and Landscaping	1	LS	20,000.00	20,000
				$255,400

CONSTRUCTION SUBTOTAL ITEMS 1-8	$3,233,200
+ 10% Contingency/Adjustment Due to Prelim. Nature of Estimate	$323,300
Subtotal	$3,556,500
+ 10% Bidding & Construction Change Order Contingency	$355,700
CONSTRUCTION GRAND TOTAL	$3,912,200
A. Engineering Design Fee	300,000
B. Reimbursables	
1. Surveying	4,000
2. Soils Borings	6,000
3. Construction Inspection-Full Time (15 mo)	50,000
4. Construction Materials Testing	30,000
C. Operations & Maintenance Manual	50,000
Planning, Design & Construction Engineering Subtotal	$440,000
1984 PROJECT TOTAL	$4,352,200
+ 112% Cost Escalation to 1986 Construction Season	$4,874,500
For Preliminary Project Budget Use	$4,900,000

END OF MILES CITY ESTIMATE

SECTION VII - C.

C. Operational Cost Estimates and Staffing Requirements

1. Water Heating Cost at the Fort Peck Hatchery Site

One of the major considerations is site selection between Ft. Peck and Miles City is that of water heating for optimum egg incubation and fish rearing.

At Ft. Peck, recorded winter temperatures in the reservoir indicate that 38°F water could be expected from the existing deep intake as long as 60 days during periods when the optimum rearing water temperature would be 60°F.

Water Heating Demand

Heating demand is found by the equation

$$Q = (M)x(cp)x(\text{Delta } T)$$

where:

Q = heat rate in Btu/hr
M = mass flow rate in lb./hr
cp= heat capacity for water = 1.0 Btu/lb.-°F
Delta T= temperature difference in °F

During egg incubation and young fry rearing the water budget shows a need for 500 gpm of 60 F water.

Q=500 gal/min. x 8.33 lb/gal. x 60 min/hr x 1.0 Btu/lb.-°F x (60 - 38)°F = 5.5×10^6 Btu/hr

Q=5.5×10^6 Btu/hr or 5500 MBH

Heating Alternatives

Various methods of achieving the water heating were investigated including conventional oil and electrical boilers, a heat pump and a solar pond.

The solar pond would reduce the annual water heating cost, but it would be expensive to construct ($219,000) and it would likely necessitate repumping all the water passing through it. Thus, the energy saved by solar heating would be partially expended to pump water. Also, some type of conventional heating system would be required as a back-up for the solar pond in order to maintain temperatures on cloudy days or periods when the pond may not be operating at full capacity.

Comparisons were made on a life cycle cost basis for water heating with oil-fired boilers, electric boilers and water source heat pumps. These comparisons are presented in Table 15. During the course of this study, we were unable to determine what the

TABLE 15

LIFE CYCLE COST ANALYSIS OF PROCESS WATER HEATING

FT. PECK SITE

	OIL	ELECT. HEAT	HEAT PUMP
SIZE OF UNIT (MEH)	5,500	5,500	5,500
LIFE (YRS)	25	25	25
DISCOUNT RATE	10%	10%	10%
INITIAL COST	$ 77,000	$98,000	$148,500
ANNUAL ELECT. COST	400	107,600	13,600
ELECT. INFLATION RATE	3%	3%	3%
ANNUAL FUEL COST	86,000	-	-
FUEL INFLATION RATE	5%	-	-
ANNUAL MAINTENANCE COST	3,850	2,940	1,485
% OF INSTALLATION COST	5%	3%	1%
MAINTENANCE INFLATION	2%	2%	2%
MAJOR MAINTENANCE	25,000	15,000	7,500
PRESENT WORTH	$1,373,000	$1,412,000	328,000

BASIS: #2 FUEL OIL - $1.05 GL, 138,000 BTU/GAL
ELECTRIC - $0.04482/KWH
$2.25/KW OVER 10 KW DEMAND CHARGE
HEATING RATE - 5,500,000 BTUH OR 500 GPM AT 22°F ΔT
HEATING PERIOD - 60 CALENDAR DAYS CONTINUOUS

SEE APPENDIX - FOR COST CALCULATIONS

TABLE 15. (continued)

LIFE CYCLE COST ANALYSIS

OF PROCESS WATER HEATING

MILES CITY SITE

	OIL	ELECT. HEAT	HEAT PUMP
SIZE OF UNIT (MBH)	2500	2500	2500
LIFE (YRS)	25	25	25
DISCOUNT RATE	10%	10%	10%
INITIAL COST	$59235	$52,800	$95,700
ANNUAL ELECT. COST	$ 400	$54,078	$6193
Elect. Inflation Rate	3%	3%	3%
ANNUAL FUEL COST	39,130	—	—
Fuel Inflation Rate	5%	—	—
ANNUAL MAINTENANCE COST	2962	2640	4785
% of Installed Cost	5%	3%	1%
Maintenance Inflation	2%	2%	2%
Major Maintenance (15th YR)	25000	15000	7500
Major Maintenance Inflation	2%	2%	2%
Present Worth	$668986	$730920	$223403

Basis: Fuel Oil - $1.05/gal., #2 oil, 138,000 Btu/gal.

Elect. - $ 0.04482/KWH

$2.25/KW Demand Charge

Heat Rate - 500 gpm @ 10°F delta T

Heating Period - 60 days

cost of electrical energy might be for operation of the hatchery at Ft. Peck. There are fish hatcheries in the Federal system such as Dworshak in Idaho and Garrison in North Dakota that pay only a fraction of normal industrial electrical rates as a part of the mitigation for the management projects. If such were the case at Ft. Peck, the annual cost numbers would be somewhat lower, but probably not low enough to affect the outcome. For the purposes of this study, an electrical rate for Ft. Peck was assumed to be the same as that at Miles City or $0.04482/KWH.

Inspecting Table 13, it can be seen that the present worth is lowest with the heat pump alternative. The present worth is that amount of money that would be needed today to support the construction cost of the system, plus the operating cost over the projected life of the units, 25 years. The heat pump system has the lowest present worth cost and is therefore the recommended supplemental water heating method. In addition, the heat pump can chill as well as heat process water.

Solar Pond

A 15-acre solar pond has been included in the proposed facilities at Ft. Peck for both storage and water heating. The features of the solar pond are described in Section VI. The northeast region of Montana has favorable conditions for solar, however, the cool air temperatures in the Glasgow area reduce the effectiveness of an open solar pond to some degree.

Basically, an open solar pond could provide some rearing water heating from mid-May to mid-September. As shown by calculation in Appendix F, the pond can provide more heat capacity than is actually needed on a daily basis, however, it will provide only a two to four degree F temperature increase. During the summer months, the solar pond could be utilized to pre-heat the process prior to final heating by the heat pump.

2. Water Heating Costs at Miles City Hatchery

The analysis of process water heating for the Miles City SFH is similar to that of Fort Peck presented in Section VI. Flow rates for water heating are the same, 500 gpm, however the temperature difference is less. Only a 10°F rise is necessary to achieve the optimum 60 F water.

Water Heating Demand

From the same equation used above, the water heating demand is:

Q=500 gal/min x 8.33 lb/gal x 60 min/hr x 1.0 Btu/lb-$^{\circ}$F x (60-50)$^{\circ}$F
Q=2,500,000 Btu/hr or 2,500 MBH

Heating Alternatives

With similar reasoning as was applied to the Fort Peck facility, a heat pump system was determined to be the most cost effective method of water heating at Miles City. The unit would be rated at 2,500,000 Btu/hr output, 93 KW. The initial cost of this unit would be $75,000 - $80,000. The annual operating cost would be $6,000.

Solar Considerations

Like the Fort Peck site, the Miles City hatchery would benefit from pre-heating process water through some type of open solar pond in the summer months. Essentially, the 3-acre and 12-acre supply reservoirs serve this purpose.

The heating capacity of these two reservoirs would be similar to the 15-acre reservoir proposed at Fort Peck, or about a 2 °F to 4 °F temperature rise (averaged over 24 hours). See Appendix F for calculations.

SECTION VII - D.

D. Comparative Costs of Modern Hatchery Construction

As a comparison to hatchery construction costs at other similar facilities, an attempt has been made to equate existing hatcheries with the proposed hatcheries at either Ft. Peck or Miles City.

Based on the Department's production goals stated in Section III the size of the hatchery required is very similar to Blue Dog Lake State Fish Hatchery constructed in northeastern South Dakota by the Department of Game, Fish and Parks in 1980.

According to Mr. Robert Hanten, Hatchery Bureau Chief of South Dakota Department of Game, Fish & Parks the following first year (1982) production goals compared to the Montana goals are as follows:

	Montana	South Dakota	
Walley Fry	42,000,000	50,000,000	
Walleye Fingerling	2,100,000	1,000,000	
Northern Pike Fry	5,000,000	20,000,000	
Northern Pike Fingerling	550,000	700,000	
Largemouth Bass Fingerling	500,000	500,000	
Smallmouth Bass Fingerling	500,000	500,000	
Crappie Fingerling	300,000	3,000,000	Crappie
Channel Catfish Fingerling	22,000	----------	Bluegill
Forage Minnows	300,000	----------	etc.

Original Construction Costs including planning and design based on 1980 costs was approximately \$5.0 million. Escalating the cost by 6% annually for inflation through 1986 (same base year as Montana) would make the cost of Blue Dog Lake approximately \$7.1 million.

Comparing other warmwater/coolwater hatcheries of similar size indicates the following:

1. Garrison National Fish Hatchery located downstream of Garrison Dam (Lake Sakakawea) in North Dakota was built in 1964 for approximately \$850,000. It has a total land acreage of 182, over 36 acres of ponds, and a reservoir water supply of 5,000 gallons per minute.

Escalating the 1964 construction cost by 10% per year through 1980 and 6% per year through 1986 (Montana base year) for inflation yields an existing value (replacement cost) of the hatchery of \$5.5 million.

2. Little Grassy State Fish Hatchery located in southern Illinois was built in 1981 at a cost of \$5.5 million. Escalating this cost to 1986 yields a cost of \$7.4 million.

3. Milford State Fish Hatchery located in northeastern Kansas was built in 1983 at a cost of $6.7 million. Escalating this cost to 1986 yields a cost of $8.0 million.

4. Miles City National Fish Hatchery built in 1958 at a cost of $460,000. Escalating this cost to 1986 yields a replacement value at $5.3 million.

It is the purpose of the above examples to put the proposed Montana Warmwater/Coolwater Hatchery in economic perspective with other modern hatcheries. As the table below shows, either a single phase or a dual phase program compare favorably with other facilities discussed in this section.

	Ft. Peck	Miles City
Assume 1986 Construction	$6.5 million	$4.9 million

SECTION VIII

Hatchery Design and Construction Time Requirements and Possible Phasing Alternatives

A. Architectural and Engineering Design Recommendations and Time Schedule

Design recommendations have been set in Section VI. It is the intent of the Department to present a funding request to the 1985 Legislature seeking funding for design and construction of a warmwater/coolwater fish hatchery in eastern Montana. Assuming that the project is approved, funds will be appropriated effective July 1, 1985. Providing for two months for design consultant selection and contract negotiation by the Department of Administration, Architecture & Engineering Division and the Department of Fish, Wildlife and Parks, design could be started in September 1985.

Information and data that must be secured immediately are: (1) aerial photography and topography suitable in scale and elevation contour elevation to serve as base construction documents; (2) soils borings and analysis. Various details must be resolved so that design can proceed such as location of river intake structure(s), to what degree hatchery operations can (or should) function during construction, etc.

Normally, technical reviews by State personnel for a project of this scope and complexity are conducted at either three (30, 60, 95%) or four (25, 50, 75, 95%) intervals. Assuming design begins September 1, 1985, a typical submittal/review schedule might be:

30% - November 1, 1985
60% - February 1, 1986
95% - April 1, 1986

Final Plans could be available for advertising and bidding in May with a bid opening in late June 1986.

Ideally, a project of this size and scope would allow for an 8 to 10 month design period. However, it is also ideal to bid a project in March/April so that a full construction season is available to the building contractor. Length of design time will depend upon when design can begin and when bids need to be taken and are subject to design consultant contract negotiations.

B. Construction Phase Recommendations and Time Schedule

Based on economic analysis and because of less disruption to the hatchery operations it is recommended that the entire project be constructed in one phase. If this option is not available due to funding problems a two-phased construction program with major construction accomplished in 1986 and supplementary construction completed in 1988 has been set forth in the cost estimates found in Section VII.B.

Assuming that single-phase construction is chosen it is estimated that two full construction seasons will be required to complete construction. If construction begins June 1, 1986 it is estimated that construction could be completed by December 1, 1987 at Ft. Peck and September 1, 1987 at Miles City. It is important to note that enough building construction must be completed prior to winter 1986-87 so that interior building work can be completed during the sitework shutdown period. Therefore, it is important to complete design work in a timely fashion so that advertising, bidding, award, and administrative functions can be completed prior to the start of the construction season.

If two-phase construction is required it is estimated that Ft. Peck would require 15 and 6 months for construction and 12 and 6 months at Miles City.

Project costs for construction inspection and construction materials testing have been identified and discussed in Section VII. Obviously the length of the time necessary to complete construction will have an impact on these project costs.

C. <u>Operation & Maintenance Manuals and Training</u>

Section VII also identifies the need for an associated cost of an O & M Manual. It is important that hatchery management staff are involved in all phases of the project including design, construction, and the development of the O & M Manual. Training for staff on new equipment and methods must be a part the construction requirements as well as the O & M Manual.

Normally equipment use training is conducted by factory authorized service personnel prior to final acceptance of the project. The O & M Manual development should be started in the late stages of construction and completed within the first year of operation.

D. <u>Fish Rearing Subimpoundment at Fort Peck</u>

A 50 to 100 acre fish rearing subimpoundment complete with harvest kettle and outlet control structure would be a useful walleye and northern pike rearing area for expanding the fingerling production program for Fort Peck Reservoir. The subimpoundment could be located somewhere on the reservoir to provide direct fish draining into the lake. The States of South Dakota, Illinois and other states have successfully used these areas to increase fingerling production for reservoir management since large numbers of fingerlings are often required for stocking. In our opinion, the development of such an area on the reservoir would meet an important management need and would provide some local public relations benefit with fishermen and fishing organizations like Walleye Unlimited.

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LIST OF APPENDICES

APPENDIX A U.S. FISH AND WILDLIFE SERVICE LEASE AGREEMENT FOR MILES CITY HATCHERY

Contract sent back 3-7-83

United States Department of the Interior

FISH AND WILDLIFE SERVICE

FEB 22 1983

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228

IN REPLY REFER TO:
FR

FEB 15 1983

James W. Flynn, Director
Department of Fish, Wildlife and Parks
1470 East 6th Avenue
Helena, Montana 59620

Dear ~~Mr. Flynn~~ Jim:

The transfer of the Miles City National Fish Hatchery to the State of Montana will be completed with your signature on the attached Agreement. I have enclosed four signed Agreements for your final review and signature. Please sign each of the four Agreements and return three for our use.

The Agreement will be effective on or about March 31, 1983, but it is contingent upon the funds being appropriated by the State Legislature.

We will continue to work with your fisheries staff on improving FWS operations in Montana as well as providing any assistance possible on warmwater fish culture and fish trades. Good luck on your new warmwater fish cultural program.

Sincerely yours,

Galen L Buterbaugh

GALEN L. BUTERBAUGH
Regional Director

Attachment

Memorandum of Agreement
between
U.S. Fish and Wildlife Service
Department of the Interior
and the
State of Montana
Department of Fish, Wildlife and Parks

I. PURPOSE

THIS AGREEMENT, made and entered into by and between the Department of the Interior, United States Fish and Wildlife Service, hereafter referred to as the Service, represented by the Denver Regional Director, and the Montana State Fish, Wildlife and Parks, hereafter referred to as the State, represented by its Director, is hereby entered into under the authority of the Fish and Wildlife Act of 1956 as amended, 16 U.S.C. 742f(a)(4), and the Fish and Wildlife Coordination Act, 16 U.S.C. 661, et. seq.

The Service believes it would be mutually beneficial to discontinue Service operation of the Miles City National Fish Hatchery (NFH) temporarily in favor of State operation. This Agreement is for the purpose of facilitating the cooperation of the Service and the State in fishery programs, and for the purpose of maintaining and increasing public opportunities for fishery resources in the State of Montana, and provides for the loan of certain real and personal property of the Miles City NFH.

The lands are more particularly described as follows:

Situated in the State of Montana, County of Custer, Range 47 East, Township 7 North, Tract 1, Section 4, 5, 8, and 9; beginning at a point from which the quarter corner common to Section 5 and 8 bears North 45° 06' 38". West 613.85 feet; thence South 45° 06' 38". East approximately 72.0 feet to the centerline of the access road, thence easterly with the centerline of the access road of the U.S Range Livestock Experiment Station approximately 3,850.0 feet, thence North approximately 2,027.12 feet, thence North 48° 30' West approximately 1,610.84 feet; thence South 41° 30' west approximately 4,065.0 feet to the point of beginning; containing 168.22 acres, more or less, also a drain ditch right-of-way, said right-of-way to be 66 feet wide extending from the Northeast corner of the above described 168.22 acres to the Tongue River; also a 66 foot right-of-way for a pipeline extending from the East boundary of the aforedescribed 168.22 acres easterly to the Tongue River and including a right-of-way for intake structure and low level dam for water diversion (Exhibit A attached hereto and made a part of this Agreement). Subject to BLM oil and gas lease No. M-43267, dated May 1, 1981.

It is the intention of the Service, and the State agrees, effective upon execution of this Agreement, that Miles City NFH shall not be operated by the United States for fish rearing and conservation purposes during the term of this Agreement.

In recognition of the mutual advantages and benefits accruing to the parties hereto, the Service hereby transfers to, and the State accepts, responsibility for operation of the Miles City NFH, at State expense, under the terms set forth hereinafter for the term of this Agreement.

II. REAL PROPERTY

(1) The Service hereby grants to the State the use and control of the Miles City NFH real property described in Exhibit B, attached hereto and incorporated by reference in this Agreement.

(2) The State shall bear all costs of maintenance and repair of all real property provided by the Service under the terms of this Agreement.

(3) The State shall not grant or permit occupancy of the land or the improvements by third parties, other than those under the direct supervision and control of or under contract or agreement with the State, and such contracts and agreements shall be for the furtherance of fishery purposes only.

(4) The State shall assume responsibility for all pollution monitoring required by State and/or Federal agencies and assume responsibility for any corrective actions necessary to achieve compliance with State and/or Federal Pollution Abatement Standards.

(5) The State will not dispose of any timber nor gas, oil, or other minerals, including sand and gravel, by sale, permit, or otherwise.

(6) The State will pay the United States the full value for all damages to the lands or other property of the United States caused by it or its employees, contractors, or agents of the contractors.

(7) The State will not alter, remodel, or dispose of buildings without prior written approval of the Service.

(8) The State must comply with applicable State or Federal Occupational and Safety and Health Administration requirements.

III. PERSONAL PROPERTY

(1) The State shall be responsible for and bear all costs of maintenance, repair, or loss of personal property owned by the Service and used by the State during the term of this Memorandum of Agreement identified in Exhibit C (attached hereto and made a part of this Agreement). Maintenance schedules shall be established for such personal property similar to State schedules for like State-owned property.

(2) The State shall not dispose of or transfer from the site personal property of the Miles City NFH.

(3) The State shall conduct an annual inventory of the personal property of the Miles City NFH, and provide a copy to the Service.

(4) The Service reserves the right to recall any item of personal property described in Exhibit C, for use by the Service upon thirty (30) days written notice to the State.

(5) The State will not be liable for normal wear and tear on any item of personal property to which this Agreement pertains.

IV. GENERAL PROVISIONS

The Service does not assume and the State agrees to hold the United States harmless from any liability from any fines, claims, damages, losses, judgements, and expenses arising out of or resulting from any act, omission or activity by the State in connection with the activities undertaken in the operation, maintenance and use of the herein described real and personal property.

The Service reserves unto itself, the Department of the Interior, and/or General Services Administration, the right to make an annual Personal Property Utilization Survey of the facility to identify property that may not be necessary for conduct of the State program. Notification will be given to the State prior to the initiation of said Survey and the State will be consulted before any disposal action by the Service.

In carrying out the terms of this Agreement, the State shall not discriminate against any employee or applicant for employment because of race, creed, color, or national origin and shall require an identical provision to be included in all subcontracts.

V. TENURE OF AGREEMENT

(1) This Agreement shall be in effect for a period not to exceed 30 years following execution hereof.

(2) This Agreement or any renewal thereof may be terminated by either party upon one (1) year written notice.

(3) Upon completion of this Agreement, all personal property identified in Exhibit C will be returned within sixty (60) days to the Service in good working order. If items of personal property are lost, missing, or beyond repair due to the fault of the State, the State agrees to furnish like or similar articles of personal property in lieu thereof.

(4) This Agreement will be effective on or about March 31, 1983, but is contingent upon the funds being appropriated by the State Legislature.

ACCEPTED:

By Galen L Buterbaugh — Date 2-15-83
Regional Director, Region 6
U.S. Fish and Wildlife Service

By James W Flynn — Date 3-7-83
Director, Montana Department of
Fish, Wildlife and Parks

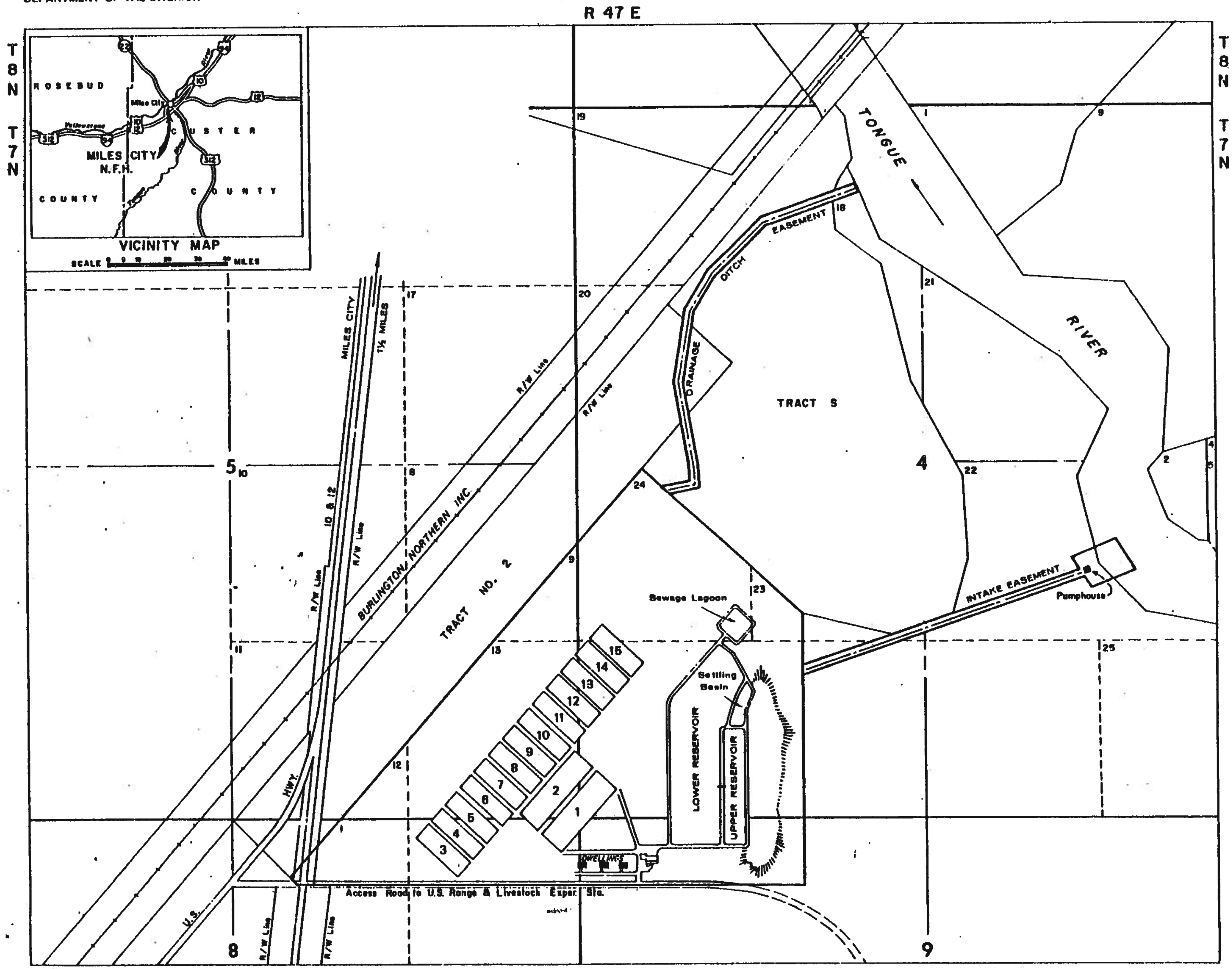
EXHIBIT A

MILES CITY NATIONAL FISH HATCHERY

CUSTER COUNTY, MONTANA

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE



PRINCIPAL MERIDIAN

COMPILED IN SURVEYS AND MAPS FROM
SURVEYS BY THE BLM & USFWS
DENVER, COLORADO

REVISED: MAY 1981

0 660 1320 2640 FEET

MEAN DECLINATION 1967

REAL PROPERTY INVENTORY OF BUILDINGS

Unit: Miles City NFH Division: Designation: I-FWS-493
State: Montana County: Custer Date: 09-30-81

INVENTORY RECORD DISPOSAL RECORD

1 Prop. No.	2 Tract Desig.	3 Use	4 Type of Construction	5 Date Acquired	6 No. Rooms	7 Space Sq.Ft.	8 % Occupied	9 Cost	Code	10 Date Excess	11 Appr. Value	12 Disposal Date	13 Sale Price
[illegible]	1	Resid.	Frame	1959		1,600	100	19,000	30				
				Reported to Energy		2472 gsf		Est.					
3	1	Resid.	Frame	1959		1,600	100	19,000	30				
				Reported to Energy		2472 gsf		Est.					
4	1	Hatchery /Office	Brick	1959		4,636	100	175,000	80				
5	1	Oil Hse.	Brick	1959		120	100	6,000	40				
								Est.					
6	1	Sump house	Steel	1958		80	100	6,000	80				
								Est.					
7	1	E. Well House	Brick	1958		80	100	6,000	80				
								Est.					
8	1	W. Well House	Brick	1958		80	100	6,000	80				
								Est.					
9	1	Garage	Frame	1960		1,848	100	11,094	40				
								Est.					
10	1	T. River Pump House	Steel	1960		48	100	4,800	80				
								Est.					

Fish and Wildlife Service
Division of Realty

REAL PROPERTY INVENTORY OF OTHER STRUCTURES AND FACILITIES

Unit: Miles City NFH
State: Montana

Division:
County: Custer

Designation: I-FWS-493
Date: 09-30-81

Inventory Record							Disposal Record			
1 Prop. No.	2 Tract Desig.	3 *Structures & Facilities	4 Description Construction & Size	5 Date Built	6 Cost	Code	7 Date Excess	8 Appraisal Value	9 Date Disposal	10 Sal Pri
11	1	Gas Storage	Steel, 1,000 gal.	1959	800	40				
12	1	Water Storage	Concrete, 12,000 gal.	1959	Est 3,500	71				
13	1	Pipeline T.R.	Asb. Cem., 14" x 2,900'	1960	Est 26,000	71				
14	1	Ponds (8)	1.5 acre ponds	1958	Est 75,000	80				
15	1	Ponds (5)	1.5 acre ponds	1960	Est 51,625	80				
16	1	Ponds (2)	3.0 acre ponds	1958	30,000	80				
17	1	Upper Reservoir	3 acres	1958	Est 10,000	71				
18	1	Lower Reservoir	11 acres	1958	Est 20,000	71				
19	1	Supply Lines	Asb. Cem.	1958	Est 50,000	71				
20	1	Sewage System	Lift station and lagoon .54 acre	1970	Est 19,409	71				
21	1	Settling Channel	Settling channel .32 acre	1970	3,572	80				
22	1M	Tongue River Intake Structure	Intake Structure	1970	9,396	80				
26	1	Sewage System	Lift Sta. & Lagoon .54 Acre	1970	19,409	71				
27	1	Settling Channel	.32 Acre	1970	3,572	80				
28	1M	Intake Structure	Tongue River	1970	9,396	80				

*Structures & Facilities, i.e.: Bridge, canal, control structure, dam, dike, fence, gauging station, pond

EXHIBIT C

Item	Property Number
Truck, Dodge 4 x 4 1/2 ton	148339
Truck, Dodge 3/4 ton	604350
Tractor, wheeled, agricultural	141678
Grader road	618506
Pump, centrifugal	144900
Pump, centrifugal	150303
Pump, centrifugal	618501
Trailer boat	132479
Range, electric, household	605467
Range, electric, household	605468
Range, electric, household	605469
Refrigerator, domestic	605321
Refrigerator, domestic	605322
Refrigerator, domestic	605323
Boat	23351
Motor, outboard	135482

UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Land Management
222 North 32nd Street
P.O. Box 30157
Billings, Montana 59107

Official Business
PENALTY FOR PRIVATE USE, $300

AN EQUAL OPPORTUNITY EMPLOYER

POSTAGE AND FEES PAID
US DEPARTMENT OF THE INTERIOR
INT-425

Miles City NFH, MT.

Mr. Juris Eglite, Div. of Realty
U. S. Fish & Wildlife Service
Denver Federal Center
P. O. Box 25486
Denver, CO 80225

11/23/82

Dear Mr. Eglite,

Per your request, here is a copy of Lease M 43267
Also, I attached BLM's Request to Fish & Wildlife
requesting your lease conditions on May 3, 1979.

Your reply of May 21, 1979 is also attached.

Hope this helps.

Esther Rivera, Oil and Gas
Land Law Examiner

11/26

11-29-82

RECEIVED
NOV 26 '82
DIVISION OF
REALTY

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
The Federal Building, Room 3035
316 North 26th Street
Billings, Montana 59101

RECEIVED
NOV 26 '82
DIVISION OF
REALTY

IN REPLY REFER TO: (RE)

May 21, 1979

Kenneth J. Sire, Chief
Minerals Adjudication Section
Bureau of Land Management
222 North 32nd Street
P. O. Box 30157
Billings, MT 59107

Dear Mr. Sire:

In reply to your letter of May 3, 1979, regarding oil and gas lease offers M 43267, M 43268 (943.12) on Fish and Wildlife Service lands.

Enclosed is a map of Miles City National Fish Hatchery showing the location of two of the lease offerings.

It is difficult to imagine any oil and gas development activity within the hatchery boundary which would not adversly impact the operation of the hatchery.

If you should need additional information, please contact Jack Larmoyeux or Rich Johnson of this office at 657-6115.

Sincerely,

John G. Wood

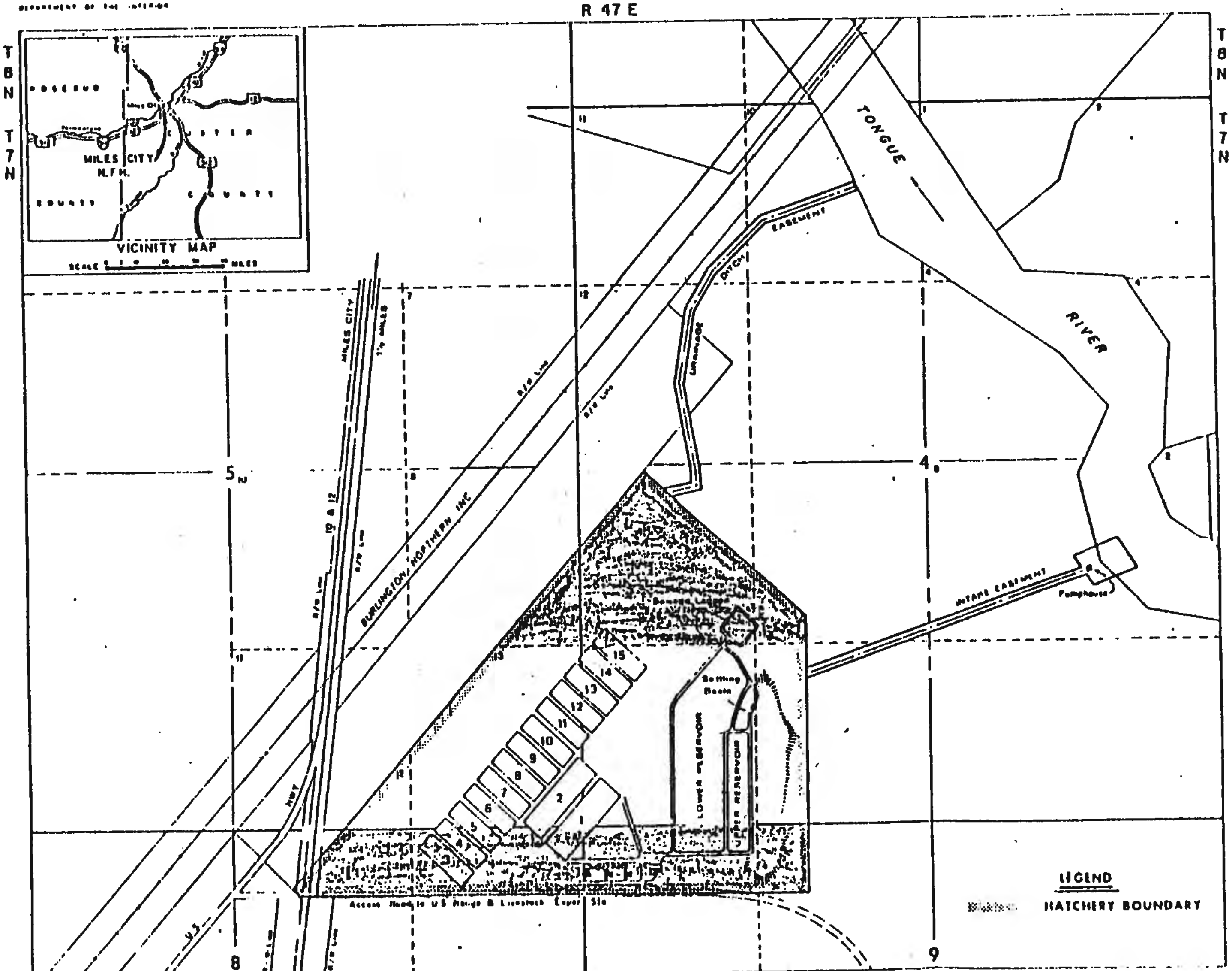
John G. Wood
Acting Area Manager

Enclosure

CC: Miles City NFH
Region 6 (FR/RE)

MILES CITY NATIONAL FISH HATCHERY

CUSTER COUNTY, MONTANA



COMPILED IN SURVEYS AND MAPS FROM SURVEYS BY THE BLM & USFWS

DENVER COLORADO

REVISED JUNE 1976

PRINCIPAL MERIDIAN MONTANA

GF MONT 193 103

M 43267 (943
M 43268

May 3, 1979

Area Manager
Fish and Wildlife Service
Federal Bldg., Rm. 3035
316 North 26th
Billings, Montana 59101

Dear Sir:

Attached are copies of the above-numbered oil and gas lease offers that have been recently filed. According to our records part of the lands in the offers were in a Relinquishment and Transfer - Excess Property to U. S. Fish and Wildlife Service on May 11, 1978.

Please inform us of lease conditions necessary to protect the Fish and Wildlife Service.

Sincerely yours,

/s/ Kenneth J. Sire

Kenneth J. Sire
Chief, Minerals Adjudication Section

Enclosures
1-Copies of Oil & Gas Lease Offers
2-OG Plats

943.12:PJDavidson:pd:5/3/79:6566

Davis
5-3-79

a known geological structure on
Form 3110-1
Eleventh Edition
(March 1977)
(Formerly 3120-...)
APR 7 1981
Acting Deputy
Conservation Manager/RE
for the Director
U. S. Geological Survey

Form approved
Budget Bureau No. 42-R0990

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Office MONTANA

Serial No. M 43267

OFFER TO LEASE AND LEASE FOR OIL AND GAS
(Sec. 17 Noncompetitive Public Domain Lease)

The undersigned hereby offers to lease all or any of the lands described in item 2 that are available for lease, pursuant and subject to the terms and provisions of the Act of February 25, 1920 (41 Stat. 437, 30 U. S. C. sec. 181), as amended, hereinafter referred to as the Act and to all reasonable regulations of the Secretary of the Interior now or hereafter in force, when not inconsistent with any express and specific provisions herein, which are made a part hereof.

1. Mr. Mrs. Miss Connie Mull
(First Name, Middle Initial, Last Name)

Please notify the leasing office of any change of address.

Box 1072
(Number and Street)

Denver, Co. 80201
(City, State, ZIP Code)

ORIGINAL

1979 APR 13 PM 2 30

DEPARTMENT OF INTERIOR

2. Land requested: State Montana County Custer T. 7N : R. 47E : PMM Meridian
8N 47E

7N- 47E
3,10: Tr. U
4: Lots 18-25, Tr. S,V, SW¼SE¼
5: Lots 6,10,11,17,21,22, SW¼NE¼, S½NW¼, SW¼, Tr. Q
6: Lots 1,2,3,6,7,8, S½NE¼, SE¼SW¼, SE¼
7: Lot 1, NE¼NW¼, S½NW¼, NE¼, S½
8N-47E
32: Lots 9,17,21,22,23,28,31,32, Tr. F,G,L,R,T, 34: Lot 4
33: Lots 12-17, Lots 20 (3.38-1.48) Tr. A,B,C

Total Area 2403.17 Acres

3. Land included ~~in lease: State~~ Montana County Custer T. : R. : Meridian

Dana
4-1-8

See attached land description.

3. Land included in lease M 43267:

T. 7 N., R. 47 E., P.M.M.
Sec. 3 & 10: Tract U
Sec. 4: Lots 18,19,20,21, 22,23,24,25, Tracts S,V, SW¼SE¼
Sec. 5: Lots 6,10,11,17,21,22, Tract Q, SW¼NE¼, S½NW¼, SW¼
Sec. 6: Lots 1,2,3,6,7,8, S½NE¼, SE¼SW¼, SE¼
Sec. 7: Lot 1, NE¼, NE¼NW¼, S½NW¼, S½

T. 8 N., R. 47 E., P.M.M.
Sec. 32: Lots 9,17,21,22, 23,28,31,32, Tracts F,G,L,T
Sec. 32: That portion of Tract R lying in Sec. 32 containing 0.95 Acres

T. 8 N., R. 47 E., P.M.M.
Sec. 33: Lots 12,13,14,15 16,17, Tracts A,
Sec. 33: Lot 20 (3.38 A.) accepted under approved survey April 24, 1947
Sec. 33: Lot 20 (1.48 A.) accepted under approved survey April 24, 1974
Sec. 34: Lot 4

7. Offeror's signature to this offer shall also constitute offeror's signature to, and acceptance of, this lease and any amendment thereto that may cover any land described in this offer open to lease application at the time the offer was filed but omitted from this lease for any reason, or signature to, or acceptance of, any separate lease for such land. The offeror further agrees that (a) this offer cannot be withdrawn, either in whole or in part, unless the withdrawal is received by the land office before this lease, an amendment to this lease, or a separate lease, whichever covers the land described in the withdrawal, has been signed in behalf of the United States, and (b) this offer and lease shall apply only to lands not within a known geologic structure of a producing oil or gas field.

8. If this lease form does not contain all of the terms and conditions of the lease form in effect at the date of filing, the offeror further agrees to be bound by the terms and conditions contained in that form.

9. It is hereby certified that the statements made herein are complete and correct to the best of offeror's knowledge and belief and are made in good faith.

Offeror duly executed this instrument this 13th day of April 19 79

(*Offeror does not fill in this block*) Total Area 2365.407 Acres Rental retained $ 2366.00

4. Amount remitted: Filing fee $10, Rental $ 2404.00 Total $ 2414.00

5. Undersigned certifies as follows:

(*a*) Offeror is a citizen of the United States. Native born X Naturalized ______ Corporation or other legal entity (specify what kind): ______

(*b*) Offeror's interests, direct and indirect, do not exceed 200,000 acres in oil and gas options or 246,080 chargeable acres in options, offers to lease and leases in the same State, or 300,000 chargeable acres in leases, offers to lease and options in each leasing district in Alaska. (*c*) Offeror accepts as a part of this lease, to the extent applicable, the stipulations provided for in 43 CFR 3103.2. (*d*) Offeror is 21 years of age or over (or if a corporation or other legal entity, is duly qualified as shown by statements made or referred to herein). (*e*) Offeror has described all surveyed lands by legal subdivisions, all lands covered by protracted surveys by appropriate subdivisions thereof, or all unsurveyed lands not covered by protracted surveys by metes and bounds, and further states that there are no settlers on unsurveyed lands described herein.

6. Offeror ☑ is ☐ is not the sole party in interest in this offer and lease, if issued. (*If not the sole party in interest, statements should be filed as prescribed in Item 6 of the Special Instructions.*)

7. Offeror's signature to this offer shall also constitute offeror's signature to, and acceptance of, this lease and any amendment thereto that may cover any land described in this offer open to lease application at the time the offer was filed but omitted from this lease for any reason, or signature to, or acceptance of, any separate lease for such land. The offeror further agrees that (*a*) this offer cannot be withdrawn, either in whole or in part, unless the withdrawal is received by the land office before this lease, an amendment to this lease, or a separate lease, whichever covers the land described in the withdrawal, has been signed in behalf of the United States, and (*b*) this offer and lease shall apply only to lands not within a known geologic structure of a producing oil or gas field.

8. If this lease form does not contain all of the terms and conditions of the lease form in effect at the date of filing, the offeror further agrees to be bound by the terms and conditions contained in that form.

9. It is hereby certified that the statements made herein are complete and correct to the best of offeror's knowledge and belief and are made in good faith.

Offeror duly executed this instrument this 13th day of April, 19 79

______ (Lessee signature) ______ (Lessee signature)

______ (Attorney-in-fact)

This lease for the lands described in item 3 above is hereby issued, subject to the provisions of the offer and on the reverse side hereof.

THE UNITED STATES OF AMERICA

By ______ (Signing officer)
Chief, Minerals Adjudication Section (Title) APR 10 1981 (Date)

Effective date of lease MAY 1 1981

THIS OFFER MAY BE REJECTED AND RETURNED TO THE OFFEROR AND WILL AFFORD THE OFFEROR NO PRIORITY IF IT IS NOT PROPERLY FILLED IN AND EXECUTED OR IF IT IS NOT ACCOMPANIED BY THE REQUIRED DOCUMENTS OR PAYMENTS.

18 U. S. C. sec. 1001 makes it a crime for any person knowingly and willfully to make to any Department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

SPECIAL STIPULATION M 43267

UNITED STATES DEPARTMENT OF AGRICULTURE
Science and Education Administration

Agricultural Research

Western Region
1333 Broadway, Suite 400
Oakland, California 94612

1. Prior to entry for the exploration or operations on station land, approval must be obtained from the Location Leader through this office.

2. All construction must be approved by this Agency.

3. Existing roadways will be used to the maximum extent. New roadways will be built only upon the approval of this Agency and in accordance with our specifications.

4. During and after exploratory or production operations, the company will be required to maintain and/or restore the work area to a satisfactory natural condition.

5. Station security policy will be adhered to by the company.

6. Station research projects will not be interferred with in any way.

5-19-80
(Date)

[illegible signature]
(Lessee's Signature)

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Land Management

This lease is issued pursuant and subject to the the terms and provisions of Section 302 of the Department of Energy Organization Act (42 U.S.C. 7152) and to the regulations of the Secretary of Energy promulgated thereunder relating to the:

(1) fostering of competition for Federal leases (including but not limited to, prohibition on bidding for development rights by certain types of joint ventures);

(2) implementation of alternative bidding systems authorized for the award of Federal leases;

(3) establishment of diligence requirements for operations conducted on Federal leases (including, but not limited to, procedures relating to the granting or ordering by the Secretary of the Interior of suspension of operations or production as they relate to such requirements);

(4) setting rates of production for Federal leases; and

(5) specifying the procedures, terms, and conditions for the acquisition and disposition of Federal royalty interests taken in kind.

... for mine, extract, remove and dispose of all the ... together with the right to construct and maintain thereupon all works, buildings, plants, waterways, roads, telegraph or telephone lines, pipelines, reservoirs, tanks, pumping stations or other structures necessary to the full enjoyment thereof, for a period of 10 years, and so long thereafter as oil or gas is produced in paying quantities, subject to any unit agreement heretofore or hereafter approved by the Secretary of the Interior, the provisions of said agreement to govern the lands subject thereto where inconsistent with the terms of this lease.

Sec. 2. The lessee agrees:

(a) Bonds. — (1) To file any bond required by this lease and the current regulations and until such bond is filed not to enter on the land under this lease. (2) To maintain any bond furnished by the lessee as a condition for ... (3) To furnish a bond in a sum double the amount of ... annual rental, but not less than $1,000 nor more than $10,000 ... (4) To furnish prior to beginning ... drilling operations and maintain at all times thereafter ... a bond in the penal sum of $10,000 with approved corporate surety, or with deposit of United States bonds as surety therefor, conditioned upon compliance with the terms of this lease ... (5) Until a general lease bond is filed ... not less than $1,000 ... for the protection of the owners of surface rights ... [illegible]

(b) Cooperative or unit plan. — Within 30 days of demand, or, if the leased land is committed to an approved unit or cooperative plan ... [illegible]

(c) Wells. — [illegible]

(d) Rentals and royalties. — [illegible]

[illegible]

and a report with respect to stockholders, investments ... [illegible]

(h) Well records. — To keep a daily drilling record, a log, and complete information on all well surveys and tests in form acceptable to or prescribed by the lessor of all wells drilled on the leased lands, and an acceptable record of all subsurface investigations affecting said lands, and to furnish them, or copies thereof, to the lessor when required. All information obtained under this paragraph, upon the request of lessee, shall not be open to inspection by the public until the expiration of the lease.

(i) Inspection. — To keep open at all reasonable times for the inspection of any duly authorized officer of the Department, the leased premises and all wells, improvements, machinery, and fixtures thereon and all books, accounts, maps and records relative to operations and surveys or investigations on the leased lands or under the lease. All information obtained pursuant to any such inspection, upon the request of the lessee, shall not be open to inspection by the public until the expiration of the lease.

(j) Diligence, prevention of waste, health and safety of workmen. — To exercise reasonable diligence in drilling and producing the wells herein provided for unless consent to suspend operations temporarily is granted by the lessor; to carry on all operations in accordance with approved methods and practice as provided in the Oil and Gas Operating Regulations, having due regard for the prevention of waste of oil or gas or damage to deposits or formations containing oil, gas, or water or to coal measures or other mineral deposits, for conservation of gas energy, for the preservation and conservation of the property for future productive operations, and for the health and safety of workmen and employees; to plug properly and effectively all wells drilled in accordance with the provisions of this lease or of any prior lease or permit upon which the right to this lease was predicated before abandoning the same; to carry out at expense of the lessee all reasonable orders of the lessor relative to the matters in this paragraph, and that on failure of the lessee so to do the lessor shall have the right to enter on the property and to accomplish the purpose of such orders at the lessee's cost: Provided, That the lessee shall not be held responsible for delays or casualties occasioned by causes beyond lessee's control.

(k) Taxes and wages, freedom of purchase. — To pay when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, oil and gas produced from the lands hereunder, or other rights, property, or assets of the lessee; to accord all workmen and employees complete freedom of purchase, and to pay all wages due workmen and employees at least twice each month in the lawful money of the United States.

(l) Equal Opportunity clause. — During the performance of this contract the lessee agrees as follows:

[illegible]

and other excavations, remove or cover all debris, and so far as reasonably possible, restore the surface of the leased land and access roads to their former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to the leased lands and improvements thereon whether or not owned by the United States. When American antiquities or other objects of historic or scientific interest including but not limited to historic or prehistoric ruins, fossils or artifacts are discovered in the performance of this lease, the item(s) or condition(s) will be left intact and immediately brought to the attention of the contracting officer or his authorized representative.

(r) Overriding royalties. — Not to create overriding royalties in excess of five percent except as otherwise authorized by the regulations.

(s) Deliver premises in case of forfeiture. — To deliver up to the lessor in good order and condition the land leased including all improvements which are necessary for the preservation of producing wells.

Sec. 3. The lessor reserves:

(a) Easements and rights-of-way. — The right to permit for joint or several use easements or rights-of-way, including easements in tunnels upon, through, or in the lands leased, occupied, or used as may be necessary or appropriate to the working of the same or of other lands containing the deposits described in the Act, and the treatment and shipment of products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(b) Disposition of surface. — The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the oil and gas therein, or to dispose of any resource in such lands which will not unreasonably interfere with operations under this lease.

(c) Monopoly and fair prices. — Full power and authority to promulgate and enforce all orders necessary to insure the sale of the production of the leased lands to the United States and to the public at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) Helium. — Pursuant to Section 1 of the Act as amended, the ownership of helium and the right to extract or have it extracted from all gas produced under this lease, subject to such rules and regulations as shall be prescribed by the Secretary of the Interior. If the lessor elects to take the helium, the lessee shall deliver all or any portion of gas containing the same to the lessor, ... [illegible]

[illegible]

Sec. 9. Unlawful interest. — It is also further agreed that no Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and that no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Sec. 3741 of the Revised Statutes of the United States, as amended (41 U.S.C. Sec. 22) and Secs. 431, 432 and 433, Title 18 U.S. Code, relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

INSTRUCTIONS

A GENERAL INSTRUCTIONS

1. This offer must be filed in ... typewritten or be hand printed in ink and must be signed in ink.

2. [illegible]

3. Offers to lease may be made by individuals 21 years of age or over who are citizens of the United States and by corporations ... [illegible]

4. [illegible]

5. [illegible]

6. [illegible]

7. [illegible]

... [illegible] The offer will be rejected and returned to the offeror and will afford the offeror no priority if not filed in accordance with the appropriate regulations.

B SPECIAL INSTRUCTIONS[1]

Item 1. — Total area of land requested should be shown in acres in space provided at bottom of Item 2. ... [illegible]

Item 2. — This space is not to be filled in. When lease is issued this space will contain the identification of the leased area and total acres.

Item 4. — The total amount remitted should include a $10 filing fee and the first year's rental of the land requested at the rate of $1.00 an acre or fraction thereof ... [illegible]

Item 5 (a). — Offeror will indicate whether a citizen by birth or naturalization ... [illegible]

If offeror is a corporation it must submit a statement containing the following information: ... [illegible]

Item 5 (b). — Acreage included in unitized leases and leases subject to ... development contracts approved by the Secretary under ... Section 17(b) is not chargeable.

Item 5 (c). — Whenever applicable the stipulations referred to will be a part of this lease and will be furnished the lessee with the lease ... [illegible]

Item 5 (e). — [illegible]

Item 6. — [illegible]

[1] [illegible]

GPO 836-783

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SURFACE DISTURBANCE STIPULATIONS

Area Oil and Gas Supervisor or District Engineer *(Address, include zip code)*

United States Geological Surv
P. O. Box 2550
3 Seventh Street West
Billings, Montana 59103
Phone: 406-657-6185

Management Agency *(name)*	Address *(include zip code)*
District Manager Miles City District Bureau of Land Management	P. O. Box 940 Miles City, Montana 59301 (Office located about two miles west of city on old U.S. Hwy. 10 and 12) Phone: 406-232-4331

1. Notwithstanding any provision of this lease to the contrary, any drilling, construction, or other operation on the leased lands that will disturb the surface thereof or otherwise affect the environment, hereinafter called "surface disturbing operation," conducted by lessee shall be subject, as set forth in this stipulation, to prior approval of such operation by the Area Oil and Gas Supervisor in consultation with appropriate surface management agency and to such reasonable conditions, not inconsistent with the purposes for which this lease is issued, as the Supervisor may require to protect the surface of the leased lands and the environment.

2. Prior to entry upon the land or the disturbance of the surface thereof for drilling or other purposes, lessee shall submit for approval two (2) copies of a map and explanation of the nature of the anticipated activity and surface disturbance to the District Engineer or Area Oil and Gas Supervisor, as appropriate, and will also furnish the appropriate surface management agency named above, with a copy of such map and explanation.

An environmental analysis will be made by the Geological Survey in consultation with the appropriate surface management agency for the purpose of assuring proper protection of the surface, the natural resources, the environment, existing improvements, and for assuring timely reclamation of disturbed lands.

3. Upon completion of said environmental analysis, the District Engineer or Area Oil and Gas Supervisor, as appropriate, shall notify lessee of the conditions, if any, to which the proposed surface disturbing operations will be subject.

Said conditions may relate to any of the following:

(a) Location of drilling or other exploratory or developmental operations or the manner in which they are to be conducted;

(b) Types of vehicles that may be used and areas in which they may be used; and

(c) Manner or location in which improvements such as roads, buildings, pipelines, or other improvements are to be constructed.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SURFACE DISTURBANCE STIPULATIONS

XXXXXXXXXXXXXXXXXXXXXX
District Engineer *(Address, include zip code)*
U.S. Geological Survey
P. O. Box 2550
Billings, MT 59103

Phone: (406) 657-6367

Management Agency *(name)*

Science and Education Administration
Agricultural Research
Western Region

Address *(include zip code)*

1333 Broadway, Suite 400
Oakland, California 94612

1. Notwithstanding any provision of this lease to the contrary, any drilling, construction, or other operation on the leased lands that will disturb the surface thereof or otherwise affect the environment, hereinafter called "surface disturbing operation," conducted by lessee shall be subject, as set forth in this stipulation, to prior approval of such operation by the Area Oil and Gas Supervisor in consultation with appropriate surface management agency and to such reasonable conditions, not inconsistent with the purposes for which this lease is issued, as the Supervisor may require to protect the surface of the leased lands and the environment.

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An environmental analysis will be made by the Geological Survey in consultation with the appropriate surface management agency for the purpose of assuring proper protection of the surface, the natural resources, the environment, existing improvements, and for assuring timely reclamation of disturbed lands.

3. Upon completion of said environmental analysis, the District Engineer or Area Oil and Gas Supervisor, as appropriate, shall notify lessee of the conditions, if any, to which the proposed surface disturbing operations will be subject.

Said conditions may relate to any of the following:

(a) Location of drilling or other exploratory or developmental operations or the manner in which they are to be conducted;

(b) Types of vehicles that may be used and areas in which they may be used; and

(c) Manner or location in which improvements such as roads, buildings, pipelines, or other improvements are to be constructed.

Form 3109-5 (August 1973)

GPO 849-258

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Land Management

______________	M 43267
(OG SIM Serial No.)	(Serial Number)

SPECIAL OIL AND GAS LEASE STIPULATIONS

The following special stipulations may be modified when specifically approved in writing by the District Engineer, Geological Survey with concurrence of the Federal surface management agency.

(Only stipulations checked apply to this lease.) — (Approximate % of lease affected by stipulation.)

(XX) No occupancy or other activity on the surface of the following-described land is allowed under this lease: — 3%

By request of USF&WS
T. 7 N., R. 47 E., P.M.M.
Sec. 4: Lots 23,24
Sec. 5: Lots 9,12,13

Reasons for this restriction are:

(XX) No occupancy or other surface disturbance will be allowed within 300 feet of the Spotted Eagle Recreation Area, T. 7 N., R. 47 E., P.M.M., Sec. 4: Tract S ______. — (3%)

(____) No drilling or storage facilities will be allowed within ____ feet of ______ located in ______. — (____)

(____) No occupancy or other surface disturbance will be allowed on slopes in excess of ______ percent. — (____)

(____) In order to ______ exploration, drilling, and other development activity will be allowed only during the period from ______ to ______. This limitation does not apply to maintenance and operation of poducing wells and facilities. Lands within the leased area to which this stipulation applies are described as follows: — (____)

(____) The ______ will not be used as an access road for activities on this lease except as follows:

______ Date

______ Lessee's Signature

MSO 3100-45 (February 1980)

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Land Management

M 43267
(Serial Number)

(OG SIM Serial No.)

SPECIAL OIL AND GAS LEASE STIPULATIONS

The following special stipulations may be modified when specifically approved in writing by the District Engineer, Geological Survey with concurrence of the Federal surface management agency.

(Only stipulations checked apply to this lease.)

(Approximate % of lease affected by stipulation.)

(XX) No occupancy or other activity on the surface of the following-described land is allowed under this lease: — 88%

By request of USDA, Ft. Keogh.

T. 7 N. R. 47 E., P.M.M.

Sec. 6,7(all lands applied for)

Sec. 5(all lands applied for except that portion managed by USF&WS

Sec. 4: Lots 18,19,20,22,25, Tr. S.V., SW¼SE¼

T. 8 N., R. 47 E., P.M.M.

Sec. 32: All, except Tr. F

Reasons for this restriction are:

(xx) No occupancy or other surface disturbance will be allowed within 1,000 feet of the Tongue River. — (3%)

(XX) No drilling or storage facilities will be allowed within 300 feet of occupied dwellings located in T. 8 N., R. 47 E., P.M.M., Sec. 32,33,34 and T. 7 N., R. 47 E., P.M.M., Sec. 3,10. — (2%)

( ) No occupancy or other surface disturbance will be allowed on slopes in excess of ________ percent. — ( )

( ) In order to ________ exploration, drilling, and other development activity will be allowed only during the period from ________ to ________. This limitation does not apply to maintenance and operation of poducing wells and facilities. Lands within the leased area to which this stipulation applies are described as follows: — ( )

( ) The ________ will not be used as an access road for activities on this lease except as follows:

[illegible]
Date

[illegible signature]
Lessee's Signature

MSO 3100-45 (February 1980)

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Land Management

M 43267
(Serial Number)

OIL AND GAS LEASE STIPULATIONS

CULTURAL AND PALEONTOLOGICAL RESOURCES - The Federal surface management agency is responsible for assuring that the leased lands are examined to determine if cultural resources are present and to specify mitigation measures. Prior to undertaking any surface-disturbing activities on the lands covered by this lease, the lessee or operator, unless notified to the contrary by the authorized officer of the surface management agency, shall:

1. Engage the services of a qualified cultural resource specialist acceptable to the Federal surface management agency to conduct an intensive inventory for evidence of cultural resource values;

2. Submit a report acceptable to the authorized officer of the surface management agency and the District Engineer, Geological Survey, and

3. Implement mitigation measures required by the surface management agency to preserve or avoid destruction of cultural resource values. Mitigation may include relocation of proposed facilities, testing and salvage or other protective measures. All costs of the inventory and mitigation will be borne by the lessee or operator, and all data and materials salvaged will remain under the jurisdiction of the U.S. Government as appropriate.

The lessee or operator shall immediately bring to the attention of the District Engineer, Geological Survey, or the authorized officer of the Federal surface management agency any cultural or paleontological resources or any other objects of scientific interest discovered as a result of surface operations under this lease, and shall leave such discoveries intact until directed to proceed by the District Engineer, Geological Survey.

ENDANGERED OR THREATENED SPECIES - The Federal surface management agency is responsible for assuring that the leased land is examined prior to undertaking any surface-disturbing activities to determine effects upon any plant or animal species, listed or proposed for listing as endangered or threatened, or their habitats. The findings of this examination may result in some restrictions to the operator's plans or even disallow use and occupancy that would be in violation of the Endangered Species Act of 1973 by detrimentally affecting endangered or threatened species or their habitats.

The lessee/operator may, unless notified by the authorized officer of the surface management agency that the examination is not necessary, conduct the examination on the leased lands at his discretion and cost. This examination must be done by or under the supervision of a qualified resources specialist approved by the surface management agency. An acceptable report must be provided to the surface management agency identifying the anticipated effects of a proposed action on endangered or threatened species or their habitats.

ESTHETICS - To maintain esthetic values, all surface-disturbing activities, semipermanent and permanent facilities may require special design including location, painting and camouflage to blend with the natural surroundings and meet the intent of the visual quality objectives of the Federal surface management agency.

EROSION CONTROL - Surface disturbing activities may be prohibited during muddy and/or wet soil periods. This limitation does not apply to operation and maintenance of producing wells using authorized roads.

Date

[signature]
Lessee's Signature

MSO 3100-47(a) (February 1980)

Form 3106-5
(November 1981)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FORM APPROVED
OMB NO. 1004-0034
Expires: February 28, 1982

Lease Serial No.
M-43267

Lease effective date
May 1, 1981

FOR BLM OFFICE USE ONLY
New Serial No.

ASSIGNMENT AFFECTING RECORD TITLE TO OIL AND GAS LEASE

PART I

1. Assignee's Name — Samuel Gary - 50%
Four Inverness Court East
Englewood, Colorado 80112

Address (include zip code) — Natomas North America, Inc. - 50%
1155 Dairy Ashford, Suite 100
Houston, Texas 77079

The undersigned, as owner of 100 percent of the record title of the above-designated oil and gas lease, hereby transfers and assigns to the assignee shown above, the record title interest in and to such lease as specified below.

2. Describe the lands affected by this assignment | Assignment approved as to lands described [redacted]

Land included in Lease M-43267:

OK

Township 7 North, Range 47 East, P.M.M.
Section 3 & 10: Tract U
Section 4: Lots 18,19,20,21,22,23,24,25, Tracts S,V, SW¼SE¼
Section 5: Lots 6,10,11,17,21,22, Tract Q, SW¼NE¼, S½NW¼, SW¼
Section 6: Lots 1,2,3,6,7,8, S½NE¼, SE¼SW¼ SE¼
Section 7: Lot 1, NE¼, NE¼NW¼, S½NW¼, S½

Township 8 North, Range 47 East, P.M.M.
Section 32: Lots 9,17,21,22,23,28,31,32, Tracts F,G,L,T
Section 32: That portion of Tract R lying in Sec. 32 containing 0.95 Acres
Section 33: Lots 12,13,14,15,16,17, TractsA,B,C
Section 33: Lot 20 (3.38 A.) accepted under approved survey dated April 24,1947
Section 33: Lot 20 (1.48 A) accepted under approved survey dated April 24,1947
Section 34: Lot 4

3

Custer County Montana, containing ~~2,365.41~~ 2,365.407 acres, more or less.

3. Specify interest or percent of assignor's record title interest being conveyed to assignee	100%
4. Specify interest or percent of record title interest being retained by assignor, if any	None
5. Specify overriding royalty being reserved by assignor	1%
6. Specify overriding royalty previously reserved or conveyed, if any	1%

7. If any payments out of production have previously been created out of this lease, or if any such payments are being reserved under this assignment, attach statement giving full details as to amount, method of payment, and other pertinent terms as provided under 43 CFR 3106.

It is agreed that the obligation to pay any overriding royalties or payments out of production of oil created herein, which, when added to overriding royalties or payments out of production previously created and to the royalty payable to the United States, aggregate in excess of 17½ percent, shall be suspended when the average production of oil per well per day averaged on the monthly basis is 15 barrels or less.

I CERTIFY That the statements made herein are true, complete, and correct to the best of my knowledge and belief and are made in good faith.

Executed this 2nd day of April, 19 82.

Connie Mull
(Assignor's Signature)
Connie Mull

P. O. Box 963
(Assignor's Address)

Denver, Colorado 80201
(City) (State) (Zip Code)

Title 18 U.S.C., Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious, or fraudulent statements or representations as to any matter within its jurisdiction.

THE UNITED STATES OF AMERICA

Assignment approved effective MAY 1 1982

By [illegible]
(Authorized Officer)

62002

CHIEF, MINERALS ADJUDICATION SECTION
(Title)

NOV 17 1982
(Date)

ORIGINAL CASE FILE COPY

PART II

ASSIGNEE'S REQUEST FOR APPROVAL OF ASSIGNMENT

A. ASSIGNEE CERTIFIES THAT

1. Assignee is over the age of majority
2. Assignee is a citizen of the United States
3. Assignee is ☐ Individual ☐ Municipality ☐ Association ☒ Corporation. If other than an individual, assignee's statement of its qualifications are attached. If previously furnished, identify the serial number of the record in which filed M065500 (943.9).
4. Assignee's interests, direct and indirect, do not exceed 200,000 acres in oil and gas options or 246,000 chargeable acres in options and leases in the same State, or 300,000 chargeable acres in leases and options in each leasing District in Alaska.
5. Assignee ☐ is ☒ is not the sole party in interest in this assignment. Information as to interests of other parties in this assignment must be furnished as provided in the regulations (43 CFR 3106).
6. A filing fee of $25.00 is attached.

B. ASSIGNEE AGREES That, upon approval of this assignment by the authorized officer of the Bureau of Land Management, he will be bound by the terms and conditions of the lease described herein as to the lands covered by this assignment, including, but not limited to, the obligation to pay all rentals and royalties due and accruing under said lease, to condition all wells for proper abandonment, to restore the leased lands upon completion of any drilling operations as prescribed in the lease, and to furnish and maintain such bond as may be required by the lessor to assure compliance with the terms and conditions of the lease and the applicable regulations.

C. IT IS HEREBY CERTIFIED That the statements made herein are true, complete, and correct to the best of undersigned's knowledge and belief and are made in good faith.

Executed this 16th day of April, 1982.

NATOMAS NORTH AMERICA, INC.

(Assignee's Signature)
Samuel A. Blaize
Vice President - Land

1155 Dairy Ashford, Suite 100
(Assignee's Address)

Houston, Texas 77079
(City) (State) (Zip Code)

Title 18 U.S.C., Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious, or fraudulent statements or representations as to any matter within its jurisdiction.

INSTRUCTIONS

1. *Use of Form* — Use only for assignment of record title interest in oil and gas leases. If more than one assignment is made out of a lease, a separate instrument of transfer is required for each assignment.

2. *Filing and Number of Copies* — File three (3) completed and manually signed copies in the appropriate BLM office. A $25.00 nonrefundable filing fee *must* accompany the assignment. File assignment within ninety (90) days *after* date of final execution.

3. *Effective Date of Assignment* — Assignment, if approved, takes effect on the first day of the month following the date of filing of *all* required papers. Assignee's qualifications *must* be in full compliance with the regulations (43 CFR 3102). If bond is necessary, it *must* be furnished prior to approval of the assignment.

4. *Statement of Interest of Other Parties* — If assignee *is not* the sole party in interest in the assignment, assignee *must* submit, at the time assignment is filed, a signed statement giving the names of any other parties who will have an interest in the lease. Within fifteen (15) days after the filing of the assignment, the assignee and all such other interested parties *must* submit, together with evidence of their qualifications to hold the lease interest, separate, signed statements giving the nature and extent of the interest of each, the nature of agreement between them, if oral; and a copy of the agreement, if written.

5. *Effect of Assignment* — Approval of assignment of a definitely described portion of the leased lands creates separate leases of the retained and the assigned portions. It does *not* change the terms and conditions of the lease or the lease anniversary date for purposes of payment of annual rental.

6. A copy of the lease out of which this assignment is made should be obtained from the assignor.

NOTICE

The Privacy Act of 1974 and the regulation in 43 CFR 2.48(d) provide that you be furnished the following information in connection with information required by this assignment and request for approval.

AUTHORITY: 30 U.S.C. 181 et. seq.

PRINCIPAL PURPOSE — The information is to be used to process the assignment and request for approval.

ROUTINE USES:
(1) The adjudication of the assignee's rights to the land or resources.
(2) Documentation for public information in support of notations made on land status records for the management, disposal, and use of public lands and resources.
(3) Transfer to appropriate Federal agencies when concurrence is required prior to granting a right in public lands or resources.
(4)(5) Information from the record and/or the record will be transferred to appropriate Federal, State, local or foreign agencies, when relevant to civil, criminal or regulatory investigations or prosecutions.

EFFECT OF NOT PROVIDING INFORMATION — If all the information is not provided, the assignment may be rejected.

Bureau of Land Management collects this information pursuant to the law (See 43 CFR 3106-3(c)).

Bureau of Land Management uses the information to create a record of lease assignment and to determine the qualifications of assignees.

A Federal lessee is obligated to report this information under provisions of 43 CFR 3106.

this time. Specifically, is the land area shown as Area A available for long-term use as a fish hatchery and is no or low cost electricity available similar to the arrangement at Garrison Dam and Garrison National Fish Hatchery.

2) Construction plans for the new Ft. Peck water treatment plant supply line. (Relocation of the line may be required if the hatchery is located in Area A.)

3) Any additional information you may have in your historical records regarding the past planning efforts for a fish hatchery below the dam. We understand that Ft. Peck was considered as a National Hatchery site prior to the selection and construction of Miles City in the late 1950's. We are also contacting the USFWS in this regard.

4) Regarding a future hatchery water supply, we understand that the City of Glasgow is planning a Water Supply Project that will include a 20"± diameter tap in Power House #1 tunnel. Can you provide any insight or direction regarding a future hatchery water supply either in conjunction with the Glasgow Project or as a separate tap/source. It is estimated that the peak hatchery water demand will be 2,500± gallons per minute.

5) Please provide any information you have available regarding general soil type, classification, compaction, and water holding capability for the area downstream of the Dam.

6) What downstream River fluctuation data is available. Specifically, what is the record high water elevation downstream of the Dam.

7) What is the status and impact to a hatchery site of the Ft. Peck re-regulation dam that we understand is under consideration or study. Will the proposed regulation project impact the use of Area A as a fish hatchery site?

8) Based on this very preliminary information regarding location, what type of Section 10 & 404 Permits may be required.

9) What are the preliminary positive and negative impacts on the community of Ft. Peck. Are there any problems or special requirements with regard to municipal tie-ins for domestic water and sewers? Are there any other special planning and/or design considrations based on the Corps of Engineers perspective?

We appreciate the positive assistance we have received to date by your staff at Ft. Peck thus far in the Study. We look forward to working with the Omaha District during the evaluation of the Ft. Peck site(s). Your prompt attention to these general questions is greatly appreciated by the Montana Department of Fish, Wildlife, and Parks. If you have any questions regarding this request, please contact Mr. Thomas L. Johnson or me at 217-753-0075.

Very truly yours,

Gary Wilken

Gary A. Wilken, P.E.

GAW:cw

cc: Emmett Colley, Dept. of FWP
Bud Butterfield, Dept. of FWP, Miles City Hatchery
Johnny Kuncheff, COE, Ft. Peck

ASSOCIATED ENGINEERS III, INC.

1201 SOUTH SIXTH STREET
SPRINGFIELD, ILLINOIS 62703
217-753-0075

PEORIA, IL
SPRINGFIELD, IL
PEKIN, IL
OLYMPIA, WA

May 4, 1984

Mr. W.E. Woodford
Chief, Operations Division
Corps of Engineers - Omaha District
6014 U.S. Post Office & Courthouse
Omaha, Nebraska 68102

SUBJ: State of Montana
Warmwater/Coolwater Fish Hatchery
Study

Dear Mr. Woodford:

We have been selected by the Montana Department of Fish, Wildlife & Parks to complete an evaluation of potential sites for a new or expanded warmwater/coolwater fish hatchery. The two sites being considered are the former Miles City National Fish Hatchery now being operated by the State of Montana and several areas immediately downstream of the Ft. Peck Dam. In February, we met with Corps of Engineers personnel at the site, Mr. Johnny Kuncheff, Montana Area Engineer, and Mr. Robert McInerney, Recreation Resources Management.

We have enclosed a topographic map indicating several possible hatchery locations at Ft. Peck. Our preliminary calculations indicate that approximately 60± acres of production ponds and a total area of 100± acres is necessary to meet production goals. As can be seen, there is apparently only one location at lower elevations downstream with that much total area available. This is the same area identified by the COE/USFWS in the 1946 Ft. Peck Master Plan for a potential hatchery site including 72 acres of ponds and 137 total acres.

In order to continue our evaluation, we are seeking input from your Agency on behalf of the State of Montana, Department of Fish, Wildlife and Parks. Specifically, we are seeking the following information:

1) The keys to Ft. Peck being considered for a hatchery site is the availability of land owned by the Corps of Engineers and a low cost electrical supply for the necessary water heating for production use. We understand the State and the Corps have addressed these points in general in the past, but an updated status is requested at

APPENDIX E

Correspondence

Date	From	To	Topic
May 4, 1984	Consultant	Corps of Engineers, Omaha	Ft. Peck Site
August 7, 1984	Corps of Engineers, Omaha	Consultant	Response to May 4 letter
May 4, 1984	Consultant	U.S.Fish & Wildlife Service, Denver	Miles City N.F.H.
May 24, 1984	USFWS, Denver	Consultant	Response to May 4
May 4, 1984	Consultant	City of Glasgow	Ft. Peck Site
May 25, 1984	City of Glasgow	Consultant	Response to May 4 letter
August 13, 1984	City of Glasgow	Corps of Engineers, Omaha	Update
May 4, 1984	Consultant	City of Miles City	Water Quality Data
March 22, 1984	Consultant	Corps of Engineers, Ft. Peck	Ft. Peck
March 30, 1984	Valley County Development Council	Consultant	Ft. Peck

APPENDIX E CORRESPONDENCE

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PLANTING PROGRAM FOR THE Miles City FISHERIES STATION Year 1984

Date Prepared 3-20-84

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
Custer Co. - continued							
Rest Res.	7	T08N,R53E,S27	21-7845-08	SMB	1-2	500	Contact Mark Gorges 232-4331
" "	7	" " "	" " "	Crappie	1-2	1,000	" " " "
Dean S. Res.	7	T07N,R48E,S12	21-2678-08	SMB	1-2	500	" " " "
" " "	7	" " "	" " "	Crappie	1-2	1,000	" " " "
Ft.Keogh Bass Pond	7	T8N,R46E,S34	assign	Crappie	1-2	1,000	Contact Jim Logan 232-3856
Krutzfeldt, Butch Res.	7	T7N,R47E,S01	assign	LMB	1-2	2,500	Contact Phil Stewart 232-4365
" " "	7	" " "	assign	Crappie	1-2	5,000	" " " "
Dawson Co. - 16							
Oil Pump Res.	7	T13N,R56E,S30	21-6238-07	C.Cat	1-2	1,000	Contact Mark Gorges 232-4331
Wilgosh Res.	7	T18N,R51E,S10	assign	LMB	1-2	2,000	New reservoir Contact Terry Hill 365-6452
" "	7	" " "	"	Crappie	1-2	2,000	" " " "
Rattlesnake Res.	7	T13N,R56E,S09	21-7505	LMB	1-2	2,000	Contact Mark Gorges 232-4331
" "	7	" " "	" "	SMB	1-2	2,000	" " " "
Fallon Co. - 39							
Maier, Ray	7	T8N,R58E,S24	assign	LMB	1-2	1,500	New BLM pond Contact Mark Gorges 232-4331
" "	7	" " "	"	Crappie	1-2	1,500	" " " "
Baker Lake	7	T07N,R59E,S13	21-1778-20	LMB	1-2	25,000	Contact John Ramsey 778-3568
South Sandstone Res.	7	T07N,R58E,S27	21-8775-08	LMB	1-2	20,000	" " " "
" " "	7	T07N,R58E,S27	21-8775-08	SMB	1-2	10,000	" " " "
" " "	7	T07N,R58E,S27	21-8775-08	Crappie	1-2	10,000	" " " "
" " "	7	" " "	" " "	NP	Fry	300,000	" " " "

PLANTING PROGRAM FOR THE Miles City FISHERIES STATION Year 1984

Date Prepared 3-20-84

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
Big Horn Co. - 22							
Stonehouse (Taylor) pond	7	T6S,R38E,S35	assign	LMB	1-2	2,000	New pond Contact Randy Wuertz 757-221
" " "	7	" " "	"	NP	Fry	200,000	" " " "
Tongue River Reservoir-Marsh) (Pike	7	T09S,R40E,S15	21-9001-08	NP	Fry	1,000,000	Contact Phil Stewart 232-43
" " "	7	T08S,R40E,S00	21-9001-06	NP	1-2	20,000	" " " "
" " "	7	" " "	" " "	WE	Fry	2,000,000	" " " "
Carter Co. - 42							
Ralph Dam	7	T2S,R62E,S03	12-3750-08	LMB	1-2	2,000	New pond Contact John Ramsey 778-356
" "	7	" " "	" " "	NP	Fry	200,000	" " " "
" "	7	" " "	" " "	Crappie	Fry	3,000	" " " "
Bucholtz Res.	7	T03S,R62E,S10	12-0726-08	Crappie	1-2	1,000	" " " "
Horton Bass Pond	7	T05S,R60E,S04	12-1700-08	LMB	1-2	500	" " " "
Kerr Pond #2	7	T04S,R60E,S15	12-2131-08	LMB	1-2	750	" " " "
West Plum Res.	7	T02S,R62E,S29	12-5150-08	LMB	1-2	750	" " " "
Cheisman Res.	7	T03S,R6TE, ST2	12-0875-08	LMB	1-2	750	" " " "
Custer Co. - 14							
Custer R & G Pond	7	T09N,R47E,S31	21-2668-08	Crappie	1-2	1,000	New pond Contact Phil Stewart 232-43
Brown Res.	7	T07N,R52E,S13	assign	LMB	1-2	500	Contact Jim Logan 232-3856
Marshall Res.	7	T10N,R54E,S8	assign	LMB	1-2	1,000	New BLM pond Contact Mark Gorges 232-433
" "	7	" " "	"	SMB	1-2	1,000	" " " "
" "	7	" " "	"	Crappie	1-2	2,000	" " " "

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PLANTING PROGRAM FOR THE Lewistown and Miles City FISHERIES STATION Year 1984

Date Prepared

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
Rosebud County - 29							
Grebe, Ed Res.	7	T11N,R33E,S33	21-3336-07	Rb	2-4	2,000	Contact K.Schaal 356-7806
Ringstveidt, Pete #1	7	T12N,R40E,S05	21-7870-20	Rb	2-4	1,500	Contact K.Schaal 356-7806
Zemple Res.	7	T09N,R37E,S08	21-9800-03	Rb	2-4	4,000	Contact K.Schaal 356-7806
Kukuchka #3 (Petticord)	7	T10N,R32E,S04	21-4783-07	Rb	2-4	1,200	Contact K.Schaal 356-7806
Philbrick, Newell Res.	7	T03N,R43E,S13	21-7152-07	Rb	2-4	1,000	Contact K. Schaal 356-7806
Hook Ranch #3	7	T10N,R43E, S12	assign	Rb	2-4	1,000	New pond contact P. Stewart or Ken Walcheck 232-4365
Kearns Res. #1	7	T10N,R37E, S11	21-4610-S20	Rb	2-4	1,000	Contact K. Schaal 356-7806
Hook Ranch #1	7	T10N,R44E,S29	21-3845-07	Rb	2-4	500	Contact P. Stewart or Ken Walcheck 232-4365
Schiffer, Art #2	7	T12N,R37E,S23	21-8325-07	Rb	2-4	1,000	Contact K. Schaal 356-7806
Wibaux County - 52	7						
Meeke, A. H. Res.	7	T16N,R59E,S30	21-5425-07	Rb	2-4	1,000	Terry Hill - 365-6452
Miske, Felix Pond	7	T12N,R59E,S31	21-5435-30	Rb	2-4	1,000	Terry Hill - 365-6452
Wibaux Pond	7	T14N,R59E, S12	12-5252-03	Rb	2-4	1,000	Contact Terry Hill 365-6452

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PLANTING PROGRAM FOR THE Lewistone and Miles City FISHERIES STATION Year 1984

Date Prepared

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
Garfield County -50							
Engdahl #3	7	T21N,R36E, S34	?	Rb	2-4	1,000	557-2442 Contact Bernie Hildebrand
McKeever Trout Res.	7	T21N,R35E, S20	16-6945-07	Rb	2-4	500	557-2442 Contact Bernie Hildebrand
Pierson Res.	7	T21N,R32E, S5	?	Rb	2-4	500	557-2442 Contact Bernie Hildebrand
Breezy Basin Res.	7	T20N,R42E,S18	?	Rb	2-4	1,000	557-2442 Contact Bernie Hildebrand
Olson, Norman #1	7	T20N,R38E,S21	16-7357-07	Rb	2-4	1,000	Contact Bernie Hildebrand
Clear, Res.	7	T17N,R39E,S24	?	Rb	2-4	1,500	Contact Bernie Hildebrand
Powder River County - 09							Contact Bernie Hildebrand
Sanburn Res.	7	T08S,R53E,S12	21-8012-07	Rb	2-4	4,000	436-2251 Contact M. Anderson
Carter, Harvey	7	T01S,R53E,S06	21-2412-07	Rb	2-4	1,000	436-2251 Contact M. Anderson
Wiltse Res.	7	T01S,R47E,S27	21-9652-07	Rb	2-4	1,000	Contact M. Anderson 436-2251
~~Prairie County~~ 45							
Clarks Reservoir	7	T13N,R48E,S18	21-2450-03	Rb	2-4	8,000	Contact M. Gorges 232-4331
Ayers #3, Res.	7	T10N,R55E,S10	21-1771-07	Rb	2-4	2,000	Contact T. Hill 365-6452
Reukauf (Harms) Res.	7	T13N,R48E,S31	21-7846-07	Rb	2-4	2,000	Contact T. Hill 365-6452
Silvertip Res.	7	T13N,R43E,S24	21-8650-98	Rb	2-4	2,000	Contact Mark Gorges 232-4331
Lee, Don Res.	7	T10N,R52E, S31	assign	Rb	2-4	800	Contact T. Hill 365-6452
Richland County - 27							
LaBonte Res.	7	T25N,R59E, S20	21-4790-7	Rb	2-4	1,000	Contact R.Schoening 482-5392
Buxbaum Res.	7	T21N,R59E, S25	21-6300-07	Rb	2-4	5,000	Contact R.Schoening 482-5392
Buxbaum West Res.	7	T20N,R59E, S17	21-2355-07	Rb	2-4	1,000	Contact R.Schoening 482-5392
Johnson Res.	7	T24N,R56E, S16	21-4155-08	Rb	2-4	1,000	Contact R.Schoening 482-5392

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PLANTING PROGRAM FOR THE Lewistown & Miles City FISHERIES STATION Year 1984

Date Prepared

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
Dawson County - 16 continued							
Jileck Res.	7	T15N, R58E,S10	assign.	Rb	2-4	1,000	New Pond Contact T. Hill - 365-6452
Kartevold Pond	7	T15N, R58E,S20	assign	Rb	2-4	500	New Pond Contact T. Hill - 365-6452
Fallon County - 39							
Pruett, Clyde	7	T10N,R58E,S27	21-7305-07	Rb	2-4	600	Contact J. Ramsey 778=3568
Schweigert, Wilbert Res.	7	T 9N,R60E,S30	12-4000-08	Rb	2-4	1,000	Contact J. Ramsey 778-3568
Pinnow Res.	7	T06N,R60E,S16	21-7273-03	Rb	2-4	2,500	Contact J. Ramsey 778-3563
Rush Hall	7	T10N,R59E,S27	21-7975-07	Rb	2-4	2,000	Contact J. Ramsey 778-3568
McKay Ranch Trout Pond	7	T 5N,R55E,S08	assign	Rb	2-4	800	Contact J. Ramsey 778=3568
Garfield County - 50							
Clark, E. Reservoir	7	T20N,R34E,S20	16-4701-07	Rb	2-4	800	557-2442 Contact B. Hildebrand
Engdahl, Pearl	7	T20N,R37E,S06	16-5069-07	Rb	2-4	800	557-2442 Contact B. Hildebrand
Engdahl, Lester	7	T20N,R37E,S17	16-5065-20	Rb	2-4	2,500	Contact B. Hildebrand
Guesanburu #2	7	T16N,R36E,S36	16-5375-07	Rb	2-4	1,000	Contact B. Hildebrand
Hauso, Sidney	7	T21N,R35E,S18	18-7790-20	Rb	2-4	1,500	Contact B. Hildebrand
Phipps, C. Res.	7	T21N,R33E,S29	16-7655-07	Rb	2-4	1,000	Contact B. Hildebrand
Phipps, Bobby	7	T18N,R35E,S13	16-7657-07	Rb	2-4	5,000	Contact B. Hildebrand
O'Connor, L.P. #1	7	T16N,R31,S25	16-7345-07	Rb	2-4	1,500	Contact B. Hildebrand
Severson, Geo.	7	T15N,R35E,S31	16-8247-07	Rb	2-4	1,000	Contact B. Hildebrand
Newman #1	7	T14N,R34E,S21	assign	Rb	2-4	500	New pond 232-4365 Contact P. Stewart
BLM Section 13 Res.	7	T18N,R31E, S13	?	Rb	2-4	1,000	557=2442 Contact B. Hildebrand
Engdahl, C. C.	7	T20N,R36E, S 1	16-5063-07	Rb	2-4	600	Contact B. Hildebrand BLM

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PLANTING PROGRAM FOR THE Lewistown and Miles City FISHERIES STATION Year 1984

Date Prepared

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
Carter County - 42							
Gardiner Res.	7	T06S,R56E, S34	12-1310-07	Rb	2-4	6,000	Contact Mark Anderson 436-:
Craft, Gerald #1	7	T08S,R56E, S09	12-1050-07	Rb	2-4	2,000	Contact Mark Anderson 436-2
Griffin, Carson	7	T02S,R56E, S27	21-3339-07	Rb	2-4	1,000	Contact John Ramsey 778-356
Walker Bros.	7	T5S, R59E, S29	12-4710-30	Rb	2-4	1,000	Contact M. Anderson 436-225
Sidney Res.	7	T05S,R59E, S29	12-4050-03	Rb	2-4	1,000	Contact M. Gorges 232-4331
Berry (new) Res. #1	7	T3S,R60E, S34	12-0725-07	Rb	2-4	500	Contact J. Ramsey 778-3568
Buck, Gary Res. #1	7	T4S,R61E, S19	12-0781-07	Rb	2-4	500	Contact M. Anderson 436-225
Buck, Gary Res. #2	7	T4S,R61E, S19	12-0782-07	Rb	2-4	500	Contact M. Anderson 436-225
King, Argaylon Res.	7	T6S,R58E, S02	12-2190-07	Rb	2-4	1,500	Contact M. Anderson 436-225
Custer County - 14							
Haughian Res. #1	7	T12N,R47E,S06	21-3570-07	Rb	2-4	2,000	Contact J. Logan 232-3856
Rogers, Houston	7	T05N,R49E,S24	21-7380-07	Rb	2-4	2,000	Contact J. Logan 232-3856
Beardsley, Pat	7	T09N,R52E,S14	21-1820-20	Rb	2-4	2,000	Contact M. Gorges 232-4331
Flemming Res-	7	T07N,R53E, S21	21-3160-03	Rb	2-4	2,500	Contact J. Logan 232-3856
Holmes, Homer Res.	7	T05N,R51E, S20	21-3334-07	Rb	2-4	1,000	Contact J. Logan 232-3856
Dawson - 16							
Camp Res.	7	T13N,R56E, S09	21-2360-30	Rb	2-4	1,000	Contact Terry Hill -365-645
Shaw, James Res.	7	T14N,R58E, S21	21-8548-07	Rb	2-4	1,000	Contact Terry Hill -365-645
Oil Pump Res.	7	T13N,R56E, S30	21-6238-07	Rb	2-4	3,000	Contact Terry Hill -365-645
Cedar Dam	7	T12N,R56E, S12	21-2420-07	Rb	2-4	500	Contact Terry Hill -365-645

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PLANTING PROGRAM FOR THE MILES CITY FISHERIES STATION Year 1984

Date Prepared 9/28/

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
VALLEY CO - 11							
Fort Peck Reservoir	6	26N,41E,00	16-5140	WE	1	15 Million	Contact Wiedenheft
Fort Peck Reservoir	6	26N,41E,00	16-5140	WE	2	200,000	Contact Wiedenheft
Fort Peck Reservoir	6	26N,41E,00	16-5140	SMB	2	65,000	Contact Wiedenheft
Fort Peck Reservoir	6	26N,41E,00	16-5140	Cisco	1	10 Million	
PHILLIPS CO - 11							
Ester Reservoir	6	27N,27E,16	15-5120	WE	2	10,000	Turn north of mile mark 133

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PLANTING PROGRAM FOR THE MILES CITY FISHERIES STATION Year 198

Date Prepared 9/28/

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
HILL CO - 12							
Beaver Creek Reservoir	6	31N,15E,25	15-4570	SMB	2	10,000	
Milk River, Sec. 4 (below Fresno Res.)	6	33N,14E,00	15-2800	SMB	2	10,000	
BLAINE CO - 24							
Lyons Reservoir	6	30N,19E,32	15-6095	LMB	2	4,000	Contact Kent Gilge
Lyons Reservoir	6	30N,19E,32	15-6095	Crappie	1	4,000	Contact Kent Gilge
Ridge Reservoir	6	26N,19E,01	16-7930	LMB	2	1,500	Contact Kent Gilge
Ridge Reservoir	6	26N,19E,01	16-7930	Crappie	1	2,000	Contact Kent Gilge
Diane Reservoir	6	24N,18E,16	16-4889	LMB	2	2,500	Contact Kent Gilge
Diane Reservoir	6	24N,18E,16	16-4889	Crappie	1	3,000	Contact Kent Gilge
PHILLIPS CO - 11							
Paleface Reservoir	6	23N,26E,20	16-7399	LMB	2	2,500	
Paleface Reservoir	6	23N,26E,20	16-7399	Crappie	1	3,000	
Bellridge Reservoir	6	23N,25E,29	16-8616	LMB	2	2,500	
Bellridge Reservoir	6	23N,24E,29	16-8616	Crappie	1	3,000	
Dogtown Reservoir	6	23N,25E,24	16-4910	LMB	2	1,000	
Undesignated	6			LMB	2	10,000	Locations will be submi by April 15

AnW AE PLANTING PROGRAM FOR THE MILES CITY FISHERIES STATION Year 1984

Date Prepared 9/28/83

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
YELLOWSTONE CO - 03							
Broadview Reservoir	5	04N,23E,09	18-7343	LMB	1	5,000	
Conter's Bass Pond	5	03N,31E,01	22-8925	LMB	1	3,000	
Anita Reservoir	5	02N,30E,09	22-7154	LMB	1	5,000	
Lake Elmo	5	01N,26E,10	22-7777	Ch. Cat	2	5,000	If available
Lake Josephine	5	01S,26E,16	22-8334	NP	2	500	
Laurel Pond	5	02S,24E,00	22-8362	SMB	1	5,000	
Broadview Reservoir	5	04N,23E,09	18-7343	Crappie	6	500	Transfer adults from Tongue River Reservoir
Lake Josephine	5	01S,26E,16	22-8334	Crappie	6	500	Transfer adults from Tongue River Reservoir
WHEATLAND CO - 44							
Lebo Lake	5	06N,13E,00	18-8230	Crappie	6	1,000	Transfer adults from Tongue River Reservoir
Lebo Lake	5	06N,13E,00	18-8230	LMB	1	50,000	
Chief Joseph Pond	5	08N,15E,00	18-7410	LMB	1	5,000	
Musselshell County				LMB	1	22,000	Planting information will be furnished by Fredenberg if fish are available
BIG HORN CO - 22							
Arapooish Pond	5	01S,34E,07	22-7164	SMB	1	5,000	
CARBON CO - 10							
Cooney Reservoir	5	04S,20E,35	22-7518	WE	1	1 million	Contact Fredenberg

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PLANTING PROGRAM FOR THE MILES CITY FISHERIES STATION Year 1984

Date Prepared 9/27/83

Name of Water	Region	Planting Location	Code No.	Species	Size	Number	Planting Instructions
TETON CO - 31							
Priest Butte Lake	4	23N,04W,09	14-8540	LMB	2	10,000	Contact Al Wipperman 454-3441
Priest Butte Lake	4	23N,04W,09	14-8540	Crappie	1-2	50,000	Contact Al Wipperman
TOOLE CO - 21							
Tiber Reservoir	4	30N,05E,28	14-9240	Crappie	1	200,000	
PETROLEUM CO - 55							
War Horse	4	16N,25E,00	18-9440	NP	1	40,000	Contact Mike Poore
Petrolia Reservoir	4	14N,27E,25	18-8720	NP	1	40,000	Contact Mike Poore
Tiber Reservoir	4	30N,05E,28	14-9240	WE	1	1 million	
Undesignated ponds	4			LMB	2	50,000	Contact Mike Poore Ponds will be designated by April 15

Montana Department of Fish, Wildlife & Parks

1420 East 6th Avenue
Helena, Montana 59620
March 28, 1984

RECEIVED
APR 2 1984
ASSOCIATED ENGINEERS III, INC.
SPRINGFIELD

Mr. Tom Johnson
Associated Engineers III, Inc.
1201 South Sixth Street
Springfield, Illinois 62703

Dear Tom:

Some time ago you requested that I submit to you our annual planting program for the number and size of fish we are requesting from the Miles City Hatchery. The rainbow are reared to about four inches in length and transferred to Miles City for distribution to the small reservoirs in the Miles City area. This does involve some type of inside holding ponds for a short period of time; maybe two weeks to a month, depending on how fast they can release them.

The remainder of the planting program is self explanatory, on the number and sizes of the warm-cool water fish. The distribution of these species in Region 4 involves travel to reservoirs near Choteau and Chester north and west of Great Falls and also areas around Lewistown.

Regions 6 and 7 are the Glasgow-Miles City area.

We also have one plant of 100,000 smallmouth bass in Noxon Rapids Reservoir on the Clark Fork of the Columbia River in extreme western Montana. Many of these trips involves 400 to 700 miles travel one way to arrive at the release site.

I have tried to explain some of the more important details and the distances to be travelled. If you need more information on the number of fish to be reared and areas to be traveled let me know.

Sincerely,

Emmett L. Colley

Emmett L. Colley
Hatchery Bureau Chief

ELC/bjm
Encl.

APPENDIX D 1983 MDFWP FISH PLANTING PROGRAM

one time. The capacity of the two holding reservoirs is 60 acre feet for the lower reservoir and 15 acre feet (approximately) for the upper reservoir. So even if the ponds had to be filled several times, the 3,650 acre feet would be more than adequate. In fact, Dick thought they could get by with about one third of that amount.

AE/bjm

STATE OF MONTANA

DEPARTMENT OF FISH, WILDLIFE AND PARKS

1982

Office Memorandum

TO : Ron Marcoux Attn: Art Whitney

DATE: 9/13/82

FROM : Keith Seaburg By: Al Elser

SUBJECT: National Fish Hatchery

I checked on the water rights for the Miles City Hatchery as discussed in Galen Buterbaugh's letter to Jim Flynn dated August 30.

The two wells for the main water supply were not refiled on according to SB 76 requirements. At least the Water Rights Division of DNR could not find them in the records. Perhaps they were never filed on. At any rate, this is not a critical problem since they could be filed on at this time by the Fish and Wildlife Service or by us if we took control of the hatchery.

The vested right on the Yellowstone with the priority date of July 1, 1927 for the original hatchery also was not refiled for. Apparently the Fish and Wildlife Service decided this right was no longer necessary.

Provisional permit 15530-S42KJ for the Yellowstone for 3,650 acre feet annually is a valid right. The priority date for this right is September 29, 1977. A copy of the permit is attached. Since this is a post 1973 right, refiling was not necessary. This right is transferable in the event we take the hatchery over. All we would need to do is file a form 608 with the DNR.

The extension of time granted until October 1, 1983 means that development of this right should begin by that date. If this hasn't happened, another extension can be asked for and probably received. After that, the right should be developed or good cause shown why it hasn't been developed. If the right is not developed, then it is lost.

I discussed the amount of water necessary to run the hatchery as related to the amount of the Yellowstone water right with Dick Thompson (Hatchery Manager) on September 7. His exact words were "3,650 acre feet of water a year would be water up the gazook". Currently the hatchery uses 650 acre feet purchased from the Tongue River Water Users. Dick thinks this is about how much is necessary and used annually. It takes 108 acre feet to fill the 14 ponds

Form No. [illegible]

Permit No. [illegible]

STATE OF MONTANA
DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

PERMIT TO APPROPRIATE WATER

THIS IS TO CERTIFY that a PROVISIONAL Permit to appropriate water is hereby granted to [illegible] FISH & WILDLIFE SERVICE, State of COLORADO with a priority date from September 19, 1977 at 1:55 p.m., pursuant to Application No. [illegible] upon finding that the criteria of Section 89-885, R.C.M. 1947, have been met.

The source and point of diversion of this appropriation shall be the Yellowstone River at points in the NE¼ SW¼ of Section 6, Township 7 North, Range 47 East, and the SW¼ NW¼ of Section 13, Township 7 North, Range 46 East, M.P.M., Custer County, Montana.

The water appropriated pursuant to this Permit shall be used for fish hatchery purposes from January 1 to December 31, inclusive, of each year, at the Miles City National Fish Hatchery and substation, located in the SW¼ of Section 4, SE¼ of Section 5, NE¼ of Section 8 and the NW¼ of Section 9, all in Township 7 North, Range 47 East, M.P.M. and the SE¼ of Section 11, S½ of Section 12, NW¼ and NW¼ SW¼ of Section 13, and the E½ of Section 14, Township 7 North, Range 46 East, M.P.M., Custer County, Montana.

The waters appropriated shall be diverted at a rate not to exceed 10 cubic feet per second or 4480 gallons per minute and a quantity of 3650 acre-feet per annum.

The diversion and distribution works for this appropriation shall be completed, and water shall be applied to beneficial use as specified above, on or before October 15, 1982 or within any authorized extension of time. The Notice of Completion of Surface Water Development, Form No. 617, shall be filed on or before December 15, 1982.

This Permit is SUBJECT TO ALL PRIOR WATER RIGHTS, and the following limitations, terms, conditions, and restrictions:

1. Any final determination of existing water rights, as provided by Montana law.

Upon a change in ownership of all or any portion of this permit, pursuant to Section 89-[illegible], R.C.M., 1947, the person receiving the interest shall notify the department.

NOTICE Failure to comply with all terms and conditions herein may result in the loss of the right to appropriate water granted by this Permit.

Dated [illegible]

Witness

[illegible] ADMINISTRATOR
WATER RESOURCES DIVISION

Recorded in State Record of Water Rights Permits, Volume 15, Page 235

United States Department of the Interior
FISH AND WILDLIFE SERVICE

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228

RECEIVED
SEP 2 1982
DIRECTOR'S OFFICE

IN REPLY REFER TO:
SS/EN
WR MT

AUG 30 1982

Mr. James W. Flynn, Director
Montana Department of Fish,
Wildlife and Parks
1420 East 6th Avenue
Helena, Montana 59620

Dear ~~Mr. Flynn~~ Jim:

This responds to the telephonic request made by Mr. Marcoux of your office for information regarding water rights at the Miles City National Fish Hatchery.

The main water supply comes from 2 wells drilled in 1957. Well #1 produces 350 gpm, up to 564.5 acre-feet annually, and well #2 produces 100 gpm, up to 155.3 acre-feet annually.

A vested right is also claimed for 2200 gpm, up to 3548.6 acre-feet annually, of water from the Yellowstone River, priority date July 1, 1927, based on diversion and use at the original Miles City Hatchery site.

Water from the Tongue River is purchased under contract dated May 18, 1960, from the Tongue River Water Users Association and the Montana Water Board. The contract stipulates that 650 acre-feet of water will be delivered from the dam at Decker, Montana during the irrigation season. There is no charge for water used after irrigation season.

The Fish and Wildlife Service filed application for Provisional Permit #15530-s42KJ for diversion of water from the Yellowstone River at a rate not to exceed 10 cfs or 4488 gpm, and a quantity of 3650 acre-feet annually. The development plans for use of the Yellowstone River at a proposed Hatchery Substation have never been completed and a request for Extension of Time was granted to October 1, 1983.

We hope this information is all that you require. Please do not hesitate to contact this office if we can be of further assistance.

Sincerely,

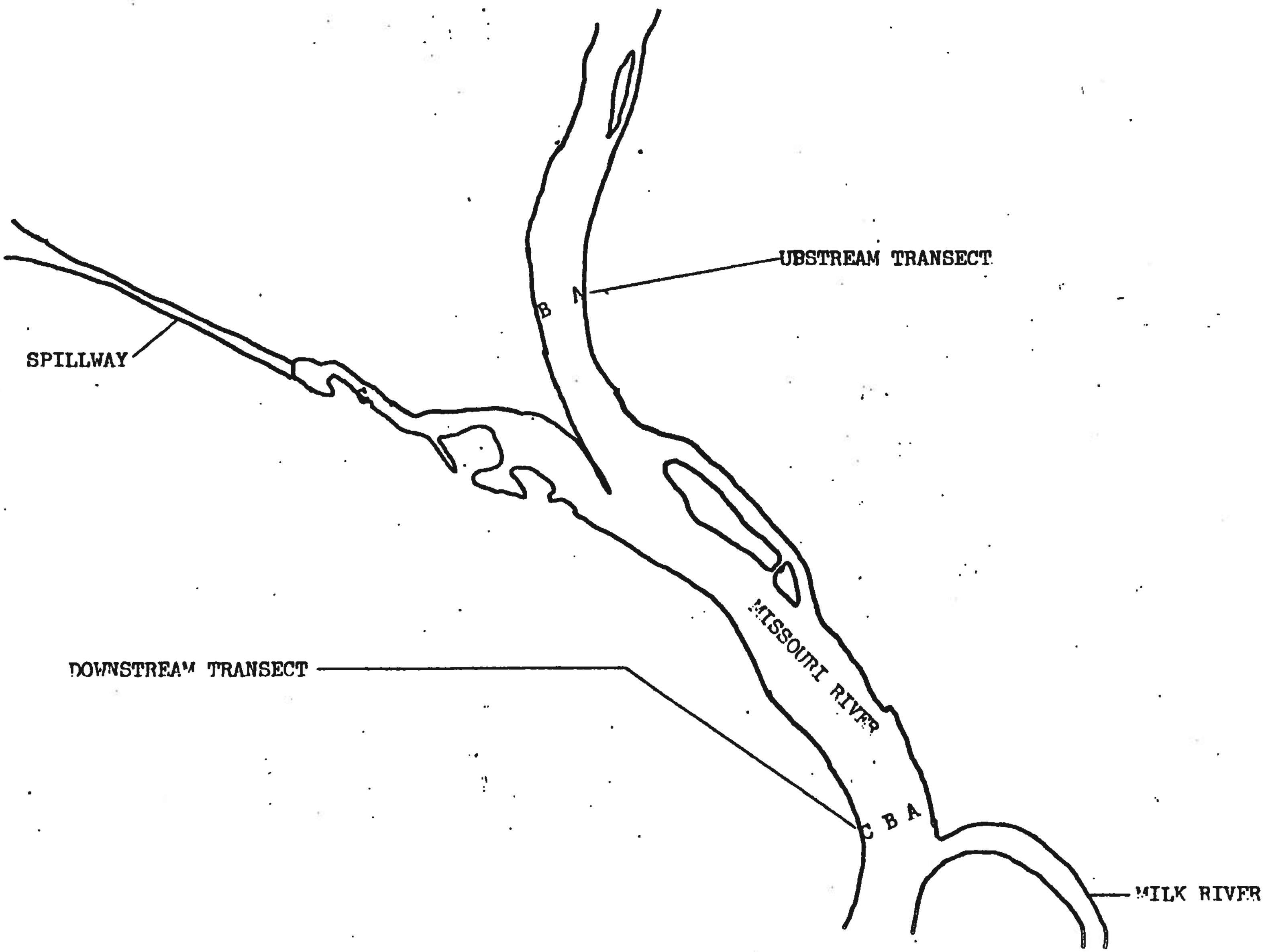
Galen L. Buterbaugh

GALEN L. BUTERBAUGH
Regional Director

APPENDIX C WATER RIGHTS DATA

FORT PECK SAMPLING LOCATIONS

LAKE NOT SAMPLED DUE TO
ICE CONDITIONS



SUMMARY OF SUPERSATURATION
BELOW FORT PECK DAM 3 MAY 1979*

Station	Meter Reading (mm Hg)	Dis. Oxygen (mg/l)	% Sat. Dis. Oxygen	Patm (mm Hg)	Water Temp. (^oC)	B_{O_2} **	P_{H_2O}	% Sat. Tot. Dis. Gas 1/	% Sat. N_2 + Ar 2/
Fort Peck Spillway									
A	87	13.9	104	764.032	3.3	.04493	5.792	111.4	113.6
Upstream Transect (Turbine)									
A	-6	12.0	88	764.032	2.8	.04553	5.605	99.2	102.2
B	-5	12.2	90	764.032	2.8	.04553	5.605	99.4	101.4
Downstream Transect									
A	-5	14.3	105	764.032	2.8	.04553	5.605	99.4	97.8
B	76	13.3	98	764.032	2.8	.04553	5.605	109.9	113.3
C	78	13.5	99	764.032	2.8	.04553	5.605	110.2	113.3

* Spillway discharge was 15,500 cfs. Turbine discharge was 13,488 cfs.
** Bunsen solubility coefficient for oxygen.
*** Gates 3, 5, 7, 9 & 11 spilling.

1/ $\%TDG = \frac{DP}{P}(100) + 100$

2/ $\%N_2 + Ar = \left[\frac{Patm + DP - .5320\,(D.O./BO_2) - P_{H_2O}}{(Patm - P_{H_2O})\,(.7902)}\right] 100$

SUMMARY OF SUPERSATURATION
BELOW FORT PECK DAM 2 MAY 1979*

Station	Meter Reading (mm Hg)	Dis. Oxygen (mg/l)	% Sat. Dis. Oxygen	Patm (mm Hg)	Water Temp. (^oC)	B_{O_2} **	P_{H_2O}	% Sat Tot. Dis. Gas 1/	% Sat N_2 + Ar 2/
Fort Peck Spillway									
A	78	13.7	98	765.81	2.0	.0465	5.294	110.2	113.45
Upstream Transect (Turbine)									
A	-3	13.0	95	765.81	2.2	.04625	5.370	99.6	101.17
B	-7	11.6	85	765.81	2.2	.04625	5.370	99.1	103.18
Downstream Transect									
A	-5	11.4	83	765.81	2.2	.04625	5.370	99.4	103.9
B	75	13.0	95	765.81	2.2	.04625	5.370	109.8	114.2
C	75	13.0	95	765.81	2.2	.04625	5.370	109.8	114.2

* Spillway discharge was 13,600 cfs. Turbine discharge was 13,200 cfs.
** Bunsen solubility coefficient for oxygen.
*** Gates 3, 5, 7 & 9 spilling.

1/ $\%TDG = \frac{DP}{P}(100) + 100$

2/ $\%N_2 + Ar = \left[\frac{Patm + DP - .5320\ (D.O./BO_2) - P_{H_2O}}{(Patm - P_{H_2O})\ (.7902)}\right] 100$

DEPARTMENT OF THE ARMY
OMAHA DISTRICT CORPS OF ENGINEERS
6014 U.S. Post Office and Courthouse
Omaha, Nebraska 68102

REPLY TO
ATTENTION OF:

December 8, 1983

Hydrologic Engineering Branch

Mr. Thomas L. Johnson
Associated Engineers III, Inc.
1201 South Sixth Street
Springfield, Illinois 62703

Dear Mr. Johnson:

In response to your November 21, 1983 request, the following information is enclosed:

a. Reservoir Water Quality Data Report - 1981
b. Gas supersaturation data - 1979.
c. Monthly data summaries - 1982

In siting the proposed hatchery facility, I would recommend the area between Fort Peck Dam to a point eight miles downstream on the left bank. Available supersaturation data indicates that spillway waters occasionally exceed 110% of saturation. Spillway usage is a relatively rare event, however, such waters should be avoided. Approximately eight miles below Fort Peck Dam the Milk River, so named because of its turbidity, joins the Missouri River. Since the Corps has no data on Milk River water quality and since turbidity is high, I would recommend avoiding the use of these waters for fish hatchery purposes. Releases through Fort Peck Dam are taken from deep in the reservoir which results in the downstream waters being very cold water year around. Since your letter mentioned a warm/cool water hatchery, the temperature may be unacceptable unless the use of Fort Peck surface waters is intended.

The reproduction and handling costs for the above material are $72.52. Please make the check payable to the Omaha District, Corps of Engineers, and mail it to the following address:

USAED, Omaha
ATTN: MRORM-F
6014 U.S. Post Office and Courthouse
Omaha, NE 68102

If we can be of further assistance, please contact Dr. John Andersen of my staff, (402) 221-4622.

Sincerely,

L S Horihan

L. S. Horihan, P.E.
Chief, Hydrologic Engineering Branch
Engineering Division

Enclosures

06309000 YELLOWSTONE RIVER AT MILES CITY, MT--Continued

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		FEBRUARY			MARCH			APRIL			MAY	
1	.0	.0	.0	---	---	---	8.0	6.5	7.5	16.5	12.0	14.0
2	.0	.0	.0	---	---	---	6.5	4.5	5.5	17.5	13.5	15.5
3	.0	.0	.0	---	---	---	4.5	3.0	3.5	18.5	15.5	16.5
4	.0	.0	.0	---	---	---	3.0	1.5	2.0	16.0	14.0	15.0
5	.0	.0	.0	---	---	---	4.5	1.0	2.5	14.5	12.5	13.5
6	.0	.0	.0	---	---	---	5.5	2.0	3.5	14.0	12.0	13.0
7	.0	.0	.0	---	---	---	3.5	3.0	3.5	14.0	12.0	13.0
8	.0	.0	.0	---	---	---	6.0	3.0	4.5	14.0	11.5	12.5
9	.0	.0	.0	---	---	---	6.0	4.5	5.0	12.5	10.5	11.5
10	.0	.0	.0	---	---	---	7.5	4.0	6.0	10.5	9.5	10.0
11	.0	.0	.0	---	---	---	9.0	6.0	7.5	10.5	9.0	9.5
12	.0	.0	.0	---	---	---	10.5	8.0	9.5	12.5	8.5	10.5
13	.0	.0	.0	---	---	---	12.0	9.0	10.5	13.5	10.5	12.0
14	.0	.0	.0	---	---	---	12.5	10.0	11.0	13.0	12.0	12.5
15	.0	.0	.0	---	---	---	11.0	10.0	10.5	13.0	12.5	12.5
16	.0	.0	.0	---	---	---	11.5	9.0	10.0	14.0	12.5	13.0
17	.0	.0	.0	---	---	---	11.5	8.0	10.0	15.5	13.0	14.5
18	.0	.0	.0	---	---	---	9.5	7.5	9.0	18.5	14.5	16.5
19	.0	.0	.0	---	---	---	7.5	6.0	6.5	17.0	15.5	16.5
20	.0	.0	.0	---	---	---	9.0	6.0	7.0	15.5	14.0	14.5
21	---	---	---	---	---	---	10.5	6.5	8.5	16.0	14.0	15.0
22	---	---	---	---	---	---	12.0	8.0	10.0	18.0	15.0	16.5
23	---	---	---	---	---	---	14.0	9.5	11.5	17.0	16.0	16.5
24	---	---	---	---	---	---	15.0	11.5	13.0	16.0	15.0	15.5
25	---	---	---	---	---	---	13.0	11.5	12.5	17.0	14.5	16.0
26	---	---	---	---	---	---	14.0	10.5	12.0	18.5	16.0	17.0
27	---	---	---	---	---	---	13.5	10.5	12.0	17.0	16.0	16.5
28	---	---	---	---	---	---	13.5	10.5	12.0	16.0	13.0	15.0
29	---	---	---	---	---	---	13.5	11.5	12.0	13.0	11.0	12.0
30	---	---	---	8.0	---	---	15.0	10.5	12.5	10.5	9.0	10.0
31	---	---	---	9.0	6.0	7.5	---	---	---	10.5	8.0	9.5
MONTH	.0	.0	.0	9.0	6.0	7.5	15.0	1.0	8.5	18.5	8.0	13.5

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		JUNE			JULY			AUGUST			SEPTEMBER	
1	12.0	10.0	11.0	---	---	---	24.0	21.5	22.5	21.5	19.5	20.5
2	13.5	11.5	12.5	---	---	---	23.5	22.0	23.0	22.0	19.0	20.5
3	14.5	12.0	13.5	---	---	---	23.5	22.0	22.5	22.0	19.5	20.5
4	15.5	13.5	14.5	---	---	---	23.0	21.5	22.5	22.0	19.5	20.5
5	17.0	14.0	15.5	---	---	---	23.5	21.5	22.5	22.0	19.5	20.5
6	15.5	13.5	14.5	---	---	---	24.0	22.0	23.0	22.5	19.5	21.0
7	15.0	13.0	13.5	---	---	---	25.0	23.0	24.0	23.0	19.5	21.0
8	14.0	12.5	13.0	---	---	---	24.0	22.0	23.0	23.0	19.5	21.0
9	14.5	12.0	13.0	---	---	---	21.5	19.5	20.5	23.0	20.0	21.5
10	15.5	13.5	14.5	---	---	---	22.0	18.5	20.0	21.0	19.0	20.0
11	17.0	14.5	16.0	---	---	---	23.0	20.0	21.5	20.0	18.0	19.0
12	19.0	16.0	17.5	---	---	---	23.5	21.0	22.5	19.0	16.0	17.5
13	20.0	18.0	19.0	---	---	---	23.5	21.0	22.5	16.0	13.5	15.0
14	21.0	19.0	20.0	---	---	---	24.5	22.0	23.0	13.0	12.0	12.5
15	21.0	19.0	20.0	---	---	---	24.0	21.5	22.5	13.0	11.0	12.0
16	19.5	17.5	19.0	---	---	---	24.0	21.5	22.5	12.0	11.0	11.5
17	17.5	16.5	17.0	---	---	---	24.5	22.0	23.0	13.5	10.5	12.0
18	16.5	15.5	16.0	---	---	---	25.0	22.0	23.5	14.5	12.0	13.0
19	16.0	15.0	15.5	---	---	---	24.5	23.0	23.5	15.5	13.0	14.0
20	16.5	15.0	16.0	---	---	---	25.5	22.5	24.0	15.5	13.0	14.5
21	18.0	16.0	17.0	---	---	---	25.0	23.0	24.0	16.0	13.5	15.0
22	19.0	17.5	18.5	---	---	---	25.0	22.5	23.5	17.0	14.5	15.5
23	19.0	18.0	18.5	23.0	22.5	23.0	23.0	20.5	22.0	17.0	15.0	16.0
24	18.0	16.0	17.5	23.0	22.0	22.5	22.5	20.0	21.0	17.5	15.5	16.5
25	16.0	15.0	15.5	22.0	20.5	21.5	22.5	20.0	21.0	18.0	15.5	16.5
26	---	---	---	21.5	20.0	20.5	21.5	19.5	20.0	16.5	16.0	16.0
27	---	---	---	21.5	20.0	21.0	22.0	18.5	20.0	15.5	13.5	14.5
28	---	---	---	22.0	20.5	21.5	22.0	19.5	21.0	13.5	12.5	13.0
29	---	---	---	22.5	21.0	22.0	22.5	19.5	21.0	12.5	11.5	12.0
30	---	---	---	23.0	21.5	22.5	22.5	20.0	21.0	11.0	10.5	10.5
31	---	---	---	23.0	22.0	22.5	22.0	20.5	21.0	---	---	---
MONTH	21.0	10.0	16.0	23.0	20.0	22.0	25.5	18.5	22.0	23.0	10.5	16.5
YEAR	25.5	.0	10.0									

06309000 YELLOWSTONE RIVER AT MILES CITY, MT--Continued

WATER-QUALITY RECORDS

PERIOD OF RECORD.--Water years 1948-52, 1965, 1974-75, 1977 to current year.

PERIOD OF DAILY RECORD.--
WATER TEMPERATURES: May 1974 to September 1975, July 1977 to current year.

INSTRUMENTATION.--Temperature recorder May 1974 to September 1975, July 1977 to current year.

REMARKS.--Temperature probe located about 25 ft (8 m) out from left bank. Flow from Tongue River enters on right bank 0.9 mi (1.4 km) upstream from gage. Temperature record is equivalent to Yellowstone River near Miles City (station 06296120) located above confluence of the Tongue River.

EXTREMES FOR PERIOD OF DAILY RECORD.--
WATER TEMPERATURES: Maximum, 28.0°C Aug. 18-20, 1981; minimum, 0.0°C on many days during winter periods.

EXTREMES FOR CURRENT YEAR.--
WATER TEMPERATURES: Maximum recorded, 25.5°C Aug. 20; minimum, 0.0°C on many days during November to February.

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		OCTOBER			NOVEMBER			DECEMBER			JANUARY	
1	16.5	12.5	14.5	10.0	7.5	9.0	.0	.0	.0	.0	.0	.0
2	16.0	13.0	14.5	10.0	8.0	9.0	.0	.0	.0	.0	.0	.0
3	14.5	13.0	14.0	10.0	8.0	9.0	.5	.0	.0	.0	.0	.0
4	13.0	11.5	12.5	9.5	8.0	8.5	1.0	.0	.5	.0	.0	.0
5	13.5	11.0	12.0	9.5	7.5	8.5	.5	.0	.5	.0	.0	.0
6	13.5	10.5	12.0	9.0	7.0	8.0	1.5	.5	.5	.0	.0	.0
7	13.0	11.0	12.0	9.0	6.5	7.5	2.0	.5	1.5	.0	.0	.0
8	12.0	11.0	12.0	8.0	6.5	7.5	2.0	1.0	1.5	.0	.0	.0
9	13.0	10.5	11.5	8.0	6.0	7.0	3.0	1.5	2.5	.0	.0	.0
10	13.0	10.5	11.5	8.0	6.0	7.0	3.5	2.5	3.0	.0	.0	.0
11	13.5	11.5	12.0	7.5	5.5	6.5	4.0	3.0	3.5	.0	.0	.0
12	11.5	8.0	9.5	7.5	5.5	6.5	3.0	2.0	2.5	.0	.0	.0
13	9.5	7.5	8.5	7.0	6.0	6.5	2.5	1.5	1.5	.0	.0	.0
14	9.5	7.5	8.5	7.0	6.0	6.5	1.5	.5	1.0	.0	.0	.0
15	10.5	7.5	9.0	7.0	5.5	6.0	.5	.0	.0	.0	.0	.0
16	10.5	8.0	9.0	7.0	5.5	6.5	.0	.0	.0	.0	.0	.0
17	10.0	8.0	9.0	7.0	6.0	6.5	.0	.0	.0	.0	.0	.0
18	10.0	7.5	8.5	6.5	5.0	6.0	.0	.0	.0	.0	.0	.0
19	11.0	8.0	9.5	5.0	4.0	4.5	.0	.0	.0	.0	.0	.0
20	9.0	7.5	8.5	5.0	3.5	4.0	.0	.0	.0	.0	.0	.0
21	8.5	7.0	7.5	5.0	3.5	4.0	.0	.0	.0	.0	.0	.0
22	7.5	5.5	6.5	5.0	4.0	4.5	.0	.0	.0	.0	.0	.0
23	6.0	5.0	5.5	5.0	4.0	4.5	.0	.0	.0	.0	.0	.0
24	6.0	5.0	5.5	4.5	4.0	4.0	.0	.0	.0	.0	.0	.0
25	7.0	5.5	6.0	4.0	3.0	3.5	.0	.0	.0	.0	.0	.0
26	8.5	6.0	7.5	3.5	1.5	2.5	.0	.0	.0	.0	.0	.0
27	9.5	7.5	8.5	1.5	.5	1.0	.0	.0	.0	.0	.0	.0
28	10.5	8.0	9.0	1.0	.0	.5	.0	.0	.0	.0	.0	.0
29	10.0	8.5	9.0	.5	.0	.0	.0	.0	.0	.0	.0	.0
30	9.5	8.0	8.5	.5	.0	.0	.0	.0	.0	.0	.0	.0
31	9.5	7.5	8.5	---	---	---	.0	.0	.0	.0	.0	.0
MONTH	16.5	5.0	9.5	10.0	.0	5.5	4.0	.0	.5	.0	.0	.0

06309000 YELLOWSTONE RIVER AT MILES CITY, MT

LOCATION.--Lat 46°25'18", long 105°51'38", in NE¼SW¼NW¼ sec.28, T.8 N., R.47 E., Custer County, Hydrologic Unit 10100001, on left bank at upstream side of bridge on State Highway 22 at Miles City, 0.8 mi (1.3 km) downstream from Tongue River, and at mile 184.2 (296.4 km).

DRAINAGE AREA.--48,253 mi^2 (124,975 km^2).

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--September 1922 to September 1923, August 1928 to current year. Monthly discharge only for some periods, published in WSP 1309.

REVISED RECORDS.--WSP 1729: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,333.3 ft (711.19 m) National Geodetic Vertical Datum of 1929 (levels by U.S. Army Corps of Engineers). Prior to May 6, 1929, nonrecording gages at pumping plant 1.2 mi (1.9 km) downstream at different datums. May 6, 1929, to Sept. 30, 1931, nonrecording gage, and Oct. 1, 1931, to Nov. 10, 1937, water-stage recorder 300 ft (91 m) upstream from present site at same datum. Nov. 11, 1937, to Sept. 30, 1946, water-stage recorder at pumping plant 1.2 mi (1.9 km) downstream at different datum. Oct. 1, 1946, to Mar. 15, 1979, water-stage recorder at site 300 ft (91 m) upstream at present datum. Mar. 16, 1979, to Sept. 21, 1979, nonrecording gage at present site and datum. Sept. 22, 1979, recording gage established at same site and datum.

REMARKS.--Water-discharge records good except those for January and February, which are poor. Some regulation by reservoirs on tributary streams. Diversions for irrigation of about 1,100,000 acres (4,450 km^2) above station (does not include flood irrigation).

AVERAGE DISCHARGE.--55 years (1922-23, 1928-82), 11,600 ft^3/s (328.5 m^3/s), 8,404,000 acre-ft/yr (10.4 km^3/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 102,000 ft^3/s (2,889 m^3/s) May 22, 1978, gage height, 16.50 ft (5.029 m); maximum gage height, 21.7 ft (6.61 m) Mar. 20, 1944 (ice jam, from floodmark, at site 300 ft (91 m) upstream at present datum); minimum discharge, 996 ft^3/s (28.2 m^3/s) Dec. 14, 1932.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 61,000 ft^3/s (1,730 m^3/s) July 2, gage height, 11.84 ft (3.609 m); minimum daily, 3,500 ft^3/s (99.1 m^3/s) Jan. 10.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5450	7850	7190	5000	6000	8540	7920	9190	21500	57000	19800	10800
2	5540	7750	7100	4900	5400	8210	7870	9380	18400	59800	19000	10400
3	5770	7640	7110	4800	4000	8330	7590	9150	16900	59600	18600	10100
4	5800	7620	7190	4700	4500	7890	7640	9040	16500	55000	17700	9810
5	5920	7640	7220	4500	5000	8050	7630	9740	16300	49900	17000	9580
6	6010	7640	7150	4800	6400	7760	7580	11600	16700	46000	16300	9480
7	6110	7600	7320	5400	7000	8200	7550	12800	19900	42400	15600	9350
8	6230	7550	7480	5800	4500	8770	7640	11500	22100	37800	14700	9130
9	6450	7550	7510	4500	4500	8440	7550	10500	22100	34300	13500	8910
10	6550	7470	7430	3500	5000	8240	7460	10300	21300	34400	13300	8670
11	6640	7420	7430	4000	5200	8830	7570	10400	20700	37000	13600	8480
12	6710	7410	7390	4300	5600	9230	7630	10100	18900	37600	14200	8380
13	6610	7390	7250	5000	6000	9340	7620	9650	18500	35900	14000	8550
14	6800	7370	7080	6200	6800	9490	8120	9060	19300	34200	13400	8760
15	6800	7340	7020	5800	8000	9490	9470	8510	23200	34000	13100	9950
16	6800	7340	7240	4500	9000	9150	9810	8490	31200	33900	12900	11800
17	7270	7380	7310	6000	11000	8600	9570	8470	35400	33700	12600	12000
18	6670	7450	7140	5600	13000	8980	9200	8990	37700	32000	12300	11600
19	6320	7400	7070	5000	14000	7980	8680	9700	42000	29700	11900	11500
20	7200	7390	7230	4700	15000	7620	8370	10800	42800	27300	11500	11800
21	7890	7420	6890	4300	15000	7520	8320	12700	41600	25600	11500	11900
22	8100	7450	7010	4200	14500	7310	8270	14200	42100	24400	11400	11700
23	8060	7460	7860	4100	14000	7240	8050	13700	44300	23400	11600	11800
24	8030	7330	7890	5000	13100	7340	7900	13100	46400	23400	11600	11700
25	7990	7470	7440	7000	12100	7400	7940	15000	49800	24200	11800	11600
26	8060	7450	7110	8000	11300	6930	8170	17400	53200	25400	11700	11500
27	8100	7390	6870	8000	10100	6750	8660	18000	53200	27100	11300	11800
28	8100	7180	6770	7400	8470	7210	9280	19700	51800	25800	11000	11800
29	8100	6920	5800	6400	---	7240	9530	24600	52400	23500	10900	11900
30	7990	7070	5600	6000	---	7640	9050	29300	54100	22100	10900	12700
31	7960	---	5200	5600	---	7770	---	26300	---	21000	10800	---
TOTAL	216030	223340	219300	165000	244470	251490	247640	401370	970300	1077400	419500	317450
MEAN	6969	7445	7074	5323	8731	8113	8255	12950	32340	34750	13530	10580
MAX	8100	7850	7890	8000	15000	9490	9810	29300	54100	59800	19800	12700
MIN	5450	6920	5200	3500	4000	6750	7460	8470	16300	21000	10800	8380
AC-FT	428500	443000	435000	327300	484900	498800	491200	796100	1925000	2137000	832100	629700

CAL YR 1981 TOTAL 3928500 MEAN 10760 MAX 54400 MIN 3260 AC-FT 7792000
WTR YR 1982 TOTAL 4753290 MEAN 13020 MAX 59800 MIN 3500 AC-FT 9428000

06296120 YELLOWSTONE RIVER NEAR MILES CITY, MT--Continued

PARTICLE-SIZE DISTRIBUTION OF SUSPENDED SEDIMENT, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	TEMPER-ATURE (DEG C) (00010)	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	SED. SUSP. FALL DIAM. % FINER THAN .004 MM (70338)	SED. SUSP. FALL DIAM. % FINER THAN .016 MM (70340)	SED. SUSP. FALL DIAM. % FINER THAN .062 MM (70342)	SED. SUSP. FALL DIAM. % FINER THAN .125 MM (70343)	SED. SUSP. FALL DIAM. % FINER THAN .250 MM (70344)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM (70331)
OCT 29...	0900	5.5	8770	55	1300	--	--	--	--	--	94
NOV 18...	0915	2.5	7070	17	325	--	--	--	--	--	94
DEC 16...	1330	1.5	7770	36	755	--	--	--	--	--	93
JAN 20...	0900	.5	6250	4	68	--	--	--	--	--	85
FEB 27...	1400	4.0	5720	24	371	--	--	--	--	--	86
MAR 24...	1500	9.5	4460	19	229	--	--	--	--	--	97
APR 22...	1000	13.0	3830	25	259	--	--	--	--	--	97
MAY 20...	1030	14.0	22000	1300	77200	62	82	91	96	100	--
JUN 17...	1700	12.5	34200	426	39300	--	--	--	--	--	72
JUL 29...	1330	23.0	10000	40	1080	--	--	--	--	--	96
AUG 18...	1400	27.0	5030	27	367	--	--	--	--	--	95
SEP 30...	0900	14.0	5310	31	444	--	--	--	--	--	93

06296120 YELLOWSTONE RIVER NEAR MILES CITY, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	COBALT, DIS-SOLVED (UG/L AS CO) (01035)	COPPER, TOTAL RECOV-ERABLE (UG/L AS CU) (01042)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)	LEAD, TOTAL RECOV-ERABLE (UG/L AS PB) (01051)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	LITHIUM DIS-SOLVED (UG/L AS LI) (01130)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG) (71900)
OCT										
29...	--	5	4	930	3	3	--	40	2	.2
JAN										
20...	--	5	1	140	4	0	--	10	10	.0
APR										
22...	--	6	3	320	14	2	--	80	7	.1
JUL										
29...	< 3	5	< 10	1100	4	3	48	50	3	.0

DATE	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	MOLYB-DENUM, DIS-SOLVED (UG/L AS MO) (01060)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI) (01067)	NICKEL, DIS-SOLVED (UG/L AS NI) (01065)	SELE-NIUM, TOTAL (UG/L AS SE) (01147)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	STRON-TIUM, DIS-SOLVED (UG/L AS SR) (01080)	VANA-DIUM, DIS-SOLVED (UG/L AS V) (01085)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN) (01092)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
OCT										
29...	.0	--	8	2	1	1	--	--	10	4
JAN										
20...	.0	--	1	3	2	2	--	--	20	50
APR										
22...	.0	--	3	3	2	2	--	--	70	10
JUL										
29...	.0	< 10	2	1	1	1	470	< 6.0	10	6

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	600	670	660	710	811	781	800	583	316	357	585	710
2	603	671	680	710	817	790	811	540	306	386	589	712
3	608	680	683	711	840	798	820	551	313	387	596	713
4	610	679	698	718	835	801	821	569	305	393	602	700
5	620	675	760	728	830	810	768	510	326	403	604	703
6	631	670	766	728	810	816	772	382	312	409	623	708
7	640	671	765	729	840	820	818	398	341	415	629	710
8	640	680	753	729	819	818	799	421	328	426	622	711
9	649	680	760	730	815	812	795	438	298	442	665	711
10	652	680	770	738	814	818	790	510	335	399	666	708
11	659	680	758	732	820	818	760	520	342	407	661	696
12	660	667	740	740	815	819	768	565	374	430	657	698
13	665	645	690	742	872	820	768	620	453	465	656	698
14	671	643	692	749	910	798	804	770	454	482	676	701
15	668	647	660	740	920	798	787	770	454	490	666	699
16	658	647	661	753	850	790	780	677	459	484	687	702
17	651	660	658	756	770	792	792	680	490	488	685	706
18	670	670	651	758	720	791	785	668	514	518	670	701
19	665	684	722	750	700	790	829	681	516	522	662	699
20	667	693	728	755	700	792	780	589	454	557	661	692
21	670	698	750	763	728	789	800	537	446	520	667	695
22	670	675	745	759	730	800	779	498	428	510	688	693
23	681	679	779	738	740	810	751	462	394	523	687	696
24	681	670	778	730	740	820	740	479	377	526	706	695
25	680	655	760	731	732	820	696	478	377	523	710	690
26	670	658	760	738	740	825	694	426	345	524	712	689
27	638	670	740	738	739	830	683	370	365	572	706	689
28	680	671	671	738	750	820	709	348	362	574	704	687
29	672	670	669	740	---	818	708	382	351	571	702	686
30	672	670	670	740	---	812	612	302	350	568	703	681
31	673	---	671	731	---	809	---	313	---	568	710	---
MEAN	654	670	718	737	793	807	767	517	383	479	663	699

WTR YR 1981 MEAN 657 MAX 920 MIN 298

06296120 YELLOWSTONE RIVER NEAR MILES CITY, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	ALKA- LINITY LAB (MG/L AS CACO3) (90410)	SULFATE DIS- SOLVED (MG/L AS SO4) (00945)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL) (00940)	FLUO- RIDE, DIS- SOLVED (MG/L AS F) (00950)	SILICA, DIS- SOLVED (MG/L AS SIO2) (00955)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L) (70301)	SOLIDS, DIS- SOLVED (TONS PER AC-FT) (70303)	SOLIDS, DIS- SOLVED (TONS PER DAY) (70302)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N) (00630)
OCT 29...	150	190	9.3	.4	11	441	.60	10400	.20
NOV 18...	150	190	9.4	.4	10	441	.60	8420	.17
DEC 16...	160	190	9.0	.4	11	448	.61	9400	.46
JAN 20...	160	240	11	.5	9.1	526	.72	8880	.34
FEB 27...	150	210	11	.4	7.9	470	.64	7260	.10
MAR 24...	160	260	14	.5	8.5	550	.75	6620	.05
APR 22...	150	250	21	.5	4.4	530	.72	5480	.01
MAY 20...	120	150	5.9	.3	11	351	.48	20800	.03
JUN 17...	95	130	9.9	.3	11	304	.41	28100	.26
JUL 29...	120	170	7.9	.3	9.6	377	.51	10200	.11
AUG 18...	150	200	9.9	.4	9.3	451	.61	6130	.01
SEP 30...	150	190	12	.5	10	441	.60	6320	.25

DATE	NITRO- GEN, AMMONIA TOTAL (MG/L AS N) (00610)	NITRO- GEN, ORGANIC TOTAL (MG/L AS N) (00605)	NITRO- GEN,AM- MONIA + ORGANIC TOTAL (MG/L AS N) (00625)	PHOS- PHORUS, TOTAL (MG/L AS P) (00665)	CARBON, ORGANIC TOTAL (MG/L AS C) (00680)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C) (00681)	CARBON, ORGANIC SUS- PENDED TOTAL (MG/L AS C) (00689)	BORON, DIS- SOLVED (UG/L AS B) (01020)	IRON, DIS- SOLVED (UG/L AS FE) (01046)
OCT 29...	.02	.92	.94	.08	--	10	.7	160	< 10
NOV 18...	.07	.36	.43	.02	8.3	--	--	150	< 10
DEC 16...	.03	.51	.54	.05	2.3	--	--	120	10
JAN 20...	.09	.38	.47	.02	--	6.8	.0	150	10
FEB 27...	.18	.65	.83	.08	4.0	--	.8	150	10
MAR 24...	.02	.62	.64	.03	3.7	3.7	--	200	20
APR 22...	.13	.74	.87	.06	--	4.1	.6	220	10
MAY 20...	.08	--	--	--	25	--	--	210	40
JUN 17...	.22	.29	.51	.23	6.5	--	--	60	30
JUL 29...	.32	.59	.91	.04	--	9.4	.1	120	12
AUG 18...	.21	.89	1.1	.06	4.3	--	--	160	< 10
SEP 30...	.10	.63	.73	.02	5.5	--	--	170	27

DATE	TIME	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS- SOLVED (UG/L AS AS) (01000)	BARIUM, DIS- SOLVED (UG/L AS BA) (01005)	BERYL- LIUM, TOTAL RECOV- ERABLE (UG/L AS BE) (01012)	BERYL- LIUM, DIS- SOLVED (UG/L AS BE) (01010)	CADMIUM TOTAL RECOV- ERABLE (UG/L AS CD) (01027)	CADMIUM DIS- SOLVED (UG/L AS CD) (01025)	CHRO- MIUM, TOTAL RECOV- ERABLE (UG/L AS CR) (01034)	CHRO- MIUM, DIS- SOLVED (UG/L AS CR) (01030)
OCT 29...	0900	7	6	--	0	< 1	0	< 1	0	0
JAN 20...	0900	7	5	--	0	< 1	0	< 1	0	0
APR 22...	1000	9	8	--	0	< 1	0	< 1	10	10
JUL 29...	1330	7	6	50	0	< 1	1	< 1	20	0

06296120 YELLOWSTONE RIVER NEAR MILES CITY, MT

LOCATION.--Lat 46°23'53", long 105°53'42", in SE¼SW¼ sec.31, T.8 N., R.47 E., Custer County, Hydrologic Unit 10100001, at Keogh Bridge, 1.6 mi (2.6 km) upstream from Tongue River, 2.0 mi (3.2 km) west of Miles City, and at mile 186.6 (300.2 km), revised.

DRAINAGE AREA.--42,847 mi^2 (110,974 km^2).

PERIOD OF RECORD.--Water years 1969 to current year.

PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: October 1968 to current year.

REMARKS.--Water discharge computed by subtracting the discharge of Tongue River at Miles City (station 06308500) from that of Yellowstone River at Miles City (station 06309000). Flow affected by reservoirs and diversion for irrigation upstream from station. Once-daily water temperatures are available in the Helena district office.

EXTREMES FOR PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: Maximum daily, 1,110 micromhos Apr. 1, 1979; minimum daily, 225 micromhos May 31, 1979.

EXTREMES FOR CURRENT YEAR.--
SPECIFIC CONDUCTANCE: Maximum daily, 920 micromhos Feb. 15; minimum daily, 298 micromhos June 9.

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	WEATHER (WMO CODE NUMBER) (00041)	SPE-CIFIC CON-DUCT-ANCE (UMHOS) (00095)	PH (UNITS) (00400)	TEMPER-ATURE, AIR (DEG C) (00020)	TEMPER-ATURE (DEG C) (00010)	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)
OCT 29...	0900	8770	1	640	8.0	7.0	5.5	11.0	94
NOV 18...	0915	7070	0	686	8.4	5.0	2.5	12.6	99
DEC 16...	1330	7770	3	670	8.1	16.5	1.5	12.9	100
JAN 20...	0900	6250	0	810	9.0	-.5	.5	14.3	107
FEB 27...	1400	5720	71	720	8.7	.5	4.0	12.6	104
MAR 24...	1500	4460	1	817	8.5	13.0	9.5	11.7	110
APR 22...	1000	3830	0	760	8.8	14.0	13.0	10.1	104
MAY 20...	1030	22000	1	525	--	21.0	14.0	8.4	89
JUN 17...	1700	34200	51	457	8.0	16.0	12.5	9.2	93
JUL 29...	1330	10000	0	560	8.5	24.0	23.0	8.9	114
AUG 18...	1400	5030	0	680	8.7	33.0	27.0	8.8	121
SEP 30...	0900	5310	1	640	8.6	9.0	14.0	9.2	97

DATE	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML) (31625)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)	HARD-NESS (MG/L AS CACO3) (00900)	HARD-NESS NONCAR-BONATE (MG/L AS CACO3) (95902)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM AD-SORP-TION RATIO (00931)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)
OCT 29...	24	K40	220	75	57	20	59	1.7	3.6
NOV 18...	--	20	230	83	57	22	58	1.7	3.7
DEC 16...	K4	44	230	70	56	22	60	1.7	3.4
JAN 20...	K30	K12	270	110	70	24	71	1.9	3.7
FEB 27...	--	--	250	97	61	23	63	1.7	3.6
MAR 24...	< 1	K1	280	120	71	26	70	1.8	3.6
APR 22...	K5	K2	260	110	60	27	73	2.0	3.6
MAY 20...	2600	3300	170	52	41	17	50	1.7	3.8
JUN 17...	250	200	160	65	41	14	38	1.3	2.3
JUL 29...	25	K18	190	68	47	17	49	1.7	3.3
AUG 18...	K6	K12	210	63	49	22	66	2.2	3.9
SEP 30...	K32	50	230	75	54	22	59	1.9	3.5

06296120 YELLOWSTONE RIVER NEAR MILES CITY, MT--Continued

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	684	750	804	888	705	675	837	657	293	256	438	551
2	675	752	803	920	709	710	836	640	315	272	453	550
3	675	754	811	935	719	729	812	629	362	276	474	531
4	666	760	809	940	720	740	815	583	361	281	475	531
5	662	759	774	945	732	775	805	587	390	281	474	518
6	649	753	772	942	734	778	805	516	373	307	492	519
7	652	751	749	947	773	800	809	529	375	312	492	528
8	644	755	744	945	771	796	818	481	442	324	519	536
9	629	753	742	928	836	782	807	476	556	348	518	516
10	623	749	728	930	838	785	822	487	504	345	510	539
11	610	749	730	913	855	762	824	484	505	340	521	526
12	612	750	769	895	858	747	839	499	446	335	492	533
13	621	756	773	883	862	731	847	531	463	333	491	546
14	623	757	767	869	864	734	820	557	423	339	514	523
15	618	766	759	857	838	720	721	556	415	340	517	526
16	672	764	774	858	809	726	671	567	369	330	516	527
17	658	760	784	820	766	730	667	579	351	332	533	505
18	659	759	778	816	645	780	669	572	325	374	535	549
19	667	761	795	791	636	781	684	537	324	359	535	524
20	642	760	794	765	589	782	690	472	315	387	543	523
21	699	761	778	757	584	798	713	470	313	412	553	517
22	728	754	780	759	570	801	727	418	288	415	551	514
23	727	751	786	754	582	803	723	419	276	386	548	504
24	748	757	755	756	600	830	726	423	262	412	539	502
25	751	777	767	748	605	835	732	402	261	392	538	532
26	753	770	765	752	607	841	713	331	271	400	525	535
27	756	772	753	520	634	838	711	332	252	395	530	562
28	750	768	778	770	636	867	704	262	255	407	537	583
29	751	774	809	776	---	872	671	262	247	402	536	602
30	733	787	848	773	---	873	671	265	238	425	528	631
31	730	---	864	749	---	878	---	277	---	443	528	---
MEAN	680	760	779	836	717	784	756	477	352	354	515	536

WTR YR 1982 MEAN 628 MAX 947 MIN 238

SUSPENDED-SEDIMENT DISCHARGE, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	TIME	TEMPERATURE (DEG C) (00010)	DISCHARGE, IN CUBIC FEET PER SECOND (00060)	SEDIMENT, SUSPENDED (MG/L) (80154)	SEDIMENT, DISCHARGE, SUSPENDED (T/DAY) (80155)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM (70331)
NOV						
03...	1400	9.5	7410	37	740	91
DEC						
15...	1230	1.0	6820	12	221	--
FEB						
09...	1300	.0	4350	5	59	--
MAR						
30...	1300	7.5	7440	134	2690	89
JUN						
09...	1255	13.5	21500	972	56400	91
23...	1215	18.0	43900	401	47500	94
JUL						
20...	1300	19.5	27000	203	14800	75
AUG						
10...	0845	18.5	13100	29	1030	94
30...	1400	22.0	10700	31	896	81
SEP						
29...	0845	11.0	11600	34	1060	97

06296120 YELLOWSTONE RIVER NEAR MILES CITY, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N) (00630)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N) (00610)	NITRO-GEN, ORGANIC TOTAL (MG/L AS N) (00605)	NITRO-GEN, AM-MONIA + ORGANIC TOTAL (MG/L AS N) (00625)	PHOS-PHORUS, TOTAL (MG/L AS P) (00665)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C) (00681)	CARBON, ORGANIC SUS-PENDED TOTAL (MG/L AS C) (00689)	BORON, DIS-SOLVED (UG/L AS B) (01020)	IRON, DIS-SOLVED (UG/L AS FE) (01046)
NOV 03...	.70	10180	.28	.17	.54	.71	.02	--	--	150	12
DEC 15...	.68	9040	.22	.11	.45	.56	<.01	4.3	.5	160	11
FEB 09...	.76	6530	.56	.26	.60	.86	.03	--	--	200	18
MAR 30...	.77	11450	.28	.13	.41	.54	.03	5.7	.6	170	9
JUN 09...	.45	19390	.20	.17	1.2	1.4	.32	9.2	.3	100	74
23...	.23	18250	.15	.21	1.1	1.3	.20	6.5	.9	50	51
JUL 20...	.31	17130	.21	.35	.85	1.2	.15	--	--	90	26
AUG 10...	.44	11420	.13	.14	.86	1.0	.04	4.5	.4	120	20
30...	.45	9820	.20	.61	1.7	2.3	.03	11	.9	230	7
SEP 29...	.49	11370	.30	.25	.75	1.0	.05	4.6	.3	130	17

DATE	TIME	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BERYL-LIUM, TOTAL RECOV-ERABLE (UG/L AS BE) (01012)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE) (01010)	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD) (01027)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, TOTAL RECOV-ERABLE (UG/L AS CR) (01034)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COPPER, TOTAL RECOV-ERABLE (UG/L AS CU) (01042)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)
JUN 09...	1255	6	3	<10	1	4	2	<10	<10	220	18	14000
23...	1215	2	--	<10	--	<1	--	20	--	19	--	7000
SEP 29...	0845	6	5	<10	<1	<1	<1	<10	<10	6	<1	890

DATE	LEAD, TOTAL RECOV-ERABLE (UG/L AS PB) (01051)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG) (71900)	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI) (01067)	NICKEL, DIS-SOLVED (UG/L AS NI) (01065)	SELE-NIUM, TOTAL (UG/L AS SE) (01147)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN) (01092)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
JUN 09...	26	12	420	42	.3	.2	160	5	1	1	160	35
23...	6	--	200	--	.1	--	23	--	1	--	40	--
SEP 29...	<1	1	50	5	--	--	7	1	1	1	30	6

06296120 YELLOWSTONE RIVER NEAR MILES CITY, MT

LOCATION.--Lat 46°23'53", long 105°53'42", in SE¼SW¼ sec.31, T.8 N., R.47 E., Custer County, Hydrologic Unit 10100001, at Keogh Bridge, 1.6 mi (2.6 km) upstream from Tongue River, 2.0 mi (3.2 km) west of Miles City, and river mile 186.6 (300.2 km).

DRAINAGE AREA.--42,847 mi^2 (110,974 km^2).

PERIOD OF RECORD.--Water years 1969 to current year.

PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: October 1968 to current year.

REMARKS.--Water discharge computed by subtracting the discharge of Tongue River at Miles City (station 06308500) from that of Yellowstone River at Miles City (station 06309000). Flow affected by reservoirs and diversion for irrigation upstream from station. Once-daily water temperatures are available in the Helena district office. Mean monthly concentrations and monthly and annual loads for selected chemical constituents have been computed using daily records of specific conductance and regression relationships between each chemical constituent and specific conductance. Bicarbonate regression equations, concentrations and loads were calculated by transposing values from measurements of alkalinity.

EXTREMES FOR PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: Maximum daily, 1,110 micromhos Apr. 1, 1979; minimum daily, 225 micromhos May 31, 1979.

EXTREMES FOR CURRENT YEAR.--
SPECIFIC CONDUCTANCE: Maximum daily, 947 micromhos Jan. 7; minimum daily, 238 micromhos June 30.

WATER QUALITY DATA, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	TIME	DISCHARGE, IN CUBIC FEET PER SECOND (00060)	WEATHER (WMO CODE NUMBER) (00041)	SPECIFIC CONDUCTANCE (UMHOS) (00095)	PH (UNITS) (00400)	TEMPERATURE, AIR (DEG C) (00020)	TEMPERATURE (DEG C) (00010)	OXYGEN, DISSOLVED (MG/L) (00300)	OXYGEN, DISSOLVED (PERCENT SATURATION) (00301)	HARDNESS (MG/L AS CACO3) (00900)	HARDNESS NONCARBONATE (MG/L AS CACO3) (95902)
NOV											
03...	1400	7410	0	765	8.3	19.5	9.5	10.5	101	264	100
DEC											
15...	1230	6820	2	740	7.8	-6.0	1.0	13.4	103	252	92
FEB											
09...	1300	4350	1	820	7.9	--	.0	11.8	88	270	90
MAR											
30...	1300	7440	2	870	8.4	6.5	7.5	10.6	98	286	120
JUN											
09...	1255	21500	1	522	7.9	21.5	13.5	9.2	96	153	54
23...	1215	43900	0	244	8.8	21.0	18.0	8.0	92	87	13
JUL											
20...	1300	27000	0	385	8.1	27.0	19.5	8.2	98	128	28
AUG											
10...	0845	13100	1	495	8.7	16.5	18.5	8.4	97	167	50
30...	1400	10700	0	545	8.4	20.5	22.0	8.9	112	164	41
SEP											
29...	0845	11600	1	582	--	4.0	11.0	9.4	93	195	70

DATE	CALCIUM DISSOLVED (MG/L AS CA) (00915)	MAGNESIUM, DISSOLVED (MG/L AS MG) (00925)	SODIUM, DISSOLVED (MG/L AS NA) (00930)	SODIUM ADSORPTION RATIO (00931)	POTASSIUM, DISSOLVED (MG/L AS K) (00935)	ALKALINITY LAB (MG/L AS CACO3) (90410)	SULFATE DISSOLVED (MG/L AS SO4) (00945)	CHLORIDE, DISSOLVED (MG/L AS CL) (00940)	FLUORIDE, DISSOLVED (MG/L AS F) (00950)	SILICA, DISSOLVED (MG/L AS SIO2) (00955)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L) (70301)
NOV											
03...	66	24	68	1.9	3.5	160	230	12	.5	8.3	509
DEC											
15...	63	23	64	1.8	3.8	160	220	11	.5	9.8	491
FEB											
09...	67	25	67	1.8	4.2	180	260	11	.5	13	556
MAR											
30...	70	27	77	2.0	3.6	170	270	10	.4	9.6	570
JUN											
09...	38	14	49	1.8	3.1	99	150	8.0	.4	12	334
23...	23	7.2	16	.8	2.0	74	45	3.8	.2	12	154
JUL											
20...	33	11	29	1.2	2.3	100	83	5.6	.3	11	235
AUG											
10...	42	15	45	1.6	3.2	117	130	7.5	.4	9.3	323
30...	41	15	44	1.5	3.2	123	140	7.6	.4	10	340
SEP											
29...	50	17	48	1.5	3.1	125	150	7.8	.4	11	363

06309000 YELLOWSTONE RIVER AT MILES CITY, MT--Continued

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		FEBRUARY			MARCH			APRIL			MAY	
1	.0	.0	.0	5.5	2.5	4.0	12.5	8.0	10.5	18.0	13.5	16.0
2	.5	.0	.0	6.0	3.0	4.0	12.0	9.5	10.5	17.5	15.5	16.0
3	.0	.0	.0	6.5	3.5	5.0	11.5	8.5	10.0	16.5	14.5	15.5
4	.5	.0	.0	7.0	4.0	5.5	9.5	7.5	8.5	17.0	13.5	15.5
5	.0	.0	.0	7.5	4.5	6.0	11.0	6.5	8.5	16.5	14.0	15.0
6	.5	.0	.0	6.5	5.0	5.5	10.5	7.5	9.0	14.0	12.5	13.5
7	.0	.0	.0	7.0	4.0	5.5	10.0	7.0	8.5	13.0	12.0	12.5
8	.0	.0	.0	7.5	4.5	6.0	11.0	6.5	8.5	12.5	10.5	11.5
9	.0	.0	.0	7.5	4.5	6.0	10.0	7.0	8.5	13.5	10.0	11.5
10	.0	.0	.0	8.0	5.0	6.5	12.0	7.0	9.5	13.5	11.0	12.0
11	.0	.0	.0	8.5	5.0	6.5	13.5	8.0	10.5	11.5	10.0	10.5
12	.0	.0	.0	9.0	5.5	7.0	14.0	9.5	11.5	10.0	9.0	9.5
13	.0	.0	.0	9.5	5.5	7.5	12.5	10.0	11.0	10.5	8.5	9.5
14	.0	.0	.0	9.5	6.0	7.5	13.5	9.0	11.0	12.5	9.0	11.0
15	.5	.0	.0	10.0	6.5	8.0	15.0	10.0	12.5	14.5	11.0	13.0
16	.5	.0	.0	10.5	6.5	8.5	15.0	11.5	13.5	13.0	13.0	13.0
17	1.5	.0	.5	9.5	7.5	8.5	16.0	11.5	13.5	14.0	12.5	13.0
18	1.0	.0	.5	9.0	7.0	8.0	---	---	---	14.5	12.5	13.5
19	3.0	.5	1.5	10.0	7.0	8.0	---	---	---	14.0	12.5	13.5
20	4.5	2.5	3.5	9.0	6.0	7.5	---	---	---	16.0	13.5	15.0
21	4.5	3.0	3.5	8.5	5.0	6.5	15.5	12.0	13.5	17.5	15.5	16.5
22	5.5	3.5	4.5	9.5	5.0	7.0	16.0	11.5	13.5	17.0	15.5	16.5
23	6.0	3.5	5.0	8.5	6.5	7.5	16.5	12.0	14.5	15.5	15.0	15.5
24	6.5	4.0	5.0	10.0	6.0	8.0	18.0	13.5	15.5	15.5	14.5	15.0
25	6.0	4.0	5.0	11.0	7.0	9.0	16.5	14.5	15.5	15.5	14.5	15.0
26	6.0	4.0	5.0	10.5	7.5	9.0	18.0	14.0	15.5	16.5	14.5	15.5
27	4.0	3.0	4.0	9.0	7.0	8.0	16.5	13.0	14.5	16.5	16.0	16.0
28	5.0	2.5	4.0	10.5	7.0	8.5	16.0	12.5	14.0	16.5	15.5	16.0
29	---	---	---	12.0	7.5	9.5	16.5	13.0	14.5	16.0	15.0	15.5
30	---	---	---	10.0	8.5	9.0	17.5	14.0	15.5	16.5	15.0	16.0
31	---	---	---	11.0	8.0	9.5	---	---	---	17.0	16.0	16.5
MONTH	6.5	.0	1.5	12.0	2.5	7.0	18.0	6.5	12.0	18.0	8.5	14.0

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		JUNE			JULY			AUGUST			SEPTEMBER	
1	16.5	15.5	16.0	20.5	19.5	20.0	26.0	22.0	23.5	22.5	18.0	20.0
2	15.5	14.5	15.0	21.5	19.5	20.5	26.0	22.0	23.5	22.0	18.5	20.0
3	15.5	15.0	15.0	21.5	20.0	21.0	26.0	22.0	24.0	21.0	17.0	18.5
4	16.0	14.0	15.0	22.0	20.5	21.5	26.0	23.0	24.0	22.0	16.5	19.0
5	16.5	14.5	15.5	23.0	21.0	22.0	26.0	22.0	23.5	21.5	18.5	19.5
6	17.5	15.5	16.5	23.5	22.0	22.5	25.5	22.5	24.0	22.0	18.0	19.5
7	18.5	16.5	17.5	24.0	22.0	23.0	25.5	22.5	23.5	22.5	18.0	20.0
8	18.0	17.5	18.0	22.5	21.0	21.5	24.5	22.5	23.5	23.5	18.5	20.5
9	18.0	16.0	17.0	22.0	20.0	21.0	24.5	21.5	23.0	24.0	18.5	21.0
10	16.0	15.0	15.5	23.0	21.0	22.0	25.5	21.0	23.0	22.5	19.0	20.5
11	15.5	14.5	15.0	22.5	21.0	21.5	26.0	21.5	23.5	23.5	18.5	21.0
12	15.5	14.5	15.0	23.0	21.0	22.0	27.0	22.0	24.0	23.5	19.0	21.0
13	16.0	15.0	15.5	24.5	21.5	22.5	26.0	22.5	24.0	23.0	19.0	21.0
14	15.5	14.5	15.0	25.0	22.0	23.5	27.5	22.5	24.5	21.5	19.0	20.0
15	14.0	13.0	13.0	24.5	22.5	23.5	27.0	22.5	24.5	21.5	18.0	19.0
16	14.0	12.0	13.0	25.0	22.0	23.5	26.5	22.5	24.0	20.5	16.5	18.5
17	13.5	12.5	13.0	24.5	22.0	23.0	27.5	22.5	24.5	20.0	15.5	17.5
18	14.0	12.5	13.5	25.5	22.0	23.5	28.0	22.5	25.0	20.5	16.0	18.0
19	15.0	13.5	14.5	24.5	23.0	23.5	28.0	23.0	25.0	20.5	16.0	18.0
20	16.5	14.5	15.5	26.0	22.5	24.0	28.0	23.0	25.5	20.0	17.0	18.0
21	17.0	16.0	16.5	26.0	23.0	24.5	25.0	23.0	24.0	19.5	16.0	17.5
22	18.0	16.0	17.0	26.0	23.0	24.0	26.5	22.0	24.0	19.0	15.0	17.0
23	18.5	16.5	17.5	25.0	22.5	23.5	25.5	21.5	23.5	18.5	15.0	16.5
24	19.0	17.0	18.0	23.0	21.5	22.5	26.0	21.5	23.5	18.0	15.0	16.0
25	19.5	18.0	18.5	21.5	20.0	21.0	26.5	22.0	24.0	16.0	14.0	15.5
26	19.5	18.0	19.0	21.0	19.0	20.0	26.0	22.0	23.5	15.0	13.0	13.5
27	20.0	19.0	19.5	23.0	19.0	20.5	25.5	21.5	23.0	14.5	12.0	13.0
28	19.5	19.0	19.0	24.0	20.0	21.5	25.5	20.5	23.0	16.0	12.0	14.0
29	19.5	18.0	19.0	24.5	21.0	22.5	26.0	21.0	23.0	16.0	13.5	14.5
30	20.5	18.5	19.5	24.5	22.0	23.0	25.0	20.0	22.5	16.5	13.5	14.5
31	---	---	---	25.5	22.0	23.5	22.5	18.5	20.5	---	---	---
MONTH	20.5	12.0	16.5	26.0	19.0	22.5	28.0	18.5	23.5	24.0	12.0	18.0
YEAR	28.0	.0	11.0									

06309000 YELLOWSTONE RIVER AT MILES CITY, MT--Continued

WATER-QUALITY RECORDS

PERIOD OF RECORD.--Water years 1948-52, 1965, 1974-75, 1977 to current year.

PERIOD OF DAILY RECORD.--
WATER TEMPERATURES: May 1974 to September 1975, July 1977 to current year.

INSTRUMENTATION.--Temperature recorder May 1974 to September 1975, July 1977 to current year.

REMARKS.--Temperature probe located about 25 ft (8 m) out from left bank. Flow from Tongue River enters on right bank 0.9 mi (1.4 km) upstream from gage. Temperature record is equivalent to Yellowstone River near Miles City (station 06296120) located above confluence of the Tongue River.

EXTREMES FOR PERIOD OF DAILY RECORD.--
WATER TEMPERATURES: Maximum, 28.0°C Aug. 18-20, 1981; minimum, 0.0°C on many days during winter periods.

EXTREMES FOR CURRENT YEAR.--
WATER TEMPERATURES: Maximum, 28.0°C Aug. 18-20; minimum, 0.0°C on many days during November to February.

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		OCTOBER			NOVEMBER			DECEMBER			JANUARY	
1	16.0	14.0	15.0	9.0	7.0	8.0	.0	.0	.0	2.0	1.5	1.5
2	15.5	12.5	14.0	8.0	7.5	7.5	.0	.0	.0	2.5	1.0	1.5
3	15.5	13.0	14.5	8.5	7.0	7.5	.0	.0	.0	2.5	1.5	2.0
4	16.0	13.5	14.5	8.5	7.0	7.5	.0	.0	.0	2.0	1.0	1.5
5	16.5	14.0	15.5	9.5	7.0	8.0	.0	.0	.0	2.5	1.0	1.5
6	17.0	14.5	15.5	9.0	7.5	8.5	.0	.0	.0	2.5	1.5	2.0
7	17.0	14.5	15.5	10.0	8.0	9.0	.0	.0	.0	2.5	1.5	2.0
8	17.0	14.5	15.5	10.0	8.5	9.5	.0	.0	.0	1.5	1.0	1.5
9	15.5	13.5	15.0	9.5	8.0	8.5	.0	.0	.0	1.5	1.0	1.5
10	14.5	12.5	13.5	8.0	7.0	7.5	.0	.0	.0	2.0	.5	1.0
11	13.5	11.0	12.0	7.0	6.0	6.5	.0	.0	.0	1.5	.5	1.0
12	13.0	11.0	12.0	6.0	5.5	5.5	.0	.0	.0	1.5	.0	.5
13	13.5	11.0	12.0	6.0	4.5	5.5	.0	.0	.0	2.0	.5	1.0
14	13.0	11.0	12.0	5.0	4.0	4.5	.0	.0	.0	2.0	.5	1.0
15	11.5	10.0	10.5	4.5	3.0	3.5	.5	.0	.0	1.5	1.0	1.0
16	9.5	7.5	8.0	4.5	3.5	4.0	.5	.0	.5	1.5	.5	1.0
17	7.5	6.5	7.0	4.0	2.5	3.0	.5	.0	.5	.5	.5	.5
18	7.5	6.0	7.0	3.5	2.0	3.0	.0	.0	.0	1.0	.5	.5
19	9.5	7.0	8.5	3.0	2.0	2.5	.0	.0	.0	1.0	.5	.5
20	10.5	8.0	9.5	3.0	1.5	2.5	.0	.0	.0	1.0	.5	.5
21	11.0	9.5	10.5	3.0	2.0	2.5	.0	.0	.0	.5	.0	.5
22	10.0	7.5	9.0	3.0	2.0	2.5	.0	.0	.0	2.0	.5	1.0
23	8.0	7.0	7.5	2.5	1.0	2.0	.0	.0	.0	3.0	1.0	2.0
24	7.0	6.5	6.5	1.5	.5	1.0	.0	.0	.0	3.0	1.5	2.5
25	7.0	5.5	6.0	1.0	.0	.5	.0	.0	.0	3.0	2.0	2.5
26	6.0	5.5	5.5	1.5	.0	.5	.0	.0	.0	3.0	1.5	2.0
27	5.5	5.0	5.0	.5	.0	.0	.0	.0	.0	2.5	1.0	1.5
28	7.0	5.0	5.5	1.5	.5	1.0	.0	.0	.0	1.0	.5	1.0
29	7.0	5.0	6.0	1.5	1.0	1.0	.0	.0	.0	.5	.0	.0
30	7.5	5.5	6.5	1.5	.0	1.5	1.5	.0	1.0	.5	.0	.0
31	8.0	6.0	7.0	---	---	---	2.0	1.0	1.5	.0	.0	.0
MONTH	17.0	5.0	10.5	10.0	.0	4.5	2.0	.0	.0	3.0	.0	1.0

06309000 YELLOWSTONE RIVER AT MILES CITY, MT

LOCATION.--Lat 46°25'18", long 105°51'38", in NE¼SW¼NW¼ sec.28, T.8 N., R.47 E., Custer County, Hydrologic Unit 10100001, on left bank at upstream side of bridge on State Highway 22 at Miles City, 0.8 mi (1.3 km) downstream from Tongue River, and at mile 184.2 (296.4 km).

DRAINAGE AREA.--48,253 mi^2 (124,975 km^2).

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--September 1922 to September 1923, August 1928 to current year. Monthly discharge only for some periods, published in WSP 1309.

REVISED RECORDS.--WSP 1729: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,333.3 ft (711.19 m) National Geodetic Vertical Datum of 1929 (levels by U.S. Army Corps of Engineers). Prior to May 6, 1929, nonrecording gages at pumping plant 1.2 mi (1.9 km) downstream at different datums. May 6, 1929, to Sept. 30, 1931, nonrecording gage, and Oct. 1, 1931, to Nov. 10, 1937, water-stage recorder 300 ft (91 m) upstream from present site at same datum. Nov. 11, 1937, to Sept. 30, 1946, water-stage recorder at pumping plant 1.2 mi (1.9 km) downstream at different datum. Oct. 1, 1946, to Mar. 15, 1979, water-stage recorder at site 300 ft (91 m) upstream at present datum. Mar. 16, 1979, to Sept. 21, 1979, nonrecording gage at present site and datum. Sept. 22, 1979, recording gage established at same site and datum.

REMARKS.--Water-discharge records fair except those for winter period, which are poor. Some regulation by reservoirs on tributary streams. Diversions for irrigation of about 1,100,000 acres (4,450 km^2) above station (does not include flood irrigation). Several observations of water temperature were made during the year and are available in files of Helena district office.

AVERAGE DISCHARGE.--54 years (1922-23, 1928-81), 11,570 ft^3/s (327.7 m^3/s), 8,382,000 acre-ft/yr (10.3 km^3/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 102,000 ft^3/s (2,889 m^3/s) May 22, 1978, gage height, 16.50 ft (5.029 m); maximum gage height, 21.7 ft (6.61 m) Mar. 20, 1944 (ice jam, from floodmark, at site 300 ft (91 m) upstream at present datum); minimum discharge, 996 ft^3/s (28.2 m^3/s) Dec. 14, 1932.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 57,200 ft^3/s (1,620 m^3/s) June 12, gage height, 11.38 ft (3.469 m); minimum daily, 3,260 ft^3/s (92.3 m^3/s) Apr. 27.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	10500	8410	6600	7490	6000	5920	4810	6600	44000	30700	8700	4620
2	10100	8320	6600	7280	5950	5810	4710	6210	46200	28100	8290	4730
3	9810	8260	6600	7130	5850	5750	4490	6130	48500	27100	8090	4730
4	9670	8160	6200	7090	5800	5680	4200	8430	42000	26500	7860	4650
5	9550	8030	5400	7000	5800	5640	4370	11800	38800	25300	7730	4600
6	9350	7940	6000	6930	5800	5590	4670	11500	37800	24000	7310	4670
7	9230	7920	6600	6860	5750	5560	4570	9950	36800	22400	6970	4700
8	9110	7880	6200	6810	5800	5520	4500	10400	40200	20700	6660	4750
9	8990	7810	5600	6760	5200	5520	4440	11100	44900	20300	6600	4860
10	8840	7780	5200	6640	4500	5510	4440	10800	47500	19500	6130	4930
11	8810	8110	7000	6580	3600	5460	4400	10700	54400	17200	5980	4860
12	8820	8630	7600	6580	3700	5190	4300	11300	53800	15700	5900	4750
13	8810	8440	7200	6550	4200	4800	4220	14600	45300	14900	5560	4800
14	8750	8290	7800	6450	4800	4600	4230	15800	41500	15000	5470	4700
15	8780	8280	8650	6400	5600	4510	4180	14800	40900	14500	5450	4470
16	9350	8130	8200	6400	7000	4510	3900	14000	38700	13200	5250	4520
17	10100	7680	7600	6250	9550	4600	3800	13700	35800	12400	5390	4650
18	10700	7350	6600	6150	9000	4610	3700	16900	32700	11800	5230	4650
19	10500	7120	6000	6350	8000	4760	3500	23600	31300	10900	5120	4650
20	10500	7090	6700	6400	7590	4760	3480	22100	29500	10300	4910	4730
21	10600	7190	6850	6450	7330	4700	3660	21400	28100	10100	4500	4730
22	10800	7250	6600	6580	7040	4670	3840	22700	31200	9840	4220	4700
23	11600	7060	6200	6550	6630	4670	4300	25800	32800	9410	4400	4750
24	11600	7120	5200	6500	6590	4600	4170	31800	32100	9190	4420	4860
25	11000	7000	4400	6490	6350	4570	3980	37700	34900	8880	4520	4910
26	8950	6810	5200	6420	6150	4580	3540	37800	36100	8810	4370	4880
27	8570	6750	6000	6430	6000	4500	3260	37900	33800	9300	4200	5010
28	9230	6690	8450	6310	5930	4570	3770	41400	32600	9950	4100	5280
29	9050	6850	8350	6150	---	4670	5580	45800	33900	10300	4200	5450
30	8880	6800	8000	6200	---	5070	6510	46700	34000	9910	4470	5560
31	8790	---	7690	6200	---	4960	---	44800	---	9330	4570	---
TOTAL	299340	229150	207290	204380	171510	155860	127520	644220	1160100	485520	176570	144150
MEAN	9656	7638	6687	6593	6125	5028	4251	20780	38670	15660	5696	4805
MAX	11600	8630	8650	7490	9550	5920	6510	46700	54400	30700	8700	5560
MIN	8570	5690	4400	6150	3600	4500	3260	6130	28100	8810	4100	4470
AC-FT	593700	454500	411200	405400	340200	309100	252900	1278000	2301000	963000	350200	285900

CAL YR 1980 TOTAL 3939250 MEAN 10760 MAX 33300 MIN 2200 AC-FT 7814000
WTR YR 1981 TOTAL 4005610 MEAN 10970 MAX 54400 MIN 3260 AC-FT 7945000

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

PARTICLE-SIZE DISTRIBUTION OF SUSPENDED SEDIMENT, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	TIME	TEMPER-ATURE (DEG C) (00010)	DIS-CHARGE, IN CUBIC FEET PER SECOND (00060)	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	SED. SUSP. FALL DIAM. % FINER THAN .002 MM (70337)	SED. SUSP. FALL DIAM. % FINER THAN .004 MM (70338)	SED. SUSP. FALL DIAM. % FINER THAN .008 MM (70339)	SED. SUSP. FALL DIAM. % FINER THAN .016 MM (70340)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM (70331)
OCT 26...	1445	8.5	--	241	29	19	--	--	--	--	94
NOV 05...	1400	7.5	--	222	16	9.6	--	--	--	--	90
DEC 16...	0900	.0	190	--	42	22	--	--	--	--	--
21...	1400	.0	190	--	38	19	--	--	--	--	82
FEB 19...	1130	.0	530	--	651	932	--	--	--	--	97
MAR 17...	1410	8.5	--	379	154	158	--	--	--	--	96
APR 14...	1500	16.0	--	233	70	44	--	--	--	--	82
JUN 11...	0730	16.0	--	343	627	581	86	90	90	92	98
JUL 19...	1355	25.0	--	288	89	69	--	--	--	--	96
AUG 10...	1110	18.0	--	196	314	166	--	--	--	--	99
SEP 02...	1355	23.5	--	226	91	56	--	--	--	--	99

YELLOWSTONE RIVER BASIN

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

SUSPENDED-SEDIMENT, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DAY	OCTOBER MEAN CONCEN-TRATION (MG/L)	OCTOBER LOADS (T/DAY)	NOVEMBER MEAN CONCEN-TRATION (MG/L)	NOVEMBER LOADS (T/DAY)	DECEMBER MEAN CONCEN-TRATION (MG/L)	DECEMBER LOADS (T/DAY)	JANUARY MEAN CONCEN-TRATION (MG/L)	JANUARY LOADS (T/DAY)	FEBRUARY MEAN CONCEN-TRATION (MG/L)	FEBRUARY LOADS (T/DAY)	MARCH MEAN CONCEN-TRATION (MG/L)	MARCH LOADS (T/DAY)
1	63	44	36	23	32	15	24	9.7	40	24	102	88
2	63	44	38	24	30	15	31	11	44	23	146	110
3	47	32	37	23	32	16	23	8.7	33	12	152	94
4	85	58	32	20	34	18	19	8.2	22	8.9	106	66
5	79	51	26	16	32	18	41	15	19	9.2	60	36
6	68	38	30	18	27	16	42	14	24	14	54	35
7	54	30	32	19	32	20	32	13	24	13	62	44
8	52	29	63	38	28	17	25	13	27	11	51	33
9	70	38	34	20	25	16	31	13	30	12	42	34
10	99	55	23	14	32	22	43	13	28	13	363	461
11	72	40	17	10	49	34	37	14	26	13	1020	1600
12	1440	1070	10	5.9	31	19	24	9.7	17	9.6	2110	2850
13	1180	742	15	8.9	32	18	46	21	21	14	1640	1870
14	330	192	20	12	51	28	72	45	25	20	1300	1350
15	129	76	13	7.7	33	18	86	44	27	29	605	689
16	78	51	21	12	46	24	42	17	31	39	376	432
17	56	44	30	18	50	26	29	15	552	715	162	178
18	50	38	28	17	56	23	27	16	598	807	135	138
19	52	39	26	16	43	21	24	14	600	859	123	115
20	61	47	46	27	44	25	23	13	533	863	100	84
21	64	50	42	24	41	21	18	6.8	318	601	68	49
22	62	48	23	14	31	15	20	7.0	237	384	56	35
23	69	52	19	11	32	15	24	8.4	287	387	497	417
24	34	25	33	19	62	28	25	10	302	326	691	625
25	17	12	41	25	48	23	25	13	250	202	352	303
26	21	15	20	12	32	16	48	36	215	174	216	177
27	32	20	17	6.4	31	14	53	46	123	106	176	128
28	28	18	18	7.3	31	13	33	24	93	85	738	524
29	26	17	15	6.1	25	8.8	40	27	---	---	996	608
30	28	18	29	13	24	9.1	32	18	---	---	728	405
31	26	16	---	---	32	13	34	18	---	---	398	175
TOTAL	---	3049	---	487.3	---	584.9	---	541.5	---	5773.7	---	13753

DAY	APRIL MEAN CONCEN-TRATION (MG/L)	APRIL LOADS (T/DAY)	MAY MEAN CONCEN-TRATION (MG/L)	MAY LOADS (T/DAY)	JUNE MEAN CONCEN-TRATION (MG/L)	JUNE LOADS (T/DAY)	JULY MEAN CONCEN-TRATION (MG/L)	JULY LOADS (T/DAY)	AUGUST MEAN CONCEN-TRATION (MG/L)	AUGUST LOADS (T/DAY)	SEPTEMBER MEAN CONCEN-TRATION (MG/L)	SEPTEMBER LOADS (T/DAY)
1	232	131	80	74	184	109	810	2410	403	238	151	93
2	144	95	66	61	105	60	651	2020	343	206	111	69
3	90	60	63	58	80	42	746	2640	278	164	90	54
4	70	47	73	47	57	30	937	3670	224	123	86	52
5	66	44	81	46	80	42	736	2980	162	86	85	52
6	136	90	65	49	686	800	601	2390	144	76	86	52
7	182	122	66	49	5100	9580	438	1540	142	74	94	56
8	133	90	75	49	7370	9730	222	540	129	64	85	48
9	506	374	63	41	5490	9320	187	378	120	62	78	46
10	499	360	55	36	1990	2480	144	251	133	71	78	44
11	179	127	53	33	770	707	143	216	173	90	69	37
12	131	89	53	32	546	414	146	202	144	74	57	30
13	150	99	55	33	347	336	121	153	131	66	51	26
14	66	43	62	37	297	324	121	139	105	50	53	27
15	43	28	55	33	765	956	114	121	103	50	282	169
16	33	21	155	104	684	850	91	89	120	66	250	173
17	32	20	580	388	887	1140	91	80	125	70	122	84
18	47	29	311	196	967	1210	89	69	133	92	62	38
19	87	52	110	66	550	799	77	61	245	142	69	47
20	81	66	1870	2600	436	554	90	69	148	76	69	46
21	87	77	7980	12400	301	376	103	73	107	56	56	37
22	89	80	3260	3030	235	292	101	65	117	71	50	33
23	86	78	616	437	216	261	94	61	192	140	50	33
24	90	81	315	195	208	249	375	542	609	339	48	31
25	84	76	292	170	218	266	3040	6210	853	444	47	31
26	68	62	244	136	257	332	1190	1250	461	264	50	32
27	68	62	213	113	737	1410	3690	7350	245	128	168	157
28	65	59	206	111	983	2160	3640	3850	295	156	2510	2340
29	62	57	1820	1690	939	2530	3700	2910	235	131	1090	892
30	62	57	726	494	889	2500	1760	1280	200	114	330	247
31	---	---	323	200	---	---	715	436	193	114	---	---
TOTAL	---	2676	---	23008	---	49859	---	44045	---	3897	---	5076

TOTAL LOAD FOR YEAR: 152750.4 TONS.

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DAY	MAX	MIN FEBRUARY	MEAN	MAX	MIN MARCH	MEAN	MAX	MIN APRIL	MEAN	MAX	MIN MAY	MEAN
1	.0	.0	.0	---	---	---	---	---	---	20.0	13.0	16.5
2	.0	.0	.0	---	---	---	---	---	---	22.0	15.0	18.5
3	.0	.0	.0	---	---	---	---	---	---	21.5	17.0	19.5
4	.0	.0	.0	---	---	---	---	---	---	18.0	13.5	15.0
5	.0	.0	.0	---	---	---	---	---	---	14.5	10.0	12.5
6	.0	.0	.0	---	---	---	---	---	---	14.5	10.0	12.5
7	.0	.0	.0	---	---	---	---	---	---	17.0	11.0	14.0
8	.0	.0	.0	---	---	---	---	---	---	17.5	13.0	15.0
9	.0	.0	.0	---	---	---	---	---	---	13.5	11.5	12.5
10	.0	.0	.0	---	---	---	---	---	---	11.5	9.0	10.0
11	.0	.0	.0	---	---	---	---	---	---	13.0	8.5	10.5
12	.0	.0	.0	---	---	---	---	---	---	17.5	10.0	14.0
13	.0	.0	.0	---	---	---	---	---	---	17.0	12.5	15.0
14	.0	.0	.0	---	---	---	---	---	---	15.0	13.0	14.0
15	.0	.0	.0	---	---	---	12.0	8.5	11.0	14.0	12.5	13.0
16	.0	.0	.0	---	---	---	12.0	7.0	9.5	13.5	11.5	12.5
17	.0	.0	.0	---	---	---	13.5	6.5	10.0	18.5	12.5	15.0
18	.0	.0	.0	---	---	---	10.0	7.0	8.5	22.0	14.0	18.0
19	---	---	---	---	---	---	6.5	4.0	5.0	19.5	16.5	18.0
20	---	---	---	---	---	---	9.0	3.5	6.0	16.5	13.0	14.0
21	---	---	---	---	---	---	13.0	5.5	9.0	16.5	13.0	14.5
22	---	---	---	---	---	---	16.0	8.5	12.0	21.5	14.0	17.5
23	---	---	---	---	---	---	18.5	11.0	14.5	19.0	16.5	18.0
24	---	---	---	---	---	---	18.0	12.5	15.5	16.0	14.0	15.0
25	---	---	---	---	---	---	14.0	11.5	12.5	21.0	13.0	17.0
26	---	---	---	---	---	---	14.5	8.5	11.5	23.0	15.0	19.0
27	---	---	---	---	---	---	16.0	10.0	13.0	20.0	16.5	18.5
28	---	---	---	---	---	---	17.0	11.0	14.0	17.5	12.0	15.0
29	---	---	---	---	---	---	15.5	12.0	13.5	13.5	9.5	11.5
30	---	---	---	---	---	---	18.0	10.5	14.0	13.0	9.5	11.0
31	---	---	---	---	---	---	---	---	---	18.5	9.5	14.0
MONTH	.0	.0	.0	---	---	---	18.5	3.5	11.0	23.0	8.5	15.0

DAY	MAX	MIN JUNE	MEAN	MAX	MIN JULY	MEAN	MAX	MIN AUGUST	MEAN	MAX	MIN SEPTEMBER	MEAN
1	18.5	13.0	16.0	25.0	21.5	23.5	27.0	20.0	23.5	22.0	18.0	20.0
2	20.0	15.0	17.5	24.5	22.0	23.5	23.5	20.5	22.0	23.5	17.5	20.5
3	21.0	14.0	17.5	25.0	21.5	23.0	25.5	19.0	22.0	24.0	18.0	21.0
4	22.5	15.5	19.0	25.5	22.5	24.0	25.0	18.5	22.0	23.5	18.5	21.0
5	24.0	16.0	20.0	24.5	22.0	23.0	26.0	20.5	23.0	24.0	18.5	21.0
6	20.0	14.0	16.5	23.0	21.0	22.0	26.5	20.5	23.5	24.5	19.0	22.0
7	18.0	12.5	15.5	24.5	20.0	22.5	27.0	21.0	24.0	25.0	19.5	22.0
8	16.0	12.5	14.5	23.0	22.0	22.5	25.0	20.5	22.5	24.5	18.5	21.5
9	18.0	11.5	14.5	22.5	20.5	21.5	20.5	16.5	18.0	24.5	19.0	22.0
10	20.5	15.0	18.0	24.5	19.5	22.0	22.0	15.5	18.5	21.5	18.5	20.0
11	23.0	15.5	19.5	26.5	21.0	23.5	24.0	17.5	20.5	20.0	16.0	18.0
12	25.0	18.5	21.5	27.5	22.5	25.0	24.5	19.0	21.5	19.5	14.5	17.0
13	24.5	20.0	22.5	28.5	22.5	25.5	25.0	18.5	22.0	15.5	11.5	14.0
14	24.0	20.5	22.5	28.5	23.5	26.0	26.5	20.5	23.5	11.5	10.0	10.5
15	26.0	19.5	22.5	27.5	23.5	25.5	25.0	20.0	22.5	13.0	9.0	11.5
16	24.0	20.5	22.5	25.5	20.0	22.5	26.5	20.0	23.0	14.0	11.5	13.0
17	22.5	20.0	21.0	20.5	18.0	19.5	27.0	21.0	24.0	16.5	10.5	13.5
18	22.5	18.0	20.5	24.5	17.5	21.0	28.5	22.0	25.0	17.5	12.0	15.0
19	23.0	18.0	20.5	26.5	20.5	23.5	26.5	23.0	24.5	17.0	12.5	15.0
20	25.0	19.5	22.5	28.0	22.0	25.0	28.0	21.5	25.0	17.0	12.0	14.5
21	27.0	21.0	24.0	29.5	23.5	26.0	26.5	22.5	24.5	18.0	12.5	15.5
22	28.5	22.0	25.5	29.5	23.5	26.5	25.0	21.5	23.0	19.0	15.0	17.0
23	27.0	23.5	25.0	29.0	25.0	27.0	22.0	18.0	20.5	18.0	14.0	16.0
24	24.5	21.0	23.0	25.5	22.5	25.0	22.0	16.5	19.5	19.0	14.5	17.0
25	24.0	20.0	22.0	22.0	19.0	20.5	23.0	17.5	20.0	19.0	15.0	17.0
26	27.0	20.0	23.5	24.5	18.5	21.5	22.5	18.0	20.0	17.0	14.5	15.5
27	27.0	22.5	25.0	24.0	20.0	22.0	23.5	17.0	20.0	15.5	13.5	14.5
28	26.5	23.0	24.5	24.0	20.0	22.0	24.5	19.5	22.0	13.5	10.5	12.0
29	25.0	22.5	23.5	23.5	19.0	21.0	24.5	20.5	22.5	10.5	9.5	10.0
30	23.5	21.0	22.0	25.0	18.5	22.0	25.0	20.0	22.0	9.5	8.0	9.0
31	---	---	---	25.0	20.0	22.5	23.0	20.0	21.5	---	---	---
MONTH	28.5	11.5	21.0	29.5	17.5	23.0	28.5	15.5	22.0	25.0	8.0	16.5
YEAR	29.5	.0	11.5									

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI) (01067)	NICKEL, DIS-SOLVED (UG/L AS NI) (01065)	SELE-NIUM, TOTAL (UG/L AS SE) (01147)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG) (01077)	SILVER, DIS-SOLVED (UG/L AS AG) (01075)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN) (01092)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
OCT									
26...	.0	5	0	0	0	1	0	10	3
FEB									
19...	<.1	19	<1	1	<1	<1	<1	90	10
JUN									
11...	--	16	4	1	1	1	<1	70	62
AUG									
10...	<.1	9	1	<1	<1	<1	<1	40	26

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DAY	MAX	MIN OCTOBER	MEAN	MAX	MIN NOVEMBER	MEAN	MAX	MIN DECEMBER	MEAN	MAX	MIN JANUARY	MEAN
1	16.0	11.0	14.0	9.5	5.5	8.0	.0	.0	.0	.0	.0	.0
2	16.5	11.5	14.5	9.5	6.0	8.0	.0	.0	.0	.0	.0	.0
3	15.0	12.5	13.5	9.0	6.0	8.0	.5	.0	.0	.0	.0	.0
4	12.0	10.0	11.0	8.5	5.5	7.5	.5	.0	.0	.0	.0	.0
5	12.5	9.0	10.5	7.5	5.0	6.5	.0	.0	.0	.0	.0	.0
6	12.5	7.5	10.5	6.5	3.5	5.5	.0	.0	.0	.0	.0	.0
7	13.5	9.5	12.0	7.0	3.5	5.5	.5	.0	.0	.0	.0	.0
8	12.5	10.0	11.5	6.0	5.0	5.5	.0	.0	.0	.0	.0	.0
9	12.5	8.0	10.5	6.0	2.5	4.5	.5	.0	.0	.0	.0	.0
10	13.0	8.5	11.0	6.0	3.0	4.5	.5	.0	.0	.0	.0	.0
11	14.5	11.0	12.5	5.5	2.5	4.0	.0	.0	.0	.0	.0	.0
12	11.5	7.0	9.0	5.5	2.5	4.5	.0	.0	.0	.0	.0	.0
13	8.5	5.0	7.0	5.0	3.5	4.5	.0	.0	.0	.0	.0	.0
14	8.5	5.5	7.0	5.0	3.5	4.5	.0	.0	.0	.0	.0	.0
15	10.0	5.5	8.0	5.0	2.5	4.0	.0	.0	.0	.0	.0	.0
16	10.5	6.0	8.5	5.5	3.0	4.5	.0	.0	.0	.0	.0	.0
17	9.5	8.0	8.5	6.0	4.0	5.0	.0	.0	.0	.0	.0	.0
18	9.5	5.5	7.5	6.0	2.5	4.5	.0	.0	.0	.0	.0	.0
19	11.0	7.0	9.0	2.5	1.0	2.0	.0	.0	.0	.0	.0	.0
20	9.5	5.5	7.5	2.5	.0	1.0	.0	.0	.0	.0	.0	.0
21	7.5	4.5	5.5	2.0	.0	1.0	.0	.0	.0	.0	.0	.0
22	5.0	3.0	4.0	2.5	1.0	1.5	.0	.0	.0	.0	.0	.0
23	3.5	1.0	2.5	3.0	1.0	2.0	.0	.0	.0	.0	.0	.0
24	4.5	3.0	3.5	2.5	1.0	1.5	.0	.0	.0	.0	.0	.0
25	6.5	3.5	5.0	1.5	.0	.5	.0	.0	.0	.0	.0	.0
26	9.0	4.5	7.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
27	9.5	6.0	8.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
28	10.5	7.0	9.0	.5	.0	.0	.0	.0	.0	.0	.0	.0
29	9.5	6.5	8.5	.5	.0	.0	.0	.0	.0	.0	.0	.0
30	9.0	6.5	7.5	.5	.0	.0	.0	.0	.0	.0	.0	.0
31	8.0	4.5	6.5	---	---	---	.0	.0	.0	.0	.0	.0
MONTH	16.5	1.0	8.5	9.5	.0	3.5	.5	.0	.0	.0	.0	.0

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	SODIUM AD-SORP-TION RATIO (00931)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	ALKA-LINITY LAB (MG/L AS CACO3) (90410)	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)	FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950)	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L) (70300)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) (70301)
OCT 26...	1.4	4.2	220	240	4.2	.3	6.8	548	551
DEC 21...	1.7	5.2	250	300	5.5	.4	5.6	639	686
FEB 19...	1.1	7.7	86	38	2.9	.1	5.5	183	155
APR 14...	1.6	5.9	250	290	5.3	.4	2.4	620	644
JUN 11...	1.6	4.7	180	170	3.7	.3	3.0	438	426
AUG 10...	1.2	3.9	170	120	2.7	.3	7.6	381	352

DATE	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L) (00530)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N) (00608)	NITRO-GEN, AM-MONIA + ORGANIC TOTAL (MG/L AS N) (00625)	PHOS-PHORUS, TOTAL (MG/L AS P) (00665)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P) (00671)
OCT 26...	.75	357	12	<.09	<.06	.66	.08	.02	.03
DEC 21...	.87	328	4	<.09	.09	.42	.03	.02	.02
FEB 19...	.25	262	611	.43	.70	4.4	.23	.13	.11
APR 14...	.84	390	27	<.10	.13	.82	<.01	<.01	<.01
JUN 11...	.60	406	--	.26	<.06	1.2	.22	.04	<.01
AUG 10...	.52	202	97	<.10	.17	1.4	.09	.08	.03

DATE	TIME	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA) (01007)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD) (01027)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, TOTAL RECOV-ERABLE (UG/L AS CR) (01034)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COBALT, TOTAL RECOV-ERABLE (UG/L AS CO) (01037)
OCT 26...	1445	1	1	100	68	<1	<1	<10	0	<1
FEB 19...	1130	2	1	100	31	1	<1	20	<10	8
JUN 11...	0730	2	2	<100	84	1	4	<10	<10	7
AUG 10...	1110	2	1	100	66	<1	1	20	<10	1

DATE	COBALT, DIS-SOLVED (UG/L AS CO) (01035)	COPPER, TOTAL RECOV-ERABLE (UG/L AS CU) (01042)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, TOTAL RECOV-ERABLE (UG/L AS PB) (01051)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG) (71900)
OCT 26...	<3	5	1	410	<10	3	0	20	5	.1
FEB 19...	<3	31	5	13000	180	15	1	270	17	.1
JUN 11...	<1	22	13	9600	91	7	4	220	51	.2
AUG 10...	<1	20	5	5400	13	8	<1	140	12	.2

06308500 TONGUE RIVER AT MILES CITY, MT--Continued
(National Stream Quality Accounting Network)

WATER-QUALITY RECORDS

LOCATION.--Samples collected at private ranch bridge, 11 mi (17.7 km) upstream from gaging station.

PERIOD OF RECORD.--Water years 1946 to current year.

PERIOD OF DAILY RECORD.--
WATER TEMPERATURES: April 1949 to current year.
SUSPENDED-SEDIMENT DISCHARGE: October 1977 to current year.

INSTRUMENTATION.--Temperature recorder April to July 1974, July 1977 to current year.

REMARKS.--Water-quality and sediment samples have been taken at private ranch bridge, 11 mi (17.7 km) upstream from gaging station since October 1977. Flow affected by ice during most of winter months.

EXTREMES FOR PERIOD OF DAILY RECORD.--
WATER TEMPERATURES: Maximum recorded (water years 1949-80, 1982), 30.5°C May 22, 1980; minimum, 0.0°C on many days during winter periods.
SEDIMENT CONCENTRATIONS: Maximum daily mean, 7,980 mg/L May 21, 1982; minimum daily mean, 6 mg/L Feb. 18, 1980.
SEDIMENT LOADS: Maximum daily, 84,400 tons (76,600 megagrams) May 18, 1978; minimum daily, 0.13 ton (0.12 megagram) May 5, 1981.

EXTREMES FOR CURRENT YEAR.--
WATER TEMPERATURES: Maximum, 29.5°C July 21, 22; minimum, 0.0°C on many days during November to February.
SEDIMENT CONCENTRATIONS: Maximum daily mean, 7,980 mg/L May 21; minimum daily mean, 10 mg/L Nov. 12.
SEDIMENT LOADS: Maximum daily, 12,400 tons (11,200 megagrams) May 21; minimum daily, 5.9 tons (5.4 megagrams) Nov. 12.

WATER QUALITY DATA, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	TIME	DIS-CHARGE, IN CUBIC FEET PER SECOND (00060)	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	WEATHER (WMO CODE NUMBER) (00041)	SPE-CIFIC CON-DUCT-ANCE (UMHOS) (00095)	PH (UNITS) (00400)	TEMPER-ATURE, AIR (DEG C) (00020)	TEMPER-ATURE (DEG C) (00010)	TUR-BID-ITY (NTU) (00076)	OXYGEN, DIS-SOLVED (MG/L) (00300)
OCT 26...	1445	--	241	1	775	8.4	17.5	8.5	8.0	10.5
DEC 21...	1400	190	--	1	980	8.3	2.5	.0	4.1	12.8
FEB 19...	1130	530	--	51	252	7.1	13.0	.0	400	11.9
APR 14...	1500	--	233	0	940	8.5	20.0	16.0	13	9.0
JUN 11...	0730	--	343	0	665	8.2	15.0	16.0	410	8.8
AUG 10...	1110	--	196	0	551	8.7	16.0	18.0	110	8.6

DATE	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)	OXYGEN DEMAND, CHEM-ICAL (HIGH LEVEL) (MG/L) (00340)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML) (31625)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)	HARD-NESS (MG/L AS CACO3) (00900)	HARD-NESS NONCAR-BONATE (MG/L AS CACO3) (95902)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)
OCT 26...	99	28	K8	61	334	110	61	44	58
DEC 21...	97	18	K6	45	439	190	80	58	81
FEB 19...	89	97	270	K13000	82	.00	18	9.0	22
APR 14...	102	16	K3	K43	385	130	70	51	69
JUN 11...	97	38	1700	1400	248	72	50	30	58
AUG 10...	99	17	1100	2100	223	50	48	25	40

06308500 TONGUE RIVER AT MILES CITY, MT

LOCATION.--Lat 46°20'44", long 105°48'10", in NE¼NE¼SE¼ sec.23, T.7 N., R.47 E., Custer County, Hydrologic Unit 10090102, on right bank 4 mi (6 km) south of Miles City and at mile 8.1 (13.0 km).

DRAINAGE AREA.--5,379 mi^2 (13,932 km^2).

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--April 1938 to April 1942, April 1946 to current year. Published as "near Miles City" April 1938 to April 1942. Not equivalent to records published as "near Miles City" May 1929 to October 1932. Monthly discharge only for some periods, published in WSP 1309.

REVISED RECORDS.--WSP 1729: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,375.76 ft (724.132 m) National Geodetic Vertical Datum of 1929 (levels by U.S. Army Corps of Engineers). April 1938 to April 1942, nonrecording gage at site 8 mi (13 km) upstream at different datum. April 1946 to Sept. 30, 1963, at datum 1.00 ft (0.305 m) higher.

REMARKS.--Water-discharge records good except those for winter periods, which are poor. Flow regulation by Tongue River Reservoir (station 06307000), and many small reservoirs in Wyoming (combined capacity about 15,000 acre-ft, 18.5 hm^2). Diversions for irrigation of about 100,800 acres (408 km^2), revised, above station.

AVERAGE DISCHARGE.--39 years (1938-41, 1946-82), 440 ft^3/s (12.46 m^3/s), 318,800 acre-ft/yr (393 hm^3/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 13,300 ft^3/s (377 m^3/s) June 15, 1962, gage height, 12.33 ft (3.758 m), present datum, from rating curve extended above 8,220 ft^3/s (233 m^3/s) on basis of float measurement; maximum gage height, 13.27 ft (4.045 m) Mar. 19, 1960, Feb. 15, 1971 (ice jam), present datum; no flow July 9-19, Aug. 13, 14, Sept. 28, 1940.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 1,510 ft^3/s (42.8 m^3/s) July 5, gage height 4.17 ft (1.271 m), maximum gage height, 10.02 ft (3.054 m) Feb. 21 (backwater from ice jam); minimum daily discharge, 110 ft^3/s (3.12 m^3/s) Jan. 10, result of freezeup.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	256	233	170	150	220	320	209	343	219	1100	219	229
2	256	233	180	130	190	280	244	343	212	1150	222	229
3	252	233	190	140	130	230	248	343	196	1310	219	222
4	252	233	200	160	150	230	248	237	193	1450	203	222
5	237	222	210	140	180	220	248	209	196	1500	196	226
6	206	222	220	120	210	240	244	277	360	1470	196	226
7	203	222	230	150	200	260	248	277	696	1300	193	222
8	203	222	220	190	150	240	252	241	489	901	183	209
9	203	222	240	160	150	300	274	241	629	748	190	219
10	206	219	260	110	170	470	267	241	462	646	199	209
11	206	219	260	140	180	580	263	233	340	560	193	196
12	252	219	230	150	210	500	252	226	281	512	190	193
13	233	219	210	170	240	422	244	222	359	467	187	187
14	215	219	200	230	300	386	241	219	404	424	176	190
15	219	219	200	190	400	422	237	222	463	393	180	222
16	244	219	190	150	460	426	233	248	460	363	203	256
17	288	219	190	190	480	407	229	248	475	327	206	256
18	281	222	150	220	500	379	229	233	463	288	256	226
19	281	222	180	220	530	347	222	222	538	295	215	252
20	284	219	210	210	600	311	303	458	471	284	190	248
21	288	215	190	140	700	267	327	575	463	263	193	248
22	288	222	180	130	600	233	331	344	460	237	226	248
23	277	219	170	130	500	307	335	263	448	241	270	244
24	267	212	170	150	400	335	335	229	444	464	206	241
25	263	229	180	200	300	319	335	215	452	724	193	241
26	260	220	180	280	300	303	335	206	479	389	212	237
27	237	140	170	320	320	270	339	196	707	726	193	293
28	237	150	150	270	340	263	339	199	815	392	196	345
29	237	150	130	250	---	226	339	308	999	291	206	303
30	233	160	140	210	---	206	339	252	1040	270	212	277
31	233	---	150	200	---	163	---	229	---	226	219	---
TOTAL	7597	6374	5950	5600	9110	9862	8289	8299	14213	19711	6342	7116
MEAN	245	212	192	181	325	318	276	268	474	636	205	237
MAX	288	233	260	320	700	580	339	575	1040	1500	270	345
MIN	203	140	130	110	130	163	209	196	193	226	176	187
AC-FT	15070	12640	11800	11110	18070	19560	16440	16460	28190	39100	12580	14110

CAL YR 1981 TOTAL 114557.4 MEAN 314 MAX 2200 MIN 2.2 AC-FT 227200
WTR YR 1982 TOTAL 108463.0 MEAN 297 MAX 1500 MIN 110 AC-FT 215100

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

PHYTOPLANKTON ANALYSES, JULY 1981 TO SEPTEMBER 1981

DATE	JUL 23,81		AUG 19,81		SEP 30,81	
TIME	0830		1300		1245	
TOTAL CELLS/ML	910		10000		16000	
DIVERSITY: DIVISION	1.3		1.4		0.3	
.CLASS	1.3		1.4		0.3	
..ORDER	2.3		1.9		0.4	
...FAMILY	2.8		2.6		0.4	
....GENUS	3.2		3.2		0.4	
ORGANISM	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT
BACILLARIOPHYTA (DIATOMS)						
.BACILLARIOPHYCEAE						
..ACHNANTHALES						
...ACHNANTHACEAE						
....ACHNANTHES	14	2	--	-	--	-
....COCCONEIS	28	3	200	2	160	1
..BACILLARIALES						
...NITZSCHIACEAE						
....NITZSCHIA	170#	18	67	1	43	0
..EUPODISCALES						
...COSCINODISCACEAE						
....CYCLOTELLA	42	5	34	0	--	-
..FRAGILARIALES						
...FRAGILARIACEAE						
....FRAGILARIA	--	-	67	1	--	-
....SYNEDRA	--	-	--	-	29	0
..NAVICULALES						
...GOMPHONEMACEAE						
....GOMPHONEMA	--	-	67	1	--	-
...NAVICULACEAE						
....NAVICULA	130	14	100	1	29	0
..SURIRELLALES						
...SURIRELLACEAE						
....CYMATOPLEURA	14	2	--	-	--	-
CHLOROPHYTA (GREEN ALGAE)						
.CHLOROPHYCEAE						
..CHLOROCOCCALES						
...CHLOROCOCCACEAE						
....SCHROEDERIA	--	-	200	2	29	0
....TETRAEDRON	--	-	--	-	58	0
...DICTYOSPHAERIACEAE						
....DICTYOSPHAERIUM	14	2	--	-	--	-
...OOCYSTACEAE						
....ANKISTRODESMUS	98	11	470	5	29	0
....CLOSTERIOPSIS	--	-	34	0	29	0
....OOCYSTIS	42	5	1900#	18	--	-
....SELENASTRUM	--	-	67	1	--	-
...SCENEDESMACEAE						
....COELASTRUM	56	6	1400	13	120	1
....CRUCIGENIA	--	-	270	3	--	-
....GLOEOACTINIUM	--	-	--	-	58	0
....SCENEDESMUS	220#	25	980	10	170	1
..VOLVOCALES						
...CHLAMYDOMONADACEAE						
....CHLAMYDOMONAS	42	5	170	2	--	-
...PHACOTACEAE						
....PHACOTUS	--	-	67	1	--	-
..ZYGNEMATALES						
...DESMIDIACEAE						
....STAURASTRUM	--	-	--	-	14	0
CRYPTOPHYTA (CRYPTOMONADS)						
.CRYPTOPHYCEAE						
..CRYPTOMONADALES						
...CRYPTOCHRYSIDACEAE						
....CHROOMONAS	14	2	--	-	--	-
CYANOPHYTA (BLUE-GREEN ALGAE)						
.CYANOPHYCEAE						
..CHROOCOCCALES						
...CHROOCOCCACEAE						
....ANACYSTIS	28	3	980	10	--	-
....GOMPHOSPHAERIA	--	-	--	-	15000#	95
..OSCILLATORIALES						
...OSCILLATORIACEAE						
....OSCILLATORIA	--	-	2900#	28	--	-
EUGLENOPHYTA (EUGLENOIDS)						
.EUGLENOPHYCEAE						
..EUGLENALES						
...EUGLENACEAE						
....TRACHELOMONAS	--	-	340	3	14	0

NOTE: # - DOMINANT ORGANISM; EQUAL TO OR GREATER THAN 15%

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

PHYTOPLANKTON ANALYSES, OCTOBER 1980 TO MAY 1981

DATE	NOV 18,80		MAR 24,81		MAY 19,81	
TIME	1300		0930		1030	
TOTAL CELLS/ML	170		370		3800	
DIVERSITY: DIVISION	1.5		1.5		1.6	
.CLASS	1.5		1.5		1.6	
..ORDER	2.8		2.6		2.3	
...FAMILY	2.8		2.6		3.1	
....GENUS	2.8		2.7		3.2	
ORGANISM	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT
BACILLARIOPHYTA (DIATOMS)						
.BACILLARIOPHYCEAE						
..ACHNANTHALES						
...ACHNANTHACEAE						
....ACHNANTHES	--	-	--	-	20	1
....COCCONEIS	13	8	--	-	20	1
..BACILLARIALES						
...NITZSCHIACEAE						
....NITZSCHIA	13	8	39	10	440	12
..EUPODISCALES						
...COSCINODISCACEAE						
....CYCLOTELLA	39#	23	130#	34	--	-
....STEPHANODISCUS	--	-	--	-	780#	20
..FRAGILARIALES						
...FRAGILARIACEAE						
....DIATOMA	--	-	13	3	--	-
....FRAGILARIA	--	-	--	-	20	1
....SYNEDRA	--	-	26	7	20	1
..NAVICULALES						
...NAVICULACEAE						
....NAVICULA	39#	23	13	3	240	6
CHLOROPHYTA (GREEN ALGAE)						
.CHLOROPHYCEAE						
..CHLOROCOCCALES						
...DICTYOSPHAERIACEAE						
....DICTYOSPHAERIUM	--	-	--	-	80	2
...HYDRODICTYACEAE						
....PEDIASTRUM	--	-	--	-	580#	15
...OOCYSTACEAE						
....ANKISTRODESMUS	--	-	--	-	360	9
....OOCYSTIS	13	8	--	-	--	-
....SELENASTRUM	--	-	--	-	20	1
...SCENEDESMACEAE						
....SCENEDESMUS	--	-	52	14	560	15
..VOLVOCALES						
...CHLAMYDOMONADACEAE						
....CHLAMYDOMONAS	26#	15	26	7	--	-
CYANOPHYTA (BLUE-GREEN ALGAE)						
.CYANOPHYCEAE						
..CHROOCOCCALES						
...CHROOCOCCACEAE						
....AGMENELLUM	--	-	--	-	160	4
....ANACYSTIS	13	8	64#	17	340	9
EUGLENOPHYTA (EUGLENOIDS)						
.EUGLENOPHYCEAE						
..EUGLENALES						
...EUGLENACEAE						
....TRACHELOMONAS	13	8	13	3	180	5

NOTE: # - DOMINANT ORGANISM; EQUAL TO OR GREATER THAN 15%

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

SUSPENDED-SEDIMENT, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DAY	MEAN CONCEN-TRATION (MG/L)	LOADS (T/DAY)	MEAN CONCEN-TRATION (MG/L)	LOADS (T/DAY)	MEAN CONCEN-TRATION (MG/L)	LOADS (T/DAY)	MEAN CONCEN-TRATION (MG/L)	LOADS (T/DAY)	MEAN CONCEN-TRATION (MG/L)	LOADS (T/DAY)	MEAN CONCEN-TRATION (MG/L)	LOADS (T/DAY)
	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH	
1	88	44	48	36	23	8.7	35	14	120	42	39	25
2	59	29	30	23	12	4.2	28	11	118	35	23	14
3	50	23	30	23	14	5.7	29	12	99	35	23	14
4	54	26	29	22	22	7.7	27	12	44	15	20	11
5	60	30	34	26	17	5.5	24	9.7	21	7.9	16	9.0
6	64	32	36	28	25	7.4	25	11	26	9.8	24	13
7	58	27	39	30	27	8.0	22	9.5	23	8.1	21	11
8	40	17	44	34	29	12	30	12	26	7.0	10	5.4
9	54	23	38	30	40	16	26	11	21	5.4	15	8.1
10	84	32	28	22	42	16	55	21	22	5.3	16	8.5
11	57	21	19	15	43	46	36	15	22	5.9	16	8.4
12	47	17	14	11	41	44	13	5.6	30	9.7	17	8.9
13	46	18	26	20	32	26	18	7.8	28	11	16	8.3
14	45	18	34	27	49	46	17	6.9	19	7.7	20	9.9
15	42	17	25	20	49	60	18	7.3	18	8.3	15	6.9
16	83	60	35	27	41	48	20	7.0	10	5.9	16	7.0
17	575	503	45	35	30	28	19	6.7	57	46	21	8.8
18	1450	1320	32	24	43	29	15	5.7	98	95	23	9.2
19	771	625	30	22	37	12	15	6.1	56	60	16	6.4
20	261	193	34	27	31	10	13	5.3	84	100	12	4.8
21	135	99	45	40	52	17	12	5.2	133	162	18	7.2
22	437	354	40	34	45	16	9	4.1	119	145	14	5.4
23	1310	1270	23	17	28	9.1	19	8.7	128	159	19	7.4
24	1310	1130	21	12	26	5.6	23	11	103	131	19	7.1
25	541	429	42	24	19	5.6	18	7.8	116	143	17	6.4
26	219	164	42	25	32	14	18	7.3	148	123	27	10
27	130	97	23	13	42	20	17	6.4	77	58	40	14
28	89	66	61	41	48	26	22	8.3	52	35	33	12
29	72	54	46	34	57	31	21	7.9	---	---	25	8.8
30	70	52	32	15	29	15	22	8.3	---	---	50	18
31	58	43	---	---	30	13	55	21	---	---	49	17
TOTAL	---	6833	---	757	---	612.5	---	292.6	---	1476.0	---	310.9

DAY	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
1	34	12	25	.88	1370	7400	108	196	90	56	52	28
2	42	15	46	1.2	1080	5830	90	139	70	45	68	39
3	63	22	38	.88	981	5560	66	90	80	54	64	32
4	38	13	22	.28	983	5840	66	83	77	46	48	23
5	46	16	22	.13	949	5640	81	96	263	156	60	30
6	69	23	23	.23	920	5460	79	88	252	163	74	41
7	56	9.2	24	.16	980	5820	75	69	190	118	71	40
8	32	3.6	32	.53	937	5570	70	56	240	143	62	34
9	15	1.0	86	2.3	819	4860	56	39	452	281	51	27
10	18	.97	46	1.7	757	4290	50	29	325	211	49	25
11	21	1.2	58	6.0	610	3460	46	24	166	103	56	29
12	27	1.5	392	90	727	4120	205	116	118	67	52	26
13	34	1.9	480	152	1000	5670	256	104	140	76	41	20
14	31	1.7	235	62	1080	6420	98	31	106	57	41	21
15	36	1.4	100	22	1050	5950	49	15	64	35	50	26
16	19	.62	73	14	689	3530	62	20	67	34	41	22
17	26	.84	155	30	520	2250	46	15	83	45	44	24
18	24	.78	195	31	478	1940	39	12	81	44	41	23
19	23	.75	122	18	377	1330	49	12	59	32	43	26
20	16	.52	103	14	278	916	46	11	54	29	47	27
21	28	.91	90	12	208	646	38	10	68	35	42	24
22	36	1.2	390	63	234	720	35	5.7	89	52	34	19
23	44	1.4	1230	232	199	586	44	7.4	107	66	38	21
24	59	2.2	820	166	186	537	78	19	84	52	36	20
25	56	2.1	260	53	179	498	170	78	74	48	35	21
26	60	2.1	210	142	179	488	238	148	75	42	34	21
27	50	1.9	780	1260	158	400	203	137	56	31	30	19
28	33	1.2	1510	3260	140	344	382	268	105	53	30	18
29	30	1.1	1220	3290	142	322	304	213	94	48	28	17
30	21	.79	1870	6560	123	258	131	92	68	35	38	26
31	---	---	1320	6770	---	---	115	78	54	28	---	---
TOTAL	---	141.88	---	22255.29	---	96655	---	2301.1	---	2285	---	769

TOTAL LOAD FOR YEAR: 134689.27 TONS.

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DAY	MAX	MIN JUNE	MEAN	MAX	MIN JULY	MEAN	MAX	MIN AUGUST	MEAN	MAX	MIN SEPTEMBER	MEAN
1	---	---	---	---	---	---	28.0	21.5	24.5	22.0	15.5	18.5
2	---	---	---	---	---	---	28.5	21.5	24.5	21.5	17.0	19.0
3	---	---	---	---	---	---	28.0	21.0	24.5	20.0	15.5	17.5
4	---	---	---	---	---	---	28.0	22.0	25.0	22.5	15.0	19.0
5	---	---	---	---	---	---	27.0	21.5	24.0	22.5	18.5	20.0
6	---	---	---	---	---	---	25.5	21.5	23.5	22.0	17.5	19.5
7	---	---	---	---	---	---	25.5	20.5	23.0	22.5	16.5	19.5
8	---	---	---	---	---	---	25.5	21.0	23.0	23.0	17.0	20.0
9	---	---	---	---	---	---	24.5	20.5	22.5	24.0	17.5	21.0
10	---	---	---	---	---	---	25.5	19.5	22.5	22.5	18.0	20.5
11	---	---	---	---	---	---	26.5	20.0	23.5	23.0	16.5	20.0
12	---	---	---	---	---	---	27.5	20.5	24.0	23.5	17.5	20.5
13	---	---	---	---	---	---	26.5	21.5	24.0	23.0	17.0	20.5
14	---	---	---	---	---	---	28.0	21.5	24.5	22.0	18.0	20.0
15	---	---	---	---	---	---	27.5	21.5	24.5	20.5	15.5	18.5
16	---	---	---	---	---	---	27.0	21.5	24.0	19.5	14.5	17.0
17	---	---	---	---	---	---	28.0	21.0	24.5	19.5	13.5	16.5
18	---	---	---	---	---	---	29.0	22.0	25.5	20.0	14.0	17.5
19	---	---	---	---	---	---	29.0	22.5	25.5	20.0	14.5	17.5
20	---	---	---	---	---	---	28.0	23.0	25.5	19.0	16.0	17.5
21	---	---	---	---	---	---	25.5	22.0	23.5	19.0	14.5	16.5
22	---	---	---	---	---	---	26.5	20.0	23.0	18.5	13.5	16.0
23	---	---	---	---	---	---	26.5	21.0	23.5	18.5	13.5	16.0
24	---	---	---	---	---	---	26.0	20.5	23.5	17.5	14.0	16.0
25	---	---	---	---	---	---	26.5	21.0	23.5	16.5	14.0	15.5
26	---	---	---	---	---	---	26.0	21.0	23.5	14.5	11.5	13.0
27	---	---	---	---	---	---	25.5	20.0	22.5	14.0	10.0	12.0
28	---	---	---	---	---	---	25.5	19.0	22.5	16.0	11.0	14.0
29	---	---	---	28.0	---	---	25.5	19.5	22.5	16.5	13.5	15.0
30	---	---	---	27.0	23.0	24.5	25.0	18.5	21.0	16.5	13.5	15.0
31	---	---	---	27.0	20.5	24.0	21.5	15.5	18.5	---	---	---
MONTH	---	---	---	28.0	20.5	24.5	29.0	15.5	23.5	24.0	10.0	17.5
YEAR	29.0	.0	8.5									

PARTICLE-SIZE DISTRIBUTION OF SUSPENDED SEDIMENT, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	TEMPER-ATURE (DEG C) (00010)	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	SED. SUSP. FALL DIAM. % FINER THAN .004 MM (70338)	SED. SUSP. FALL DIAM. % FINER THAN .016 MM (70340)	SED. SUSP. FALL DIAM. % FINER THAN .062 MM (70342)	SED. SUSP. FALL DIAM. % FINER THAN .125 MM (70343)	SED. SUSP. FALL DIAM. % FINER THAN .250 MM (70344)	SED. SUSP. FALL DIAM. % FINER THAN .500 MM (70345)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM (70331)
OCT												
29...	1400	5.0	276	81	60	--	--	--	--	--	--	98
NOV												
18...	1330	1.0	273	45	33	--	--	--	--	--	--	97
DEC												
16...	0930	.5	430	37	43	--	--	--	--	--	--	88
JAN												
23...	0930	.5	170	8	3.7	--	--	--	--	--	--	92
FEB												
25...	1300	1.0	456	144	177	--	--	--	--	--	--	85
MAR												
24...	0930	6.0	144	15	5.8	--	--	--	--	--	--	--
APR												
21...	1500	15.0	12	39	1.3	--	--	--	--	--	--	--
MAY												
19...	1030	14.0	57	89	14	--	--	--	--	--	--	98
JUN												
19...	0830	17.0	1380	472	1760	61	74	87	91	98	100	--
JUL												
23...	0830	21.5	E62	44	7.4	--	--	--	--	--	--	98
AUG												
19...	1300	27.0	182	62	30	--	--	--	--	--	--	99
SEP												
30...	1245	15.5	252	52	35	--	--	--	--	--	--	--

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
	OCTOBER			NOVEMBER			DECEMBER			JANUARY		
1	15.5	12.5	14.0	8.0	4.5	6.5	.0	.0	.0	.0	.0	.0
2	15.0	10.0	12.5	7.0	5.0	6.0	.0	.0	.0	.0	.0	.0
3	16.5	10.5	13.5	7.5	4.5	6.0	.0	.0	.0	.0	.0	.0
4	17.0	11.0	14.0	7.5	4.5	6.0	.0	.0	.0	.0	.0	.0
5	17.5	12.0	15.0	9.5	5.5	7.5	.0	.0	.0	.0	.0	.0
6	18.0	12.5	15.0	9.0	6.5	8.0	.0	.0	.0	.0	.0	.0
7	17.5	12.0	15.0	10.0	7.0	8.5	.0	.0	.0	.0	.0	.0
8	17.5	12.5	15.0	9.5	7.5	9.0	.0	.0	.0	.0	.0	.0
9	15.0	11.0	13.5	7.5	5.5	6.5	.0	.0	.0	.0	.0	.0
10	13.0	8.0	10.5	6.0	3.5	5.0	.0	.0	.0	.0	.0	.0
11	12.0	6.5	9.5	5.5	4.5	5.0	.0	.0	.0	.0	.0	.0
12	12.5	8.0	10.5	5.0	3.5	4.0	.0	.0	.0	.0	.0	.0
13	14.0	9.5	11.5	4.5	2.5	3.5	.0	.0	.0	.0	.0	.0
14	13.0	8.5	11.0	3.5	.5	2.0	.0	.0	.0	.0	.0	.0
15	11.5	8.0	9.5	---	---	---	.0	.0	.0	.0	.0	.0
16	8.0	4.5	---	---	---	---	.0	.0	.0	.0	.0	.0
17	5.5	4.0	4.5	---	---	---	.0	.0	.0	.0	.0	.0
18	7.0	4.0	5.5	---	---	---	.0	.0	.0	.0	.0	.0
19	10.0	5.5	8.0	---	---	---	.0	.0	.0	.0	.0	.0
20	11.5	7.0	9.5	1.5	---	---	.0	.0	.0	.0	.0	.0
21	11.5	9.0	10.5	2.0	.0	1.0	.0	.0	.0	.0	.0	.0
22	10.5	4.5	---	2.0	.0	1.5	.0	.0	.0	.0	.0	.0
23	5.0	2.5	4.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
24	4.5	2.0	3.5	.5	.0	.0	.0	.0	.0	.0	.0	.0
25	5.0	2.0	3.5	.5	.0	.0	.0	.0	.0	.0	.0	.0
26	4.0	2.5	3.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
27	4.0	3.0	3.0	.5	.0	.0	.0	.0	.0	.0	.0	.0
28	5.5	2.0	4.0	.5	.0	.0	.0	.0	.0	.0	.0	.0
29	7.0	3.0	5.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
30	7.5	4.0	6.0	.5	.0	.0	.0	.0	.0	.0	.0	.0
31	8.0	4.5	6.5	---	---	---	.0	.0	.0	.0	.0	.0
MONTH	18.0	2.0	9.0	10.0	.0	3.5	.0	.0	.0	.0	.0	.0

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
	FEBRUARY			MARCH			APRIL			MAY		
1	.0	.0	.0	5.0	.0	2.5	13.0	6.0	10.0	22.5	11.5	17.0
2	.0	.0	.0	6.0	.5	3.5	13.0	9.5	11.0	18.5	15.0	16.5
3	.0	.0	.0	7.0	1.5	4.5	11.5	7.5	9.5	16.5	11.5	14.0
4	.0	.0	.0	7.5	2.0	5.0	9.0	6.0	7.5	18.5	10.0	14.5
5	.0	.0	.0	8.5	3.0	5.5	11.5	3.5	8.0	19.5	11.0	15.5
6	.0	.0	.0	7.0	3.5	5.5	11.5	6.5	9.0	14.0	10.5	11.5
7	.0	.0	.0	8.0	2.5	5.5	10.0	4.0	7.0	12.5	9.5	10.5
8	.0	.0	.0	8.0	2.0	5.0	14.5	3.5	8.5	12.5	8.5	10.5
9	.0	.0	.0	8.0	2.5	5.5	11.5	4.5	8.0	19.0	8.0	13.0
10	.0	.0	.0	8.5	2.5	5.5	---	---	---	17.5	11.0	14.0
11	.0	.0	.0	9.0	2.5	6.0	---	---	---	13.5	9.5	11.0
12	.0	.0	.0	9.5	3.5	6.5	---	---	---	10.5	9.0	9.5
13	.0	.0	.0	10.0	3.5	7.0	---	---	---	14.0	8.5	11.0
14	.0	.0	.0	10.0	4.5	7.5	---	---	---	18.0	10.5	14.0
15	.0	.0	.0	10.5	4.5	8.0	---	---	---	19.0	14.5	16.5
16	.0	.0	.0	11.0	5.0	8.5	---	---	---	15.5	13.5	14.0
17	.0	.0	.0	9.5	7.5	8.5	---	---	---	14.5	12.5	13.5
18	.0	.0	.0	9.0	5.5	7.5	---	---	---	17.0	12.0	14.5
19	.0	.0	.0	9.5	5.0	7.5	---	---	---	18.5	11.5	15.0
20	.0	.0	.0	10.0	5.0	7.5	---	---	---	21.5	14.0	18.0
21	.0	.0	.0	8.5	3.5	6.0	---	---	---	22.0	17.5	19.5
22	.0	.0	.0	10.5	3.5	7.5	16.5	8.0	12.0	---	---	---
23	.5	.0	.0	10.0	6.5	8.5	20.0	9.5	15.0	---	---	---
24	1.5	.0	.0	10.5	5.0	8.0	21.0	11.0	16.0	---	---	---
25	1.5	.0	.0	11.5	5.5	9.0	17.5	13.0	15.0	---	---	---
26	4.0	.0	2.0	11.5	6.5	9.0	19.5	12.0	15.0	---	---	---
27	2.5	1.0	1.5	8.5	6.5	7.5	15.5	11.5	13.0	---	---	---
28	4.0	.0	2.0	11.5	5.5	8.5	15.0	9.5	12.0	---	---	---
29	---	---	---	13.5	6.0	10.0	17.0	10.5	13.0	---	---	---
30	---	---	---	10.5	7.0	9.0	21.0	12.5	16.0	---	---	---
31	---	---	---	10.0	6.0	8.0	---	---	---	---	---	---
MONTH	4.0	.0	.0	13.5	.0	7.0	21.0	3.5	11.5	22.5	8.0	14.0

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

PESTICIDE ANALYSES, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	PCB, TOTAL (UG/L) (39516)	ALDRIN, TOTAL (UG/L) (39330)	CHLOR-DANE, TOTAL (UG/L) (39350)	DDD, TOTAL (UG/L) (39360)	DDE, TOTAL (UG/L) (39365)	DDT, TOTAL (UG/L) (39370)	DI-AZINON, TOTAL (UG/L) (39570)	DI-ELDRIN TOTAL (UG/L) (39380)	ENDRIN, TOTAL (UG/L) (39390)	ETHION, TOTAL (UG/L) (39398)
NOV											
18...	1330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

DATE	HEPTA-CHLOR, TOTAL (UG/L) (39410)	HEPTA-CHLOR EPOXIDE TOTAL (UG/L) (39420)	LINDANE TOTAL (UG/L) (39340)	MALA-THION, TOTAL (UG/L) (39530)	METH-OXY-CHLOR, TOTAL (UG/L) (39480)	METHYL PARA-THION, TOTAL (UG/L) (39600)	METHYL TRI-THION, TOTAL (UG/L) (39790)	PARA-THION, TOTAL (UG/L) (39540)	TOX-APHENE, TOTAL (UG/L) (39400)	TOTAL TRI-THION (UG/L) (39786)
NOV										
18...	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	851	911	979	952	1140	1040	1100	1220	540	392	546	659
2	880	930	1000	990	1140	1040	1090	1230	515	405	549	657
3	880	932	1040	960	1150	1060	1100	1290	494	457	551	645
4	871	929	1060	998	1210	1060	1100	1370	468	452	555	662
5	870	924	1040	991	1220	1060	1090	1360	434	463	558	659
6	870	920	1140	990	1210	1080	1140	1360	403	468	564	647
7	880	920	1140	1010	1220	1090	1140	1420	396	467	580	648
8	908	920	1150	1040	1230	1080	1140	1320	374	463	577	641
9	900	917	1140	1040	1230	1100	1130	1250	347	472	580	651
10	909	919	1100	1040	1240	1100	1110	1060	328	499	589	640
11	920	920	1100	1060	1250	1080	1150	930	353	511	573	642
12	931	912	1060	1000	1300	1090	1180	924	337	522	605	651
13	918	925	1060	1020	1300	1100	1180	963	334	561	586	659
14	921	920	1040	1040	1220	1080	1180	945	337	592	618	662
15	920	921	920	1040	1220	1080	1180	951	343	594	620	655
16	870	939	920	1050	1180	1100	1190	956	330	620	619	663
17	860	940	890	1060	1100	1110	1180	994	316	599	640	659
18	842	943	881	1100	1100	1120	1220	1020	350	601	641	653
19	861	948	966	1080	1020	1140	1220	1040	351	618	641	659
20	888	931	961	1100	648	1140	1240	1050	348	617	631	663
21	900	930	970	1100	703	1150	1250	1070	360	613	632	668
22	882	913	1020	1090	469	1160	1240	1010	366	611	609	665
23	861	951	1020	1020	619	1140	1260	985	359	599	586	659
24	870	942	1030	1020	885	1140	1260	1520	355	554	621	660
25	900	1040	1020	1000	900	1140	1240	1070	357	540	621	663
26	901	1040	1070	988	969	1140	1240	1050	359	512	626	654
27	909	1010	1060	968	1000	1150	1260	963	354	488	642	670
28	900	1020	1020	980	1000	1140	1270	765	370	489	655	680
29	900	980	1020	1020	---	1140	1270	717	370	497	659	682
30	910	960	978	1020	---	1030	1220	577	380	504	668	656
31	908	---	931	1120	---	1030	---	531	---	524	655	---
MEAN	890	944	1020	1030	1070	1100	1190	1060	378	526	606	658

WTR YR 1981 MEAN 872 MAX 1520 MIN 316

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	NITROGEN, AMMONIA DISSOLVED (MG/L AS N) (00608)	NITROGEN, ORGANIC TOTAL (MG/L AS N) (00605)	NITROGEN, ORGANIC DISSOLVED (MG/L AS N) (00607)	NITROGEN, AMMONIA + ORGANIC TOTAL (MG/L AS N) (00625)	NITROGEN, AMMONIA + ORGANIC DIS. (MG/L AS N (00623)	PHOSPHORUS, TOTAL (MG/L AS P) (00665)	PHOSPHORUS, DISSOLVED (MG/L AS P) (00666)	CARBON, ORGANIC TOTAL (MG/L AS C) (00680)	CARBON, ORGANIC DISSOLVED (MG/L AS C) (00681)	CARBON, ORGANIC SUSPENDED TOTAL (MG/L AS C) (00689)
OCT 29...	.02	.85	.82	.85	.84	.02	.02	15	--	--
NOV 18...	.02	.51	.39	.53	.41	.04	.02	--	18	--
DEC 16...	.04	--	.69	--	.73	.00	.02	14	--	--
JAN 23...	.06	.76	.78	.81	.84	.04	.04	13	--	--
FEB 25...	.13	.44	.40	.57	.53	.09	.06	--	22	1.5
MAR 24...	.06	.85	.57	1.2	.63	.02	.02	11	11	--
APR 21...	.10	2.2	.53	2.3	.63	.04	.01	5.1	--	--
MAY 19...	.05	.63	.30	.77	.35	.05	.01	--	15	.9
JUN 19...	.09	.92	.77	1.0	.86	.24	.05	10	--	--
JUL 23...	.18	.71	.56	.82	.74	.06	.02	4.4	--	--
AUG 19...	.18	.42	.36	.56	.54	.05	.02	--	4.3	.6
SEP 30...	.08	.57	.42	.68	.50	.02	.01	6.2	--	--

DATE	TIME	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DISSOLVED (UG/L AS AS) (01000)	BARIUM, TOTAL RECOVERABLE (UG/L AS BA) (01007)	BARIUM, DISSOLVED (UG/L AS BA) (01005)	CADMIUM TOTAL RECOVERABLE (UG/L AS CD) (01027)	CADMIUM DISSOLVED (UG/L AS CD) (01025)	CHROMIUM, TOTAL RECOVERABLE (UG/L AS CR) (01034)	CHROMIUM, DISSOLVED (UG/L AS CR) (01030)	COBALT, TOTAL RECOVERABLE (UG/L AS CO) (01037)
NOV 18...	1330	2	1	100	60	1	< 1	0	10	0
FEB 25...	1300	2	1	300	70	1	< 1	10	0	2
MAY 19...	1030	2	2	100	70	0	< 1	10	0	3
AUG 19...	1300	1	1	200	60	0	< 1	10	0	0

DATE	COBALT, DISSOLVED (UG/L AS CO) (01035)	COPPER, TOTAL RECOVERABLE (UG/L AS CU) (01042)	COPPER, DISSOLVED (UG/L AS CU) (01040)	IRON, TOTAL RECOVERABLE (UG/L AS FE) (01045)	IRON, DISSOLVED (UG/L AS FE) (01046)	LEAD, TOTAL RECOVERABLE (UG/L AS PB) (01051)	LEAD, DISSOLVED (UG/L AS PB) (01049)	MANGANESE, TOTAL RECOVERABLE (UG/L AS MN) (01055)	MANGANESE, DISSOLVED (UG/L AS MN) (01056)	MERCURY TOTAL RECOVERABLE (UG/L AS HG) (71900)
NOV 18...	< 3	5	2	420	< 10	3	3	20	9	.0
FEB 25...	< 3	7	2	2200	20	4	1	100	5	.1
MAY 19...	< 3	8	2	1100	< 10	4	1	120	5	.3
AUG 19...	< 3	4	2	1100	< 10	2	0	40	3	.1

DATE	MERCURY DISSOLVED (UG/L AS HG) (71890)	NICKEL, TOTAL RECOVERABLE (UG/L AS NI) (01067)	NICKEL, DISSOLVED (UG/L AS NI) (01065)	SELENIUM, TOTAL (UG/L AS SE) (01147)	SELENIUM, DISSOLVED (UG/L AS SE) (01145)	SILVER, TOTAL RECOVERABLE (UG/L AS AG) (01077)	SILVER, DISSOLVED (UG/L AS AG) (01075)	ZINC, TOTAL RECOVERABLE (UG/L AS ZN) (01092)	ZINC, DISSOLVED (UG/L AS ZN) (01090)
NOV 18...	.0	5	3	0	0	0	0	10	10
FEB 25...	.0	4	0	0	0	0	0	30	5
MAY 19...	.0	8	1	0	0	0	0	10	3
AUG 19...	.0	0	0	0	0	0	0	0	7

06308500 TONGUE RIVER AT MILES CITY, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	COLI- FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML) (31625)	STREP- TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)	HARD- NESS (MG/L AS CACO3) (00900)	HARD- NESS NONCAR- BONATE (MG/L AS CACO3) (95902)	CALCIUM DIS- SOLVED (MG/L AS CA) (00915)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG) (00925)	SODIUM, DIS- SOLVED (MG/L AS NA) (00930)	SODIUM AD- SORP- TION RATIO (00931)	POTAS- SIUM, DIS- SOLVED (MG/L AS K) (00935)	ALKA- LINITY LAB (MG/L AS CACO3) (90410)	SULFATE DIS- SOLVED (MG/L AS SO4) (00945)
OCT											
29...	K28	150	380	130	66	53	71	1.6	5.6	250	280
NOV											
18...	--	K6	380	120	68	50	69	1.6	5.8	260	280
DEC											
16...	K20	65	380	120	70	51	64	1.4	5.7	260	260
JAN											
23...	74	64	440	160	77	59	85	1.8	4.6	280	330
FEB											
25...	K2	K15	360	130	63	49	75	1.7	4.3	230	290
MAR											
24...	K3	K10	420	160	70	60	98	2.1	5.7	260	360
APR											
21...	K6700	120	410	140	62	61	130	2.8	6.5	270	410
MAY											
19...	50	120	390	150	66	54	90	2.0	5.0	240	320
JUN											
19...	790	1000	140	33	31	16	18	.7	2.2	110	74
JUL											
23...	380	280	230	60	46	28	45	1.3	3.3	170	150
AUG											
19...	40	42	250	68	50	30	45	1.4	3.9	180	140
SEP											
30...	60	40	280	88	52	36	44	1.3	3.9	190	170

DATE	CHLO- RIDE, DIS- SOLVED (MG/L AS CL) (00940)	FLUO- RIDE, DIS- SOLVED (MG/L AS F) (00950)	SILICA, DIS- SOLVED (MG/L AS SIO2) (00955)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L) (70300)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L) (70301)	SOLIDS, DIS- SOLVED (TONS PER AC-FT) (70303)	SOLIDS, DIS- SOLVED (TONS PER DAY) (70302)	SOLIDS, RESIDUE AT 105 DEG. C, SUS- PENDED (MG/L) (00530)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N) (00630)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N) (00631)	NITRO- GEN, AMMONIA TOTAL (MG/L AS N) (00610)
OCT											
29...	5.0	.4	4.2	652	636	.89	486	--	.00	.00	.00
NOV											
18...	4.7	.3	4.2	627	638	.85	462	6	.00	.00	.02
DEC											
16...	4.2	.3	4.7	656	616	.89	762	11	.05	.06	--
JAN											
23...	5.3	.5	5.0	736	735	1.0	338	2	.00	.00	.05
FEB											
25...	4.4	.3	4.6	610	629	.83	751	2	.02	.03	.13
MAR											
24...	6.1	.3	4.5	721	761	.98	280	8	.00	.04	.35
APR											
21...	7.1	.4	6.8	875	846	1.1	28.3	24	.00	.01	.10
MAY											
19...	4.9	.3	5.7	691	690	.94	107	72	.03	.04	.14
JUN											
19...	3.0	.1	8.2	216	219	.29	805	434	.16	.17	.08
JUL											
23...	3.0	.2	7.2	396	385	.54	66.3	41	.21	.01	.11
AUG											
19...	2.7	.2	6.3	387	386	.53	190	31	< .10	< .10	.14
SEP											
30...	3.1	.4	5.4	444	430	.60	302	61	.12	.11	.11

06308500 TONGUE RIVER AT MILES CITY, MT--Continued
(National Stream Quality Accounting Network)

WATER-QUALITY RECORDS

IOD OF RECORD.--Water years 1946 to current year.

IOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: January 1951 to September 1981 (discontinued).
ATER TEMPERATURES: April 1949 to current year.
SUSPENDED-SEDIMENT DISCHARGE: October 1977 to current year.

STRUMENTATION.--Temperature recorder April to July 1974, July 1977 to current year.

MARKS.--Flow affected by ice during most of winter months.

TREMES FOR PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: Maximum daily, 2,390 micromhos Sept. 11, 1958; minimum daily, 215 micromhos Feb. 16, 1971.
WATER TEMPERATURES: Maximum recorded (water years 1949-80), 30.5°C May 22, 1980; minimum, 0.0°C on many days during winter periods.
SEDIMENT CONCENTRATIONS: Maximum daily mean, 5,900 mg/L May 18, 1978; minimum daily mean, 6 mg/L Feb. 18, 1980.
SEDIMENT LOADS: Maximum daily, 84,400 tons (76,600 megagrams) May 18, 1978; minimum daily, 0.13 ton (0.12 megagram) May 5, 1981.

TREMES FOR CURRENT YEAR.--
SPECIFIC CONDUCTANCE: Maximum daily, 1,520 micromhos May 24; minimum daily, 316 micromhos June 17.
WATER TEMPERATURES: Minimum, 0.0°C on many days during November to March.
SEDIMENT CONCENTRATIONS: Maximum daily mean, 1,870 mg/L May 30; minimum daily mean, 9 mg/L Jan. 22.
SEDIMENT LOADS: Maximum daily, 7,400 tons (6,710 megagrams) June 1; minimum daily, 0.13 ton (0.12 megagram) May 5.

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	WEATHER (WMO CODE NUMBER) (00041)	SPE-CIFIC CON-DUCT-ANCE (UMHOS) (00095)	PH (UNITS) (00400)	TEMPER-ATURE, AIR (DEG C) (00020)	TEMPER-ATURE (DEG C) (00010)	TUR-BID-ITY (NTU) (00076)	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)	OXYGEN DEMAND, CHEM-ICAL (HIGH LEVEL) (MG/L) (00340)
OCT 29...	1400	276	3	880	8.1	14.0	5.0	35	10.9	93	17
NOV 18...	1330	273	0	1040	8.2	9.5	1.0	9.0	12.8	97	14
DEC 16...	0930	430	3	940	8.0	4.5	.5	5.1	12.8	96	2
JAN 23...	0930	170	0	1100	8.2	3.5	.5	1.6	13.1	99	14
FEB 25...	1300	456	0	870	8.4	14.5	1.0	45	14.1	108	10
MAR 24...	0930	144	0	1150	8.4	9.5	6.0	5.5	12.3	107	15
APR 21...	1500	12	53	1200	8.7	13.0	15.0	12	10.2	111	41
MAY 19...	1030	57	1	990	--	17.5	14.0	39	9.5	100	23
JUN 19...	0830	1380	1	345	7.8	15.0	17.0	240	8.3	93	34
JUL 23...	0830	E62	0	590	8.4	21.5	21.5	26	8.4	104	21
AUG 19...	1300	182	0	610	8.6	31.5	27.0	32	8.7	120	39
SEP 30...	1245	252	1	670	8.3	15.0	15.5	13	9.5	103	40

06308500 TONGUE RIVER AT MILES CITY, MT

LOCATION (REVISED).--Lat 46°20'44", long 105°48'10", in NE¼NE¼SE¼ sec.23, T.7 N., R.47 E., Custer County, Hydrologic Unit 10090102, on right bank 4 mi (6 km) south of Miles City and at mile 8.1 (13.0 km).

DRAINAGE AREA.--5,379 mi^2 (13,932 km^2).

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--April 1938 to April 1942, April 1946 to current year. Published as "near Miles City" April 1938 to April 1942. Not equivalent to records published as "near Miles City" May 1929 to October 1932. Monthly discharge only for some periods, published in WSP 1309.

REVISED RECORDS.--WSP 1729: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,375.76 ft (724.132 m) National Geodetic Vertical Datum of 1929 (levels by U.S. Army Corps of Engineers). April 1938 to April 1942, nonrecording gage at site 8 mi (13 km) upstream at different datum. April 1946 to Sept. 30, 1963, at datum 1.00 ft (0.305 m) higher.

REMARKS.--Water-discharge records fair except those for winter periods, which are poor. Flow regulation by Tongue River Reservoir (station 06307000), and many small reservoirs in Wyoming (combined capacity about 15,000 acre-ft, 18.5 hm^2). Diversions for irrigation of about 90,000 acres (364 km^2) above station.

AVERAGE DISCHARGE.--38 years (1938-41, 1946-81), 444 ft^3/s (12.57 m^3/s), 321,700 acre-ft/yr (397 hm^3/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 13,300 ft^3/s (377 m^3/s) June 15, 1962, gage height, 12.33 ft (3.758 m), present datum, from rating curve extended above 8,220 ft^3/s (233 m^3/s) on basis of float measurement; maximum gage height, 13.27 ft (4.045 m) Mar. 19, 1960, Feb. 15, 1971 (ice jam), present datum; no flow July 9-19, Aug. 13, 14, Sept. 28, 1940.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 2,250 ft^3/s (63.7 m^3/s) June 14, gage height unknown, from observer gage height and extension of rating curve developed at nonrecording gage site 11.0 mi (17.7 km) upstream at different datum; minimum daily discharge, 2.2 ft^3/s (0.062 m^3/s) May 5, as result of diversions for irrigation.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	186	280	140	150	130	237	130	13	2000	673	230	199
2	181	280	130	150	110	220	130	9.8	2000	573	240	212
3	171	284	150	150	130	220	128	8.6	2100	503	250	187
4	178	277	130	160	130	211	128	4.7	2200	467	220	180
5	184	284	120	150	140	208	128	2.2	2200	437	220	187
6	184	284	110	170	140	203	125	3.7	2200	411	240	206
7	173	287	110	160	130	200	61	2.5	2200	339	230	209
8	161	290	150	150	100	200	42	6.1	2200	295	220	206
9	156	294	150	150	95	200	25	9.8	2200	260	230	193
10	141	290	140	140	90	197	20	14	2100	215	240	190
11	134	294	400	150	100	194	22	38	2100	196	230	193
12	137	297	400	160	120	194	20	85	2100	196	210	187
13	148	290	300	160	140	192	21	117	2100	150	200	183
14	146	290	350	150	150	184	20	97	2200	117	200	193
15	146	290	450	150	170	171	14	82	2100	114	200	193
16	214	290	430	130	220	161	12	73	1900	120	190	196
17	324	290	350	130	300	156	12	71	1600	123	200	203
18	338	280	250	140	360	148	12	58	1500	111	200	212
19	300	270	120	150	400	148	12	54	1310	92	199	222
20	274	290	120	150	440	148	12	52	1220	92	196	212
21	271	331	120	160	450	148	12	50	1150	100	193	209
22	300	314	130	170	450	144	12	60	1140	60	215	209
23	359	270	120	170	460	144	12	70	1090	62	229	209
24	320	220	80	170	470	139	14	75	1070	90	229	209
25	294	210	110	160	455	139	14	75	1030	170	241	222
26	277	220	160	150	307	137	13	250	1010	230	206	229
27	277	210	180	140	277	130	14	600	938	250	203	229
28	274	250	200	140	246	130	14	800	911	260	187	226
29	277	270	200	140	---	130	13	1000	840	260	190	229
30	277	170	190	140	---	130	14	1300	776	260	193	252
31	277	---	160	140	---	128	---	1900	---	250	190	---
TOTAL	7079	8196	6150	4680	6710	5291	1206	6981.4	49485	7476	6621	6186
MEAN	228	273	198	151	240	171	40.2	225	1650	241	214	206
MAX	359	331	450	170	470	237	130	1900	2200	673	250	252
MIN	134	170	80	130	90	128	12	2.2	776	60	187	180
AC-FT	14040	16260	12200	9280	13310	10490	2390	13850	98150	14830	13130	12270

CAL YR 1980 TOTAL 96953.0 MEAN 265 MAX 1000 MIN 67 AC-FT 192300
WTR YR 1981 TOTAL 116061.4 MEAN 318 MAX 2200 MIN 2.2 AC-FT 230200

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued

SUSPENDED-SEDIMENT DISCHARGE, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	TIME	TEMPER-ATURE (DEG C) (00010)	DIS-CHARGE, IN CUBIC FEET PER SECOND (00060)	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM (70331)
NOV							
03...	1400	11.0	10800	--	18	525	92
DEC							
17...	1300	3.5	13900	--	9	338	--
MAR							
08...	1200	1.0	13500	--	3	109	--
MAY							
26...	1100	7.5	14300	--	11	425	--
JUN							
25...	1500	11.0	--	11300	8	244	40
AUG							
27...	1200	11.0	9100	--	46	1130	71

MISSOURI RIVER MAIN STEM

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N) (00608)	NITRO-GEN,AM-MONIA + ORGANIC TOTAL (MG/L AS N) (00625)	PHOS-PHORUS, TOTAL (MG/L AS P) (00665)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P) (70507)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P) (00671)
NOV									
03...	.59	12700	<.09	.08	.43	.02	.02	--	<.02
DEC									
17...	.59	16200	<.10	.09	.41	.03	.02	.02	.01
MAR									
08...	.60	16100	<.10	.07	.46	.02	.04	<.01	<.01
MAY									
26...	.56	15900	<.10	.17	.60	.01	<.01	.03	<.01
JUN									
25...	.56	12500	<.10	.43	1.6	.04	.02	.02	.02
AUG									
27...	.57	10200	<.10	.12	.70	.05	.03	.01	<.01

DATE	TIME	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA) (01007)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD) (01027)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, TOTAL RECOV-ERABLE (UG/L AS CR) (01034)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COBALT, TOTAL RECOV-ERABLE (UG/L AS CO) (01037)
NOV										
03...	1400	4	4	200	66	<1	<1	<10	<10	<1
MAR										
08...	1200	4	4	<100	39	1	<1	10	<10	1
MAY										
26...	1100	4	4	<100	44	<1	<3	<10	<10	<1
JUN										
25...	1500	4	5	<100	46	<1	<1	10	10	<1
AUG										
27...	1200	4	4	<100	43	<1	<1	10	<10	<1

DATE	COBALT, DIS-SOLVED (UG/L AS CO) (01035)	COPPER, TOTAL RECOV-ERABLE (UG/L AS CU) (01042)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, TOTAL RECOV-ERABLE (UG/L AS PB) (01051)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG) (71900)
NOV										
03...	<3	6	4	390	<10	7	1	20	4	.1
MAR										
08...	<3	4	2	30	<10	<1	<1	10	2	.1
MAY										
26...	<1	3	3	160	<9	3	<1	20	3	.1
JUN										
25...	2	2	5	120	<3	<1	<1	10	3	<.1
AUG										
27...	<1	2	1	190	8	<1	2	20	8	.1

DATE	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI) (01067)	NICKEL, DIS-SOLVED (UG/L AS NI) (01065)	SELE-NIUM, TOTAL (UG/L AS SE) (01147)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG) (01077)	SILVER, DIS-SOLVED (UG/L AS AG) (01075)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN) (01092)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
NOV									
03...	.0	2	1	1	1	<1	<1	20	6
MAR									
08...	<.1	1	<1	1	1	<1	<1	20	<3
MAY									
26...	.1	3	2	1	1	<1	<1	<10	<12
JUN									
25...	<.1	8	6	<1	<1	<1	<1	10	4
AUG									
27...	<.1	4	1	1	1	<1	<1	10	<3

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued
(National Stream Quality Accounting Network)

WATER-QUALITY RECORDS

PERIOD OF RECORD.--Water years 1964, 1975 to current year.

WATER QUALITY DATA, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982

DATE	TIME	DIS-CHARGE, IN CUBIC FEET PER SECOND (00060)	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	WEATHER (WMO CODE NUMBER) (00041)	SPE-CIFIC CON-DUCT-ANCE (UMHOS) (00095)	PH (UNITS) (00400)	TEMPER-ATURE, AIR (DEG C) (00020)	TEMPER-ATURE (DEG C) (00010)	COLOR (PLAT-INUM-COBALT UNITS) (00080)	TUR-BID-ITY (FTU) (00076)
NOV 03...	1400	10800	--	0	698	8.5	17.0	11.0	--	13
DEC 17...	1300	13900	--	2	691	8.4	-5.0	3.5	0	2.8
MAR 08...	1200	13500	--	0	702	8.2	-24.0	1.0	0	.50
MAY 26...	1100	14300	--	1	640	8.3	16.5	7.5	150	2.8
JUN 25...	1500	--	11300	1	648	8.4	27.0	11.0	5	1.5
AUG 27...	1200	9100	--	1	638	8.3	12.0	11.0	5	2.8

DATE	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./100 ML) (31625)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)	HARD-NESS (MG/L AS CACO3) (00900)	HARD-NESS NONCAR-BONATE (MG/L AS CACO3) (95902)	CALCIUM TOTAL RECOV-ERABLE (MG/L AS CA) (00916)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, TOTAL RECOV-ERABLE (MG/L AS MG) (00927)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)
NOV 03...	9.6	94	K1	K10	250	90	--	59	--	25
DEC 17...	12.2	98	K3	K5	240	84	38	58	21	24
MAR 08...	13.7	103	<1	K12	260	93	42	64	19	25
MAY 26...	10.9	99	<1	K5	240	83	50	58	19	23
JUN 25...	11.3	110	K2	K5	240	81	29	58	20	23
AUG 27...	11.4	111	53	K28	230	79	32	55	20	23

DATE	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM AD-SORP-TION RATIO (00931)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	ALKA-LINITY LAB (MG/L AS CACO3) (90410)	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)	FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950)	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L) (70300)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) (70301)
NOV 03...	52	1.6	3.7	160	180	11	.6	9.1	437	437
DEC 17...	50	1.5	3.9	160	190	14	.7	7.1	432	444
MAR 08...	52	1.5	3.7	170	200	9.4	.8	7.0	441	464
MAY 26...	47	1.4	3.8	160	180	8.4	.7	7.7	411	423
JUN 25...	46	1.4	3.8	160	160	8.3	.7	7.5	410	403
AUG 27...	46	1.4	3.6	150	170	8.6	.7	7.6	416	407

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT

LOCATION.--Lat 48°02'39", long 106°21'21", in NW¼ sec.6, T.26 N., R.42 E., McCone County, Hydrologic Unit 10060001, on right bank 2 mi (3 km) upstream from Milk River, 6 mi (10 km) south of Nashua, 8 mi (13 km) downstream from Fort Peck Dam, and at mile 1,763.5 (2,837.5 km).

DRAINAGE AREA.--57,556 mi^2 (149,070 km^2).

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--March 1934 to current year.

REVISED RECORDS.--WSP 1729: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,018.00 ft (615.086 m) National Geodetic Vertical Datum of 1929 (U.S. Army Corps of Engineers bench mark). Prior to Apr. 14, 1938, at site 0.7 mi (1.1 km) upstream at different datum; Apr. 14, 1938, to Sept. 30, 1963, at present site at datum 2.00 ft (0.610 m) higher, all water-stage recorders. Since Oct. 1, 1969, published discharge is determined by flowmeters at Fort Peck Dam.

REMARKS.--Flow completely regulated by Fort Peck Lake. Diversions for irrigation of about 880,400 acres (3,560 km^2) above station.

COOPERATION.--Records since Oct. 1, 1969, furnished by U.S. Army Corps of Engineers; 2 to 4 discharge measurements are made each year and the records are reviewed by Geological Survey. Records for March 1934 to September 1969 collected and computed by Geological Survey.

AVERAGE DISCHARGE.--5 years (1934-39, prior to Fort Peck Lake reaching operational level), 6,347 ft^3/s (179.7 m^3/s), 4,598,000 acre-ft/yr (5.67 km^3/yr); 39 years (1943-82, after operational level in Fort Peck Lake was reached), 10,030 ft^3/s (284.0 m^3/s), 7,267,000 acre-ft/yr (8.96 km^3/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 51,000 ft^3/s (1,440 m^3/s) including 32,000 ft^3/s (906 m^3/s) inflow from spillway 1 mi (2 km) downstream from station, Aug. 8, 1946; maximum gage height observed, 12.30 ft (3.749 m) Mar. 10, 1936 (ice jam), site and datum then in use; maximum daily reverse flow, 400 ft^3/s (11.3 m^3/s) Mar. 29, 1943 (backwater from Milk River).

EXTREMES FOR CURRENT YEAR.--Maximum daily discharge, 15,600 ft^3/s (442 m^3/s) Jan. 21; minimum daily, 6,400 ft^3/s (181 m^3/s) Sept. 26.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	13500	13200	11600	12100	14200	14900	9000	10200	14800	10800	10900	8300
2	13000	11500	10500	11900	14200	14200	9400	10400	14100	10800	10600	8900
3	13300	10800	9600	12000	13000	15300	9200	10900	14400	11900	10800	7900
4	13200	10600	11200	12500	11200	15200	9100	10100	14000	12000	9900	7000
5	13100	10700	11100	13400	11800	15500	9100	10200	13700	12200	10300	7200
6	13000	10800	11200	12100	11700	15400	11900	10100	14000	11800	10600	6700
7	13000	10800	11600	11500	12000	14900	13400	9800	13900	12300	10000	8100
8	12600	10500	12400	11700	11900	13500	13100	9300	13700	13200	10100	7800
9	12800	10700	12800	11100	13500	13500	13300	9800	13800	13800	9600	8100
10	13500	10900	12700	11700	14700	13200	12900	10000	14500	14000	10400	7800
11	13400	11100	12400	13200	14600	13300	12500	10100	13800	13600	9500	7400
12	10800	10900	12300	14200	14500	13700	10700	10100	14000	14400	9100	7400
13	10700	10800	12400	15200	14400	13500	9900	10800	13300	14200	9900	7100
14	9800	10800	12900	14900	14200	13400	11400	10700	9800	12500	8900	6800
15	9900	10700	13600	15400	14100	13400	11300	10300	10400	9800	9200	6700
16	10000	9100	14400	14400	14800	13600	11200	10200	11300	13700	9500	6700
17	9900	8800	13900	14200	14700	13200	11200	10300	11400	13700	9400	7100
18	9800	10400	14300	14600	15300	13000	10600	10600	11100	13900	9800	6800
19	10000	9900	12100	14300	15500	13200	11200	10300	11200	13900	8900	6600
20	10100	9400	12000	15000	14800	12600	11200	10300	11000	13800	9500	6700
21	10100	10600	12000	15600	15000	12100	10900	10100	10800	13700	8900	7400
22	10100	10100	12400	14100	14400	12900	11100	12600	11500	14100	8600	7300
23	10100	10200	12700	14700	15400	12800	10000	12300	11300	13600	8500	8100
24	11800	10800	12300	14000	15200	12900	10200	12800	11200	14100	8900	6900
25	10000	12100	11500	14800	15100	13200	10100	13900	11800	14200	8300	6700
26	11500	11000	12400	13900	15100	13100	9900	14300	11100	13200	8600	6400
27	11700	13200	11300	14200	15200	13000	10200	14400	11000	12300	9100	7000
28	12700	12800	12100	14400	14600	12900	10300	14300	11500	13300	8900	7700
29	13300	12600	11900	15400	---	13200	10300	12700	10800	10300	8100	11700
30	12700	11600	12200	14900	---	11700	10300	12600	11000	11800	8400	11700
31	13600	---	12200	15100	---	8900	---	14600	---	11500	8500	---
TOTAL	363000	327400	378000	426500	395100	415200	324900	349100	370200	398400	291700	228000
MEAN	11710	10910	12190	13760	14110	13390	10830	11260	12340	12850	9410	7600
MAX	13600	13200	14400	15600	15500	15500	13400	14600	14800	14400	10900	11700
MIN	9800	8800	9600	11100	11200	8900	9000	9300	9800	9800	8100	6400
AC-FT	720000	649400	749800	846000	783700	823500	644400	692400	734300	790200	578600	452200

CAL YR 1981 TOTAL 4421100 MEAN 12110 MAX 15000 MIN 7300 AC-FT 8769000
WTR YR 1982 TOTAL 4267500 MEAN 11690 MAX 15600 MIN 6400 AC-FT 8465000

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued

PHYTOPLANKTON ANALYSES, JULY 1981 TO SEPTEMBER 1981

DATE	JUL 25,81	AUG 31,81	SEP 29,81
TIME	1200	1400	1100
TOTAL CELLS/ML	200	220	270
DIVERSITY: DIVISION	1.3	0.8	1.5
.CLASS	1.3	0.8	1.5
..ORDER	2.8	0.8	2.2
...FAMILY	3.0	1.6	2.4
....GENUS	3.2	1.6	2.4

ORGANISM	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT
BACILLARIOPHYTA (DIATOMS)						
.BACILLARIOPHYCEAE						
..ACHNANTHALES						
...ACHNANTHACEAE						
....COCCONEIS	14	7	--	-	--	-
....RHOICOSPHENIA	28	14	--	-	--	-
..BACILLARIALES						
...NITZSCHIACEAE						
....NITZSCHIA	28	14	--	-	--	-
..EUPODISCALES						
...COSCINODISCACEAE						
....CYCLOTELLA	14	7	--	-	29	11
..FRAGILARIALES						
...FRAGILARIACEAE						
....DIATOMA	14	7	--	-	--	-
....SYNEDRA	--	-	--	-	43#	16
..NAVICULALES						
...CYMBELLACEAE						
....CYMBELLA	28	14	82#	38	--	-
...NAVICULACEAE						
....NAVICULA	14	7	82#	38	--	-
CHLOROPHYTA (GREEN ALGAE)						
.CHLOROPHYCEAE						
..CHLOROCOCCALES						
...CHLOROCOCCACEAE						
....SCHROEDERIA	--	-	--	-	29	11
...OOCYSTACEAE						
....ANKISTRODESMUS	14	7	--	-	29	11
....KIRCHNERIELLA	--	-	55#	25	--	-
CRYPTOPHYTA (CRYPTOMONADS)						
.CRYPTOPHYCEAE						
..CRYPTOMONADALES						
...CRYPTOCHRYSIDACEAE						
....CHROOMONAS	14	7	--	-	--	-
CYANOPHYTA (BLUE-GREEN ALGAE)						
.CYANOPHYCEAE						
..CHROOCOCCALES						
...CHROOCOCCACEAE						
....ANACYSTIS	28	14	--	-	86#	32
..NOSTOCALES						
...NOSTOCACEAE						
....CYLINDROSPERMUM	--	-	--	-	57#	21

NOTE: # - DOMINANT ORGANISM; EQUAL TO OR GREATER THAN 15%

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued

PHYTOPLANKTON ANALYSES, OCTOBER 1980 TO JUNE 1981

DATE	DEC 1,80		MAR 30,81		MAY 28,81		JUN 30,81	
TIME	1200		1300		1200		1400	
TOTAL CELLS/ML	360		210		500		65	
DIVERSITY: DIVISION	0.4		0.9		1.8		0.7	
.CLASS	0.4		0.9		1.8		0.7	
..ORDER	1.2		1.8		2.9		2.3	
...FAMILY	1.3		1.8		2.9		2.3	
....GENUS	1.8		2.2		3.2		2.3	
ORGANISM	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT
BACILLARIOPHYTA (DIATOMS)								
.BACILLARIOPHYCEAE								
..ACHNANTHALES								
...ACHNANTHACEAE								
....COCCONEIS	--	-	--	-	28	6	--	-
....RHOICOSPHENIA	--	-	--	-	--	-	13#	20
..BACILLARIALES								
...NITZSCHIACEAE								
....NITZSCHIA	13	4	--	-	28	6	13#	20
..EUPODISCALES								
...COSCINODISCACEAE								
....CYCLOTELLA	--	-	52#	25	42	8	13#	20
..FRAGILARIALES								
...FRAGILARIACEAE								
....ASTERIONELLA	230#	64	39#	19	110#	22	--	-
....DIATOMA	39	11	39#	19	56	11	13#	20
..NAVICULALES								
...CYMBELLACEAE								
....CYMBELLA	13	4	--	-	--	-	--	-
...NAVICULACEAE								
....NAVICULA	39	11	13	6	14	3	--	-
CHLOROPHYTA (GREEN ALGAE)								
.CHLOROPHYCEAE								
..CHLOROCOCCALES								
...OOCYSTACEAE								
....ANKISTRODESMUS	--	-	--	-	42	8	13#	20
..VOLVOCALES								
...CHLAMYDOMONADACEAE								
....CHLAMYDOMONAS	--	-	--	-	56	11	--	-
CHRYSOPHYTA								
.CHRYSOPHYCEAE								
..OCHROMONADALES								
...OCHROMONADACEAE								
....OCHROMONAS	--	-	--	-	42	8	--	-
CRYPTOPHYTA (CRYPTOMONADS)								
.CRYPTOPHYCEAE								
..CRYPTOMONADALES								
...CRYPTOCHRYSIDACEAE								
....CHROOMONAS	13	4	65#	31	--	-	--	-
...CRYPTOMONADACEAE								
....CRYPTOMONAS	13	4	--	-	14	3	--	-
CYANOPHYTA (BLUE-GREEN ALGAE)								
.CYANOPHYCEAE								
..CHROOCOCCALES								
...CHROOCOCCACEAE								
....ANACYSTIS	--	-	--	-	70	14	--	-

NOTE: # - DOMINANT ORGANISM; EQUAL TO OR GREATER THAN 15%

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued

SUSPENDED-SEDIMENT DISCHARGE, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	TEMPER-ATURE (DEG C) (00010)	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM (70331)
OCT						
28...	1400	8.5	8800	25	594	97
DEC						
01...	1200	.0	11200	6	181	--
30...	1300	1.0	10000	4	108	--
JAN						
26...	1300	.0	12800	3	104	--
MAR						
03...	1200	1.0	12600	3	102	44
30...	1300	5.5	7600	2	41	76
APR						
28...	1400	8.5	9700	7	183	75
MAY						
28...	1200	10.5	14600	5	197	65
JUN						
30...	1400	13.0	14100	16	609	62
JUL						
25...	1200	13.0	14300	16	618	59
AUG						
31...	1400	14.0	13800	10	373	70
SEP						
29...	1100	14.0	14500	24	940	75

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	COBALT, DIS-SOLVED (UG/L AS CO) (01035)	COPPER, TOTAL RECOV-ERABLE (UG/L AS CU) (01042)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, TOTAL RECOV-ERABLE (UG/L AS PB) (01051)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG) (71900)
DEC 01...	< 3	6	2	180	< 10	4	0	10	2	.0
MAR 30...	< 3	4	2	100	20	3	4	10	8	.2
MAY 28...	< 3	4	2	80	10	3	4	10	3	.2
AUG 31...	< 3	3	2	190	< 10	13	3	10	4	.1

DATE	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI) (01067)	NICKEL, DIS-SOLVED (UG/L AS NI) (01065)	SELE-NIUM, TOTAL (UG/L AS SE) (01147)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG) (01077)	SILVER, DIS-SOLVED (UG/L AS AG) (01075)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN) (01092)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
DEC 01...	.0	4	2	1	1	0	0	10	< 3
MAR 30...	.0	3	2	1	1	0	0	30	0
MAY 28...	.0	3	2	0	0	0	0	20	4
AUG 31...	.0	3	2	1	1	0	0	20	< 3

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	750	805	811	760	741	751	722	730	714	670	681	673
2	789	775	781	760	750	752	721	722	713	683	682	681
3	780	780	810	755	750	759	728	722	716	671	682	678
4	787	771	802	756	749	761	728	723	713	667	682	681
5	780	779	798	760	750	761	727	721	716	669	681	680
6	785	778	801	752	750	762	723	722	715	673	678	679
7	785	772	799	761	760	760	723	730	715	675	676	685
8	785	780	794	760	753	760	722	718	713	667	679	676
9	780	780	799	760	750	761	722	710	714	659	681	685
10	780	785	798	750	755	760	728	709	701	656	680	688
11	785	770	798	755	750	760	720	702	708	663	687	675
12	787	790	799	758	759	760	722	703	699	644	688	685
13	780	770	796	760	760	760	721	709	704	669	682	681
14	786	785	800	710	759	758	722	718	707	670	675	701
15	782	789	795	760	750	759	721	712	714	659	674	686
16	790	770	800	760	751	761	721	702	702	655	680	680
17	782	780	800	756	754	758	722	700	703	653	684	680
18	780	779	802	752	751	759	721	699	702	664	679	684
19	787	780	801	759	751	757	721	706	687	667	682	682
20	790	772	800	759	750	758	721	706	695	668	675	677
21	790	780	800	761	755	758	720	710	704	665	680	672
22	785	779	809	752	750	761	720	715	709	660	675	675
23	780	788	810	760	753	758	720	707	705	657	676	679
24	783	795	810	757	751	760	720	708	701	662	685	674
25	785	790	818	760	750	760	719	708	706	661	683	677
26	782	789	811	759	753	758	720	710	707	661	683	680
27	785	792	810	757	750	758	720	710	709	666	684	680
28	790	790	815	761	750	753	721	720	704	667	681	677
29	782	801	811	752	---	758	720	721	704	665	682	676
30	789	805	820	760	---	758	715	712	694	660	687	677
31	790	---	818	760	---	754	---	715	---	657	680	---
MEAN	784	783	804	756	752	758	722	713	706	664	681	680

WTR YR 1981 MEAN 734 MAX 820 MIN 644

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	CHLORIDE, DIS-SOLVED (MG/L AS CL) (00940)	FLUORIDE, DIS-SOLVED (MG/L AS F) (00950)	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L) (70300)	SOLIDS, SUM OF CONSTITUENTS, DIS-SOLVED (MG/L) (70301)	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	NITROGEN, NO2+NO3 TOTAL (MG/L AS N) (00630)	NITROGEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631)	NITROGEN, AMMONIA TOTAL (MG/L AS N) (00610)	NITROGEN, AMMONIA DIS-SOLVED (MG/L AS N) (00608)
OCT											
28...	9.3	.7	6.3	483	480	.66	11500	.00	.00	.02	.24
DEC											
01...	8.4	.7	6.4	498	489	.68	15100	.00	.00	.03	.33
30...	8.7	.6	6.0	480	455	.65	13000	.00	.00	.09	.57
JAN											
26...	11	.7	6.5	489	500	.67	16900	.00	.00	.10	--
MAR											
03...	9.0	.6	6.1	491	478	.67	16700	.00	.00	.09	--
30...	8.5	.7	6.5	491	482	.67	10100	.05	.01	.08	.08
APR											
28...	12	.7	6.8	483	469	.66	12700	.01	.00	.63	.13
MAY											
28...	12	.6	6.7	467	470	.64	18400	.05	.00	.07	.05
JUN											
30...	8.7	.6	7.3	465	466	.63	17700	.03	.06	.25	.31
JUL											
25...	16	.6	7.7	437	447	.59	16900	.06	.07	.18	.16
AUG											
31...	7.8	.6	7.7	---	451	.61	16800	.14	.16	--	.28
SEP											
29...	8.9	.7	8.3	444	447	.60	17400	.44	.04	.07	.07

DATE	NITROGEN, ORGANIC TOTAL (MG/L AS N) (00605)	NITROGEN, ORGANIC DIS-SOLVED (MG/L AS N) (00607)	NITROGEN, AMMONIA + ORGANIC TOTAL (MG/L AS N) (00625)	NITROGEN, AMMONIA + ORGANIC DIS. (MG/L AS N) (00623)	PHOSPHORUS, TOTAL (MG/L AS P) (00665)	PHOSPHORUS, DIS-SOLVED (MG/L AS P) (00666)	PHOSPHORUS, ORTHO, TOTAL (MG/L AS P) (70507)	CARBON, ORGANIC TOTAL (MG/L AS C) (00680)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C) (00681)	CARBON, ORGANIC SUS-PENDED TOTAL (MG/L AS C) (00689)
OCT										
28...	1.3	.75	1.3	.99	.02	.01	.00	5.5	--	--
DEC										
01...	.97	.47	1.0	.80	.03	.03	--	--	5.6	.2
30...	.61	.31	.70	.88	.03	.03	--	7.4	--	--
JAN										
26...	.53	--	.63	--	.02	.01	--	17	--	--
MAR										
03...	.80	--	.89	--	.04	--	--	8.1	--	--
30...	.29	.28	.37	.36	.01	.00	--	--	4.6	.2
APR										
28...	.57	.43	1.2	.56	.02	.01	.02	8.7	--	--
MAY										
28...	.88	.51	.95	.56	.02	.01	.03	--	16	.4
JUN										
30...	.75	.69	1.0	1.0	.03	.01	.03	13	--	--
JUL										
25...	.70	.81	.88	.97	.03	.03	.00	3.6	--	--
AUG										
31...	--	.50	.53	.78	< .01	.03	.01	--	6.3	.2
SEP										
29...	.42	.40	.49	.47	.04	< .01	.02	3.9	--	--

DATE	TIME	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA) (01007)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD) (01027)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHROMIUM, TOTAL RECOV-ERABLE (UG/L AS CR) (01034)	CHROMIUM, DIS-SOLVED (UG/L AS CR) (01030)	COBALT, TOTAL RECOV-ERABLE (UG/L AS CO) (01037)
DEC										
01...	1200	3	4	0	40	0	< 1	0	20	0
MAR										
30...	1300	3	3	100	40	0	< 1	10	0	0
MAY										
28...	1200	4	4	0	40	0	< 1	10	0	0
AUG										
31...	1400	4	4	100	40	0	< 1	0	10	1

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT--Continued
(National Stream Quality Accounting Network)

WATER-QUALITY RECORDS

PERIOD OF RECORD.--Water years 1964, 1975 to current year.

PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: October 1974 to September 1981 (discontinued).

REMARKS.--Once-daily water temperatures are available in the Helena district office.

EXTREMES FOR PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: Maximum daily, 1,080 micromhos Nov. 30, 1976; minimum daily, 520 micromhos June 29, 1978.

EXTREMES FOR CURRENT YEAR.--
SPECIFIC CONDUCTANCE: Maximum daily, 820 micromhos Dec. 30; minimum daily, 644 micromhos July 12.

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	WEATHER (WMO CODE NUMBER) (00041)	SPE-CIFIC CON-DUCT-ANCE (UMHOS) (00095)	PH (UNITS) (00400)	TEMPER-ATURE, AIR (DEG C) (00020)	TEMPER-ATURE (DEG C) (00010)	COLOR (PLAT-INUM-COBALT UNITS) (00080)	TUR-BID-ITY (NTU) (00076)	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)
OCT											
28...	1400	8800	1	758	8.8	3.5	8.5	5	.50	14.3	129
DEC											
01...	1200	11200	2	800	8.3	-10.0	.0	--	3.6	13.3	96
30...	1300	10000	1	820	8.3	10.0	1.0	--	1.0	13.0	98
JAN											
26...	1300	12800	3	800	8.3	.0	.0	--	.50	13.1	96
MAR											
03...	1200	12600	0	730	8.3	11.0	1.0	--	1.7	12.8	97
30...	1300	7600	3	751	8.4	5.0	5.5	--	2.2	12.0	104
APR											
28...	1400	9700	1	750	8.2	18.0	8.5	5	1.3	11.6	106
MAY											
28...	1200	14600	0	740	8.4	25.0	10.5	5	1.5	11.0	106
JUN											
30...	1400	14100	0	642	8.3	30.0	13.0	5	.70	10.6	108
JUL											
25...	1200	14300	1	715	8.3	19.5	13.0	0	1.6	8.7	88
AUG											
31...	1400	13800	0	672	8.5	15.0	14.0	5	2.8	11.6	121
SEP											
29...	1100	14500	2	680	8.2	13.0	14.0	5	2.8	8.6	90

DATE	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML) (31625)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)	HARD-NESS (MG/L AS CACO3) (00900)	HARD-NESS NONCAR-BONATE (MG/L AS CACO3) (95902)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM AD-SORP-TION RATIO (00931)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	ALKA-LINITY LAB (MG/L AS CACO3) (90410)	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)
OCT											
28...	K2	< 1	260	110	60	26	63	1.7	4.2	150	220
DEC											
01...	K4	K5	260	110	61	26	62	1.7	3.8	150	230
30...	K2	< 1	250	85	57	25	58	1.6	3.9	160	200
JAN											
26...	K5	K2	260	99	61	26	65	1.8	3.5	160	230
MAR											
03...	< 1	K2	260	110	60	26	62	1.7	3.8	150	220
30...	K1	< 1	270	120	67	26	59	1.6	4.0	150	220
APR											
28...	38	K54	260	110	61	25	59	1.6	3.9	150	210
MAY											
28...	K4	< 1	260	110	62	26	59	1.6	3.9	150	210
JUN											
30...	> 200	> 270	250	88	58	25	56	1.5	3.8	160	210
JUL											
25...	< 1	K1	250	100	59	25	55	1.5	3.5	150	190
AUG											
31...	K1	< 1	240	79	56	24	54	1.7	3.7	160	200
SEP											
29...	K1	K1	250	93	60	25	54	1.6	3.9	160	190

06132000 MISSOURI RIVER BELOW FORT PECK DAM, MT

LOCATION.--Lat 48°02'39", long 106°21'21", in NW¼ sec.6, T.26 N., R.42 E., McCone County, Hydrologic Unit 10060001, on right bank 2 mi (3 km) upstream from Milk River, 6 mi (10 km) south of Nashua, 8 mi (13 km) downstream from Fort Peck Dam, and at mile 1,763.5 (2,837.5 km).

DRAINAGE AREA.--57,556 mi^2 (149,070 km^2).

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--March 1934 to current year.

REVISED RECORDS.--WSP 1729: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,018.00 ft (615.086 m) National Geodetic Vertical Datum of 1929 (U.S. Army Corps of Engineers bench mark). Prior to Apr. 14, 1938, at site 0.7 mi (1.1 km) upstream at different datum; Apr. 14, 1938, to Sept. 30, 1963, at present site at datum 2.00 ft (0.610 m) higher, all water-stage recorders. Since Oct. 1, 1969, published discharge is determined by flowmeters at Fort Peck Dam.

REMARKS.--Flow completely regulated by Fort Peck Lake. Diversions for irrigation of about 880,400 acres (3,560 km^2) above station.

COOPERATION.--Records since Oct. 1, 1969, furnished by U.S. Army Corps of Engineers; 2 to 4 discharge measurements are made each year and the records are reviewed by Geological Survey. Records for March 1934 to September 1969 collected and computed by Geological Survey.

AVERAGE DISCHARGE.--5 years (1934-39, prior to Fort Peck Lake reaching operational level), 6,347 ft^3/s (179.7 m^3/s), 4,598,000 acre-ft/yr (5.67 km^3/yr); 38 years (1943-81, after operational level in Fort Peck Lake was reached), 9,986 ft^3/s (282.8 m^3/s), 7,235,000 acre-ft/yr (8.92 km^3/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 51,000 ft^3/s (1,440 m^3/s) including 32,000 ft^3/s (906 m^3/s) inflow from spillway 1 mi (2 km) downstream from station, Aug. 8, 1946; maximum gage height observed, 12.30 ft (3.749 m) Mar. 10, 1936 (ice jam), site and datum then in use; maximum daily reverse flow, 400 ft^3/s (11.3 m^3/s) Mar. 29, 1943 (backwater from Milk River).

EXTREMES FOR CURRENT YEAR.--Maximum daily discharge, 15,000 ft^3/s (425 m^3/s) Aug. 27; minimum daily, 7,300 ft^3/s (207 m^3/s) Apr. 15.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	12400	9100	11200	10200	12300	10000	7800	9900	14300	14300	12400	14800
2	12200	9100	10900	10200	12100	11000	7900	10300	14500	14100	11700	14600
3	12100	8800	10100	10000	13500	12600	8200	9600	14100	14400	12900	14200
4	9800	8800	10000	10100	12800	11600	7800	11500	13800	14100	14800	14000
5	9500	8900	11100	10800	13200	12000	7600	10600	13300	14100	14600	13800
6	9900	8700	10500	11200	13100	13200	7800	10400	13800	14800	14200	13500
7	9500	8900	9600	12000	13300	14000	7800	10600	13400	13900	14100	14000
8	10200	8900	10000	12600	13100	12700	7900	10200	11600	14100	14000	14000
9	10000	8900	9900	13100	13200	13600	7900	9800	11600	14500	14000	14100
10	9700	9000	10200	13400	13100	14000	7900	9700	13200	14100	14000	14100
11	9100	9900	10200	12700	13100	13800	7700	10100	14400	14000	13700	13800
12	9100	9200	10100	13000	13200	13900	7900	9800	13700	14200	13800	13700
13	8900	9400	9600	13400	13400	14300	7400	9200	13700	14700	14200	14000
14	8900	9100	9700	13000	14100	13900	7800	10500	12600	14400	14200	14200
15	8800	9600	9800	13400	13600	13300	7300	11000	13900	13900	14400	13700
16	8900	9200	9900	13100	14400	12000	7600	10800	13200	14500	14400	14100
17	8600	9100	10100	12700	13900	9600	7600	10800	13700	14100	12100	14600
18	9100	9000	9900	12400	13900	9600	7900	10500	13700	14200	12500	14000
19	8700	9000	10000	13600	11800	9900	7800	10600	12200	14300	14300	14100
20	9300	8900	8900	12900	9900	9800	7600	10700	13200	14300	14300	13900
21	8900	9100	9600	13200	10300	9700	8000	10900	10000	14400	14400	14100
22	8800	9200	9900	12900	10000	9400	8100	10600	12600	14300	14300	13900
23	9400	9500	10100	13000	10000	9800	8000	10500	13500	13700	14300	14900
24	8700	9300	10600	12700	9800	9500	7700	10500	13900	14500	14300	14400
25	8800	9500	10000	12700	10100	9500	8000	10700	13500	14300	14600	14200
26	8400	9900	10200	12800	9700	9900	8400	12900	13200	14300	14300	13900
27	8700	8200	10100	13100	10000	10000	9400	14900	13300	14200	15000	14200
28	8800	8200	10000	11900	9900	9600	9700	14600	13600	14300	15000	14500
29	8700	8500	9900	11900	---	8500	10100	14200	13400	14200	14000	14500
30	8800	9100	10000	11900	---	7600	10200	14500	14100	13200	14600	14200
31	8400	---	10300	11800	---	8200	---	14500	---	12900	13800	---
TOTAL	291100	272000	312400	381700	340800	346500	242800	345400	399000	439300	433200	424000
MEAN	9390	9067	10080	12310	12170	11180	8093	11140	13300	14170	13970	14130
MAX	12400	9900	11200	13600	14400	14300	10200	14900	14500	14800	15000	14900
MIN	8400	8200	8900	10000	9700	7600	7300	9200	10000	12900	11700	13500
AC-FT	577400	539500	619600	757100	676000	687300	481600	685100	791400	871400	859300	841000

CAL YR 1980 TOTAL 3829000 MEAN 10460 MAX 14600 MIN 5800 AC-FT 7595000
WTR YR 1981 TOTAL 4228200 MEAN 11580 MAX 15000 MIN 7300 AC-FT 8387000

WATER SUPPLY — EVAPORATION

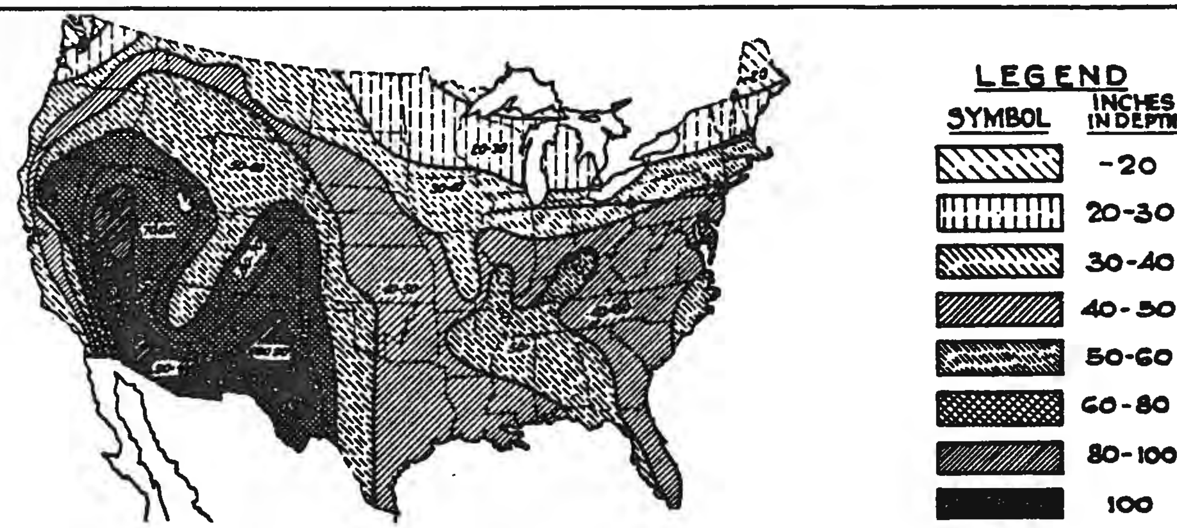


FIG. A - ANNUAL EVAPORATION FROM WATER SURFACE. *

TABLE B - RECORDED EVAPORATION FROM RESERVOIR SURFACES. **

Station	Elevation, feet	Years	Temperature of air, degrees Fahrenheit	Wind velocity: Nearby U.S. Weather Bureau Station		Wind velocity: At the pan, miles per hour	Relative humidity, per cent	Reservoir surface evaporation, inches			Percentage range of annual evaporation	Coefficient for pan
				Height, feet	Velocity, miles per hour			April to September	Annual	Maximum per month		
United States:												
Ithaca, N.Y.	800	1918 to 1930	47	100	9.1	1.8	78	17.11	22.54	4.17	90 to 114	0.69
Washington, D.C.	280	1915 to 1917	54	85	6.5	2.3	69	23.52	34.53	4.87	97 to 103	0.69
Chapel Hill, N.C.	500	1921 to 1930	61	...	....	1.1	69	20.03	28.56	4.71	93 to 109	0.69
Madison, Wis.	800	1908 to 1911	46	78	10.0	...	75	12.91	19.82	3.04	97 to 102	0.83
Columbus, Ohio	763	1918 to 1930	52	230	10.7	2.0	74	19.21	26.81	4.94	89 to 108	0.69
Columbus, Mo.	750	1910 to 1927	54	84	8.0	1.5	71	20.28	28.13	5.31	88 to 114	0.69
Grand Forks, N.D.	820	1905 to 1920	38	58	9.8	...	79	21.72	27.07	5.82	90 to 117	0.83
Rapid City, S.D.	3,240	1916 to 1921	46	...	....	2.0	58	25.61	36.43	7.02	92 to 112	0.69
Lincoln, Neb.	1,250	1917 to 1930	51	81	10.0	4.1	69	32.06	42.04	9.92	87 to 118	0.69
Mitchell, Neb.	4,080	1911 to 1920	47	...	....	7.0	..	34.17	41.78	9.28	83 to 118	0.44
Lawrence, Kan.	825	1910 to 1919	55	...	....	4.4	..	31.25	44.80	7.62	....	0.69
Manhattan, Kan.	1,010	1924 to 1929	54	...	....	3.4	..	30.14	42.65	8.06	91 to 112	0.69
Austin, Tex.	475	1916 to 1929	68	148	7.5	2.0	68	28.72	42.47	8.49	77 to 116	0.83
Amarillo, Tex.	3,680	1907 to 1919	56	49	13.0	9.6	56	49.00	66.00	12.63	84 to 109	0.94
Denver, Colo.	5,340	1916	49	...	7.8	4.5	64	38.00	52.15	8.20	....	0.99
Salt Lake, Utah	4,250	1928 to 1930	52	203	6.2	3.6	50	40.07	50.94	10.10	95 to 103	0.69
Yuma, Ariz.	127	1917 to 1929	69	54	5.2	1.3	44	36.29	53.45	9.55	91 to 116	0.69
Independence, Calif.	3,800	1909 to 1911	56	28	6.0	...	45	38.04	55.26	8.00	....	0.83
Salton Sea, Calif.	230	1910	73	...	....	4.1	40	66.35	97.10	13.10	....	0.56
Corvallis, Ore.	235	1922 to 1930	52	...	....	1.5		21.88	30.08	5.92	91 to 106	0.69

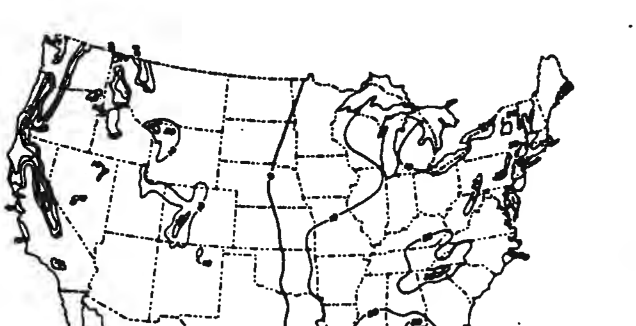


FIG. C - *** Average annual excess of precipitation over the demands of evaporation and transpiration, in inches. West of the zero line there is generally no annual excess except in mountain areas and in the Pacific North West.

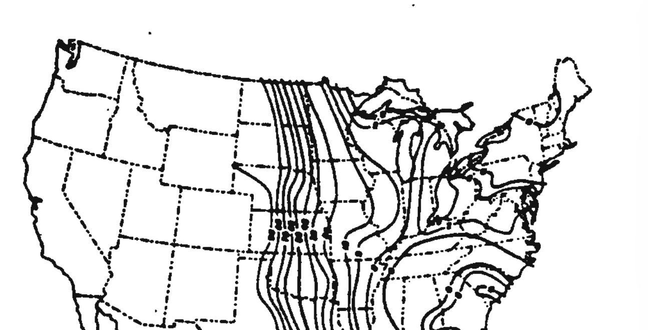


FIG. D - *** Percentage of years that annual precipitation has been less than demands for evaporation and transpiration. Throughout the West, except in mountain areas and the Pacific North West, annual demands of evaporation and transpiration always or nearly always exceed annual precipitation.

* From Public Water Supplies by F. E. Turneaure & H. L. Russell.
** Data from Report - Robert Follansbee - See Trans. - A.S.C.E. Vol. 99 Pg. 708.
*** From Physics of the Earth - IX. Hydrology - Published by McGraw-Hill.

STATION LOCATION

GLASGOW, MONTANA

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude North	Longitude West	Elevation above Sea level: Ground at temperature site	Elevation above Ground: Wind instruments	Extreme thermometers	Psychrometer	Sunshine Switch	Tipping bucket rain gage	Weighing rain gage	8" rain gage	Hygrothermometer	Automatic Observing Equipment *	Remarks
COOPERATIVE																
Valley along Milk River	7/1893	3/1905	NA	48° 15'	106° 40'											
Bend of Milk River	7/1905	4/1907	Unknown	48° 10'	106° 38'	2092		5					2			
401 First Avenue South	5/1907	3/1908	Unknown	48° 11'	106° 38'	2090		5					2			
341 First Avenue South	2/1909	3/1909	50' ESE	48° 11'	106° 38'	2090		5					2			
441 First Avenue South	11/1910	3/1911	350' WNW	48° 11'	106° 38'	2090		5					2			
710 Second Avenue South	5/1911	4/1916	970' WNW	48° 11'	106° 38'	2090		5					2			
604 Second Avenue North	5/1916	3/1927	1660' NE	48° 11'	106° 38'	2092		5					2			
Hall Residence 305 Fifth Avenue South	3/1927	12/01/40	2420' SSE	48° 11'	106° 38'	2088		5					3			
CITY																
305 Fifth Avenue South	12/01/40	7/01/43	No Change	48° 11'	106° 38'	2088	42	5	5				3			
Bank Building 501 First Avenue South	6/06/43	10/25/55	1500' NW	48° 11'	106° 38'	2090	53	34	34				33			
AIRPORT																
Utility Building Municipal Airport † † International Airport (effective 6/1966)	10/25/55	5/5/69	1 mile NE	48° 13'	106° 37'	2277 e2284	30 c20	5	5	NA	NA	NA a3 b5	3 b5	NA d6	NA	a - Installed 5/25/57 b - Moved 75' NNW 6/9/59. c - Effective 8/6/62. d - Commissioned 1650' NNE of thermometer site 5/12/64. e - Effective 5/12/64.
Administration Building International Airport	5/5/69	Present	385' SSW	48° 13'	106° 37'	2284	f20	5	5	NA	NA	5	5	f6	NA	f - Not moved 5/5/69.

* Type
M = AMOS
T = AUTOB

SUBSCRIPTION:
Price and ordering information available through: National Climatic Data Center, Federal Building, Asheville, North Carolina 28801, ATTN: Publications.

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L. Ray Hoxit
Acting Director
National Climatic Data Center

USCOMM-NOAA-ASHEVILLE - 925

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FEDERAL BUILDING
ASHEVILLE, N.C. 28801

U.S. MAIL

Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
#1943	-0.7	16.9	20.2	49.8	52.5	59.6	70.6	70.5	58.6	50.6	34.7	25.6	42.4
1944	25.4	21.7	21.2	47.7	60.0	61.6	70.0	67.2	59.4	52.4	26.7	20.6	44.5
1945	15.8	19.2	35.2	40.8	51.2	59.2	73.4	69.6	54.2	47.8	23.4	13.0	41.9
1946	16.6	17.5	40.2	52.2	53.2	64.2	74.6	67.9	57.0	42.2	24.1	15.4	43.8
1947	18.3	12.3	21.8	44.6	53.5	61.6	76.4	70.9	57.0	51.2	27.2	24.7	43.3
1948	22.1	11.6	25.6	44.5	57.9	64.2	71.0	72.8	63.4	48.0	32.4	9.9	43.6
1949	2.4	4.4	28.6	52.4	60.8	65.2	70.8	73.8	57.5	43.4	40.4	8.5	42.4
1950	-14.2	13.6	20.0	38.9	52.4	61.6	68.8	65.4	58.1	48.0	24.2	15.8	37.7
1951	6.4	7.9	12.7	40.1	57.7	59.8	71.9	66.5	53.4	42.8	27.2	8.0	37.9
1952	4.6	14.3	18.0	51.2	57.8	65.0	68.4	68.9	62.1	45.7	30.9	19.3	42.2
1953	17.4	23.4	29.8	38.0	51.7	64.2	71.9	71.4	59.9	53.1	38.3	26.5	45.5
1954	1.0	31.6	23.0	38.4	53.1	61.1	73.9	68.8	56.8	45.9	41.2	28.7	43.6
#1955	12.6	11.5	21.8	46.4	54.1	63.7	73.2	73.3	56.8	49.8	14.4	8.1	40.5
1956	5.6	9.9	26.2	38.7	55.1	67.6	68.7	67.1	57.7	47.3	32.9	20.9	41.5
1957	0.5	12.5	29.5	41.0	57.1	63.3	74.6	69.2	57.7	42.5	33.0	28.1	42.4
1958	25.1	13.7	27.4	44.9	61.5	60.8	67.0	72.7	58.6	47.4	25.9	15.2	43.4
1959	5.5	3.1	32.0	42.4	50.7	65.6	71.7	69.1	55.8	40.1	22.8	26.1	40.4
1960	9.1	12.9	22.8	42.5	55.2	62.3	75.5	68.6	60.2	48.0	28.4	17.4	41.9
1961	18.8	24.9	37.8	39.7	56.4	71.6	72.9	75.0	51.1	44.7	27.6	10.4	44.2
1962	11.9	12.8	19.3	47.2	53.6	64.8	66.6	68.5	56.9	49.1	38.9	24.5	42.8
1963	3.3	23.3	37.9	43.3	52.9	63.6	72.0	70.8	65.1	53.9	31.9	16.4	44.6
#1964	20.9	27.7	24.1	44.7	57.0	63.9	74.3	68.0	55.0	49.3	27.1	1.4	42.8
1965	6.4	11.1	10.5	41.8	53.2	61.9	71.0	69.4	48.1	52.2	26.8	22.7	39.6
1966	-1.2	7.8	32.0	37.8	55.3	62.3	71.6	65.4	62.1	45.9	23.9	18.9	40.1
1967	12.5	15.1	21.8	37.0	50.9	60.6	71.0	70.5	62.2	46.4	30.6	15.9	41.2
1968	11.2	18.5	38.1	42.0	52.1	60.4	69.0	65.0	57.6	45.8	32.9	9.9	41.9
1969	-7.0	8.2	18.3	47.6	53.8	58.3	66.1	73.4	61.9	38.7	34.5	22.8	39.7
1970	7.0	18.4	24.4	39.5	54.1	67.4	72.6	72.2	56.1	42.8	26.8	12.0	41.1
1971	5.1	14.3	24.6	44.9	55.8	65.0	68.8	77.2	56.5	44.3	32.3	10.8	41.6
1972	4.3	10.5	30.3	44.3	55.6	65.6	64.7	71.1	53.6	42.1	32.8	6.4	40.1
1973	18.1	23.6	39.0	41.6	56.2	65.6	69.8	72.9	56.6	49.3	21.3	15.7	44.2
1974	10.4	25.5	29.6	47.5	50.7	66.2	73.3	64.0	55.4	49.2	33.2	25.1	44.2
1975	18.5	12.6	24.7	35.9	52.8	62.4	73.1	64.9	56.3	45.0	30.1	18.5	41.2
1976	13.8	29.5	29.3	47.8	58.2	62.5	70.3	70.0	59.8	42.2	26.4	18.9	44.1
1977	3.1	26.5	33.6	48.2	58.3	65.7	69.1	61.2	55.2	46.0	24.5	8.3	41.6
1978	-2.1	7.4	24.5	43.8	54.8	62.7	67.1	65.9	58.5	45.4	21.3	9.2	38.2
1979	-4.3	1.5	23.4	36.3	50.4	64.3	72.2	69.7	62.5	49.0	26.9	26.5	39.9
1980	7.3	16.4	27.9	51.9	61.1	66.1	72.3	64.7	57.8	47.7	36.3	18.2	44.2
1981	25.3	25.8	38.9	48.2	56.8	60.6	71.7	73.1	60.8	44.1	37.1	17.7	46.7
1982	-5.1	9.8	24.6	40.6	51.2	62.3	69.7	69.3	56.8	45.2	25.7	19.0	39.1
RECORD MEAN	9.1	15.7	26.9	43.5	55.0	63.5	71.1	69.4	57.8	46.5	29.3	16.8	42.0
MAX	19.2	26.2	37.8	55.8	67.7	76.1	85.3	83.7	71.4	59.5	39.9	26.7	54.1
MIN	-1.0	5.1	16.0	31.2	42.2	50.8	56.8	55.0	44.1	33.5	18.7	6.9	29.9

Heating Degree Days

GLASGOW, MT

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1962-63	23	43	243	486	780	1247	1917	1162	830	643	378	84	7836
#1963-64	4	13	72	341	984	1503	1359	1077	1261	602	267	92	7575
1964-65	0	52	298	482	1135	1974	1816	1507	1689	690	359	118	10120
1965-66	11	41	502	389	1137	1305	2053	1599	1016	812	316	132	9313
1966-67	5	78	136	588	1225	1422	1624	1396	1335	835	479	149	9222
1967-68	19	12	136	571	1024	1517	1664	1344	826	683	397	158	8353
1968-69	38	78	235	589	956	1706	2236	1584	1440	515	361	219	9957
1969-70	39	7	150	807	908	1301	1798	1297	1251	758	334	46	8696
1970-71	5	7	296	680	1142	1638	1856	1416	1246	595	285	59	9224
1971-72	27	0	267	635	973	1676	1883	1579	1067	614	305	55	9081
1972-73	71	11	338	703	958	1814	1452	1152	802	691	277	68	8337
1973-74	8	7	255	480	1306	1522	1692	1103	1089	526	436	70	8494
1974-75	3	88	283	481	945	1229	1437	1463	1244	867	373	102	8515
1975-76	5	68	260	613	1042	1437	1583	1022	1099	510	215	109	7963
1976-77	9	10	185	695	1151	1421	1917	1074	967	497	233	59	8221
1977-78	32	140	292	583	1205	1752	2081	1610	1252	628	319	111	10008
1978-79	42	70	233	601	1306	1725	2145	1780	1283	853	455	86	10579
1979-80	6	17	114	489	1139	1187	1788	1404	1145	398	175	49	7911
1980-81	2	63	232	536	854	1446	1225	1091	799	499	250	145	7142
1981-82	10	6	169	639	834	1459	2171	1546	1246	728	418	121	9347
1982-83	16	39	271	607	1171	1417							

Cooling Degree Days

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1969	0	0	0	0	20	26	79	276	62	0	0	0	463
1970	0	0	0	0	3	129	250	236	38	0	0	0	655
1971	0	0	0	0	9	67	153	383	22	0	0	0	634
1972	0	0	0	0	20	80	69	205	4	0	0	0	378
1973	0	0	0	0	13	91	165	259	10	0	0	0	538
1974	0	0	0	5	0	113	268	62	3	0	0	0	451
1975	0	0	0	0	1	33	263	75	6	0	0	0	378
1976	0	0	0	0	9	41	180	172	35	0	0	0	437
1977	0	0	0	1	34	85	166	29	6	0	0	0	321
1978	0	0	0	0	7	47	114	107	45	0	0	0	320
1979	0	0	0	0	8	70	236	170	48	1	0	0	533
1980	0	0	0	12	60	88	234	59	23	7	0	0	483
1981	0	0	0	0	2	22	227	265	48	0	0	0	564
1982	0	0	0	0	0	44	168	180	32	0	0	0	424

Precipitation

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
#1943	1.11	0.07	0.63	0.54	0.55	5.14	1.04	1.47	0.01	1.66	0.12	0.06	12.40
1944	0.05	0.42	1.25	0.70	1.08	5.40	0.49	2.79	0.89	0.07	0.90	0.11	14.15
1945	0.57	0.42	1.25	0.94	1.08	2.38	0.71	0.42	1.17	0.72	0.59	0.57	10.82
1946	0.22	0.33	0.21	0.05	1.09	3.06	3.44	0.36	2.76	0.78	0.63	0.61	13.54
1947	0.45	0.19	0.50	1.65	0.66	3.31	1.28	5.55	0.49	0.38	0.25	0.41	15.12
1948	0.32	0.58	0.53	1.69	2.48	3.44	2.23	0.88	0.38	0.02	0.69	1.00	14.24
1949	0.37	0.46	0.20	T	1.39	1.18	1.48	0.69	0.36	0.83	0.02	1.49	8.47
1950	1.33	0.51	0.83	0.85	1.12	6.95	0.54	2.27	3.30	0.31	0.67	0.34	19.02
1951	1.40	0.78	0.54	1.69	0.63	2.22	0.87	1.63	1.40	0.85	0.48	0.79	13.28
1952	0.50	1.45	0.49	0.30	1.99	3.54	2.03	1.39	0.78	0.02	0.11	0.19	12.79
1953	0.48	0.85	0.64	1.63	4.92	3.45	0.58	0.98	0.33	0.27	0.15	1.05	15.33
1954	1.20	0.21	1.37	1.29	2.48	2.04	0.21	4.88	1.14	1.05	0.12	0.25	16.24
#1955	0.52	0.59	0.54	2.62	3.11	0.69	2.60	0.09	0.42	0.10	0.82	0.46	12.56
1956	0.11	0.49	0.13	0.07	2.29	1.68	1.62	2.03	0.10	0.03	0.38	0.26	9.19
1957	0.48	0.56	0.05	1.33	1.00	2.86	0.98	2.01	0.51	0.45	0.09	0.07	10.39
1958	0.13	0.33	0.29	0.58	0.03	2.06	1.15	0.52	0.31	0.13	1.26	0.28	7.07
1959	0.48	0.50	0.14	0.42	1.18	2.79	0.57	0.59	1.26	1.02	0.72	0.03	9.70
1960	0.43	0.32	0.27	0.72	1.43	1.61	0.55	0.95	0.04	0.34	0.30	0.34	7.30
1961	0.09	0.45	0.35	0.55	1.04	1.17	1.66	0.38	2.04	0.78	0.19	0.19	8.89
1962	0.34	0.45	0.55	0.21	2.50	4.43	5.17	1.87	0.48	1.15	0.43	0.19	17.77
1963	0.32	0.47	0.27	1.22	1.13	5.36	1.65	3.30	0.32	0.12	0.21	0.30	14.67
1964	0.21	0.19	0.61	0.41	2.52	2.78	1.20	0.85	0.52	0.20	0.26	0.78	10.53
1965	0.46	0.20	0.30	0.51	3.25	4.64	0.91	3.01	0.79	T	0.12	0.12	14.31
1966	0.51	0.14	0.10	0.59	1.91	0.89	3.13	3.65	0.41	0.68	0.34	0.23	12.58
1967	0.84	0.25	0.83	0.84	0.68	2.23	0.12	0.18	2.20	1.13	0.36	0.26	9.92
1968	0.13	0.15	0.10	0.67	0.23	2.24	0.82	2.00	0.75	0.10	0.07	0.39	7.65
1969	1.24	0.14	0.17	1.99	0.25	1.23	3.45	0.05	0.27	1.33	T	0.36	10.48
1970	0.49	0.05	0.27	1.51	1.88	2.43	1.07	0.04	1.32	0.44	0.49	0.26	10.25
1971	0.99	0.21	0.27	0.42	0.91	1.26	0.20	0.78	0.48	1.08	0.04	0.26	6.90
1972	0.55	0.59	0.50	0.84	2.73	3.77	2.30	2.40	0.69	0.22	0.02	0.61	15.22
1973	T	0.09	0.27	1.24	0.54	4.35	0.59	1.21	1.43	0.24	0.46	0.78	11.20
1974	0.18	0.25	0.93	0.49	3.27	2.00	2.31	2.69	0.07	0.42	0.26	0.25	13.12
1975	0.11	0.23	0.61	1.30	1.93	1.20	4.18	1.37	0.42	1.77	0.40	0.38	13.90
1976	0.27	0.13	0.30	0.60	0.64	4.27	5.00	1.16	0.41	0.21	0.26	0.28	13.53
1977	0.42	0.12	0.11	0.17	1.83	1.16	0.78	0.58	2.62	0.40	0.24	0.86	9.29
1978	0.19	0.40	0.25	0.51	3.65	2.72	2.63	0.16	4.14	0.28	0.48	0.45	15.86
1979	0.15	0.74	0.43	1.27	2.46	0.48	0.75	0.76	0.27	0.57	0.18	0.05	8.11
1980	0.50	0.14	0.36	0.22	0.46	2.55	0.44	1.36	0.87	1.35	0.20	0.50	8.95
1981	0.06	0.10	0.31	0.19	2.13	1.83	1.72	0.23	0.08	1.40	0.55	0.19	8.79
1982	0.75	0.43	0.72	0.22	3.74	1.03	0.97	1.19	0.98	1.09	0.06	1.03	12.21
RECORD MEAN	0.46	0.38	0.46	0.83	1.73	2.63	1.60	1.47	0.95	0.57	0.35	0.44	11.87

Snowfall

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1943-44	0.0	0.0	0.0	1.0	0.5	T	T	4.0	9.3	T	T	0.0	14.8
1944-45	0.0	0.0	2.0	T	4.8	1.0	6.2	4.9	4.8	0.4	0.0	0.0	24.1
1945-46	0.0	0.0	T	1.5	6.6	7.1	2.0	7.1	3.7	T	T	0.0	24.0
1946-47	0.0	0.0	T	2.9	8.0	7.5	4.7	1.9	5.4	6.0	0.0	0.0	36.4
1947-48	0.0	0.0	0.0	1.5	1.4	1.9	2.1	8.3	6.5	7.5	T	0.0	29.2
1948-49	0.0	0.0	0.0	T	3.4	11.7	5.4	5.0	2.2	0.0	T	0.0	27.7
1949-50	0.0	0.0	T	1.8	T	15.3	15.5	6.5	8.0	5.2	2.5	1.3	56.1
1950-51	0.0	0.0	0.3	0.7	7.8	4.7	15.0	5.4	4.3	8.1	0.0	0.0	49.3
1951-52	0.0	0.0	2.3	8.3	5.9	6.0	8.0	21.4	6.8	2.2	0.0	0.0	60.9
1952-53	0.0	0.0	0.0	T	0.6	2.9	7.0	8.0	9.8	6.4	5.1	0.0	39.8
1953-54	0.0	0.0	0.0	0.0	T	5.2	20.1	1.3	11.2	10.5	1.1	0.0	49.4
1954-55	0.0	0.0	T	T	0.2	2.7	10.5	10.3	6.9	9.4	T	0.0	40.0
#1955-56	0.0	0.0	0.0	T	9.7	5.2	2.7	5.3	1.3	0.2	5.2	0.0	29.6
1956-57	0.0	0.0	0.0	T	0.7	4.1	7.6	9.4	0.5	T	0.0	0.0	21.3
1957-58	0.0	0.0	0.4	1.3	0.6	1.2	1.7	6.0	3.0	T	0.0	0.0	14.2
1958-59	0.0	0.0	T	T	17.2	4.5	7.6	6.7	0.7	1.8	T	0.0	38.5
1959-60	0.0	0.0	T	5.4	5.6	0.3	5.8	3.8	0.9	5.3	T	0.0	27.1
1960-61	0.0	0.0	0.0	0.8	1.7	4.2	1.5	1.8	5.0	1.3	0.0	0.0	16.3
1961-62	0.0	0.0	T	5.0	1.4	1.9	3.0	4.8	5.5	T	0.0	0.0	21.6
1962-63	0.0	0.0	T	2.0	T	1.4	3.2	3.9	1.4	5.3	T	0.0	17.2
1963-64	0.0	0.0	0.0	0.0	2.0	2.5	2.1	1.9	3.6	2.3	0.0	0.0	14.4
1964-65	0.0	0.0	T	1.6	2.4	10.8	10.7	6.6	4.9	3.1	T	0.0	40.1
1965-66	0.0	0.0	1.1	0.0	1.0	1.2	8.4	2.5	2.8	1.7	1.7	0.0	20.4
1966-67	0.0	0.0	0.0	1.6	4.6	3.9	14.2	4.3	14.8	12.1	3.1	0.0	58.6
1967-68	0.0	0.0	0.0	0.0	0.4	4.6	2.7	3.1	T	6.2	0.9	0.0	16.9
1968-69	0.0	0.0	0.0	T	0.7	5.7	24.1	2.7	3.3	0.6	0.0	0.0	37.1
1969-70	0.0	0.0	0.0	1.0	T	4.1	5.5	0.6	2.6	13.7	T	0.0	27.5
1970-71	0.0	0.0	0.1	1.1	6.7	3.4	24.2	4.3	1.1	T	0.4	0.0	41.3
1971-72	0.0	0.0	0.0	0.1	0.6	6.3	12.7	10.6	3.3	0.7	T	0.0	34.3
1972-73	0.0	0.0	0.2	2.2	0.3	13.9	T	1.2	0.1	4.0	T	0.0	21.9
1973-74	0.0	0.0	0.0	0.0	5.1	10.6	2.1	2.6	6.1	0.6	T	0.0	27.1
1974-75	0.0	0.0	0.0	0.2	1.0	2.3	1.5	3.5	7.4	4.0	T	0.0	19.9
1975-76	0.0	0.0	0.0	7.0	5.5	4.7	3.9	7.5	4.9	0.2	0.0	0.0	26.7
1976-77	0.0	0.0	0.0	1.6	2.3	4.0	7.7	0.3	0.7	0.4	0.0	0.0	17.0
1977-78	0.0	0.0	0.0	0.2	4.3	13.2	3.8	4.4	3.0	3.5	0.0	0.0	33.4
1978-79	0.0	0.0	T	T	7.6	6.5	2.4	15.9	7.1	7.8	0.5	0.0	47.8
1979-80	0.0	0.0	0.0	T	2.7	0.4	9.4	1.3	2.6	0.7	0.0	0.0	17.1
1980-81	0.0	0.0	0.0	3.1	1.0	11.0	1.1	0.8	0.1	T	0.0	0.0	17.1
1981-82	0.0	0.0	0.0	4.4	1.8	2.9	16.4	7.3	7.5	1.7	T	0.0	42.0
1982-83	0.0	0.0	1.5	0.6	0.4	11.2							
RECORD MEAN	0.0	0.0	0.1	1.5	2.9	5.2	6.9	4.4	3.5	2.7	0.4	0.0	27.6

# Indicates a station move or relocation of instruments. See Station Location table.

Record mean values above are means through the current year for the period beginning in 1944 for temperature and precipitation, 1956 for snowfall.

Meteorological Data For The Current Year

Station: GLASGOW, MONTANA # 94008 INTERNATIONAL AIRPORT Standard time used: MOUNTAIN Latitude: 48° 13' N Longitude: 106° 37' W Elevation (ground): 2284 feet Year: 1982

Month	Temperature °F Averages Daily maximum	Daily minimum	Monthly	Extremes Highest	Date	Lowest	Date	Degree days Base 65 °F Heating	Cooling	Precipitation in inches Water equivalent Total	Greatest in 24 hrs.	Date	Snow, Ice pellets Total	Greatest in 24 hrs.	Date
JAN	5.4	-15.5	-5.1	44	26	-39	6	2171	0	0.75	0.15	31	16.4	3.0	31
FEB	20.0	-.5	9.8	51	20	-37	3	1546	0	0.43	0.27	21-22	7.3	4.4	21-22
MAR	32.2	16.9	24.6	50	27	-15	5	1246	0	0.72	0.13	17-18	7.5	2.0	1
APR	52.5	28.6	40.6	78	23	9	5	728	0	0.22	0.04	15	1.7	1.0	1
MAY	60.5	41.9	51.2	81	2	33	31	418	0	3.74	1.63	27-28	T	T	30
JUN	75.2	49.3	62.3	91	22	36	7	121	44	1.03	0.32	8	0.0	0.0	
JUL	83.1	56.3	69.7	95	30	46	17	16	168	0.97	0.51	15-16	0.0	0.0	
AUG	83.6	55.0	69.3	97	11	43	27	39	180	1.19	0.40	26	0.0	0.0	
SEP	70.1	43.5	56.8	92	9	33	30	271	32	0.98	0.73	26-27	1.5	1.5	28
OCT	56.6	33.8	45.2	77	14	21	30	607	0	1.09	0.61	17-18	0.6	0.6	1
NOV	35.9	15.5	25.7	52	18	-5	22	1171	0	0.06	0.04	11	0.4	0.2	21
DEC	28.7	9.3	19.0	47	16	-14	8	1417	0	1.03	0.36	13-14	11.2	5.2	2
YEAR	50.3	27.8	39.1	97	AUG 11	-39	JAN 6	9751	424	12.21	1.63	MAY 27-28	46.6	5.2	DEC 2

Month	Relative humidity, pct. Hour 05 (Local time)	Hour 11	Hour 17	Hour 23	Wind Resultant Direction	Speed m.p.h.	Average speed m.p.h.	Fastest mile Speed m.p.h.	Direction	Date	Percent of possible sunshine	Average sky cover, tenths, sunrise to sunset	Number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperature °F Maximum (b) 90° and above	Maximum 32° and below	Minimum 32° and below	Minimum 0° and below	Average station pressure mb Elev. 2298 feet m.s.l.
JAN	59	57	57	57	07	3.8	11.6	35	30	15		8.5	3	1	27	16	7	0	2	0	28	31	29	933.6
FEB	67	66	67	67	07	1.9	9.8	30	30	6		6.6	6	9	13	8	2	0	2	0	21	27	16	935.7
MAR	76	69	68	74	07	3.3	12.7	39	29	12		7.0	6	7	18	12	4	1	3	0	12	29	4	929.9
APR	68	45	38	59	36	1.4	11.8	40	31	29		6.2	6	12	12	9	1	1	2	0	4	18	0	931.9
MAY	76	58	51	70	36	2.9	11.5	37	28	6		7.6	2	9	20	14	0	1	0	0	0	0	0	931.3
JUN	78	48	42	66	10	3.2	8.5	25	32	23		6.1	4	17	9	6	0	7	0	1	0	0	0	933.0
JUL	73	47	34	59	33	1.2	10.5	32	11	21		5.4	8	14	9	9	0	10	0	3	0	0	0	932.3
AUG	71	41	29	54	10	3.1	11.1	30	30	2		3.5	18	10	3	12	0	10	1	10	0	0	0	934.6
SEP	65	44	36	55	03	1.8	10.2	31	05	27		5.2	12	6	12	4	1	0	0	2	0	0	0	935.0
OCT	77	60	52	72	34	2.1	9.9	26	30	27		5.8	10	9	12	8	0	0	0	0	0	9	0	933.6
NOV	74	62	57	70	08	1.7	9.0	26	33	1		6.2	7	9	14	2	0	0	1	0	9	30	2	933.0
DEC	76	73	75	75	01	1.8	8.8	28	33	27		7.9	1	11	19	9	2	0	7	0	22	31	8	932.3
YEAR	72	56	51	65	05	1.7	10.4	40	31	APR 29		6.3	83	114	168	109	17	30	18	16	96	175	59	933.0

Normals, Means, And Extremes

Month	Temperatures °F Normal Daily maximum	Daily minimum	Monthly	Extremes Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F Heating	Cooling	Precipitation in inches Water equivalent Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Ice pellets Maximum monthly	Year	Maximum in 24 hrs.	Year
(a)				27		27					27		27		27		27		27	
J	18.9	-.5	9.2	55	1968	-47	1969	1730	0	0.39	1.24	1969	T	1973	0.37	1969	24.2	1971	8.8	1971
F	25.4	5.0	15.2	59	1976	-37	1982	1394	0	0.32	0.74	1979	0.05	1970	0.27	1982	15.9	1979	4.7	1979
M	35.6	14.8	25.2	75	1966	-27	1960	1234	0	0.37	0.93	1974	0.05	1957	0.40	1964	14.8	1967	5.0	1967
A	55.0	30.6	42.8	91	1980	-3	1975	666	0	0.71	1.99	1969	0.07	1956	1.16	1969	13.7	1970	8.4	1970
M	66.7	41.7	54.2	99	1980	20	1976	344	10	1.31	3.74	1982	0.03	1958	2.07	1974	5.2	1956	5.0	1956
J	73.9	50.1	62.0	98	1974	33	1979	151	65	2.72	5.36	1963	0.48	1979	2.47	1972	0.0		0.0	
J	84.3	56.6	70.5	104	1960	41	1977	15	190	1.43	5.17	1962	0.12	1967	3.98	1962	0.0		0.0	
A	83.0	54.9	69.0	106	1971	37	1956	30	168	1.51	3.65	1966	0.04	1970	2.45	1965	0.0		0.0	
S	70.4	44.0	57.2	99	1960	21	1961	263	32	0.85	4.14	1978	0.04	1960	1.98	1978	1.5	1982	1.5	1982
O	59.2	33.6	46.4	88	1970	5	1972	577	0	0.56	1.77	1975	T	1965	1.21	1981	7.0	1975	5.3	1975
N	39.1	18.9	29.0	75	1975	-21	1955	1080	0	0.39	1.26	1958	T	1969	0.37	1981	17.2	1958	4.5	1958
D	26.5	7.6	17.1	59	1979	-38	1977	1485	0	0.31	1.03	1982	0.03	1959	0.36	1982	13.9	1972	7.0	1972
YR.	53.2	29.8	41.5	106	AUG 1971	-47	JAN 1969	8969	465	10.87	5.36	JUN 1963	T	JAN 1973	3.98	JUL 1962	24.2	JAN 1971	8.8	JAN 1971

Month	Relative humidity pct. Hour 05 (Local time)	Hour 11	Hour 17	Hour 23	Wind Mean speed m.p.h.	Prevailing direction	Fastest mile ¢ Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	% Thunderstorms	% Heavy fog, visibility ¼ mile or less	Temperatures °F Max. (b) 90° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below	Average station pressure mb. Elev. 2298 feet m.s.l.
(a)	18	18	18	18	13		14	14			27	27	27	27	27	27	23	23	18	18	18	18	10
J	73	70	70	73	10.3		39	36	1971		7.1	5	8	18	9	2	0	2	0	24	31	18	934.7
F	77	72	72	78	10.6		44	28	1974		7.2	5	7	16	7	1	0	2	0	18	28	11	934.0
M	79	66	59	75	11.2		41	30	1979		6.9	5	10	16	7	1	*	2	0	10	28	4	930.6
A	76	52	45	67	12.7		46	32	1978		7.0	5	8	17	7	1	1	1	*	1	16	*	932.2
M	73	47	41	63	11.9		41	12	1980		6.7	6	10	15	10	*	4	*	1	0	3	0	930.7
J	77	48	41	66	10.9		39	24	1972		6.0	7	12	11	11	0	8	*	2	0	0	0	930.9
J	74	44	35	60	10.5		46	08	1976		4.5	13	12	6	8	0	8	*	9	0	0	0	932.9
A	69	42	32	55	10.9		44	27	1975		4.8	12	11	8	7	0	6	*	8	0	0	0	933.0
S	72	46	38	61	10.8		46	30	1971		5.5	10	9	11	6	*	2	*	2	0	2	0	934.0
O	73	53	46	65	10.6		44	32	1968		6.2	8	8	15	5	*	*	1	0	1	13	0	933.6
N	78	66	63	74	9.3		48	27	1978		6.9	6	7	17	6	1	0	2	0	9	27	2	934.1
D	78	73	74	76	9.9		39	32	1979		7.3	4	9	18	8	2	0	3	0	20	31	9	932.7
YR.	75	57	51	68	10.8		48	27	NOV 1978		6.3	86	111	168	91	9	27	12	21	82	178	43	932.8

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 113 in July 1900; lowest temperature -59 in February 1936; maximum monthly precipitation 10.29 in June 1923; maximum monthly snowfall 28.0 in January 1916.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

% Based on available record. Station operated less than 24 hours daily prior to July 1968.

¢ Based on record beginning July 1968.

Local Climatological Data
Annual Summary With Comparative Data
1982
GLASGOW, MONTANA

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

Narrative Climatological Summary

Founded in the days of national expansion as a railroad shop town, Glasgow is situated in the valley of the Milk River, about 20 miles upstream from where the Milk River joins the Missouri. It lies on the natural route from the plains to Marias Pass in the northern Rockies. The City is located on the valley floor at an average elevation of about 2,100 feet above sea level. Hills rise sharply from the northern edge of the City to flat "tableland" about 200 feet higher than the valley. The Weather Service Office is located on this flat land about 1 mile north-northeast of the City. A gradual incline commences 3 to 4 miles to the south and southwest of the City and reaches to the rolling hills which separate the Milk River drainage from the Fort Peck Reservoir on the Missouri. The northern shore of Fort Peck Reservoir lies about 15 miles south of Glasgow. This is a body of water impounded by Fort Peck Dam which was completed in 1939. The dam, at full capacity, backs water up the Missouri Valley for over 180 miles. The reservoir's shape is very irregular, but its average width south of Glasgow is about 10 miles.

Glasgow's climate is of the "continental" type, with a large annual range in temperature and limited precipitation. Fort Peck Reservoir, to the south, seems to have little climatic effect as far north as Glasgow, except for brief periods of morning fog in the late fall which occasionally drifts northward from the lake before "freeze-up."

While the normal annual precipitation for Glasgow is only 10.87 inches, 78 percent of it falls during the six so-called "growing months," April through September, with May and June accounting for 38 percent of the annual total. This average time distribution of precipitation helps to make the climate quite favorable for the growing of small grains. Winter precipitation nearly always falls as snow; but as a rule, although snow seldom accumulates to any great depth, it usually is formed into drifts in the open, unprotected areas. Blizzards during the winter months occur occasionally, but usually are of short duration; however, it is wise for travelers and stockmen to be on the alert for this danger during the winter months. Glasgow itself is well protected from most strong winds and blizzard conditions by hills to the north of the City, but occasionally the unprotected surrounding areas feel the full brunt of these winter storms.

Glasgow has a wide range of temperature. Winters are quite cold, with an average normal temperature of 13.8 degrees for the December-February period. The coldest temperature ever recorded was -59 degrees, which occurred in February 1936. Mild winter weather occasionally does occur, sometimes caused when the "chinook" or "foehn" wind, which descends the eastern slopes of the Rocky Mountains, reaches as far east as Glasgow. Very cold spells also occur, at least once each winter, but as a rule, these last only a few days. Summers are characterized by warm, sunny weather which can last for several weeks at a time. The average normal temperature for the summer, June through August, is 67.2 degrees. Sunny weather predominates during the warmer season, but interruptions in the form of clouds and showers do occur - usually in the afternoons and evenings. A few days of really hot weather in July and August occur at times, but hot days are seldom oppressive because usually they are accompanied by low humidity. The warmest temperature ever recorded in Glasgow is 113 degrees, which occurred in July 1900.

As is usually the case with a "continental" type climate in northern latitudes, the change from summery to wintry weather in the fall at Glasgow is usually quite rapid, as is the change from wintry weather in the spring.

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STATION LOCATION

MILES CITY, MONTANA

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude North	Longitude West	Elevation above Sea level: Ground at temperature site	Elevation above Ground: Wind instruments	Extreme thermometers	Psychrometer	Sunshine Switch	Tipping bucket rain gage	Weighing rain gage	8" rain gage	Hygrothermometer	Automatic Observing Equipment *	Remarks
Ft. Keogh, 3 miles SW of Miles City	8/01/77	1/14/79		46° 23'	105° 53'	2365		?					?			Latitude, longitude, and elevation of ground for Fort Keogh sites approximate.
Fort Keogh Quartermaster Office	11/18/78	8/20/80		46° 23'	105° 53'	2365		14					37			
Fort Keogh Library Building	8/20/80	8/20/81		46° 23'	105° 53'	2365		14					37			
Fort Keogh Southeast Part	8/20/81	6/15/83		46° 23'	105° 53'	2365		9					33			
Fort Keogh Post Surgeon	6/15/83	12/31/99		46° 23'	105° 53'	2365		? Unk					? Unk			
CITY																
Stebbins Building SW corner 6th & Main	10/01/91	11/01/95	3 miles NE	46° 25'	105° 49'	2353	53	40	40				34			
Foster Bruning Building NE corner 7th & Main	11/01/95	5/31/99	500 ft. ENE	46° 25'	105° 49'	2351	49	41	41				34			
Leighton Block NW corner 5th & Main	5/31/99	9/17/05	1000 ft. WSW	46° 25'	105° 49'	2352	50	42	42				33			
Foster Bruning Building NE corner 7th & Main	9/17/05	10/02/16	1000 ft. ENE	46° 25'	105° 49'	2351	48	26	26				32			
Post Office Building NE corner 7th & Pleasant	10/02/16	1/15/43	500 ft. NNW	46° 25'	105° 49'	2351	55	48	48		a39	b39	39			a - Added 3/28/23. b - Added 12/2/40.
AIRPORT																
Miles City Airport 2 mi. NW of Post Office	1/01/33	3/01/36		46° 26'	105° 52'	2629										Observations by WBO personnel; most data recorded from Post Office Building site.
Radio Range Station	3/01/36	11/07/36	2.8 mi. WSW	46° 25'	105° 56'	2626										CAA began part time observations.
Radio Watch House SE corner of Miles City Municipal Airport	11/07/36	Present	2.8 mi. ENE	46° 26'	105° 52'	2629	40	5	5	NA	NA	NA c4	3	NA	NA	Began full airway observations 1/15/37. c - Installed 5/1975.

* Type
M = AMOS
T = AUTOB

SUBSCRIPTION:
Price and ordering information available through: National Climatic Data Center, Federal Building, Asheville, North Carolina 28801, ATTN: Publications.

I certify that this is an official publication of the National Oceanic and Atmospheric Administration, and is compiled from records received at the National Climatic Data Center, Asheville, North Carolina 28801.

Acting Director
National Climatic Data Center

USCOMM-NOAA-ASHEVILLE - 900

DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
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ASHEVILLE, N.C. 28801

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM 210
FIRST CLASS

Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1943	5.8	25.4	25.0	51.8	53.8	62.5	73.4	72.6	58.6	51.6	34.2	28.7	45.3
1944	26.6	18.2	23.6	47.1	59.6	60.8	70.1	67.8	60.4	53.4	30.1	21.9	45.0
1945	19.3	24.0	36.5	41.8	51.9	58.5	73.9	71.6	56.8	50.4	30.7	17.7	44.4
1946	25.6	25.4	41.4	53.3	52.8	65.0	75.8	70.5	59.1	41.7	29.6	22.0	46.8
1947	22.8	17.6	24.0	43.6	54.2	61.4	77.0	75.2	59.9	53.3	29.2	24.2	45.2
1948	22.2	17.0	28.7	48.0	58.0	65.0	71.6	74.0	65.4	49.7	33.1	14.0	45.6
1949	2.2	7.2	26.2	52.5	60.9	65.8	73.5	75.8	59.3	43.7	42.9	15.6	43.8
1950	-4.5	21.5	24.7	39.6	51.0	61.9	69.4	68.1	58.8	51.2	27.4	24.9	41.1
1951	15.4	22.3	20.4	40.6	58.2	59.4	73.7	69.5	53.6	44.0	30.1	9.9	41.4
1952	6.4	21.1	22.4	52.3	58.2	68.6	71.7	71.7	64.3	47.9	30.7	26.4	45.2
1953	27.3	28.2	35.9	38.9	50.9	65.2	74.0	72.6	62.3	54.2	39.9	29.4	48.2
1954	9.8	37.2	26.7	42.3	54.1	62.2	77.7	71.9	59.5	47.3	41.5	29.4	46.6
1955	21.7	17.2	27.1	47.8	56.1	64.0	76.0	76.4	60.0	51.8	19.0	15.6	44.4
1956	10.6	17.7	34.9	41.6	58.0	73.0	73.1	70.8	61.8	51.1	34.3	28.4	46.3
1957	6.3	19.9	32.8	42.9	58.1	63.8	78.4	72.3	59.3	46.3	34.4	33.3	45.7
1958	30.5	19.4	32.0	46.4	64.8	62.6	68.5	75.9	63.0	50.9	32.7	21.2	47.3
1959	11.7	9.3	36.8	44.0	52.7	69.5	75.8	74.2	58.7	43.4	26.3	30.6	44.4
1960	17.5	18.2	29.1	45.6	58.7	66.7	80.2	71.7	62.9	51.4	32.8	23.1	46.5
1961	24.4	31.7	40.1	42.1	58.2	74.2	75.7	78.3	52.6	47.0	29.9	17.6	47.7
1962	16.7	20.7	26.1	49.3	56.4	67.5	70.8	71.3	58.7	51.0	39.1	27.6	46.3
1963	7.5	28.6	40.3	44.1	56.6	66.8	75.5	73.9	67.2	55.7	37.7	19.8	47.8
1964	24.6	27.5	28.3	46.5	57.7	66.4	78.2	69.0	56.5	50.3	25.6	7.7	44.8
1965	13.5	18.2	17.3	44.6	54.5	64.9	74.2	71.2	48.0	52.7	32.7	25.3	43.1
1966	6.1	13.6	35.0	41.1	59.1	66.2	78.3	69.0	65.6	48.0	25.7	21.2	44.1
1967	23.4	25.7	29.2	41.1	52.6	63.3	74.3	73.9	64.5	49.1	32.6	18.1	45.6
1968	14.3	24.1	40.1	43.6	53.2	62.9	73.6	68.9	61.3	48.7	34.5	12.3	44.8
1969	-0.7	16.5	25.5	51.0	58.1	60.7	71.8	77.5	66.0	40.3	37.5	25.7	44.1
1970	11.7	27.4	27.7	39.6	56.4	69.6	76.7	76.3	58.1	44.0	31.4	17.7	44.7
1971	11.2	20.4	31.6	46.4	56.9	68.0	72.1	79.2	57.9	44.7	34.6	12.2	44.6
1972	9.1	17.4	36.0	45.8	57.0	64.6	68.1	72.2	56.3	43.7	33.4	13.2	43.4
1973	20.3	26.8	40.5	42.4	56.2	66.6	72.8	74.8	58.4	50.3	29.6	22.8	46.8
1974	18.8	31.3	34.1	48.0	52.3	69.0	77.8	66.3	57.3	50.2	35.0	27.1	47.3
1975	22.2	16.4	27.7	38.8	54.3	64.0	76.8	69.4	58.4	47.3	31.0	22.6	44.1
1976	18.6	32.4	32.5	48.6	59.1	65.6	76.4	74.1	62.9	44.2	29.4	25.5	47.4
1977	7.7	31.7	36.2	51.2	61.4	71.1	74.4	65.8	59.2	49.1	28.5	14.2	45.9
1978	2.6	11.4	31.4	46.7	56.7	66.0	71.5	70.4	63.0	48.6	22.7	12.8	42.0
1979	0.2	8.0	29.8	41.4	53.7	67.3	74.6	72.0	65.7	50.7	29.8	29.1	43.6
1980	13.5	24.0	31.7	53.0	62.3	68.0	76.5	67.4	60.8	49.2	38.4	24.5	47.5
1981	31.0	27.9	40.7	51.3	57.1	63.9	75.1	74.7	63.8	45.0	37.0	21.9	49.1
1982	1.9	17.2	30.8	41.9	52.6	63.7	73.1	74.2	59.4	46.7	28.4	21.4	42.6
RECORD													
MEAN	15.1	21.3	31.5	45.5	56.5	65.5	74.4	72.3	60.5	48.6	32.1	22.0	45.4
MAX	25.5	32.2	42.8	57.9	69.0	78.1	88.8	86.8	74.2	61.5	42.8	32.1	57.6
MIN	4.7	10.4	20.1	33.1	44.0	52.8	60.0	57.8	46.7	35.7	21.4	11.9	33.2

Heating Degree Days

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1962-63	10	39	205	427	769	1156	1784	1012	758	620	269	38	7087
1963-64	0	5	34	294	814	1396	1248	1081	1131	547	259	68	6877
1964-65	0	66	253	448	1176	1775	1591	1307	1472	606	329	66	9089
1965-66	1	28	510	375	963	1224	1826	1434	923	711	251	72	8318
1966-67	0	64	87	521	1169	1353	1284	1094	1103	711	402	91	7879
1967-68	5	5	116	489	969	1447	1570	1180	767	636	361	122	7667
1968-69	11	34	159	498	909	1628	2038	1352	1217	415	260	172	8693
1969-70	0	0	69	759	817	1214	1653	1045	1149	754	275	32	7767
1970-71	0	0	259	646	1003	1459	1664	1243	1032	550	257	39	8152
1971-72	8	3	245	621	905	1636	1732	1376	890	569	277	28	8290
1972-73	55	10	277	653	941	1603	1379	1063	752	671	281	74	7759
1973-74	3	0	209	446	1056	1301	1431	941	951	507	389	56	7290
1974-75	4	53	241	452	891	1168	1323	1355	1151	779	331	83	7831
1975-76	0	20	211	546	1013	1311	1437	941	999	486	195	81	7240
1976-77	1	3	140	642	1061	1219	1774	923	888	415	171	3	7240
1977-78	0	58	200	485	1091	1574	1934	1499	1035	543	272	68	8759
1978-79	14	24	167	502	1263	1614	2010	1594	1086	705	368	62	9409
1979-80	1	14	66	437	1048	1107	1595	1183	1026	377	156	32	7042
1980-81	1	38	168	495	792	1248	1047	1036	747	407	248	91	6318
1981-82	1	4	115	616	831	1331	1960	1337	1055	685	383	108	8426
1982-83	10	12	226	559	1092	1344							

Cooling Degree Days

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1969	0	0	0	1	53	51	219	394	104	0	0	0	822
1970	0	0	0	0	16	176	367	358	60	3	0	0	980
1971	0	0	0	0	15	136	236	449	38	0	0	0	874
1972	0	0	0	0	34	143	157	238	20	0	0	0	592
1973	0	0	0	0	15	128	250	312	19	0	0	0	724
1974	0	0	0	5	2	182	407	101	14	0	0	0	711
1975	0	0	0	0	9	60	373	165	18	5	0	0	630
1976	0	0	0	0	17	106	365	292	84	4	0	0	868
1977	0	0	0	8	66	192	296	90	33	0	0	0	685
1978	0	0	0	0	22	105	222	198	114	0	0	0	661
1979	0	0	0	4	26	138	305	237	92	0	0	0	802
1980	0	0	0	22	78	133	364	119	48	12	0	0	776
1981	0	0	0	2	8	65	318	312	88	0	0	0	793
1982	0	0	0	0	5	79	267	304	67	0	0	0	722

Precipitation

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1943	0.55	0.26	0.27	0.29	1.38	6.12	1.04	2.57	0.31	1.65	0.55	0.02	15.01
1944	0.65	0.31	0.96	1.53	1.49	9.78	0.68	2.09	0.87	T	0.35	0.24	18.95
1945	0.43	0.08	0.89	0.59	2.95	2.01	1.53	1.23	1.91	0.46	0.19	0.33	12.60
1946	0.15	0.08	0.50	0.63	3.32	2.17	1.22	1.00	4.60	3.20	0.41	0.52	17.80
1947	0.34	0.19	1.10	1.84	0.66	3.87	0.75	1.83	0.31	0.40	0.31	0.28	11.88
1948	0.42	0.74	0.61	1.09	1.79	4.91	4.58	0.69	0.45	T	0.49	0.31	16.08
1949	0.76	0.91	0.51	0.29	1.32	0.92	0.95	0.11	0.37	2.43	0.02	0.20	8.79
1950	0.29	0.62	1.83	1.10	0.94	3.99	1.05	0.48	2.09	0.40	0.52	0.35	13.66
1951	0.08	0.28	0.15	0.67	1.54	3.05	1.56	4.00	1.42	0.70	0.32	1.14	14.91
1952	0.42	0.92	0.59	0.10	1.68	2.06	1.48	0.95	0.93	0.01	0.61	0.11	9.86
1953	0.71	0.53	0.53	2.54	4.06	2.43	2.40	1.37	0.23	1.57	0.02	0.22	16.61
1954	0.47	0.08	0.90	0.80	0.82	2.52	0.82	2.40	1.03	0.35	0.14	0.05	10.38
1955	0.17	0.63	0.38	1.47	5.33	1.96	0.73	0.17	0.31	0.63	0.75	0.53	13.06
1956	0.52	0.13	0.08	0.43	2.43	0.98	1.83	1.52	0.26	0.54	0.61	0.22	9.55
1957	0.58	0.35	0.90	1.92	1.89	3.01	0.38	1.24	0.58	0.50	1.25	0.02	12.62
1958	0.32	0.47	0.64	1.61	0.24	2.85	3.58	0.45	0.14	1.16	1.26	0.50	13.22
1959	0.81	1.30	0.07	1.02	1.34	1.59	0.22	0.40	1.26	0.53	0.91	0.03	9.48
1960	0.51	0.37	0.68	0.72	1.32	1.25	0.33	0.78	T	0.22	0.12	0.69	6.99
1961	0.08	0.77	0.38	0.97	2.34	0.84	0.47	0.36	2.83	0.09	0.56	0.28	9.97
1962	0.35	0.41	0.65	0.57	4.97	4.59	4.51	0.37	1.07	0.61	0.43	0.47	19.00
1963	0.80	0.66	0.28	2.69	1.68	4.78	1.19	1.11	1.92	T	0.18	0.66	15.95
1964	0.72	0.57	0.93	1.25	1.42	4.72	0.54	2.33	0.23	0.25	1.33	0.62	14.91
1965	0.96	0.53	0.75	2.12	1.41	3.46	3.59	0.22	1.77	T	0.39	0.40	15.60
1966	0.67	0.53	0.77	0.85	1.07	3.26	1.61	0.62	0.52	0.34	0.80	0.54	11.58
1967	0.33	0.87	1.78	2.11	1.79	5.23	0.86	T	2.35	0.47	0.38	1.33	17.50
1968	0.84	0.77	0.29	0.48	1.64	5.18	0.93	3.88	0.48	0.63	0.72	1.78	17.62
1969	0.70	0.24	0.73	2.82	1.99	2.63	3.40	0.17	0.05	1.09	0.03	1.33	15.18
1970	0.69	1.06	0.83	2.59	3.18	2.01	1.06	0.03	1.43	0.99	0.88	0.43	15.18
1971	1.78	0.76	0.56	1.26	1.55	2.12	0.10	1.61	1.01	6.31	0.42	1.24	18.72
1972	1.48	0.73	0.60	0.45	2.83	3.62	1.97	3.34	0.68	0.66	0.15	1.03	17.54
1973	0.14	0.33	0.16	4.22	1.92	3.30	0.27	1.72	4.02	0.57	0.17	0.82	17.64
1974	0.22	0.19	0.72	1.17	4.13	1.29	1.35	1.44	0.32	2.24	0.23	0.34	13.64
1975	0.81	0.33	1.23	2.70	4.77	3.68	1.66	0.67	0.44	2.31	0.91	0.56	20.07
1976	0.23	0.18	0.36	1.43	1.00	3.41	1.11	0.78	1.06	0.75	0.19	0.27	10.77
1977	0.68	0.10	0.97	0.24	2.45	1.38	1.91	2.26	1.91	1.16	1.50	1.23	15.79
1978	0.51	1.19	0.12	0.47	6.81	1.39	2.51	0.81	3.40	0.27	2.17	0.63	20.28
1979	0.33	1.14	0.26	0.76	1.36	0.77	2.79	0.67	0.03	0.32	0.20	0.05	8.68
1980	0.33	0.33	0.28	0.66	0.28	3.04	0.53	2.04	0.73	1.61	0.29	0.33	10.45
1981	0.05	0.06	0.28	0.20	2.87	2.57	0.36	1.12	0.72	1.39	0.78	0.23	10.63
1982	0.96	0.20	0.73	0.53	2.61	5.10	0.69	0.61	2.23	1.61	0.10	1.01	16.38
RECORD													
MEAN	0.51	0.47	0.62	1.22	2.21	3.13	1.46	1.24	1.19	0.99	0.51	0.51	14.06

Snowfall

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1943-44	0.0	0.0	0.0	1.2	2.0	T	7.1	4.6	3.4	T	T	0.0	18.3
1944-45	0.0	0.0	T	T	1.4	3.0	4.9	1.2	1.3	1.9	1.2	0.0	14.9
1945-46	0.0	0.0	0.0	T	4.0	4.1	2.3	2.0	2.3	0.0	0.0	0.0	14.7
1946-47	0.0	0.0	0.0	8.2	2.7	6.0	5.7	3.0	11.0	12.2	0.0	0.0	48.8
1947-48	0.0	0.0	0.0	T	2.8	4.9	7.2	3.9	6.4	0.7	0.2	0.0	26.1
1948-49	0.0	0.0	0.0	T	1.5	7.7	14.7	19.0	5.6	T	T	0.0	48.5
1949-50	0.0	0.0	T	12.6	0.0	4.1	3.3	6.5	16.0	5.2	1.4	2.0	51.1
1950-51	0.0	0.0	0.7	0.6	5.9	4.3	3.1	4.1	1.9	3.7	0.0	T	24.3
1951-52	0.0	0.0	0.0	4.2	5.0	15.0	4.4	7.5	6.1	0.8	0.0	0.0	43.0
1952-53	0.0	0.0	0.0	0.0	1.4	1.0	7.8	7.1	5.3	8.2	2.0	0.0	32.8
1953-54	0.0	0.0	0.0	T	T	1.6	7.4	0.3	10.4	1.3	T	0.0	21.0
1954-55	0.0	0.0	T	1.7	1.2	0.6	2.7	8.4	3.8	1.0	0.0	0.0	19.4
1955-56	0.0	0.0	T	0.6	14.6	6.5	5.3	1.1	0.5	4.1	T	0.0	32.7
1956-57	0.0	0.0	0.0	T	4.0	1.5	5.6	3.8	8.6	2.0	0.0	0.0	25.5
1957-58	0.0	0.0	0.0	3.0	1.9	0.1	2.8	4.4	1.7	T	0.0	0.0	13.9
1958-59	0.0	0.0	0.0	T	8.9	10.8	10.3	11.8	0.6	3.5	0.0	0.0	45.9
1959-60	0.0	0.0	T	T	7.0	T	6.0	4.3	3.1	1.0	0.0	0.0	21.4
1960-61	0.0	0.0	0.0	T	2.0	6.0	1.4	6.0	3.0	T	0.0	0.0	18.4
1961-62	0.0	0.0	T	T	4.0	3.0	5.9	4.5	2.5	T	0.0	0.0	19.9
1962-63	0.0	0.0	T	T	1.4	3.1	9.6	6.0	0.4	9.0	0.0	0.0	29.5
1963-64	0.0	0.0	0.0	0.0	0.2	6.1	11.2	5.5	11.1	4.8	0.0	0.0	38.9
1964-65	0.0	0.0	0.0	0.0	14.4	7.3	13.4	3.5	6.9	4.0	T	0.0	49.5
1965-66	0.0	0.0	T	0.0	3.0	4.2	8.3	5.9	4.0	0.9	T	0.0	26.3
1966-67	0.0	0.0	0.0	T	7.9	3.7	2.4	5.8	17.8	16.6	8.6	0.0	62.8
1967-68	0.0	0.0	0.0	T	2.5	12.6	7.5	7.2	0.6	3.9	T	0.0	34.3
1968-69	0.0	0.0	0.0	T	2.2	18.0	6.9	2.4	6.0	1.9	0.0	0.1	37.5
1969-70	0.0	0.0	0.0	2.6	T	10.5	6.3	10.7	5.2	11.5	T	0.0	46.8
1970-71	0.0	0.0	0.6	0.3	3.3	3.4	17.2	6.6	5.1	T	0.1	0.0	36.6
1971-72	0.0	0.0	0.0	2.5	4.6	12.6	14.8	6.0	2.9	T	0.1	0.0	43.5
1972-73	0.0	0.0	7.1	3.3	T	10.0	1.7	3.3	0.4	5.1	0.0	T	30.9
1973-74	0.0	0.0	T	T	1.7	8.6	2.1	1.9	5.8	2.9	2.8	0.0	25.8
1974-75	0.0	0.0	T	0.1	0.7	3.4	5.6	3.3	12.3	10.6	T	0.0	36.0
1975-76	0.0	0.0	0.0	2.8	6.8	4.8	1.4	0.9	3.5	1.6	0.0	0.0	21.8
1976-77	0.0	0.0	0.0	4.4	1.7	2.6	6.4	0.8	5.4	T	0.0	0.0	21.3
1977-78	0.0	0.0	0.0	T	19.4	14.8	5.3	11.9	0.2	T	0.0	0.0	51.6
1978-79	0.0	0.0	T	0.0	16.8	6.7	3.3	11.8	2.2	3.5	T	0.0	44.3
1979-80	0.0	0.0	0.0	T	2.2	0.8	3.7	2.7	2.2	T	0.0	0.0	11.6
1980-81	0.0	0.0	0.0	3.0	0.9	2.0	T	1.0	T	T	0.0	0.0	6.9
1981-82	0.0	0.0	0.0	T	2.0	2.0	7.2	1.9	5.8	2.6	0.0	0.0	21.5
1982-83	0.0	0.0	T	T	1.0	10.4							
RECORD													
MEAN	0.0	0.0	0.3	1.4	4.1	5.6	6.1	5.2	4.9	3.0	0.4	0.1	31.1

# Indicates a station move or relocation of instruments. See Station Location table.

Record mean values above are means through the current year for the period beginning in 1938 for temperature and precipitation, 1941 for snowfall. Average temperature and total precipitation through 1937, monthly and seasonal snowfall through 1940 and monthly and seasonal degree days through 1942 are from the Post Office Building and all other data are from the Airport.

Meteorological Data For The Current Year

Station: MILES CITY, MONTANA # 24037 MUNICIPAL AIRPORT Standard time used: MOUNTAIN Latitude: 46° 26' N Longitude: 105° 52' W Elevation (ground): 2629 feet Year: 1982

Month	Temperature °F Averages Daily maximum	Daily minimum	Monthly	Extremes Highest	Date	Lowest	Date	Degree days Base 65 °F Heating	Cooling	Precipitation in inches Water equivalent Total	Greatest in 24 hrs.	Date	Snow, Ice pellets Total	Greatest in 24 hrs.	Date
JAN	13.3	-9.6	1.9	44	26	-32	23	1960	0	0.96			7.2		
FEB	27.3	7.0	17.2	58	21	-36	3	1337	0	0.20			1.9		
MAR	40.0	21.5	30.8	62	28	-6	5	1055	0	0.73			5.8		
APR	53.4	30.4	41.9	80	23	6	5	685	0	0.53			2.6		
MAY	62.1	43.0	52.6	85	2	32	31	383	5	2.61			0.0		
JUN	75.4	52.0	63.7	94	22	39	7	108	79	5.10			0.0		
JUL	85.8	60.3	73.1	99	21	48	17	10	267	0.69			0.0		
AUG	87.9	60.5	74.2	101	14	50	27	12	304	0.61			0.0		
SEP	71.8	47.0	59.4	96	9	32	29	226	67	2.23			T		
OCT	57.6	35.8	46.7	78	14	25	20	559	0	1.61			T		
NOV	37.4	19.3	28.4	55	18	2	23	1092	0	0.10			1.0		
DEC	29.8	12.9	21.4	44	17	-9	8	1344	0	1.01			10.4		
YEAR	53.5	31.7	42.6	101	AUG 14	-36	FEB 3	8771	722	16.38			28.9		

Month	Relative humidity, pct. Hour 05 (Local time)	Hour 11	Hour 17	Hour 23	Wind Resultant Direction	Speed m.p.h.	Average speed m.p.h.	Fastest mile Speed m.p.h.	Direction	Date	Percent of possible sunshine	Average sky cover, tenths, sunrise to sunset	Number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperature °F Maximum (b) 90° and above	Maximum 32° and below	Minimum 32° and below	Minimum 0° and below	Average station pressure mb Elev. 2634 feet m.s.l.
JAN	66	67	66	67	35	3.6	10.6									18	4	0	0	0	25	31	25	920.8
FEB	74	71	69	77	32	1.1	9.1									5	0	1	1	0	15	25	10	924.1
MAR	83	69	65	81	36	2.5	11.6									7	3	0	2	0	7	29	2	917.7
APR	79	55	46	68	32	2.9	11.9									7	1	0	0	0	4	14	0	920.4
MAY	79	61	54	75	30	3.8	11.2									15	0	4	3	0	0	1	0	919.7
JUN	84	53	48	70	06	2.0	9.3									13	0	12	0	2	0	0	0	921.1
JUL	74	43	32	57	32	1.9	9.1									9	0	8	0	11	0	0	0	921.1
AUG	67	39	32	52	09	3.5	10.4									6	0	10	0	14	0	0	0	922.8
SEP	71	45	38	60	35	2.5	9.6									5	0	1	1	5	0	1	0	923.1
OCT	83	60	53	75	31	3.5	10.1									9	0	0	0	0	0	11	0	922.5
NOV	79	65	65	74	20	1.0	8.9									3	0	0	0	0	9	29	0	921.4
DEC	76	73	75	78	29	2.2	9.8									7	5	0	4	0	18	30	7	921.1
YEAR	76	58	54	70	34	1.6	10.1									104	13	36	11	32	78	171	44	921.3

Normals, Means, And Extremes

Month	Temperatures °F Normal Daily maximum	Daily minimum	Monthly	Extremes Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F Heating	Cooling	Precipitation in inches Water equivalent Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs. $	Year
(a)				45		45					45		45		27	
J	26.1	4.7	15.4	62	1953	-37	1969	1538	0	0.49	1.78	1971	0.05	1981	0.42	1944
F	32.8	10.4	21.6	67	1980	-37	1939	1215	0	0.51	1.30	1959	0.06	1981	0.77	1952
M	41.6	18.7	30.2	83	1943	-27	1947	1079	0	0.65	1.83	1950	0.07	1959	0.61	1944
A	57.8	32.7	45.3	92	1980	6	1982	591	0	1.26	4.22	1973	0.10	1952	1.36	1947
M	68.9	43.6	56.3	99	1980	15	1954	288	17	2.06	6.81	1978	0.24	1958	2.39	1955
J	77.4	52.3	64.9	104	1961	32	1951	117	128	3.32	9.78	1944	0.77	1979	2.71	1964
J	88.9	59.8	74.4	109	1980	41	1945	9	308	1.55	4.58	1948	0.10	1971	2.02	1962
A	87.2	57.7	72.5	110	1949	35	1966	16	255	1.20	4.00	1951	T	1967	1.65	1943
S	73.5	46.2	59.9	105	1950	20	1942	217	68	1.19	4.67	1941	T	1960	2.67	1941
O	62.1	35.5	48.8	93	1963	9	1972	508	0	0.71	6.31	1971	T	1965	1.38	1953
N	43.1	21.7	32.4	75	1965	-23	1955	978	0	0.51	2.17	1978	0.02	1953	1.18	1957
D	32.2	11.7	22.0	69	1939	-35	1977	1333	0	0.48	1.78	1968	0.02	1957	0.50	1941
YR	57.6	32.9	45.3	110	AUG 1949	-37	JAN 1969	7889	776	13.93	9.78	JUN 1944	T	AUG 1967	2.71	JUN 1964

Month	Snow, Ice pellets Maximum monthly	Year	Maximum in 24 hrs. $	Year	Relative humidity pct. Hour 05 (Local time)	Hour 11	Hour 17	Hour 23	Wind Mean speed m.p.h.	Prevailing direction	Fastest mile Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset ø	Mean number of days Sunrise to sunset ø Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperatures °F Max. (b) 90° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below	Average station pressure mb. Elev. 2634 feet m.s.l.
(a)	42		17		22	22	22	22	33	14					13	18	18	18	45	33	32	30	38	38	38	38	10
J	17.2	1971	7.5	1964	74	70	69	74	9.6	NW					6.8	6	8	17	8	2	0	1	0	18	31	13	922.9
F	19.0	1949	6.5	1952	80	70	68	77	9.7	NW					7.0	5	8	15	7	2	*	2	0	13	27	7	922.4
M	17.8	1967	5.0	1957	79	62	55	74	10.7	NW					6.9	5	8	18	8	2	*	1	0	7	27	3	918.8
A	16.6	1967	10.5	1947	77	53	46	67	11.8	NW					6.8	5	8	17	8	1	1	1	*	1	14	0	920.3
M	8.6	1967	2.0	1953	77	49	44	66	11.1	SE					6.5	6	10	15	11	*	4	1	1	*	2	0	919.2
J	2.0	1950	2.0	1950	77	47	41	65	10.3	SE					5.5	8	10	12	12	*	8	*	4	0	*	0	919.8
J	0.0		0.0		68	39	31	53	9.7	SE					4.0	15	12	4	8	0	7	*	15	0	0	0	921.5
A	0.0		0.0		66	39	30	50	9.8	SE					4.0	15	11	5	7	0	6	*	13	0	0	0	921.5
S	7.1	1972	0.7	1950	72	47	38	59	9.9	NW					5.1	10	10	10	7	*	2	1	3	0	1	0	922.6
O	12.6	1949	3.8	1946	75	51	47	65	9.9	SSE					5.4	12	8	11	6	*	*	1	*	*	11	0	922.7
N	19.4	1977	8.0	1964	78	64	63	74	9.8	SSE					6.6	7	7	16	6	2	*	1	0	7	26	2	922.9
D	18.0	1968	7.0	1958	77	72	71	76	9.8	SSE					6.5	7	8	16	7	2	*	2	0	15	30	7	921.4
YR	19.4	NOV 1977	10.5	APR 1947	75	55	50	67	10.2	SE					5.9	101	108	156	93	12	29	10	37	61	170	32	921.3

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 111 in July 1901; lowest temperature -49 in February 1899; minimum monthly precipitation 0.00 in August 1889 and earlier; maximum precipitation in 24 hours 3.74 in May 1908; maximum monthly snowfall 35.3 in March 1894; maximum snowfall in 24 hours 28.0 in March 1894.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

ø Through 1962.

$ Greatest in calendar day through 1964.

Local Climatological Data

Annual Summary With Comparative Data

1982

MILES CITY, MONTANA

Narrative Climatological Summary

Miles City is located on the western edge of the northern great plains in a shallow part of the Yellowstone Valley. The Tongue River runs south from its confluence with the Yellowstone just west of the city. To the north the river bluffs are from 200 to 300 feet above the valley floor. There are no nearby mountain ranges to influence climatic conditions. Temperatures range from very cold in winter to quite warm in summer, which is characteristic of continental locations. Annual rainfall averages about 13 inches a year, and the climate is classed as semi-arid with less than 10 inches about one year in seven.

The temperature has ranged from a low of -65°, at Fort Keogh 3 miles southwest of the present City, on January 13, 1888, to a high of 111° on July 31, 1901. Cold waves accompanied by temperatures of zero or lower occur frequently during the winter, are usually accompanied by northerly winds and snow, and last from two to four days. Periods of several days with minimums of zero or lower can be expected during the winter months, and the longest period of record, 33 days, occurred January 9 to February 10, 1916. Spring and fall are cool with maximum temperatures of 90° or above rarely occurring as early as April or as late as October. Zero readings have been reported as late as April 1 and as early as October 28. Maximum temperatures of 90° or more occur frequently in July and August, but as to be expected in a semi-arid region, humidities are low and the heat is not as oppressive as would be expected from such warm temperatures. From July 14 through August 1, 1936, there were 19 consecutive days with temperatures of 90° or above. At the observation station in the City proper from July 13 through August 6, 1951, there were 25 consecutive days in that range.

About 70 percent of the precipitation falls during the growing season, April through September, with greatest monthly amounts usually falling during May and June. Precipitation during the spring and summer often falls during periods of shower or thunderstorm activity; however, general rains also are frequent in late spring and early summer. Measurable snowfall can be expected as late as May and as early as September.

Killing freezes have been reported as late as the last week in May and as early as the first week of September, but generally do not occur after the last week in April or earlier than the first week of October. The growing season averages about 158 days. Sunny growing seasons, with May and June rainfall being the heaviest of the year, encourage rapid crop development. Crops grown in this area seldom have difficulty in reaching maturity, although hail sometimes causes local damage during the middle of the summer.

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE / NATIONAL CLIMATIC DATA CENTER ASHEVILLE, N.C.

APPENDIX B CLIMATOLOGICAL DATA FOR MILES CITY, MONTANA AND GLASGOW, MONTANA

AND

1980-81 & 1981-82 U.S.G.S. WATER QUALITY
DATE: MISSOURI RIVER AT FORT PECK DAM, MT.
TONGUE RIVER AT MILES CITY, MT.
YELLOWSTONE RIVER AT MILES, MT.
GAS SUPER SATURATION DATA AT FORT PECK DAM

REVISED

MAINTENANCE SURVEY

Station MILES CITY NFH　　Date 4-19-78　　Page 1 of 1

Survey Team [illegible]

FACILITIES (Including Modifications Costing More than $600)

* Possibly YACC

Prop. No.	Item	Date Acqd.	Initial Cost $	Replacement Cost $	Custodial Maint. $	Cyclical Maint. $	Rehab. Maint. ($60,000 or under)	Rehab. Construc. (over $60,000)	Conditions and Comments (Safety, Energy, YACC, etc.)
1	Residence	1959	19,000	—					Excess Property
2	Residence	1959	19,000	$74,000			$6,000		New Roofing, Wall & Ceiling Insulation
3	Residence	1959	19,000	74,000			6,000		New Gas Furnaces and Basement Storm Windows
4	Hatchery Bldg	1959	175,000	680,000			17,000		Seal Roof, Insulate Ceiling & Walls, Rain Gutters
5	Oil House	1959	6,000	23,000			—		OK \ 2 Overhead Heaters and 2 Garage Doors
6	[illegible] House	1958	6,000	25,000			4,000		Replace with Concrete Block House, Overhaul 2 Pumps.
7	Well House	1958	6,000	25,000			700		Overhaul Pump and Minor Electrical Work
8	Well House	1958	6,000	25,000			700		Overhaul Pump and Minor Electrical Work.
9	Garage	1960	11,094	42,000			2,000		New Roofing
10	Pump House	1960	4,800	18,000			4,000		Replace with Concrete Block House
11	Gas Storage	1959	800	3,000			—		OK
12	Water Storage	1959	3,500	14,000			—		OK
13	Pipeline - 290' of 12"	1960	26,000	98,000			1,300		Replace 6" Drive.
14	8 Earthen Ponds	1958	75,000	306,000			10,000		Replace 3 Concrete Structures, Replace 8-12" Drain Lines,
15	5 Earthen Ponds	1960	51,625	194,000				$135,000	Replace 5-12" Drain Lines, Refine Dikes, Replace Slide Gates \ Replace Slide Gates.
16	2 Earthen Ponds	1958	30,000	123,000			50,000		3 Cross Dikes in Each Pond, 3 Concrete Drain Structures
17	Reservoir	1958	10,000	41,000			—		OK
18	Reservoir	1958	20,000	82,000				145,000	Deepen & Reshape; New Concrete Raceway.
19	Supply Lines	1958	50,000	204,000			—		OK.
20	Sewage System	1970	19,409	44,000			1,000		* Raise Dike Around Lagoon
21	Settling Channel	1970	3,572	8,000			8,000		Remove the Silt
22	Intake Structure	1970	9,396	21,000			—		OK
A	Landscaping						27,000		* Landscape Around Houses & Office, Add Sprinkler System.
B	Pipe Line							72,000	6" Pipe Line from New Well to Reservoir
C	Wind Generator						13,000		Wind Charger & Batteries for Pump at New Well
D	Paving							160,000	Pave Entrance Road and Parking Areas
E	Entrance Sign						3,300		* Informational Sign Along Highway

Total = $166[illegible]

accountants' corner, inc.
FORM 47-5471
FORMERLY 517W

RECAPITULATION

PROJECT* Miles City N.F.H.
LOCATION Miles City, Montana
~~ARCHITECT~~ ENGINEER Hoovestol
SUMMARY BY Hoovestol
PRICES BY (Means)
CHECKED BY

ESTIMATE NO. 1
SHEET NO. 3 of 3
DATE 5-19-78

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	~~TOTAL~~ ESTIMATED MATERIAL COST	UNIT PRICE	TOTAL ESTIMATED ~~LABOR~~ COST
A	Landscaping & Sprinklers	3	Acres	#7,000	#21,000		#21,000
B	Pipe Line	5500	ft.	#10.00	#55,000		#55,000
C	Wind Generator & Batteries	1	LS	LS	#10,000		#10,000
D	Paving - Entrance Road & Parking	12,000	sq. yd	#10.00	#120,000		#120,000
E	Entrance Sign	1	Ea.	#3,000	#3,000		#3,000
	Total						#510700
	Contingencies & Engineering	30%					155,300
	Grand Total						#666,000

FORM 47-5171

RECAPITULATION

PROJECT, Miles City N.F.H. ESTIMATE NO. 1

LOCATION Miles City, Mont. SHEET NO. 2 of 3

~~ARCHITECT~~ ENGINEER Hoovestol DATE 5-19-78

SUMMARY BY Hoovestol PRICES BY (Means) CHECKED BY

Item No.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	ESTIMATED MATERIAL COST	UNIT PRICE	TOTAL ESTIMATED COST
14	Earth Ponds						
	3 Concrete Kettles	9	cu.yd.	$150	$1,350		$1,350
	8 - 12"x30' Pipe	240	ft.	10	2400		2400
	Reface Gate Valves	8	Ea.	400	3200		3200
	Remove Old Kettles	3	Ea.	300	900		900
	Subtotal						$7,850
15	Earth Ponds						
	5 - 12"x30' Pipe	150	ft.	$10	$1,500		$1,500
	Reface Gate Valves	5	Ea.	400	2,000		2,000
	Clean + Reline Ditch	2,000	ft.	50	100,000		100,000
	Subtotal						$103,500
16	Earth Ponds - Subdivide Into 4 Ponds Each						
	Earthwork	7000	cu.yd.	$2.00	$14,000		$14,000
	New Kettles + Gates	8	Ea.	3,000	24,000		24,000
	Subtotal						$38,000
17	Domestic Water Reservoir - No Work						
18	Reservoir - Deepen + Reshape						
	Earthwork (wet)	35,000	cu.yd.	$3.00	$105,000		$105,000
	Concrete Raceway 60'x16'x3'	55	cu.yd.	150	8,300		8,300
	Subtotal						$113,300
19	Supply Lines - No Work						
20	Sewage System - Raise Dike						
	Earthwork (+2 ft.)	350	cu.yd.	$2.00	$700		$700
21	Settling Pond - Clean Out						
	Earthwork (wet)	2,000	cu.yd.	$3.00	$6,000		$6,000
22	Intake Structure - No Work						

FORM 47-5171
FORMERLY 5170

RECAPITULATION

PROJECT. Miles City N.F.H.
LOCATION Miles City, Montana
~~ARCHITECT~~ ENGINEER Larry Hoovestol
SUMMARY BY Hoovestol PRICES BY (Means)

ESTIMATE NO. 1
SHEET NO. 1 of 3
DATE 5-19-78

CHECKED BY

No.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	~~TOTAL~~ ESTIMATED MATERIAL COST	UNIT PRICE	TOTAL ESTIMATED ~~LABOR~~ COST
1.	Residence - No Work						
2,3	Residences - Weatherize						
	New Roofing (shingles)	22	sq.	#75	#1,650	x 2 =	#3,300
	Wall Insulation (Foam)	1200	sq.ft.	1.50	1,800	x 2 =	3,600
	Ceiling Insulation (Blown)	500	cu.ft.	1.00	500	x 2 =	1,000
	New Furnace (Gas)	1	Ea.	500	500	x 2 =	1,000
	Basement Storm Windows	12	Ea.	25	300	x 2 =	600
	Subtotal				4,750		#9,500
4	Hatchery Building - Weatherize						
	Seal Roof	46	sq.	#50	#2,300		#2,300
	Insulate Ceiling (Blown)	1,500	cu.ft.	1.00	1,500		1,500
	Insulate Walls (Foam?)	3,200	sq.ft.	2.00	6,400		6,400
	Rain Gutters	125	ft.	2.00	250		250
	Overhead Doors	2	Ea.	700	1400		1400
	Overhead Heaters	2	Ea.	700	1400		1400
	Subtotal						#13,250
5	Oil House - No Work						
6	Pump House - New Block House	1	Ea	L.S.	#3,000		#3,000
7	Well House - Maint. & Elect.	-	LS	L.S.	500		#500
8	Well House - Maint & Elect.	-	LS	LS	500		#500
9	Garage - New Roofing	21	sq.	#75	#1,575		#1,600
10	Pump House - New Block House	1	Ea.	LS	#3,000		#3,000
11	Gas Storage - No Work						
12	Water Storage - No Work						
13	Pipeline - New 8" Valve	1	Ea.	#750	#750		#1,000

COSTS

Elements of development and their estimated lump sum construction costs are as follows:

	Phase 1	Phase 2
Water Supply and Drainage Systems		
Shallow Well Development	55,000.	
Rehab Tongue River Intake	10,000.	
Rehab and Expand Reservoir	123,000.	
Pump Replacement		50,000.
New Main Drainage Line	50,000.	
Water Treatment System		510,000.
Fish Rearing Facilities		
Grade and Seal Ponds	140,000.	
Rehab Pond Drains	2,000.	
Riprap Existing Ponds	190,000.	
Divide Two 3A Ponds	23,000.	
Construct Eight 1A Ponds	340,000.	
Construct Twelve .1A Ponds	89,000.	
Construct Four Raceways		20,000.
Construct Four Recirculating Ponds		24,000.
Buildings		
New Holding House		50,000.
Weatherize Hatchery Building	25,000.	
Weatherize Other Existing Buildings	10,000.	
Hatchery Building Addition	150,000.	
Chemical-Fertilizer-Feed Storage Building	25,000.	
Equipment Storage Building Addition	20,000.	
Site Improvements		
Site Drainage		5,000.
Landscaping		6,000.
Paving of Roads and Parking Areas	175,000.	
Wind Screening (Shelterbelt)		1,000.
Other		
Standby Power System	25,000.	
Solar System for Hatchery Building	40,000.	
Solar Systems for Three Residences	30,000.	
Sub Totals	1,522,000.	666,000.

Total project funding need is summarized as follows:

	Phase 1	Phase 2
Total Construction cost	1,522,000.	666,000.
Contingencies (10%)	152,000.	67,000.
Inflation (10%/yr.)	(1 1/2 yr.) 228,000.	(2 1/2 yr.) 166,000.
Engineering (15%)	228,000.	100,000.
Construction Management (5%)	76,000.	33,000.
Subtotal	2,206,000.	1,032,000.
Washington FWS Administration (2%)	44,000.	21,000.
TOTAL PROJECT COST:	2,250,000.	1,053,000.

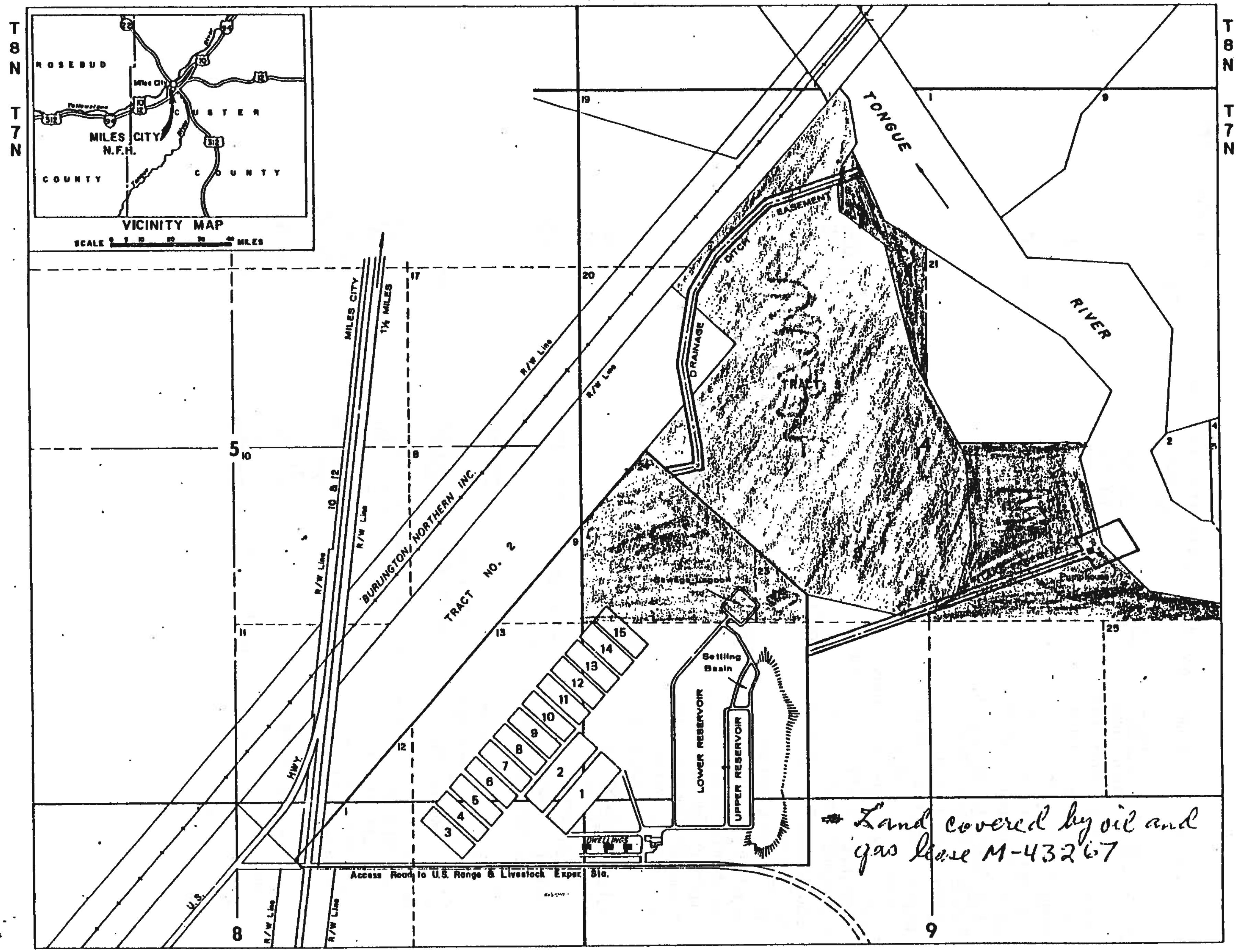
MILES CITY NATIONAL FISH HATCHERY

UNITED STATES
DEPARTMENT OF THE INTERIOR

CUSTER COUNTY, MONTANA

TED S
FISH AND WILDLIFE SERVICE

R 47 E



R 47 E
PRINCIPAL MERIDIAN

0 660 1320 2640 FEET
0 ¼ ½ MILE

COMPILED IN SURVEYS AND MAPS FROM
SURVEYS BY THE BLM & USFWS
DENVER, COLORADO

REVISED: MAY 1981

MEAN DECLINATION 1967

6F MONT 493 402

DEPARTMENT OF THE ARMY
OMAHA DISTRICT CORPS OF ENGINEERS
6014 U.S. POST OFFICE AND COURTHOUSE
OMAHA, NEBRASKA 68102

REPLY TO
ATTENTION OF

August 7, 1984

RECEIVED
AUG 9 1984
COCHRAN & WILKEN, INC.
SPRINGFIELD

Planning Division

Mr. Gary A. Wilken, P.E.
Associated Engineers III, Inc.
1201 South Sixth Street
Springfield, Illinois 62703

Dear Mr. Wilken:

In response to your request for information concerning a potential fish hatchery downstream from Fort Peck Dam, I am furnishing the following comments, numbered according to your questions. These comments are preliminary and are subject to some revision at a later date.

1. It appears that the land shown in Area A on your map might be available for use as a hatchery site. However, construction of the hatchery there would affect the Duck Creek waterfowl habitat, the designated recreation area, and the existing roads. More detailed review of this and other sites would be required by the Corps of Engineers before approval. You may also wish to consider Corps land north and west of the river in Section 34 of T. 27 N., R. 41E., where sufficient land may be available.

Low-cost preference power may be available from the Western Area Power Administration (WAPA), the Federal agency that markets power from the main stem dams. We understand that WAPA would likely consider a State-owned facility such as a fish hatchery to be eligible for low-cost power; however, we also understand that the demand for this low-cost power exceeds the supply available. More information can be obtained from WAPA's Billings, Montana, office.

The Corps supplies low-cost power to the Garrison National Fish Hatchery in North Dakota under a special June 26, 1961, agreement with the Department of the Interior.

In any case, it would appear that modifications to the existing local power network would be required. In order to tap the Fort Peck 4,160-volt townsite feeder, a short underground section of this feeder, running from the Power Plant #1 5,000-volt switchgear to the first overhead pole, would have to be replaced with a larger cable. Also, station service transformer B may need to be uprated or replaced.

2. A drawing showing the location of the new water treatment supply line is included as enclosure 1. It appears that the line is located within Area A and would have to be relocated if the hatchery were located at that site.

3. A check of some of our records did not reveal much information other than it appears that a hatchery was considered at Fort Peck in the early 1970's by a group of local businessmen.

4. Because your request is one of a number of similar requests to tap various Corps penstocks, we are seeking general policy guidance concerning this matter from our Division office. In the meantime, we offer the following comments. The tap located on Tunnel #1 would be sufficient to supply both the fish hatchery and the city of Glasgow at the withdrawal rates determined by your office and the city. We must note, as we have in the past to Glasgow city officials, that this supply could not be guaranteed at all times because of the necessity to dewater the tunnels for maintenance and inspections. A description of the outage requirements is included as enclosure 2. In addition, a water storage contract would have to be set up to define the water withdrawal amounts and charges and the operation and maintenance requirements.

5. We have no recent soil information regarding the area directly downstream from the dam. However, recent drill holes in the flood plain 2 to 8 miles downstream from the dam have been logged and general soil information gained from these holes is provided in enclosure 3. The Fort Peck Project Office may have drill hole logs taken closer to the areas you are interested in and may be contacted if the information I have provided you is not sufficient.

6. Downstream river fluctuations range from 0 to 2.5 feet at gage 1, which is located at the water's edge just northeast of Area A. Enclosures 4 through 6 are three figures that show typical fluctuations at that gage and gages farther downstream.

The record high-water elevation from normal operation of the power plant is about 2036.5 feet m.s.l., which occurred in early July 1975 when the dam's outlet works were releasing about 35,000 c.f.s.

7. A reregulation dam at a number of different locations and with a variety of operation schemes has been considered. The most promising plan consists of a third powerhouse with a capacity of 105 megawatts and a reregulation dam located about 1.5 to 2 miles downstream. The reregulation dam would periodically back water up to between elevations 2040 feet m.s.l. and 2050 feet m.s.l., depending on its operation. We should also

note that levees are being considered to limit the amount of overbank flooding. In addition, increases in river stages could increase the natural groundwater levels. From our preliminary analysis, it appears that the groundwater levels would not increase appreciably from their existing levels, although further study is required. At this time, it is difficult to give you much definitive information as we do not know which plan, if any, would be recommended and will not know for at least a year.

8. A Section 404 and possibly a Section 10 permit would be required from the Corps for location of the hatchery in Area A. Further information would be required to determine whether permits would be required for hatcheries located in Areas B and C.

9. In general, we feel that there would be some minor positive impacts to the community. The fish hatchery would create another attraction for visitors and residents to visit. Also, it would boost the population of the community slightly during the construction and operation of the hatchery and therefore increase the socioeconomic welfare of the community.

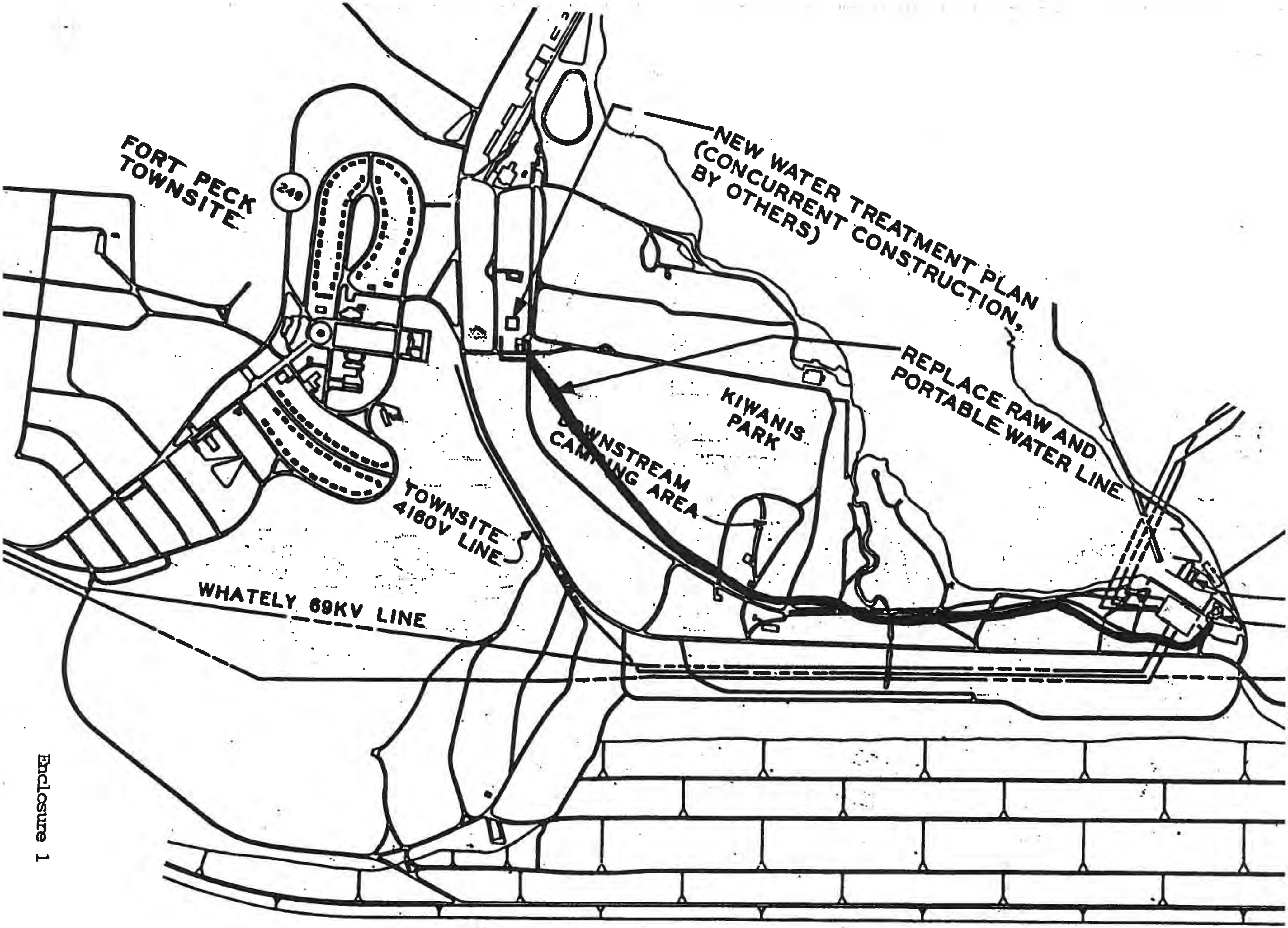
I have discussed municipal tie-ins for domestic water supply and sewers with Mr. Johnny Kuncheff, the Fort Peck Project Manager and it appears that there would be no major complications for providing service to a small office or visitors center.

I hope these comments will enable you to make a more informed comparison of the two hatchery sites being considered. If you have any questions, please contact Mr. John Peta at (402) 221-4586.

Sincerely,

Arvid L. Thomsen
Chief, Planning Division

Enclosures


FORT PECK TOWNSITE
249
NEW WATER TREATMENT PLAN (CONCURRENT CONSTRUCTION, BY OTHERS)
REPLACE RAW AND PORTABLE WATER LINE
KIWANIS PARK
DOWNSTREAM CAMPING AREA
TOWNSITE 4160V LINE
WHATELY 69KV LINE

Enclosure 1

Fort Peck Powerhouse Outage Expectations

The Corps of Engineers could not guarantee a continuous supply of water as there are various maintenance requirements that necessitate outages. Listed below are the expected outages.

1. Each unit is down for at least two weeks every year from September through May. However, this would not disrupt the water supply since the penstocks would remain watered.
2. Once every five years the penstocks are dewatered and inspected. This could take from two weeks to one month. When Tunnel No. 1 is dewatered the 20 inch tap would be dry and the 10 inch tap on Tunnel No. 2 would have to furnish the water for the Fort Peck townsite, the City of Glasgow and the Fish Hatchery during this period.
3. In an emergency, both tunnels could be dewatered and no water would be available from either tap.

Enclosure 2

Fort Peck Soil Information

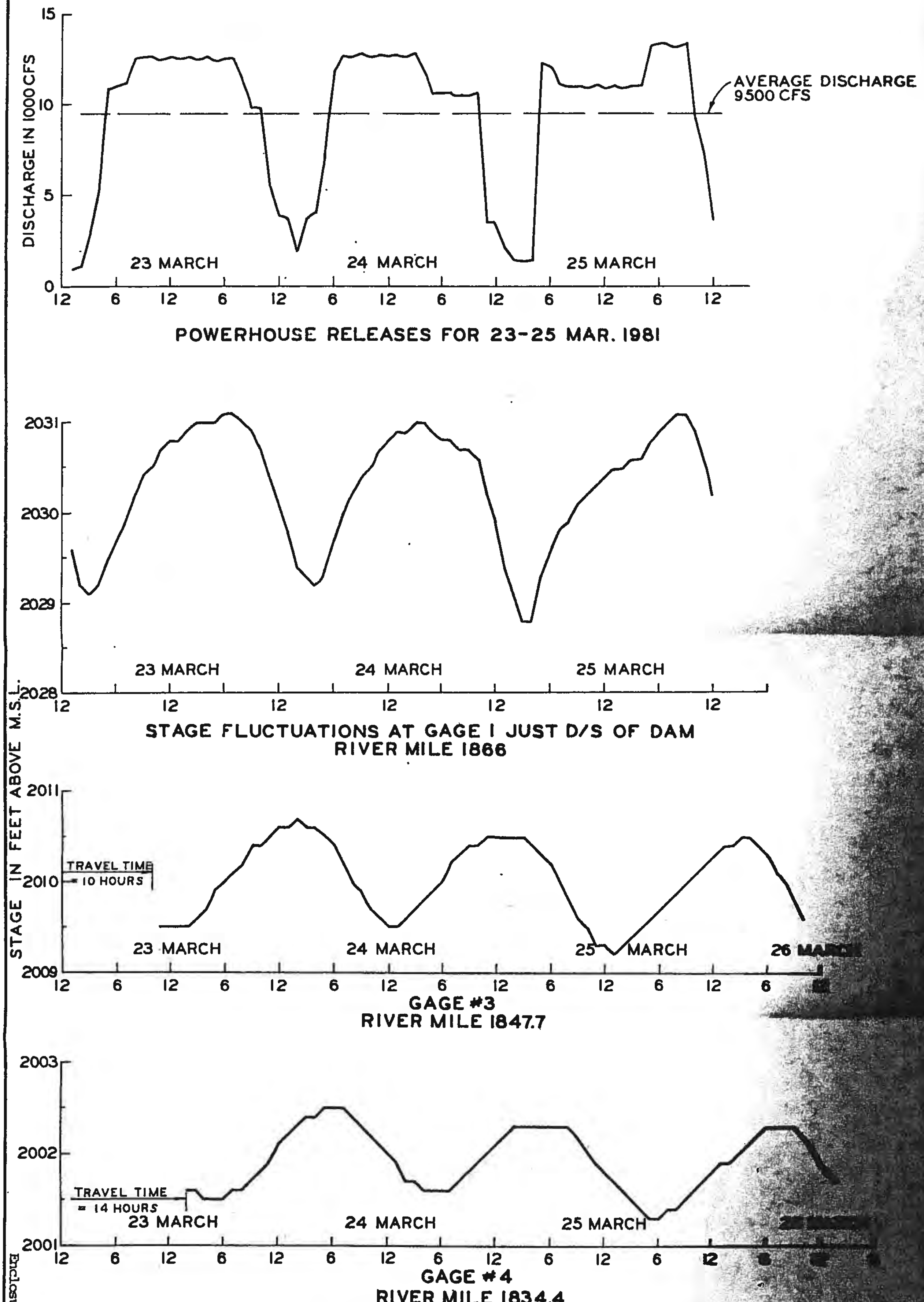
Holes drilled for piezometer installation from two to eight miles downstream of the dam indicate that the following general description is typical for the upper 10 feet.

Soils are usually poorly graded to silty sands. Silty days and sandy clays occur occasionally and range up to 8 feet in thickness. A clay or silt "cap", up to 6 feet in thickness is common at the surface.

Permeability values given below are estimates only. Silt and Sandy Clays: $1.x10^{-1}$ to $1x10^{-3}$ permeability. Poorly Graded Sands: $1x10^{0}$ to $1x10^{-1}$ permeability. Silty Sands: $1x10^{0}$ to $1x10^{-1}$ permeability.

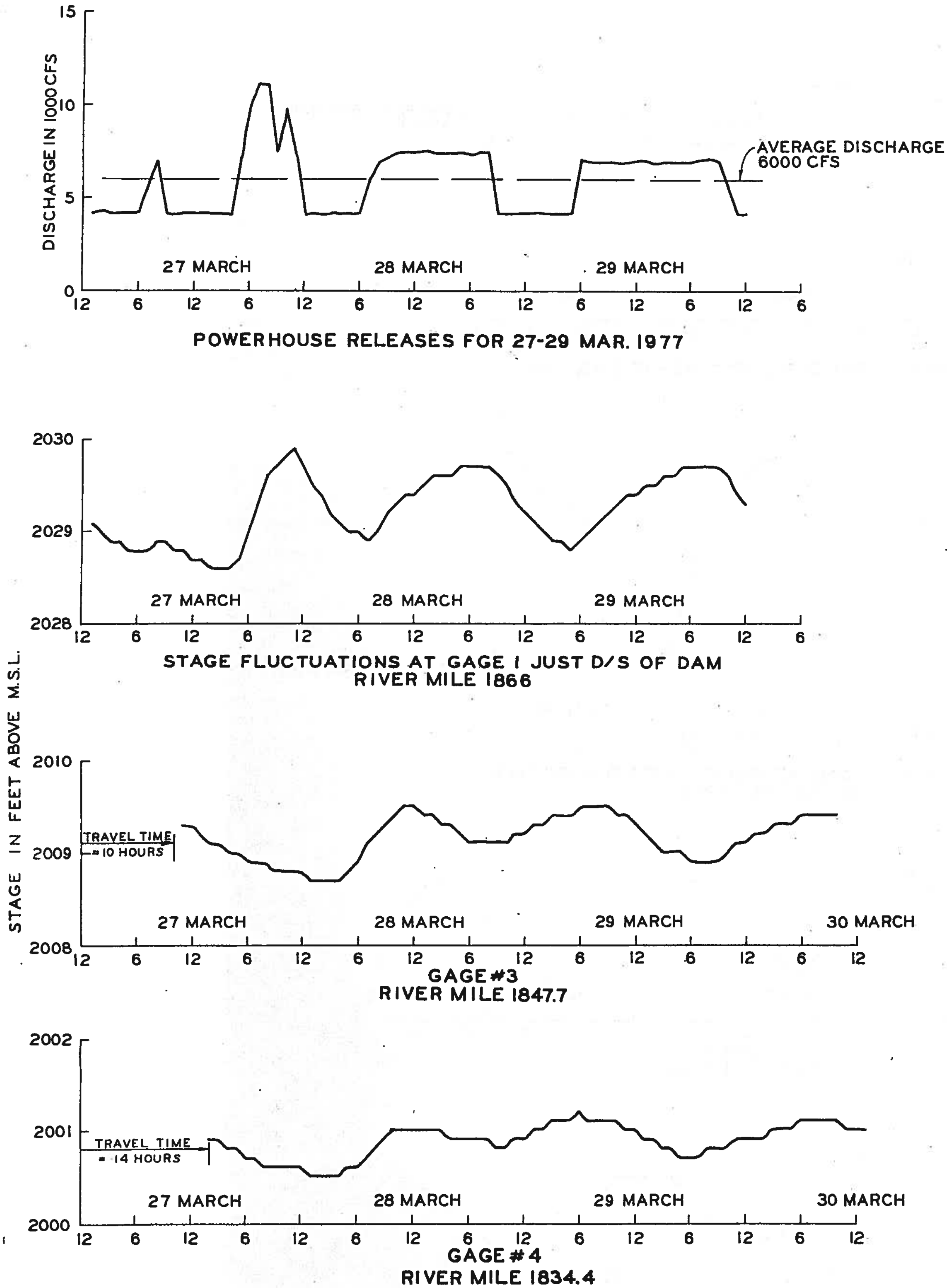
Unified Soil Classifications in general are (CL), (SP), and (SM). Classifications for the "surface clays" is commonly (CL) and (ML).

Enclosure 3



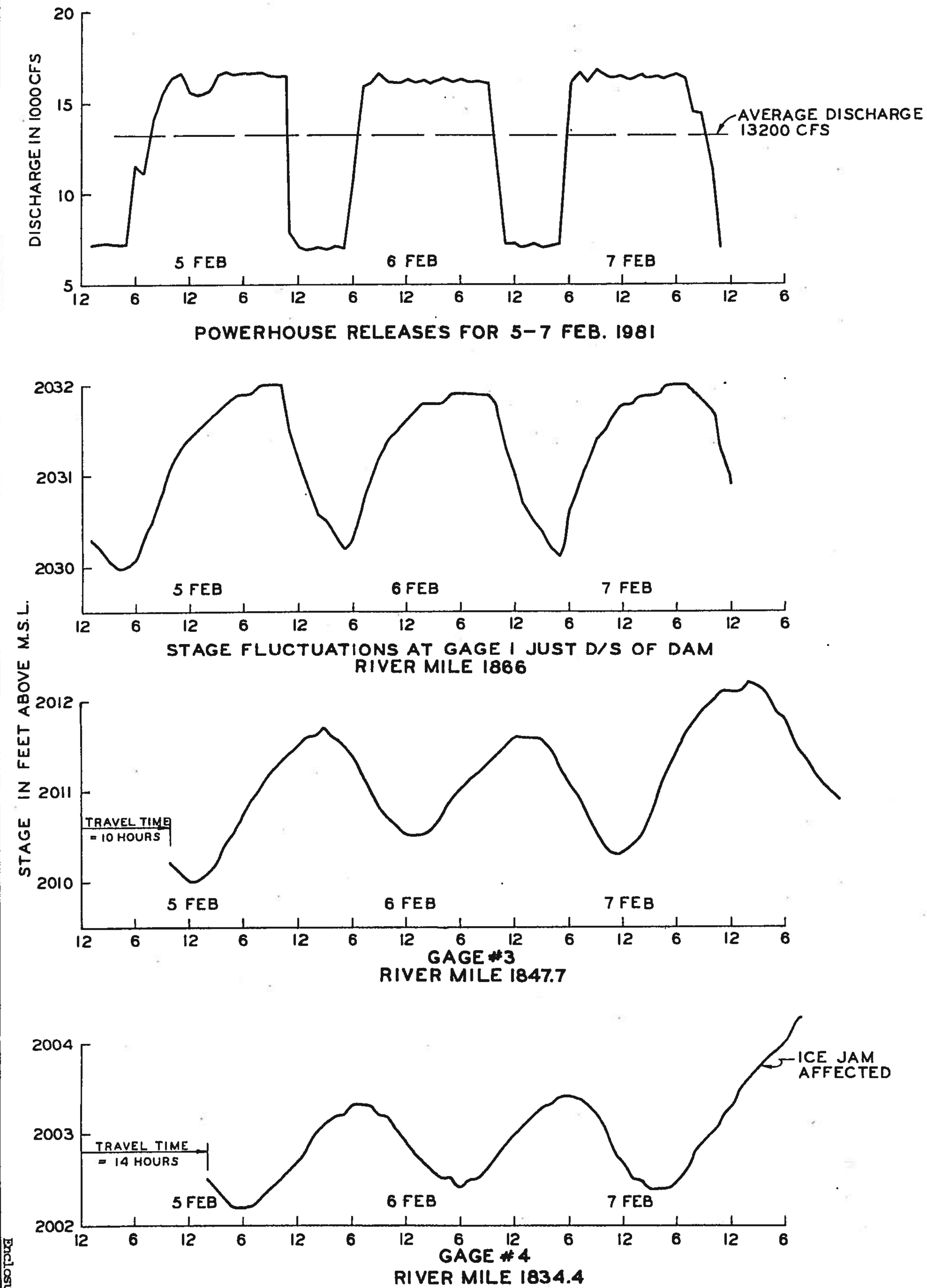
FORT PECK
ADDITIONAL HYDROPOWER
RELEASE PATTERN & STAGE
FLUCTUATION D/S OF THE DAM

Enclosure 5



MISSOURI RIVER
FORT PECK LAKE, MONTANA
ADDITIONAL HYDROPOWER STUDY
RELEASE PATTERN & STAGE
FLUCTUATION D/S OF THE DAM

Enclosure 4



MISSOURI RIVER
FORT PECK LAKE, MONTANA
ADDITIONAL HYDROPOWER STUDY
RELEASE PATTERN & STAGE
FLUCTUATION D/S OF THE DAM

Enclosure 6

ASSOCIATED ENGINEERS III, INC.

1201 SOUTH SIXTH STREET

SPRINGFIELD, ILLINOIS 62703
217-753-0075

PEORIA, IL
SPRINGFIELD, IL

PEKIN, IL
OLYMPIA, WA

May 4, 1984

Mr. William Godby
Chief, Office of Engineering
U.S. Fish & Wildlife Service
Denver Engineering Center - Room 428
3900 South Wadsworth Road
Denver, CO 80235

SUBJ: State of Montana
Warmwater-Coolwater Fish Hatchery
Study

Dear Mr. Godby:

We have been selected by the Montana Department of Fish, Wildlife and Parks to complete an evaluation of potential sites for a new or expanded warmwater/coolwater fish hatchery. The two sites being considered are the former Miles City National Fish Hatchery now being operated by the State of Montana and several areas immediately downstream of the Ft. Peck Dam.

The Department of FW&P has given us copies of all construction drawings for the Miles City facility which were provided to them by your office. These drawings have been very helpful in our review of existing conditions as well as studying expansion possibilities at Miles City.

At this time, on behalf of the Montana Department of Fish, Wildlife and Parks, we are seeking further information and data that you may have readily available which will assist us in our planning efforts. Specifically:

<u>MILES CITY</u>

1) We understand the sediment pond was built upstream of the storage reservoir in 1970±. Do your records indicate the dates and amount of dredging required to maintain the pond?

2) We have reviewed the Tongue River water supply intake structure. The original construction (Drawing IF-MONT-16-74.0) in 1958± indicates two parallel 100' X 15"Ø perforated buried intake lines. The intakes were extended in 1963± (Drawing IF-MONT-16-79.0) by

adding two extension 50' X 15"Ø pipe on the north end of the line. In 1970± a surface intake structure was also added. Do you have design calculations and/or performance records that indicate the design or actual capacity for any or all of these construction phases?

3) Do you have stream gauging information available for the Tongue River near the intake structure? What is the historical low and high water elevations? Have these elevations impacted design or operation considerations?

4) Do you have any general soils information regarding soil type, classification, water holding capability, erodibility, etc?

FT. PECK

5) A copy of the Corps of Engineers, Ft. Peck Master Plan dated 1946 showed a proposed USFWS fish hatchery immediately downstream of the Dam on the west bank of the Missouri River (approximately 72 acres of ponds & 137 acres total). In addition, we have been told that Ft. Peck may have been under consideration as a hatchery site prior to the selection of Miles City National Fish Hatchery. Do you have any information regarding either one of these subjects?

We appreciate your assistance in this matter. Should you have any questions please contact Mr. Thomas L. Johnson or me at 217-753-0075.

Very truly yours,

Gary Wilken

Gary A. Wilken, P.E.

GAW:cw
cc: Emmett Colley, DFWP
Bud Butterfield, DFWP, Miles City

TJ-FYI

United States Department of the Interior
FISH AND WILDLIFE SERVICE

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228

RECEIVED
MAY 29 1984
COCHRAN & WILKEN, INC.
SPRINGFIELD

IN REPLY REFER TO:

FR/EN

May 24, 1984

Associated Engineers III, Inc.
1201 Sixth Street
Springfield, Illinois 62703

ATTN: Mr. Gary A. Wilken, P.E.

Dear Mr. Wilken:

We have received your letter concerning the State of Montana warmwater/coldwater fish hatchery study and do have correspondence and plan files for Miles City and Fort Peck. Since you will be doing site evaluations in the Miles City, Montana, area, we assume you will be coming through Denver. Due to the extent and degree of information that you request, we suggest that you plan your trip to stop by our office to search our Miles City NFH files and make any copies that you deem necessary.

If you have any questions regarding this matter, please contact Marshal Fox at (303) 234-3616.

Sincerely,

Marshal D. Fox

Marshal D. Fox, P.E.
Acting Regional Engineer

cc: Bill Godby, OEN

ASSOCIATED ENGINEERS III, INC.

1201 SOUTH SIXTH STREET SPRINGFIELD, ILLINOIS 62703
217-753-0075

PEORIA, IL
SPRINGFIELD, IL

PEKIN, IL
OLYMPIA, WA

May 4, 1984

Mr. Brent Magill, City Engineer
City of Glasgow
Glasgow, MT 59230

SUBJ: State of Montana
Warmwater/Coolwater Fish
Hatchery Study

Dear Mr. Magill:

We have been selected by the Montana Department of Fish, Wildlife, and Parks to complete an evaluation of potential sites for a new or expanded warmwater/coolwater fish hatchery. The two sites being considered are the former Miles City National Fish Hatchery now being operated by the State of Montana and several areas immediately downstream of the Ft. Peck Dam.

In talking with Mr. Johnny Kuncheff, COE, Montana Area Engineer and Mr. Manson Bailey, Jr. of the Valley County Development Council we understand that the City of Glasgow is considering a Water Supply Project that would bring water from the Ft. Peck Dam Powerhouse.

One of the prime considerations for any hatchery site is water supply. We are seeking information from both the Corps of Engineers and your office regarding the various options that may be available. We are estimating a peak water demand of 2,500± gallons per minute.

If you feel there is any potential for joint planning and possible future use should a hatchery site be selected and ultimately constructed at Ft. Peck we would be interested in talking with you on behalf of the Montana Department of Fish, Wildlife and Parks.

If you should have any questions, please contact Tom Johnson or me at 217-753-0075.

Very truly yours,

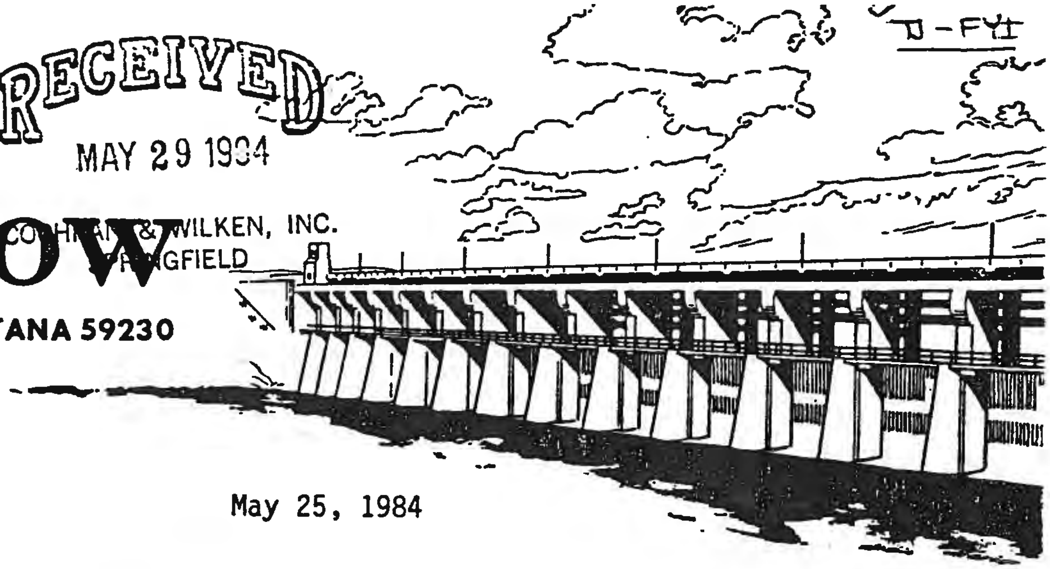
Gary A. Wilken, P.E.

GAW:cw
cc: Emmett Colley, FW&P
Bud Butterfield, FW&P, Miles City
Johnny Kuncheff, COE, Ft. Peck
Manson Bailey, Jr. Valley County Development Council

TJ - FYI

RECEIVED
MAY 29 1984
...HRAN & WILKEN, INC.
...NGFIELD

CITY OF
Glasgow
GLASGOW, MONTANA 59230



May 25, 1984

Mr. Gary A. Wilken, P.E.
Associated Engineers III, Inc.
1201 South Sixth Street
Springfield, Illinois 62703

SUBJECT: STATE OF MONTANA WARMWATER/COOLWATER FISH HATCHERY STUDY

Dear Mr. Wilken:

This is an acknowledgement of your correspondence relative to Glasgow's proposed project to obtain a new source of water supply for the city via a connection at Fort Peck Dam. This would allow a gravity flow volume to the city, except for periods when the lake level is lower than the highest elevation enroute. This has occurred only four days in the past. An in-line pump is planned to overcome such times of low gravity pressure.

It was greatly appreciated to have the recent three way telephone contact, between you, myself, and Manson Bailey, regarding the potential for joint planning and availability of adequate water through the same system to satisfy both the city's needs and a warmwater/coldwater fish hatchery for the state.

You have the brief outline and principle of the Glasgow proposed project sent to you by Mr. Bailey. The prominent question, now, Is there adequate water in these projections to satisfy both needs, as it is now designed?

As we talked on the phone, this would depend on the peaking times and call of either project. Use of the in-line pump would greatly increase the volume of supply, if called for a certain times.

A collaboration of planning would be beneficial to both the City of Glasgow and the State of Montana in development of the proposed projects.

The City of Glasgow wants to see the most beneficial use of all available facilities and seek direction from your firm as to how this planning could be coordinated. As a point of information, the engineering firm of Black & Veatch of Kansas City, Missouri, conducted the study for the city.

We do seek a greater knowledge of the principle operation of this type of fish hatchery and rearing system so as to be in better decision making and planning postion and are open for suggestions.

Thank you for your letter and our phone information.

Sincerely
Brent W. Magill

Brent W Magill, City Engineer
Glasgow, Montana

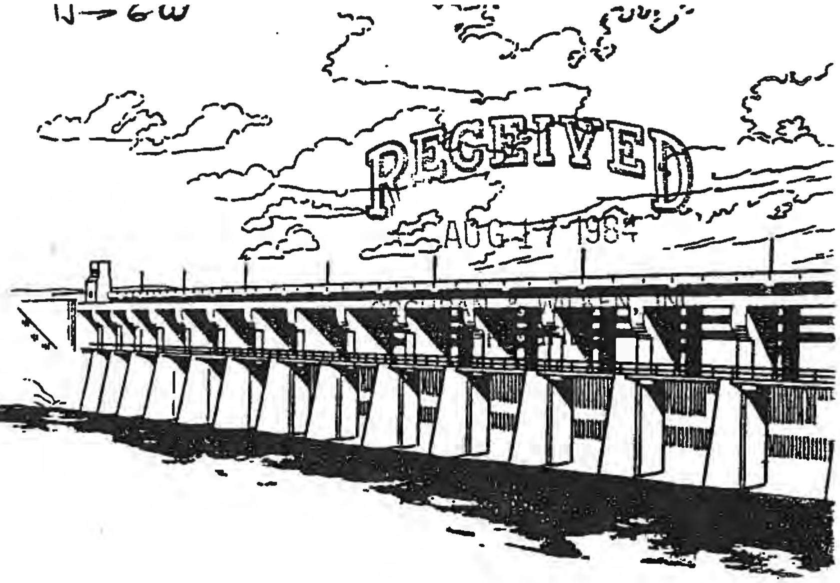
BWM/brc
cc: Wilmer Zeller, Glasgow Mayor
Emmett Colley, FW&P, Helena
Bud Butterfield, FW&P, Miles City
Johnny Kuncheff, COE, Fort Peck
Manson Bailey, Jr., VCDC

IJ→GW

CITY OF

Glasgow

GLASGOW, MONTANA 59230



RECEIVED
AUG 17 1984

August 13, 1984

William R. Andrews, Jr.
Colonel, Corps of Engineers
District Engineer
Omaha District Corps of Engineers
6014 U.S. Post Office and Courthouse
Omaha, Nebraska 68102

Re: Glasgow Water Supply Project.

Dear Colonel Andrews:

This is to brief you and your staff as to the present status of our cities proposed alternate water supply project in a formal manner. I have conversed with Mr. Peta on this so you are perhaps basically familiar with our situation, as follows:

- In an official election in November of 1983 a large majority of the citizens voted to proceed with the proposal to construct a pipeline to Fort Peck Dam for a new source of water supply.
- The city hired municipal bond brokerage counseling as well as professional water rate restructuring councel to adjust rates to accommodate a project of this size.
- The project financing proposal to the citizens was for half in revenue bonds with the remainder in general obligation bonds. As you know, general obligation (GO) bonds call for a vote on the issue. In the issuance of G.O. bonds taxes can be levied on property if water revenues are not adequate to make the bond payments.
- June 5, 1984 election was held on this financing proposal for the project. It was voted down by a similar large margin as the previous approval. Two factors stand out for the reverse. 1. Possible reliance on property taxes. 2. Projected water rate increases, especially among the elderly and low income families.
- Alternative source of funding is being sought. The City prepared and submitted an application to the Montana Department of Natural Resources for a loan and grant under the new "Renewable Resource Program" of Montana. This will take legislative approval but does have more favorable features than the revenue bond route, including lower interest.

William R. Andrews, Jr., Colonel
Page 2
August 13, 1984

The above information is to indicate the continued interest in the project which is more vivid during this drought period which calls for water use restrictions, not only in Glasgow and Hinsdale but other municipalities along the "hi-line." The Milk River has quit flowing at several points and the first time it has been dry east of Nashua since establishing a hydrography measuring station there 47 years ago.

Thank you and your staff for the continued interest in this and other projects of this area.

Sincerely,

Wilmer Zeller

Wilmer Zeller
Mayor

WZ/rb
cc: Arvid L. Thomsen
C. of E. Planning Division

Johnny Kuncheff
C. of E. Fort Peck

Emmet Colley
Mt. Dept. FW&P

Gary A. Wilken, P.E.
Associate Engineers III

Manson Bailey, Jr.
Valley County Development Council

ASSOCIATED ENGINEERS III, INC.

1201 SOUTH SIXTH STREET SPRINGFIELD, ILLINOIS 62703
217 - 753-0075

PEORIA, IL
SPRINGFIELD, IL

PEKIN, IL
OLYMPIA, WA

May 4, 1984

Water Plant Superintendent
Miles City, MT 59301

SUBJ: Water Supply
Miles City State Fish Hatchery

Dear Sir:

We have been selected by the Montana Department of Fish, Wildlife and Parks to complete an evaluation of potential expansion at the Miles City State Fish Hatchery. One aspect of the study is to consider improving the water supply to the hatchery by adding an intake/pumping facility along the Yellowstone River.

We would appreciate any information you could provide us regarding water quality, quantity and type of treatment at your water plant. This data will be helpful in helping us study the potential of the Yellowstone River as a water supply for the hatchery.

If you have any questions regarding this request, please feel free to call Mr. Tom Johnson or me, collect, at 217-753-0075. Thank you.

Very truly yours,

Gary Wilken

Gary A. Wilken, P.E.

GAW:cw
cc: Emmett Colley, DFWP
Bud Butterfield, DFWP, Miles City State Fish Hatchery
Keith Seaburg, DFWP, Miles City Regional Office

ASSOCIATED ENGINEERS III, INC.

1201 SOUTH SIXTH STREET
SPRINGFIELD, ILLINOIS 62703
217-753-0075

PEORIA, IL
SPRINGFIELD, IL
PEKIN, IL
OLYMPIA, WA

March 22, 1984

Mr. Johnny Kuncheff, Area Engineer
U.S. Army Corps of Engineers - Montana Area
Box 208
Fort Peck, Montana 59223

Dear Mr. Kuncheff:

Gary Wilken and I would like to thank you, and Mr. Ron Wallem and Bob McInerney of your staff, for the hospitality shown to us during our visit to the Fort Peck Area on February 26 & 27, 1984. We appreciate the time and interest shown by you and your staff regarding the Montana Warmwater/Coolwater Fish Hatchery Study being conducted by our firm. Enclosed is a copy of the Plan-of-Work for the study, to better acquaint you with the study objectives and approach.

The active participation and support of the Omaha District Corps of Engineers in the potential Fort Peck siting of a warmwater/coolwater hatchery at the project is a major factor influencing the possible selection of the Fort Peck Reservoir Site. We look forward to working with you, your staff and the Omaha District in the development of this study. As the study progresses, we appreciate the comments, concerns and suggestions of the Area Office and District as they relate to the potential siting of a hatchery on the project.

Mr. Wallem mentioned the possibility of obtaining a set of construction plans for the new Fort Peck water treatment plant supply line. These documents would be extremely useful to the study effort (we would be happy to cover reproduction costs if necessary). Available tailwater water quality data would also be appreciated.

We are in the process of evaluating the potential hatchery sites we observed with Mr. McInerney during our visit. We will provide potential hatchery layout drawings and development criteria for review by your staff and the District in the future.

Improved warmwater/coolwater reservoir fisheries management capability is the major goal of the Montana Department of Fish, Wildlife and Parks, hatchery study. Improved reservoir fishing and recreational use of Fort Peck

Reservoir as well as other eastern Montana waters will result from the development of the warmwater/coolwater hatchery program, regardless of the eventual siting of a new hatchery, a goal which we believe is supported by the Department and by the Omaha District.

We will keep you and your staff updated as the study progresses. Please feel free to contact our firm at any time for additional information or to discuss any matter of concern. Thank you for your assistance in the project.

Sincerely,

Thomas L. Johnson

Thomas L. Johnson,
Fisheries Biologist

TLJ:cw
cc: Emmett Colley,
Montana Department of Fish, Wildlife & Parks

Enclosure (1)

Valley County Development Council

Courthouse Annex, Room 2
Post Office Box 832
Glasgow, Montana 59230
Tel: (406) 228-9389

March 30, 1984

Mr. Gary Williams
Associated Engineers III
1201 So. 6th St.
Springfield, Illinois 62703

RE: Montana Warm Water Fish Hatchery

Dear Mr. Williams:

It was good to make your acquaintance via our tele-con recently.

Attached is some information you may find helpful in your analytical project with the State of Montana Fish, Wildlife, and Parks warm water fish hatchery/rearing in eastern Montana.

As I mention, the City of Glasgow has a proposal to take water from a 20" tap in Powerhouse #1 at Fort Peck Dam and deliver water through an 18 mile pipeline to Glasgow, gravity flow. To allow the flow with less friction, the first portion would be 24" pipe and would deliver some 3 million gallons of water to Glasgow, gravity flow. The city would only need to take water during the day and not at that capacity at this time. (Highest use so far has been 2.5 million gallons per day.) This would leave considerable for a use such as a fish hatchery complex.

The tap in the powerhouse was placed there at the time of construction for other than powerhouse use or designated at that time for a future warm water fish hatchery.

Should you come this way again, I would surely like to visit with you.

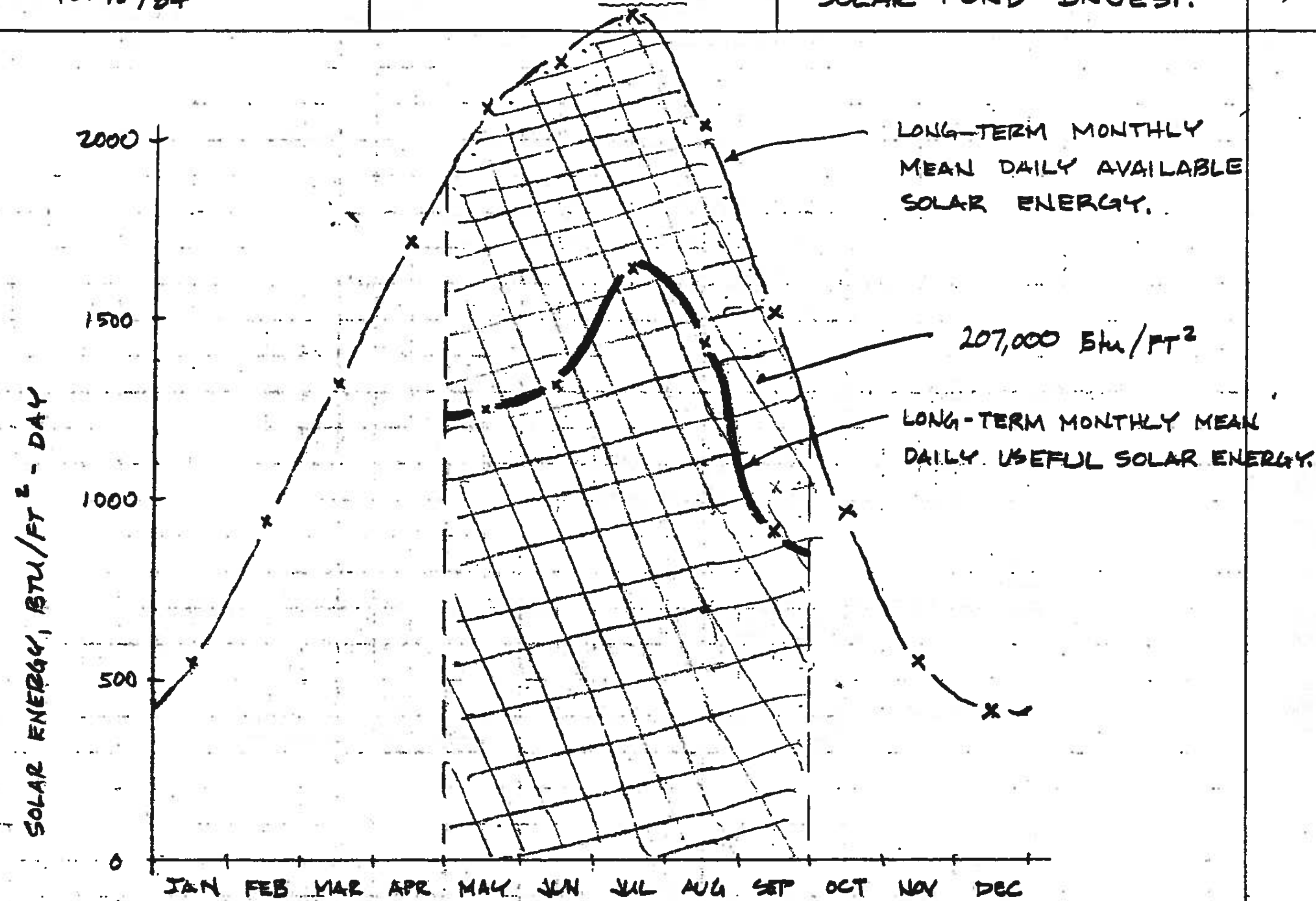
Sincerely,

Manson Bailey

Manson Bailey, Jr.
Executive Director

MB/vj

APPENDIX F SOLAR HEATING CALCULATIONS



LONG-TERM MONTHLY AVERAGE DAILY AVAILABLE SOLAR RADIATION AT GLASGOW, MT.

SOURCE: Environmental Science Services Administration, "Climatic Atlas of the United States." Washington, U.S. Department of Commerce, 1968.

 100 Btu/FT²-DAY × 15 days = 1500 Btu/FT²

MEAN PERCENTAGE OF POSSIBLE SUNSHINE FOR GLASGOW

MAY	60%
JUN	60%
JUL	70%
AUG	70%
SEP.	60%

GIVENS: POND IS 15 ACRES × 4.5' AVG DEPTH

ΔT: 60 − 38°F = 22°F April
60 − 41°F = 19°F May

FLOW: 500 GPM

ENERGY REQUIRED:

MAY: 60 − 41 = 19°F
SEPT.: 60 − 50 = 10°F

MAY

$$500\,gpm\left(8.33\,\frac{lb}{gal}\right)\left(60\,\frac{min}{hr}\right)\left(1.0\,\frac{Btu}{lb\text{-}°F}\right)(19°F) = 4.75\times10^6\ Btu/HR$$

$$4.75\times10^6\,\frac{Btu}{HR}\times24\times30\text{ days} = \underline{\underline{3420\times10^6\ Btu}}$$ MAY TOTAL

SEP.

$$500\times8.33\times60\times1.0\times10° = 2.5\times10^6\ Btu/HR$$

$$2.5\times10^6\,\frac{Btu}{HR}\times24\times30\text{ days} = \underline{\underline{1800\times10^6\ BTU}}$$ SEP. TOTAL

SOLAR HEAT AVAILABLE:

MAY: 1250 BTU/FT^2/DAY
SEP: 905 BTU/FT^2/DAY

$$V_i = \text{Volume} = 500\,gpm\times60\,\frac{min}{hr}\times10\text{ hrs.}\Big/7.48\,\frac{gal}{ft^3} = 40{,}106\ FT^3$$

$$\dot{t} = \frac{Q A \theta}{C_p V (62.4)} + \frac{V_{inflow}}{V_{pond}}(t_i - t_w)$$

θ = 10 hrs. 7:30 A − 4:30 PM

Solar Pond is 15 Acres × 4.5' deep.

$$V_w = 15\times43560\times4.5 = 2{,}940{,}300\ FT^3$$

$$\dot{t} = \frac{1250\,(A)(1)}{(1.0)(4.5A)\,62.4} + \frac{40{,}106\ FT^3}{2940300\ FT^3}\,(38-40)\ ^\circ F$$

$\dot{t} = 4.45 - 0.03 = \underline{4.4\ ^\circ F}$ Temp. increase in daylight hours.

FOR SUNSET HOURS — 4:30 PM → 7:30 AM 14 HOURS

HEAT LOSS Q_L @ 40 Btu/SF-HR × 14 = 560 Btu/S.F.

$$\dot{t}_{14} = -\frac{560\,(A)\,1}{(1.0)(4.5A)\,62.4} + \frac{56150}{2940300}\,(38-42)$$

V_i = 500 gpm × 60 × 14 / 7.48 = 56,150. FT^3

$\dot{t}_{14}$ = − 1.99 − 0.08 = 2.07 SAY $\underline{2.0\ ^\circ F}$ Temp. decrease @ night

AVERAGE USEFUL HEAT OVER 24-HOUR PERIOD —

$Q_{NET} = Q_{GAIN} - Q_{LOSS}$ = 1250 − 560 = 690 Btu/S.F. / DAY

ASSUME COULD AVERAGE Q_{NET} = 600 Btu/FT^2/DAY

MAY, JUN, JUL, AUG, SEP. ½ OF MAY & SEP. OR 4 MO.

$$600\ \frac{Btu}{FT^2 \cdot DAY} \times 120\ DAYS \times 653400 = 4.7 \times 10^{10}\ Btu$$

ON A DAILY BASIS IN MAY —

THE 15 ACRE SOLAR POND Q_{NET} = 653400 S.F. × 600 = 392 × 10^6 Btu

THE DAILY NEED IS 4.75 × 10^6 Btu/HR × 24 = 114. × 10^6 Btu

ON A DAILY BASIS IN SEP.

$$Q_{NET} = Q_{GAIN} - Q_{LOSS} = 905 - 560 = 345 \text{ Btu/S.F./DAY}$$

$$345 \text{ Btu/S.F./DAY} \times 653,400 \text{ S.F.} = 225 \times 10^6 \text{ Btu} \quad [\text{AVAILABLE}]$$

$$2.5 \times 10^6 \text{ Btu/HR} \times 24 \text{ HR} = 6 \times 10^6 \text{ Btu} \quad [\text{NEEDED}]$$

IN OCT. $Q_{GAIN} \approx Q_{LOSS} \Longrightarrow \therefore$ NO NET GAIN AND SOLAR POND NO LONGER USEFUL

HOWEVER, IT CAN BE SEEN THAT THE 15-ACRE SOLAR POND IN MAY THRU SEP. CAN PRODUCE ALL THE REQUIRED HEATING NEEDS ON SUNNY DAYS. OF COURSE, BACK-UP SYSTEMS WOULD BE NECESSARY TO MAINTAIN TEMPS. DURING CLOUDY PERIODS.

IT CAN BE ASSUMED THAT A SHALLOW SOLAR POND IN A STATIC CONDITION WOULD MAINTAIN A TEMPERATURE NEAR THAT OF THE MEAN AMBIENT AIR TEMPERATURE. IN MAY, THE MEAN $T_{AMB} = 51.2$ (APPENDIX B).

IF THE INITIAL POND TEMP. IS TAKEN AS 51.2°F, THEN FROM ABOVE, THE NET DAILY INCREASE IS 2 - 2.4°F, THEN WATER DELIVERED TO THE HATCHERY WOULD BE ABOUT 53.5°F ON AN AVERAGE DAY IN MAY. A HEAT PUMP OR SOME OTHER HEATING SYSTEM WOULD THEN BE REQUIRED TO RAISE THE REARING WATER TEMP. TO THE DESIRED 60°F.

APPENDIX G HATCHERY OPERATIONAL COST ESTIMATES

1. SALARIES (INCLUDING BENEFITS)

1	Hatchery Manager	$23,000
1	Ass. Hatchery Manager	20,000
1	Hatchery Biologist	16,000
1	Hatcherymen	12,000
6	Part-time for 6 months	20,000
		$91,000.

2. PERSONAL SERVICES

Travel and expenses to conferences meetings etc. — $4,500

3. FISH FOOD: Dry Feed @ 30¢/lb $5,000 — 5000
Fertilizer, 30 Ton @ $75 — 2250
$7250

4. TELEPHONE — $2,000

5. ELECTRICITY @ $0.04482 /KWH
$2.25/KW Demand Charge over 10KW

a. Building Lighting: based on 3 watts/FT² avg., 9 hours of lighting/day and hatchery in continuous operation 365 days/YR.

$$\text{COST} = (\text{AREA})(3\,\text{W/S.F.})(9\,\text{HRS/DAY})(365\,\text{DAYS/YR})(\$0.04482/\text{KWH})$$

$$= (10000)(3)(9)(365)(0.04482) / 1000\,\text{W/KW} = \$6053\,/\text{YR}$$

Cochran & Wilken, Inc.
CONSULTING ENGINEERS

Job # ________ Sheet 2 of 4
Subject MILES CITY O & M COSTS
Client ________
By LDC Checked ________ Date 10/10/84

b. Water Heating:

Based on the analysis presented in Paragraph ___ of Text.

Heat 500 GPM, 10°F for 60 days ⇒ 24 × 60 = 1440 HRS/YR.

$$Q = \dot{m} c_p \Delta T$$

$$Q = 500 \frac{gal}{min} \times 8.33 \frac{lb}{gal} \times 60 \frac{min}{hr} \times 1.0 \frac{Btu}{lb\ °F} \times (60-50)°F =$$

$$Q = 2.5 \times 10^6 \ Btu/HR.$$

For heat pump, Coefficient of Performance (COP) = 7.9

$$COST = \frac{2.5 \times 10^6 \ Btu/HR \times \$0.04482/KWH \times 1440 \ HRS/YR}{7.9 \ C.O.P. \times 3413 \ Btu/KWH}$$

COST = $5984.

SAY **$6,000 /YR**

c. Water Pumping:

Based on 4000 GPM in Mar thru Aug; 1000 GPM Sep. thru Feb.

YELLOWSTONE:

$$HP = \frac{GPM \times HEAD}{3960 \times EFF.} = \frac{4000 \times 150'}{3960 \times EFF} = 202 \ HP. \quad \text{Say } 200 \ HP$$

$$W = 1.73 \times 480 \times 240 A \times 0.8 PF = 159437 \ W = 159 \ KW$$

$$COST = 159 \ KW \times 24 \frac{HR}{day} \times 180 \ days \times \$0.04482/KWH = \underline{\$30,870} /YR$$

Cochran & Wilken, Inc.
CONSULTING ENGINEERS

Job # ______ Sheet 3 of 4
Subject MILES CITY O&M COSTS
Client ______
By RDC Checked ______ Date 10/10/84

TONGUE:

HP = 20

KW = 1.73 × 480 × 27 A × 0.8 / 1000 = 17.9 say 18 KWH

COST = 18 KW × 24 × 180 days × 0.04482 = $3485 / YR

REUSE PUMPING:

2 ea @ 20 HP for 180 days

2 × 3485 = $6970. / YR

DEMAND CHARGE:

2.25 ×	150 KW	=	$337.5	× 12		4050.
2.25 ×	8 KW	=	18.	× 12	=	216.
2.25 ×	16 KW	=	36.	× 12		432.
						$4698.

PUMPING TOTAL $46,023.

Cochran & Wilken, Inc.
CONSULTING ENGINEERS

Job #
Sheet 4 of 4
Subject MILES CITY - O & M COSTS
Client
By LDC Checked Date 10/10/84

6. BUILDING HEATING

Natural Gas @ First 15 MCF $4.74
Over 15 MCF $5.417

Previous years billing has been approximately
The proposed building has doubled in size. Thus → $5000

7. FISH TRANSPORTATION $5000

Use: 1½-TON flatbed with 500 gal tank &
Pickup trucks

8. SPARE PARTS & REPAIRS 7000

9. EQUIPMENT SERVICE & MAINTENANCE 1000
(belts, hoses, oil changes, tune-ups, etc.)

10. START-UP CAPITAL ASSESTS 50000
(tools, lumber, misc. pipe fittings, chain, nets,
buckets, boots, etc.)

O & M TOTAL $230,773.

MONTANA-DAKOTA UTILITIES CO.
P.O. Box 1098 Miles City MT 59301 232-0110

June 14, 1984

Lincoln Cochran
Cochran & Wilken
1201 S 6th
Springfield, Il 62703

Dear Mr. Cochran:

The following are the electric and gas rates that you requested regarding the Miles City Fish Hatchery. These rates are now current.

New Rates Aug 15.

RESIDENTIAL RATES (on houses)

Electric :	Base Rate	$2.25		
	First 300 KWH	$.05865	($17.59)	.07532
	Over 300	$.07270		
Gas :	First 15 MCF	$4.74		
	Over 15 MCF	$5.417		
	Minimum Bill	$5.00		

COMMERCIAL

Electric Demand Rate 22

Over 10.0 KW;	$2.25 per KW		
KWH	$.04482	.06033	Non-Demand Rate 20
		.04482	Demand Rate 22

Gas

All MCF used:	$5.411 year around
Minimum Bill:	$10.00

Hope these are the figures that you need for your study.

Sincerely,

Linda Anderson

Linda Anderson
Consumer Service Clerk

la

OIL-FIRED BOILER –

Boiler w/controls, C.I., 5520 MBH	$ 31,800
Heat Transfer Package, 550 GPM (controls, converter, pumps)	20,100
Breeching & misc. piping	5000
Buried Fuel Tank, 12,000 gal. (30 days)	12200
Fuel pumps & piping	750
	69850
+10% Cont.	6985
	$ 76835.

ELECTRIC BOILER –

Boiler w/standard controls, 1620 KW	46300
Electrical	2500
Heat Transfer Package	20100
	88900
+10% Cont.	8890
	$ 97,790

HEAT PUMP –

Centrifugal for 5500 MBH including stainless steel tubes & foul guard system

Unit	100000
Foul guard	20000
Installation	10000
Piping	5000
	135000
+ 10% Cont.	13500
	$148,500

NOTE: EITHER THE ELECTRIC BOILER OR THE HEAT PUMP WOULD INCREASE THE SIZE REQUIREMENT FOR THE STANDBY GENERATOR & SWITCHGEAR. THIS COST HAS NOT BEEN INCLUDED ABOVE, BUT WOULD PROBABLY BE IN THE RANGE OF $10,000.

OIL- FIRED -

$$\frac{5.5 \times 10^6 \times \$1.05/gal}{138{,}000\ Btu/gal \times .70\ eff} = \$59.78/HR$$

PLUS SOME ELECT.

SAY $60.-/HR

ELECTRIC BOILER -

$$\frac{5.5 \times 10^6\ Btu/HR}{3413\ Btu/KW} \times \$0.04482/KWH = \$72.23/HR$$

HEAT PUMP -

$$\frac{5.5 \times 10^6\ Btu/HR \times \$0.04482/KWH}{3413\ Btu/KW \times 7.9\ C.O.P.} = \$9.14/HR$$

To OPERATE 60 days per year - 60 × 24 hr/day = 1440

OIL - FIRED : $60 × 1440 = $86400

ELECT. BOILER : $72.23 × 1440 = 104011
3622 Demand Charge on 1610 KW
$107,633

HEAT PUMP : $9.14 × 1440 = 13,162.
436 Demand charge on 194 KW
$13,598

ENERGY REQUIRED :

$$500\ gpm \times 8.33\ \frac{lb}{gal} \times 60\ \frac{min}{hr} \times 1.0\ \frac{Btu}{lb\,°F} \times (60-50)°F = 2.5 \times 10^{6}\ Btu/HR$$

CONSTRUCTION COSTS :

OIL-FIRED BOILER -

Boiler w/controls, C.I., 2920 MBH	19,000
Heat Transfer Package, 550 GPM (controls, converters & pumps)	20,100
Breeching & misc. piping	5,000
Buried fuel tank, 8000 gal. (30 days)	9,000
Fuel Pumps & Piping	750
	$53,850
+ 10% Cont.	5385
	$59,235

ELECTRIC BOILER -

Boiler w/standard controls, 2764 MBH, 810 KW	20,400
Electrical	7,500
Heat Transfer Package	20,100
	$48,000
+ 10% Cont.	4800
	$52,800

HEAT PUMP -

Centrifugal (McQuay) for 2500 MBH

BASIC UNIT W/ STAINLESS STEEL TUBES	60 000
FOUL GUARD	12 000
INSTALLATION	10,000
PIPING	5,000
	$87,000
+ 10% Cont.	8700
	$95,700

NOTE: EITHER THE ELECTRIC BOILER OR THE HEAT PUMP WOULD INCREASE THE SIZE REQUIREMENT FOR THE STANDBY GENERATOR & SWITCHGEAR. THIS COST HAS NOT BEEN INCLUDED IN THE ABOVE, BUT WOULD PROBABLY BE IN THE RANGE OF $10,000.

	MILES CITY WATER HEATING	ANNUAL ELECT. COST

ASSUME TO OPERATE FOR 60 CALENDAR DAYS CONTINUOUS.
(60 × 24 HRS/DAY) = 1440 HRS.

OIL-FIRED UNIT –

USE LUMP SUM FOR BURNER, ETC. $400.

ELECTRICAL BOILER –

810 KW × 1440 × $.04482/KWH = $52278

Demand 800 KW × $2.25 1800

$54078

HEAT PUMP –

$$\frac{2{,}500{,}000 \times \$0.04482 \times 1440 \text{ HRS}}{7.9 \text{ C.O.P.} \times 3413 \text{ Btu/KWH}} = \$5984$$

+ Demand 93 KW × $2.25 209

$6193

OIL COST –

$$\frac{2{,}500{,}000 \text{ Btu/HR} \times 1440 \text{ HRS} \times \$1.05/\text{GAL}}{138{,}000 \text{ Btu/GAL} \times .70 \text{ (EFF)}} = \$39{,}130$$

APPENDIX H REARING UNIT CARRYING CAPACITY (DENSITY) PROJECTIONS

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

****

HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	60' x 6'x 3' conc. raceways	1080.0	8078

DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	1in. LBS.	2in. LBS.	3in. LBS.	4in. LBS.	5in. LBS.	6in. LBS.	7in. LBS.	8in. LBS.	9in. LBS.	10in. LBS.
0.1	108	216	324	432	540	648	756	864	972	1080
LBS/CUFT=	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
0.2	216	432	648	864	1080	1296	1512	1728	1944	2160
LBS/CUFT=	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
0.3	324	648	972	1296	1620	1944	2268	2592	2916	3240
LBS/CUFT=	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
0.4	432	864	1296	1728	2160	2592	3024	3456	3888	4320
LBS/CUFT=	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
0.5	540	1080	1620	2160	2700	3240	3780	4320	4860	5400
LBS/CUFT=	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
0.6	648	1296	1944	2592	3240	3888	4536	5184	5832	6480
LBS/CUFT=	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
0.7	756	1512	2268	3024	3780	4536	5292	6048	6804	7560
LBS/CUFT=	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
0.8	864	1728	2592	3456	4320	5184	6048	6912	7776	8640
LBS/CUFT=	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00
0.9	972	1944	2916	3888	4860	5832	6804	7776	8748	9720
LBS/CUFT=	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
1.0	1080	2160	3240	4320	5400	6480	7560	8640	9720	10800
LBS/CUFT=	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

****

HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	60' x 6' x 3' conc. raceway	1080.0	8078

****

DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

****

MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	11in. LBS.	12in. LBS.	13in. LBS.	14in. LBS.	15in. LBS.	16in. LBS.	17in. LBS.	18in. LBS.	19in. LBS.	20in. LBS.
0.1	1188	1296	1404	1512	1620	1728	1836	1944	2052	2160
LBS/CUFT=	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
0.2	2376	2592	2808	3024	3240	3456	3672	3888	4104	4320
LBS/CUFT=	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
0.3	3564	3888	4212	4536	4860	5184	5508	5832	6156	6480
LBS/CUFT=	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
0.4	4752	5184	5616	6048	6480	6912	7344	7776	8208	8640
LBS/CUFT=	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00
0.5	5940	6480	7020	7560	8100	8640	9180	9720	10260	10800
LBS/CUFT=	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
0.6	7128	7776	8424	9072	9720	10368	11016	11664	12312	12960
LBS/CUFT=	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40	12.00
0.7	8316	9072	9828	10584	11340	12096	12852	13608	14364	15120
LBS/CUFT=	7.70	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00
0.8	9504	10368	11232	12096	12960	13824	14688	15552	16416	17280
LBS/CUFT=	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40	15.20	16.00
0.9	10692	11664	12636	13608	14580	15552	16524	17496	18468	19440
LBS/CUFT=	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20	17.10	18.00
1.0	11880	12960	14040	15120	16200	17280	18360	19440	20520	21600
LBS/CUFT=	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00

****

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

****

HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	10' x 2' x 2' start/holding	40.0	299

****

DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

****

MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	1in. LBS.	2in. LBS.	3in. LBS.	4in. LBS.	5in. LBS.	6in. LBS.	7in. LBS.	8in. LBS.	9in. LBS.	10in. LBS.
0.1	4	8	12	16	20	24	28	32	36	40
LBS/CUFT=	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
0.2	8	16	24	32	40	48	56	64	72	80
LBS/CUFT=	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
0.3	12	24	36	48	60	72	84	96	108	120
LBS/CUFT=	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
0.4	16	32	48	64	80	96	112	128	144	160
LBS/CUFT=	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
0.5	20	40	60	80	100	120	140	160	180	200
LBS/CUFT=	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
0.6	24	48	72	96	120	144	168	192	216	240
LBS/CUFT=	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
0.7	28	56	84	112	140	168	196	224	252	280
LBS/CUFT=	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
0.8	32	64	96	128	160	192	224	256	288	320
LBS/CUFT=	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00
0.9	36	72	108	144	180	216	252	288	324	360
LBS/CUFT=	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
1.0	40	80	120	160	200	240	280	320	360	400
LBS/CUFT=	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00

****

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

****

HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	10'x2'x2' start/holding	40.0	299

****

DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

****

MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	11in. LBS.	12in. LBS.	13in. LBS.	14in. LBS.	15in. LBS.	16in. LBS.	17in. LBS.	18in. LBS.	19in. LBS.	20in. LBS.
0.1	44	48	52	56	60	64	68	72	76	80
LBS/CUFT=	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
0.2	88	96	104	112	120	128	136	144	152	160
LBS/CUFT=	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
0.3	132	144	156	168	180	192	204	216	228	240
LBS/CUFT=	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
0.4	176	192	208	224	240	256	272	288	304	320
LBS/CUFT=	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00
0.5	220	240	260	280	300	320	340	360	380	400
LBS/CUFT=	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
0.6	264	288	312	336	360	384	408	432	456	480
LBS/CUFT=	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40	12.00
0.7	308	336	364	392	420	448	476	504	532	560
LBS/CUFT=	7.70	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00
0.8	352	384	416	448	480	512	544	576	608	640
LBS/CUFT=	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40	15.20	16.00
0.9	396	432	468	504	540	576	612	648	684	720
LBS/CUFT=	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20	17.10	18.00
1.0	440	480	520	560	600	640	680	720	760	800
LBS/CUFT=	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00

****

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

****

HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
iles City SFH	12.6 x 3 x 3 st	113.4	848

****

DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

****

MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	1in. LBS.	2in. LBS.	3in. LBS.	4in. LBS.	5in. LBS.	6in. LBS.	7in. LBS.	8in. LBS.	9in. LBS.	10in. LBS.
0.1	11	23	34	45	57	68	79	91	102	113
LBS/CUFT=	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
0.2	23	45	68	91	113	136	159	181	204	227
LBS/CUFT=	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
0.3	34	68	102	136	170	204	238	272	306	340
LBS/CUFT=	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
0.4	45	91	136	181	227	272	318	363	408	454
LBS/CUFT=	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
0.5	57	113	170	227	284	340	397	454	510	567
LBS/CUFT=	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
0.6	68	136	204	272	340	408	476	544	612	680
LBS/CUFT=	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
0.7	79	159	238	318	397	476	556	635	714	794
LBS/CUFT=	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
0.8	91	181	272	363	454	544	635	726	816	907
LBS/CUFT=	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00
0.9	102	204	306	408	510	612	714	816	919	1021
LBS/CUFT=	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
1.0	113	227	340	454	567	680	794	907	1021	1134
LBS/CUFT=	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00

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DENSITY INDEX CARRYING CAPACITY PROJECTIONS

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HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	12.6' x 3 x 3 st	113.4	848

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DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

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MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	11in. LBS.	12in. LBS.	13in. LBS.	14in. LBS.	15in. LBS.	16in. LBS.	17in. LBS.	18in. LBS.	19in. LBS.	20in. LBS.
0.1	125	136	147	159	170	181	193	204	215	227
LBS/CUFT=	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
0.2	249	272	295	318	340	363	386	408	431	454
LBS/CUFT=	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
0.3	374	408	442	476	510	544	578	612	646	680
LBS/CUFT=	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
0.4	499	544	590	635	680	726	771	816	862	907
LBS/CUFT=	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00
0.5	624	680	737	794	851	907	964	1021	1077	1134
LBS/CUFT=	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
0.6	748	816	885	953	1021	1089	1157	1225	1293	1361
LBS/CUFT=	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40	12.00
0.7	873	953	1032	1111	1191	1270	1349	1429	1508	1588
LBS/CUFT=	7.70	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00
0.8	998	1089	1179	1270	1361	1452	1542	1633	1724	1814
LBS/CUFT=	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40	15.20	16.00
0.9	1123	1225	1327	1429	1531	1633	1735	1837	1939	2041
LBS/CUFT=	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20	17.10	18.00
1.0	1247	1361	1474	1588	1701	1814	1928	2041	2155	2268
LBS/CUFT=	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00

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DENSITY INDEX CARRYING CAPACITY PROJECTIONS

HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	10.8 x 3 x 3 st	97.2	727

DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	1in. LBS.	2in. LBS.	3in. LBS.	4in. LBS.	5in. LBS.	6in. LBS.	7in. LBS.	8in. LBS.	9in. LBS.	10in. LBS.
0.1	10	19	29	39	49	58	68	78	87	97
LBS/CUFT=	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
0.2	19	39	58	78	97	117	136	156	175	194
LBS/CUFT=	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
0.3	29	58	87	117	146	175	204	233	262	292
LBS/CUFT=	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
0.4	39	78	117	156	194	233	272	311	350	389
LBS/CUFT=	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
0.5	49	97	146	194	243	292	340	389	437	486
LBS/CUFT=	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
0.6	58	117	175	233	292	350	408	467	525	583
LBS/CUFT=	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
0.7	68	136	204	272	340	408	476	544	612	680
LBS/CUFT=	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
0.8	78	156	233	311	389	467	544	622	700	778
LBS/CUFT=	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00
0.9	87	175	262	350	437	525	612	700	787	875
LBS/CUFT=	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
1.0	97	194	292	389	486	583	680	778	875	972
LBS/CUFT=	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	10.8 x 3 x 3	97.2	727

DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	11in. LBS.	12in. LBS.	13in. LBS.	14in. LBS.	15in. LBS.	16in. LBS.	17in. LBS.	18in. LBS.	19in. LBS.	20in. LBS.
0.1	107	117	126	136	146	156	165	175	185	194
LBS/CUFT=	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
0.2	214	233	253	272	292	311	330	350	369	389
LBS/CUFT=	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
0.3	321	350	379	408	437	467	496	525	554	583
LBS/CUFT=	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
0.4	428	467	505	544	583	622	661	700	739	778
LBS/CUFT=	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00
0.5	535	583	632	680	729	778	826	875	923	972
LBS/CUFT=	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
0.6	642	700	758	816	875	933	991	1050	1108	1166
LBS/CUFT=	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40	12.00
0.7	748	816	885	953	1021	1089	1157	1225	1293	1361
LBS/CUFT=	7.70	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00
0.8	855	933	1011	1089	1166	1244	1322	1400	1477	1555
LBS/CUFT=	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40	15.20	16.00
0.9	962	1050	1137	1225	1312	1400	1487	1575	1662	1750
LBS/CUFT=	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20	17.10	18.00
1.0	1069	1166	1264	1361	1458	1555	1652	1750	1847	1944
LBS/CUFT=	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	10'x1.0'x0.66' initial feed	6.6	49

DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	1in. LBS.	2in. LBS.	3in. LBS.	4in. LBS.	5in. LBS.	6in. LBS.	7in. LBS.	8in. LBS.	9in. LBS.	10in. LBS.
0.1	1	1	2	3	3	4	5	5	6	7
LBS/CUFT=	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
0.2	1	3	4	5	7	8	9	11	12	13
LBS/CUFT=	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
0.3	2	4	6	8	10	12	14	16	18	20
LBS/CUFT=	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
0.4	3	5	8	11	13	16	18	21	24	26
LBS/CUFT=	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
0.5	3	7	10	13	17	20	23	26	30	33
LBS/CUFT=	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
0.6	4	8	12	16	20	24	28	32	36	40
LBS/CUFT=	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
0.7	5	9	14	18	23	28	32	37	42	46
LBS/CUFT=	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
0.8	5	11	16	21	26	32	37	42	48	53
LBS/CUFT=	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00
0.9	6	12	18	24	30	36	42	48	53	59
LBS/CUFT=	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
1.0	7	13	20	26	33	40	46	53	59	66
LBS/CUFT=	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00

DENSITY INDEX CARRYING CAPACITY PROJECTIONS

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HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	10'x1.0'x0.66'initial feed	6.6	49

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DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

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MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	11in. LBS.	12in. LBS.	13in. LBS.	14in. LBS.	15in. LBS.	16in. LBS.	17in. LBS.	18in. LBS.	19in. LBS.	20in. LBS.
0.1	7	8	9	9	10	11	11	12	13	13
LBS/CUFT=	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
0.2	15	16	17	18	20	21	22	24	25	26
LBS/CUFT=	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
0.3	22	24	26	28	30	32	34	36	38	40
LBS/CUFT=	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
0.4	29	32	34	37	40	42	45	48	50	53
LBS/CUFT=	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00
0.5	36	40	43	46	50	53	56	59	63	66
LBS/CUFT=	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
0.6	44	48	51	55	59	63	67	71	75	79
LBS/CUFT=	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40	12.00
0.7	51	55	60	65	69	74	79	83	88	92
LBS/CUFT=	7.70	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00
0.8	58	63	69	74	79	84	90	95	100	106
LBS/CUFT=	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40	15.20	16.00
0.9	65	71	77	83	89	95	101	107	113	119
LBS/CUFT=	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20	17.10	18.00
1.0	73	79	86	92	99	106	112	119	125	132
LBS/CUFT=	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00

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DENSITY INDEX CARRYING CAPACITY PROJECTIONS

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HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	6.0'circular tanks	75.2	562

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DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

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MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	1in. LBS.	2in. LBS.	3in. LBS.	4in. LBS.	5in. LBS.	6in. LBS.	7in. LBS.	8in. LBS.	9in. LBS.	10in. LBS.
0.1	8	15	23	30	38	45	53	60	68	75
LBS/CUFT=	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
0.2	15	30	45	60	75	90	105	120	135	150
LBS/CUFT=	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
0.3	23	45	68	90	113	135	158	180	203	226
LBS/CUFT=	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
0.4	30	60	90	120	150	180	211	241	271	301
LBS/CUFT=	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
0.5	38	75	113	150	188	226	263	301	338	376
LBS/CUFT=	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
0.6	45	90	135	180	226	271	316	361	406	451
LBS/CUFT=	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
0.7	53	105	158	211	263	316	368	421	474	526
LBS/CUFT=	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
0.8	60	120	180	241	301	361	421	481	541	602
LBS/CUFT=	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00
0.9	68	135	203	271	338	406	474	541	609	677
LBS/CUFT=	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
1.0	75	150	226	301	376	451	526	602	677	752
LBS/CUFT=	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00

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DENSITY INDEX CARRYING CAPACITY PROJECTIONS

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HATCHERY	REARING UNIT	VOL. CU.FT.	VOL. GALS.
Miles City SFH	6.0' circular tanks	75.2	562

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DENSITY INDEX TABLE LBS./CU.FT./INCH FISH T.LENGTH

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MAX. RECOMMENDED REARING UNIT CARRYING CAPACITY LBS. FOR FISH OF T.L.in.

DENSITY INDEX	11in. LBS.	12in. LBS.	13in. LBS.	14in. LBS.	15in. LBS.	16in. LBS.	17in. LBS.	18in. LBS.	19in. LBS.	20in. LBS.
0.1	83	90	98	105	113	120	128	135	143	150
LBS/CUFT=	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
0.2	165	180	196	211	226	241	256	271	286	301
LBS/CUFT=	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
0.3	248	271	293	316	338	361	384	406	429	451
LBS/CUFT=	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
0.4	331	361	391	421	451	481	511	541	572	602
LBS/CUFT=	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00
0.5	414	451	489	526	564	602	639	677	714	752
LBS/CUFT=	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
0.6	496	541	587	632	677	722	767	812	857	902
LBS/CUFT=	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40	12.00
0.7	579	632	684	737	790	842	895	948	1000	1053
LBS/CUFT=	7.70	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00
0.8	662	722	782	842	902	963	1023	1083	1143	1203
LBS/CUFT=	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40	15.20	16.00
0.9	744	812	880	948	1015	1083	1151	1218	1286	1354
LBS/CUFT=	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20	17.10	18.00
1.0	827	902	978	1053	1128	1203	1278	1354	1429	1504
LBS/CUFT=	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00

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