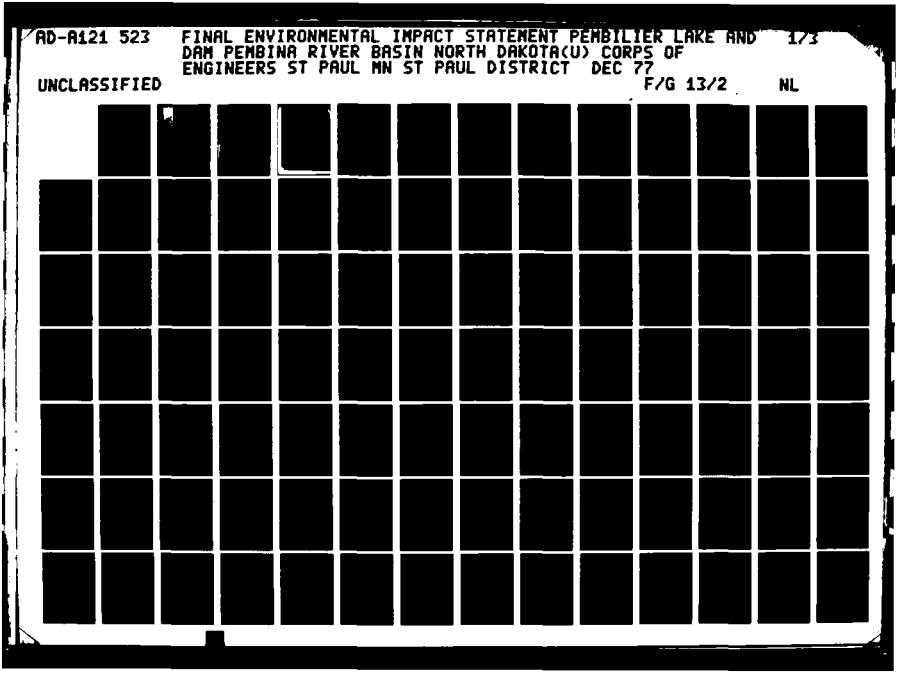
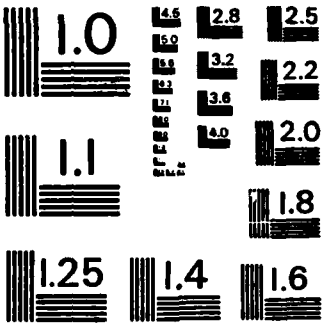
AD-A121 523 FINAL ENVIRONMENTAL IMPACT STATEMENT PEMBILIER LAKE AND 1/3
DAM PEMBINA RIVER BASIN NORTH DAKOTA(U) CORPS OF
ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 77

UNCLASSIFIED F/G 13/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FINAL

PEMBILIER LAKE AND DA

PEMBINA RIVER BASIN

NORTH DAKOTA

ENVIRONMENTAL IMPACT STATEMENT

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. A121583 / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FINAL ENVIRONMENTAL IMPACT STATEMENT, PEMBILIER LAKE AND DAM, PEMBINA RIVER BASIN, NORTH DAKOTA	5. TYPE OF REPORT & PERIOD COVERED: Final EIS 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Army Engineer District, St. Paul, 1135 U.S. Post Office and Custom House, St. Paul, MN 55101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE: December 1977 13. NUMBER OF PAGES: 252
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Environmental impact statements
Dams
Pembilier Lake
Pembina River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The project would include a rolled earth type dam across the Pembina River about 2 miles southwest of Walhalla, North Dakota. The reservoir would have a controlled storage capacity of 147,000 acre-feet of which 15,000 acre-feet would be in an 800 surface area conservation pool. Flood storage would result in a 72-percent reduction in projected average annual equivalent damages through the control of floods with a frequency of once in 36 years or less, and the reduction of larger less frequent floods. The project would result in the permanent inundation of about 800 acres of the valley, including 365 acres of woodland, 355 acres of

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

agricultural lands, and 9.5 miles of free flowing river. At design flood-pool, an additional 2,400 acres of the valley and 11.5 miles of river would be inundated for varying durations. Flood storage would result in the modification and/or destruction of existing valley habitat and would significantly affect wildlife populations beyond the limits of the design flood pool.

FINAL
ENVIRONMENTAL IMPACT STATEMENT

PEMBILIER LAKE AND DAM
PEMBINA RIVER BASIN
NORTH DAKOTA

U.S. ARMY ENGINEER DISTRICT, ST. PAUL
St. Paul, Minnesota
December 1977

SUMMARY
PEMBILIER LAKE AND DAM
PEMBINA RIVER BASIN
NORTH DAKOTA

( ) Draft Environmental Impact Statement ( ) Revised Draft Environmental Statement
(X) Final Environmental Impact Statement

Responsible Office: St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House,
St. Paul, Minnesota 55101
Telephone: 612-725-7505

1. Name of Action (X) Administrative ( ) Legislative

2. Descr tion of Action: The project would include a rolled earth type dam across the Pembina River about 2 miles southwest of Walhalla, North Dakota, near the Cavalier-Pembina County Line. The reservoir would have a controlled storage capacity of 147,000 acre-feet of which 15,000 acre-feet would be in an 800 surface area conservation pool. Storage within the conservation pool would be allocated to water supply, recreation, and sedimentation. Discharges during normal operation would utilize a multiple-gated intake structure.

3. a. Environmental Impacts: Flood storage would result in a 72-percent reduction in projected average annual equivalent damages through the control of floods with a frequency of once in 36 years or less, and the reduction of larger, less frequent floods. Allocated storage in the conservation pool would satisfy, to some degree, the basin need for an increased and dependable water supply. Recreational benefits are expected through utilization of the conservation pool and surrounding project lands. Land quality in the floodplain is expected to increase due to reduced sheet erosion. Benefits of a qualitative nature would occur to residents of the floodplain through reduced anxiety and disruption of normal life patterns during flood events. In addition, tensions between Canadian and United States residents of the basin are expected to lessen due to a reduction in the frequency of flooding.

b. Adverse Environmental Effects: The project would result in the permanent inundation of about 800 acres of the valley, including 365 acres of woodlands, 355 acres of agricultural lands, and 9.5 miles of free flowing river. At design flood-pool, an additional 2,400 acres of the valley and 11.5 miles of river would be inundated for varying durations. Flood storage would result in the modification and/or destruction of existing valley habitat and would significantly affect wildlife populations beyond the limits of the design flood pool. Significant wildlife affected would include white-tailed deer, ruffed grouse, wood ducks,

and beaver. Preliminary information indicates that the reservoir would be eutrophic. The project would require the relocation of persons from 2 farmsteads and residences within the project take-line. The aesthetic qualities of the valley would be significantly affected. Personal preference would dictate whether this impact was positive or negative.

4. Alternatives to the Proposed Action: The nonstructural alternatives to the proposed plan include: (1) Base Condition (no action): (2) Flood Warning and Forecasting Services and Emergency Protection: and (3) Floodplain Evacuation and Flood Proofing. Structural alternatives include: (4) Proposed Project; (5) Pembilier "Dry" Dam; (6) Small Reservoirs on Mainstem Tributaries; (7) Boundary Floodway; (8) Floodway in Lower Reach of Pembina River; (9) Channel Modifications; (10) Levees at Neche; (11) Levees at Neche and Agricultural Levees; (12) Combination of Levees and Boundary Floodway; (13) Combination Levees and Reduced-Size Pembilier Dam; (14) Combination of Boundary Floodway and Reduced-Size of Pembilier Dam; (15) National Economic Development (NED) Plan; and (16) Environmental Quality (EQ) Plan.

5. Coordination

a. A list of those Federal, State and local agencies and citizens and environmental groups who were furnished copies of the draft statement appears on page 108.

b. A list of those who furnished comments on the draft statement is on page 111.

6. a. Draft Statement to CEQ: 30 July 1975.

b. Revised Draft Statement to CEQ: 20 May 1977.

c. Final Statement to CEQ:

FINAL
ENVIRONMENTAL IMPACT STATEMENT

PEMBILIER LAKE AND DAM
PEMBINA RIVER BASIN
NORTH DAKOTA

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

FIGURES

TABLES

REVISED DRAFT
ENVIRONMENTAL IMPACT STATEMENT
PEMBILIER LAKE AND DAM
PEMBINA RIVER BASIN
NORTH DAKOTA

1.000 PROJECT DESCRIPTION

1.001 Introduction - The purpose of the proposed project is to reduce economic damage and social problems associated with floods on the Pembina River through the construction of a rolled earth-fill dam and associated structures on the Pembina River about 2 miles southwest of Walhalla, North Dakota, near the Cavalier-Pembina County Line. (exhibit 2). The resulting impoundment is designed to satisfy to varying degrees the basin needs of flood control, water supply and recreation. The proposed project provides for construction of an earthen dam, multiple-gated outlet structure, emergency spillway, road modifications, recreation facilities, and the purchase of wildlife compensation areas.

1.002 Dam - The dam would be an earth-fill structure with an impervious core and cutoff trench. The dam would have a maximum height of 150 feet from the river bed to the top of the fill at elevation 1106 (all elevations are feet above mean sea level) and an overall length of approximately 2,090 feet. The slope of the upstream face would be riprapped with filter blanket down to an elevation of 1005 (5 feet below the conservation pool). The top of the dam and the downstream face to an elevation of 981.3 would be protected with sod established by topsoiling and seeding. Below elevation 981.3, riprap with filter blanket would be used for tailwater erosion control.

1.003 Outlet Works and Spillway - The low-flow outlet works would consist of a circular conduit through the north (left) abutment of the earthen embankment section. The conduit would be 10.0 feet in diameter and would have an invert elevation of 970. There would be a multi-gated inlet tower at the upstream end of the conduit to control the discharges. The discharge capacity of the conduit at the conservation pool elevation (1010) would be 2,200 cubic feet per second (cfs). The discharge capacity would then increase gradually up to 4,000 cfs at the design flood elevation of 1080. When floods in excess of the design flood were experienced, the emergency spillway would be utilized to pass flows in excess of those being discharged through the low-flow conduit.

1.004 The emergency spillway would consist of a fixed crest spillway consisting of an uncontrolled ogee section discharging into a rectangular concrete chute and stilling basin on the south (right) abutment. The spillway crest would be at elevation 1080 and would be

129 feet long. The spillway outlet channel would be approximately 740 feet long with an 85-foot long stilling basin at the bottom. The stilling basin and the outlet channel apron would be constructed of reinforced concrete.

1.005 Reservoir - The reservoir created by the construction of the Pembilier Dam would have a total of 147,000 acre-feet of controlled storage. Of this amount, 128,000 acre-feet would be reserved exclusively for flood control. Of the remaining 19,000 acre-feet, 11,000 acre-feet is allotted to sedimentation storage over the 100-year economic life of the project and 4,000 acre-feet in the conservation pool would be reserved for water supply, recreation, and wildlife, with water supply receiving top priority (conservation pool is 15,000 acre-feet). An additional 4,000 acre-feet of sedimentation is anticipated outside the conservation pool over the 100-year period.

1.006 At the design conservation pool stage, the reservoir would be about 1/2 to 3/4 mile wide, 7.0 miles long and would have a surface area of about 800 acres and would permanently inundate about 9.5 miles of stream. At the design flood pool elevation of 1080 the reservior would be about 15.5 miles in length, would cover a surface area of 3,200 acres, and would inundate an additional 11.5 miles of stream (Exhibit 2).

1.007 Vegetation within the deep valleys of the Pembina River and its tributaries consists of a variety of tree and shrub growth. Within the area of the conservation pool approximately 365 acres of woodland would be cleared. An additional 25 acres of wooded lands above the permanent pool would be lost due to clearing to within 3 feet vertically, or 300 feet horizontally, of the permanent pool, whichever was less.

1.008 Land Use - Total project lands would encompass about 5,800 acres, the majority of which are covered by "natural" vegetation. Of this amount, about 50 acres would be utilized for project structures, about 1,000 acres would be utilized for recreation and fishing access, and about 800 acres would be water surface area. Based on a preliminary study by the U.S. Fish and Wildlife Service (FWS), the North Dakota Department of Game and Fish (NDG&F), and the Corps, an additional 13,200 acres of land outside the project take line in the river valley above the Vang Bridge would be required to compensate and/or mitigate for project related losses of wildlife production. Witnin the conservation pool area, about 365 acres of woodland, 355 acres of agricultural land, and 80 acres of existing river would be cleared and/or inundated.

1.009 Utilities - Secondary Highway 720 between Vang and Walhalla would be the principal crossing of the Pembina River affected in Cavalier County under the proposed conditions. One additional highway crossing would be affected by the reservoir, the crossing near the mouth of the Little South Pembina River would be abandoned.

The proposed reservoir would require raising the crossing on Secondary Highway 720 approximately 60 feet as well as a small lateral relocation of highway approaches to the high-level bridge. The proposed bridge and approaches would be constructed to the same load and traffic classification as at the present location. However, they would be built to modern engineering standards. Access would be provided for all local residents, but a greater distance of travel would be required for some residents.

1.010 Fish and Wildlife - The construction of the proposed Pembilier Dam would create an 800-acre reservoir-type lake with potential water quality problems. Preliminary evaluations, based only on nutrient concentrations of the Pembina River, suggest that the lake could exhibit an accelerated rate of eutrophication. As a result of the possible eutrophic nature of the impoundment, the potential for a quality fishery in the lake would be reduced. Potential fishery problems anticipated are related to low dissolved oxygen (D.O.) in the cold water layer (hypolimnion) of the stratified impoundment, the scarcity of suitable spawning areas for desirable fish species, abundant growth of aquatic plants (macrophytes and algae) in certain areas of the conservation pool, proliferation of "rough" fish, high sedimentation, and potential winter-kill conditions.

1.011 The potential for a downstream fishery has not yet been evaluated. A multiple-gated intake structure is currently proposed, however, and management procedures would need to be developed under post-authorization studies. Potential problems with a downstream fishery relate to low D.O., hydrogen sulfide, excessive plant production due to high nutrient content of release water (provided other aquatic parameters are suitable), temperature, and lack of suitable substrate for invertebrates. Project effects on water quality would be investigated during the post-authorization restudy phase of the project.

1.012 Because of the unique vegetative qualities of the Pembina River gorge and its associated tributaries, compensation of the wildlife losses resulting from creation of Pembilier Reservoir would require acquisition of a sizeable amount of land. Based on a preliminary habitat evaluation study conducted by the FWS and with input from the N.D. Game & Fish Dept. and the Corps of Engineers, acquisition of 16,000 acres of land, within the river valley walls from the Vang Bridge to the Canadian border, is proposed for compensation purposes. Of this 16,000 acres, approximately 2,800 acres are within the proposed project take-line. A discussion of the method used to identify the compensation land requirement is contained in Exhibit 17.

1.013 Management of project and compensation lands above the Vang Bridge would be the responsibility of the North Dakota Game and Fish Department. Unless some non-Federal governmental body indicates an intent to manage project lands below the Vang Bridge, the Corps of Engineers would assume this responsibility.

1.014 Recreation - The recommended plan includes recreational development upstream and adjacent to the permanent lake. Recreation facilities to be established would consist of camp pads, picnic sites and a shelter, a boat launch ramp and dock, parking spaces, overlooks, access roads, landscaping and related support facilities.

1.015 The effects of poor water quality and an uncertain degree of effort expended for fishery management on recreational utilization of the lake would be addressed in detail in post-authorization stages of the project.

1.016 Water Supply - An abundant and more dependable water supply for persons serviced by the water treatment facilities at Neche has been identified as one of the water resource needs of the Pembina River basin. Low stream-flows during winter months, combined with evaporation and ice losses on the existing lowhead water supply dam at Neche would result in estimated water shortages in 1980 based on a 3 percent chance occurrence drought. Water shortages would occur in 2030 for an 8 percent chance occurrence drought. Based on these estimates, the proposed Pembilier Reservoir conservation pool incorporates water storage to supplement existing water supplies for downstream areas as a proposed project purpose.

1.017 Four thousand acre-feet of the 15,000 acre-feet conservation pool capacity would be reserved for water supply and recreation purposes. Only 750 acre-feet would be needed downstream during a drought period, but an additional storage of 3,250 acre-feet would be required to account for evaporation and transmission losses and to provide a minimum downstream flow of at least 2 cfs.

1.018 Delivery of water from the proposed reservoir to a downstream water supply reservoir would be accomplished by inchannel delivery, the most economical delivery method. This method would, however, result in the greatest transmission losses. Because of ice conditions in the channel which exist during the late fall and winter demand period, a constant discharge from the reservoir would probably be the selected delivery method as opposed to a "slug" release which could break-out from under ice formations and freeze before reaching the desired downstream location. Amounts of discharge and the level of withdrawal from the reservoir would consider any fishery and/or water quality management program in the downstream channel. Operating schedules would be evaluated in post-authorization studies.

1.019 Operation and Maintenance - Operation and maintenance of the project would be a Federal responsibility, except for management and operation of specific recreation developments, water supply features, downstream maintenance, and fish and wildlife aspects which would be non-Federal responsibilities. The project would be operated

primarily for flood control and water supply while other anticipated uses such as recreation, fish and wildlife, and water quality would be accommodated to the extent possible while fulfilling the two primary objectives.

1.020 Under the tentatively proposed operating plan for flood control, the outflow discharge would not be restricted until the inflow discharge exceeded 2,200 cfs. At this point, release would be gradually increased at a constant rate up to a maximum release of 4,000 cfs. Floodwater storage would commence at discharges greater than 2,200 cfs. The outflow discharge would not exceed 4,000 cfs until the water level reached the emergency spillway elevation of 1080. The design flood would have an expected recurrence frequency of 2.8 percent (once in every 36 years) with a maximum inflow discharge of about 17,000 cfs and a maximum outflow discharge of 4,000 cfs. For the design flood, the water level in the flood pool would reach an elevation of 1080, and floodwaters would be stored above the conservation pool elevation 1010 for about 75 days.

1.021 Backwater Effects in Canada - Limited analysis indicates that at the design flood level, a flood that would be expected once in 36 years, the flood storage pool created by Pembilier Dam would be confined entirely within the United States. At the spillway design flood level, the backwater effect would extend about 1 1/2 miles into Canada. Most of the backwater would be confined within the existing river channel, although about 40 acres or less of land in Manitoba would be flooded. The backwater effect in Canada does not appear to be significant; however, this effect would be defined more accurately during post-authorization studies.

1.022 Downstream Effects in Canada - Current inundation reduction benefits in Canada stemming from partial control of Pembina River floodwaters in the United States have been evaluated by Environment Canada and the Province of Manitoba, Department of Mines, Resources, and Environmental Management. Average annual benefits in the amount of $272,000 would accrue in Canada, principally in the Gretna-Altona area and to a lesser degree along the Red River of the North downstream from Emerson. Also, it is likely that intangible benefits would accrue, particularly a lessening of the dispute along the Gretna-Neche portion of the International Boundary.

1.023 Authority - Recognizing the economic damage and social problems caused by major floods on the Pembina River in North Dakota, the Committee on Commerce of the United States Senate, at the request of local interests, adopted a resolution on 28 February 1945. The resolution requested that the Board of Engineers for Rivers and Harbors review a previous report on the Pembina River and tributaries published as House Document No. 565, Seventy-eighth Congress, Second Session.

1.024 Further authority for this report is provided by a resolution of the Committee on Public Works of the United States Senate, adopted 15 June 1950, and two resolutions of the Committee on Public Works of the House of Representatives, adopted 27 June 1950 and 19 July 1950. These resolutions requested the Board of Engineers for Rivers and Harbors to review prior reports on the Red River of the North drainage basin, which includes the Pembina River basin.

1.025 Economics - The proposed project has a benefit/cost ratio of 1.6 to 1 including benefits to Canada and a benefit/cost ratio of 1.5 to 1 excluding Canadian benefits. Total Federal first cost is currently estimated as $23,390,000 with a non-Federal cost of $1,510,000. Annual operation and maintenance costs are estimated as $97,000 Federal and $44,000 non-Federal. Economic data have been extracted from the Feasibility Report for Flood Control and Related Purposes on the Pembina River, North Dakota, U.S. Army Corps of Engineers, St. Paul District Office (Table 1).

Table 1 - Economic Data for Pembilier Reservoir

Total project investment	$27,000,000
Annual costs	
Interest & amortization	$ 1,658,000
Operations and replacement (97,000 Federal, 44,000 non-Federal)	141,000
Total	$ 1,799,000
Benefits (annual)	
Flood control (United States)	$ 2,355,000
Water supply	61,000
Recreation	131,000
Local employment	86,000
Sub total	$ 2,633,000
Flood control (Canadian)	272,000
Total	$ 2,905,000

B/C ratio 2905/1799 = 1.6 (with Canadian benefits)
2633/1799 = 1.5 (excluding Canadian benefits)

Estimate of cost sharing

	Federal	non-Federal	Total
Project investment	$25,420,000	$1,580,000	$27,000,000
Operation, maintenance & operation	97,000	44,000	141,000

Current estimate of reimbursable costs by Canada to the United States for construction of Pembilier Lake and Dam. $1,808,000

1.026 Alternate Operating Plan - By choosing an alternate operating plan and making other necessary adjustments in the project planning, a "marsh" could also be created behind the dam instead of a "lake". The advantages and disadvantages of this approach are discussed in exhibit 1. The marsh alternative would be refined during post-authorization studies. Both the "marsh" and "lake" alternatives are considered to be operational variants of the conceptual plan, pending Congressional action.

1.027 Post-authorization Study Needs. Assuming the proposed project is authorized, several studies would be conducted to provide refinements in existing data and projected project conditions. These studies would include:

a. Water quality: A water quality monitoring program is presently being negotiated with the U.S. Geological Survey. Water samples will be obtained at more frequent intervals than the present sampling program. The number of parameters measured will also be expanded. Samples will be obtained from the Pembina River near Walhalla, and near the Vang Bridge, and from the Little South Pembina River near its confluence with the main stem. The sampling program will be initiated in April 1976. Initial funding (through September 1976) is being provided by the N.D. State Water Commission and the U.S. Geological Survey. Following authorization, computer model studies will be initiated to define more precisely the projected water quality within the reservoir and downstream. Various reservoir operating schedules, including the "marsh" alternative, will be evaluated as they affect selected physical, chemical and biological parameters. These studies will be coordinated with the EPA, USFWS, and the NDGF. Should these studies indicate that existing water quality standards will be exceeded, mitigative measures (lake rehabilitation techniques) will be investigated in an attempt to reduce the adverse impacts. However, if a particular standard is exceeded by a large amount, it is probably unrealistic to assume that the condition could be corrected in an economical manner.

b. Wildlife mitigation - The preliminary habitat evaluation study was very limited in scope because of time, monies, available aerial imagery, and because uncertainties existed in operating procedures, recreational development and project boundaries. Because of these limitations, the identified compensation requirements for the proposed project are considered only as preliminary estimates. Following authorization, air photos and habitat type mapping will be obtained and used to reassess the existing habitat resources, both within the project area and in downstream reaches. More accurate estimates will also be made regarding project induced changes in habitat values based on refinements of other project features. Following this reassessment, updated compensation requirements (land, operation and maintenance, management alternatives) will be agreed upon for both terrestrial and aquatic biota.

2.000 ENVIRONMENTAL SETTING WITHOUT THE PROJECT

CLIMATE

2.001 General - The climate in the vicinity of the Pembina River basin is continental, characterized by wide variations in temperature, ample rainfall, with normal distribution for crops, and moderate snowfall. Prior to spring breakup, average snow depths of 1 to 2 1/2 feet are common. Breakup generally occurs over a period of from 7 to 10 days and, with snow concentrated in river valleys and coulees, runoff is quite rapid, producing discharges considerably in excess of those which might be expected from the average depth of snow cover on the basin. The area experiences local rainstorms of moderate intensity with rainfall from one storm varying greatly over sections of the basin. General rains covering the entire watershed are of rare occurrence. The more hazardous storms occur during the winter in the form of blizzards which endanger life and property and often disrupt transportation and communications facilities. Wind velocities average about 10 miles per hour and are generally from the northwest. Records of temperature and precipitation are available from 30 meteorological stations within and adjacent to the Pembina River drainage area which have been in operation for varying periods since 1872. In Canada, stations are maintained and operated by the Meteorological Division of the Canada Department of Transport, while in the United States they are maintained and operated by the National Weather Service of the U.S. Department of Commerce. Records are not all continuous during the periods of record. Hourly precipitation records are available for Pembina and Sarles, North Dakota, from 1940 to date.

2.002 Temperature - The average annual temperature in the basin is approximately 36 F (Table 2). The long-term mean monthly temperature during July, the warmest month, is almost 68 F, while in January, the coldest month, it is 2 F. Extreme temperatures of 112 F and -54 F have been recorded in the basin.

2.003 Precipitation - The average annual precipitation for the basin is approximately 18 inches, while the maximum monthly precipitation is 3.2 inches in June and the minimum monthly precipitation is 0.6 inch in February (Table 3). Snowfall over the basin averages about 38 inches a year, which is equivalent to about 21 percent of the average annual precipitation. The three greatest rainfall depths recorded for a 24-hour period include 8.76 inches at Boissevain, Manitoba, on 12 August 1957, 5.05 inches at Hansboro, North Dakota, in June 1952, and 5.01 inches at Walhalla, North Dakota on 3 July 1904.

Table 2 - Mean monthly temperatures, °F

Station	Period of record From	To	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Mean
Canada															
Swan Lake	1885	1929	-1	0	16	38	50	61	66	62	53	42	22	9	34.8
Pilot Mound	1895	1962	5.6	1.3	18.3	37.3	50.4	59.3	67.3	64.6	54.6		21.2	8.7	
Ninette	1913	1962	2.6	6.9	20.6	38.2	52.2	60.8	67.2	64.4	54.4	42.6	23.7	10.0	37.0
Boissevain	1912	1962			18.3	37.2	50.8	59.9	66.3	63.7	54.2	42.7			
Mean			2.4	2.7	18.3	37.6	50.8	60.2	66.7	63.6	54.1	42.4	22.3	9.2	35.8
United States(1)															
Pembina			2.4	2.8	18.4	38.5	53.2	62.8	67.8	64.7	54.5	41.6	23.4	7.0	36.0
Hannah			1.2	2.6	19.2	37.9	51.6	60.5	66.2	64.1	54.8	40.8	20.7	7.6	35.4
Langdon	1931	1960	1.9	6.2	19.7	38.4	52.5	61.3	67.8	65.9	55.3	42.9	22.9	9.6	37.0
Hansboro	1931	1960	3.0	7.3	20.0	38.5	51.9	60.5	67.2	64.9	54.7	43.2	23.9	11.1	37.2
Cavalier			1.4	6.1	21.0	39.2	53.6	62.6	69.0	65.9	55.6	43.0	24.7	10.5	37.7
Mean			2.0	5.0	19.7	38.5	52.6	61.5	67.6	65.1	55.0	42.3	23.1	9.2	36.7

(1) Normal means for 1931 to 1960 where available, otherwise means are those published for 1955, the latest published normals for those stations.

Table 3 - Mean monthly precipitation, inches

Station	Period of record From	To	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Canada															
Swan Lake	1885	1929	0.72	0.61	0.88	1.34	2.16	3.20	2.77	2.17	1.92	1.09	0.79	0.71	18.36
Cartwright	1883	1914	0.71	0.63	1.07	1.62	2.04	3.19	2.63	2.35	1.72	1.32	0.87	0.70	18.65
Pilot Mound	1895	1962	0.85	0.89	1.11	1.48	2.01	3.16	2.77	2.59	1.49	1.22	0.97	0.92	19.46
Minette	1913	1962	0.89	0.81	1.09	1.25	2.20	3.34	2.35	2.59	1.64	1.09	1.00	0.85	19.10
Boissevain	1912	1962	0.97	0.73	1.10	1.12	2.30	3.43	2.36	2.88	1.45	0.96	0.95	0.78	19.03
Mean			0.83	0.73	1.05	1.36	2.14	3.26	2.58	2.52	1.64	1.14	0.92	0.79	18.96
United States(1)															
Pembina	1931	1960	0.53	0.43	0.67	1.18	1.98	2.95	3.10	2.86	2.27	1.24	0.75	0.42	18.38
Hannah	1931	1960	0.51	0.42	0.73	0.99	2.03	3.52	2.73	2.94	1.79	1.08	0.75	0.43	17.92
Langdon	1931	1960	0.76	0.55	0.90	1.20	1.97	3.07	2.65	2.84	1.92	1.21	0.84	0.57	18.48
Hansboro	1931	1960	0.39	0.24	0.60	0.85	1.82	3.44	2.52	2.68	1.32	0.87	0.54	0.34	15.61
Cavalier			0.67	0.51	0.76	1.39	2.26	3.08	2.64	2.51	2.32	1.29	0.74	0.69	18.86
Mean			0.57	0.43	0.73	1.12	2.01	3.21	2.73	2.77	1.93	1.14	0.72	0.49	17.85

(1) Normal means for 1931 to 1960 where available, otherwise means are those published for 1955, the latest published normals for those stations.

2.004 Notable Storms - The most intense storm recorded near the Pembina River basin occurred at Beaulieu, Minnesota, approximately 130 miles southeast of Pembina on 18-23 July 1909 when 10.5 inches fell in 6 hours. A very large storm over the entire basin occurred in May 1933 when an average of 3.7 inches of rainfall occurred in 3 days. Another large storm occurred 19-21 July 1897 with a total rainfall of over 5 inches on the Pembina River basin downstream from the international boundary near Walhalla. The maximum 24-hour amounts observed in the basin were 4.43 inches at Hamilton, North Dakota, and 3.47 inches at Langdon, North Dakota.

2.005 Evaporation - No recorded data on evaporation in the Pembina River basin are available for the period of record used in this study. However, estimates of evaporation have been made from records obtained in nearby watersheds from data accumulated during the past 30 years and from data contained in the Prairie Provinces Water Board Report No. 5, Evaporation from Lakes and Reservoirs on the Canadian Prairies. An evaporation station was established at Glenora in 1963.

2.006 The nearest evaporation records in the United States are pan evaporation observations at Devils Lake, North Dakota, for the months of April through September for the period 1951 to 1971. Starting in June 1971 the Devils Lake station was moved to Langdon, North Dakota. Earlier evaporation records are available for the months of April through September since April 1930 from both Mandan and Dickinson, North Dakota, although the data for the years before 1939 have not been published. Mean monthly or annual evaporation amounts are shown on maps of the United States in various publications. The average annual gross water surface evaporation in the Pembina River basin has been estimated at 28.5 inches. As noted above, the mean annual precipitation is 18 inches, therefore, the average annual net evaporation amounts to 10.5 inches. For the site of the proposed Pembilier Lake, the average lake evaporation has been estimated at 28.35 inches (Table 4). Evaporation is very small in winter months with a minimum mean monthly rate of 0.15 inch in January. The greatest evaporation occurs during the summer months with a maximum mean monthly rate of 5.33 inches in July. Total evaporation for the 6 months of April through September was estimated at 23.9 inches at the Pembilier site. Monthly evaporation exceeds precipitation during the 7 months of April through October.

Table 4 - Mean monthly and annual evaporation data* at the proposed Pembilier site (inches)

Month	Mean precipitation	Mean gross evaporation	Mean net evaporation
January	0.63	0.15	-0.48
February	0.54	0.20	-0.34
March	0.90	0.60	-0.30
April	1.38	2.54	1.16
May	2.03	3.93	1.90
June	3.09	4.19	1.10
July	2.76	5.33	2.57
August	2.78	4.73	1.95
September	2.30	3.18	0.88
October	1.36	2.60	1.24
November	1.05	0.70	-0.35
December	0.55	0.20	-0.35
Total	19.37	28.35	8.98

*Determined by the Bureau of Reclamation, U.S. Dept. of the Interior.

PHYSIOGRAPHY

2.007 General - The Pembina River basin lies in the south-central portion of the Province of Manitoba in Canada and in the northeastern part of the State of North Dakota in the United States. Its outlet and eastern boundary is the Red River of the North while its western extremity lies in the Turtle Mountain area near the International Boundary. The basin length (east and west) is about 130 miles and its width (north and south) varies from a maximum of about 50 miles in the central portion to about 18 miles in the eastern portion.

2.008 The basin is located entirely within the Central Lowland province of the Interior Plains physiographic division and includes portions of two conspicuously different physiographic districts. They are the Red River Valley and Drift Prairie (Figure 1). The Pembina Delta, a major feature within the Red River Valley, is also discussed as a separate section because of its importance in the river basin.

2.009 Red River Valley - The eastern 32 to 38 miles of the Pembina basin lie in the Red River Valley, the lowest section in the basin. It is not a true river valley but is the nearly level bottom of a lake that once covered the area. The lake, Lake Agassiz, was formed by the presence of an ice barrier to the north which obstructed the flow of the Red River during the last glacial recession from the area. The area is a featureless plain that rises gently from an elevation of 790 at the city of Pembina to elevation 1000 at the base of the Pembina Delta. The

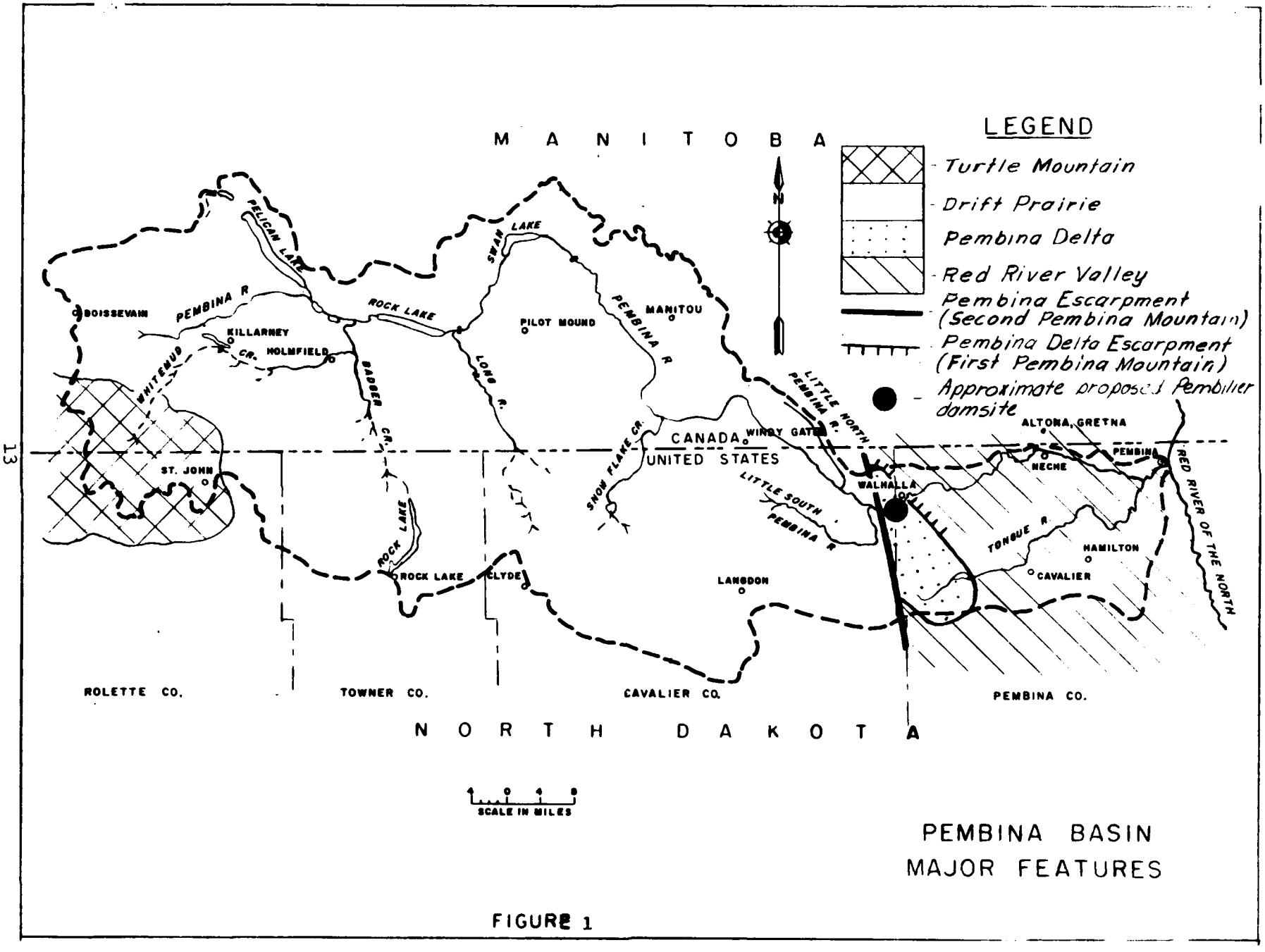

MANITOBA
LEGEND
Turtle Mountain
Drift Prairie
Pembina Delta
Red River Valley
Pembina Escarpment
(Second Pembina Mountain)
Pembina Delta Escarpment
(First Pembina Mountain)
Approximate proposed Pembilier damsite
N
PELICAN LAKE
SWAN LAKE
BOISSEVAIN
PEMBINA R
ROCK LAKE
PILOT MOUND
MANITOU
KILLARNEY
CR.
HOLMFIELD
WHITEMUD
BADGER CR.
LONE R.
PEMBINA R
LITTLE NORTH PEMBINA R.
ALTONA, GRETNA
CANADA
WINDY GATE
UNITED STATES
SNOW FLAKE CR.
PEMBINA
NECHE
ST. JOHN
WALHALLA
LITTLE SOUTH PEMBINA R
RED RIVER OF THE NORTH
TONGUE R
HAMILTON
CAVALIER
ROCK LAKE
ROCK LAKE
CLYDE
LANGDON
ROLETTE CO.
TOWNER CO.
CAVALIER CO.
PEMBINA CO.
NORTH DAKOTA
SCALE IN MILES
PEMBINA BASIN
MAJOR FEATURES

FIGURE 1

flat surface of the plain is broken only by drainages and several low, sandy ridges which have a general northwest-southeast trend. These ridges mark the shoreline of Lake Agassiz as it receded to the present level of the Red River. The area is poorly drained by the Pembina and Tongue Rivers that flow in sinuous channels across the plain in meander belts 3/4 mile wide that are marked by small sloughs and meander cutoffs.

2.010 Pembina Delta - The Pembina Delta was formed in late Pleistocene time by deposition of material carried by the debris-laden Pembina River as it flowed into Lake Agassiz. The river, at that time, was swollen with water from the melting ice fields to the north and served as an outlet for glacial lakes in the basins of the Souris and Saskatchewan Rivers. The Pembina Delta is now a sandy plain that extends westward from the Red River Valley to the Pembina Escarpment, a conspicuous regional bluffline that was the western shoreline of Lake Agassiz during its highest level. The delta covers an area of approximately 80 square miles, extends 16 miles in a north-south direction and is 2 to 9 miles wide. The delta surface slopes to the east and southeast from a high elevation of approximately 1275 near the Pembina Escarpment to 1150 near Walhalla where it drops abruptly to the plain of the Red River Valley. A steep, wooded escarpment, 100 to 150 feet high, marks the junction of the delta with the Red River Valley in the vicinity of Walhalla. East of Walhalla the delta grades gently into the Red River Valley. The escarpment at Walhalla is often called the "First Pembina Mountain", while the Pembina Escarpment is referred to as the "Second Pembina Mountain". The Pembina River flows through a valley 1/2 to 1 mile wide and has cut approximately 200 feet below the delta surface.

2.011 Drift Prairie - That portion of the Pembina River basin in Canada and west of the Pembina Escarpment in the United States lies entirely within the Drift Prairie. With the exception of the Turtle Mountain, an elevated tableland located in the extreme western portion of the basin, the Drift Prairie is an undulating, poorly drained surface which slopes from elevation 1800 at the base of Turtle Mountain to elevation 1500 at the crest of the Pembina Escarpment, 80 miles to the east. The surface is dotted with morainic hills, ridges, and undrained depressions occupied by lakes, sloughs or alkali swamps.

2.012 The Pembina River Valley within the Drift Prairie of the United States varies from 1 to 2 miles in width and is characterized by steep, wooded valley walls that rise 200 to 400 feet above the river channel and are marked by occasional unstable areas. The valley is shallower in Canada and is characterized by conspicuous erosional terraces and natural lakes formed behind debris fans at the mouths of tributaries.

2.013 The Little South Pembina River, roughly parallels the course of the Pembina River to the Pembina Escarpment at a distance of about 4 to 6 miles south of the Pembina River. As the Little South Pembina River flows out of the Drift Prairie, it turns sharply to the north and follows

the base of the Pembina Escarpment to its junction with the Pembina River. The Little North Pembina River joins the Pembina River from the northwest about 3 miles upstream from the mouth of the Little South Pembina River.

GEOLOGY

2.014 Deposits of the Red River Valley is underlain by a unit of lacustrine silt and soft clay reported to be 90 feet thick north of Walhalla, 185 feet thick at Neche and 174 feet thick at Pembina. The lacustrine materials are underlain by glacial sediments that rest on bedrock. The bedrock surface under the plain lies at a depth of 200 to 350 feet. Bedrock consists of sedimentary beds of the Ordovician, Jurassic, and Cretaceous Systems. Precambrian igneous rocks underlie the sedimentary beds.

2.015 Deltaic deposits of sand and gravel up to 130 feet thick underlie the Pembina Delta. The thickest deltaic deposits are near the eastern perimeter of the delta. These sediments are underlain by glacial drift which rests on bedrock. The bedrock surface rises from east to west, and the deltaic and glacial sediments thin rapidly to the west. Shale of the Cretaceous Carlile Formation outcrops in the Pembina River Valley near the Cavalier-Pembina County Line and is considered a unique geologic feature as it constitutes the oldest bedrock exposed at the surface in North Dakota. A short distance upstream from the county line, Cretaceous shales of the Niobrara and Pierre Formations are exposed in the river valley walls.

2.016 The Drift Prairie is mantled by a few to 100 feet of clayey glacial till which is underlain by shale of the Pierre Formation. The Pierre and Niobrara Formations are well exposed in the Pembina Escarpment and in the valleys of the Little North and South Pembina Rivers as well as the Pembina River Valley. The bedrock dips gently to the southwest.

2.017 The northeast portion of the Turtle Mountain, an erosional outlier of the Missouri Plateau, lies within the Pembina River basin. The mountain forms a rough, moraine-covered tableland that stands 400 feet above the surrounding Drift Prairie. Tertiary shales and sandstones and Cretaceous sandstones underlie the mantle of glacial debris.

2.018 Economic Mineral Deposits - Production from mineral deposits in the Pembina River basin is currently restricted to sand and gravel. A significant portion of the mineral production in Cavalier and Pembina Counties is in the Pembina basin where sand and gravel are produced from beach ridges and deposits of the Pembina Delta. Production of sand and gravel in Towner and Rolette Counties is from glacial deposits. The Pembina basin contributes only a small portion of the total produced in these counties. Sand and gravel produced throughout the basin is used extensively for fill material and road surfacing, but a high shale content renders much the material of limited value for concrete aggregate.

2.019 The Niobrara Formation outcrops extensively in the Pembina River and tributary valleys within the Drift Prairie. The formation has been investigated as a source of material for cement, but its use, at present, is not economically feasible. The Ordovician Red River Formation, buried at a depth of about 500 feet in northern Pembina County, may have some potential as a source of material for cement.

2.020 The lower portion of the Pierre Formation contains numerous thin beds of Fullers earth which may some day be of commercial value. The shales of the Carlile Formation were used in the manufacture of brick at the old Mayo Brick Plant, located on the Pembina River a few miles west of Walhalla; however, no recent or planned production of brick in the basin is known.

2.021 Exploration for petroleum has yielded no evidence of a petroleum resource in the United States' portion of the basin.

2.022 Groundwater - A comprehensive joint study of the groundwater resources of Pembina and Cavalier Counties has been made by the North Dakota State Water Commission, the United States Geological Survey and the North Dakota State Geological Survey. The results of this study are scheduled to be published in the near future. The following summary of groundwater conditions is based on communication with the investigators.

2.023 Groundwater is available throughout nearly all of the basin in quantities sufficient for domestic and farm use. Aquifers capable of supplying large, sustained yields are rare, however. In the Red River Valley, shallow wells can be developed for limited use in a surficial bed of clay and silt. Deeply buried bedrock units supply water under artesian pressure, but the water is too saline for most uses. The deposits of the Pembina River from about 2 miles southwest of Walhalla to 10 miles downstream form the best known aquifer in the area. The material consists of 20 to 25 feet of silty sand and gravel capable of yielding up to 300 gallons per minute. This aquifer supplies water of good quality for the city of Walhalla. A surficial aquifer exists at the western edge of the Red River Valley in the form of a narrow bed of sand formed along the shoreline of glacial Lake Agassiz east of the Pembina Delta. The aquifer trends from the Tongue River toward Walhalla.

2.024 Although the Pembina Delta consists of sand and gravel deposits up to 130 feet thick, they are essentially dry or have little saturated thickness and are capable of producing only limited quantities of water.

2.025 Wells in the Drift Prairie are developed primarily in the upper portion of the Pierre Formation where water is stored in and transmitted through fractures in the shale. Below this upper fractured zone, the Pierre and underlying bedrock units produce little or no water. Wells are also developed in sand beds in the superficial mantle of glacial drift.

2.026 Due to a low population and industrial density in the basin, groundwater pollution has generally not been a problem. The majority of the aquifers are shallow and recharged by direct infiltration of local precipitation.

2.027 Soil - No detailed soil survey has been made of the project area. Most of the project land would lie either on the floodplain or steep valley slopes. The soil types in these areas can be generalized as well drained, shaly alluvial soils on the valley slopes with moderately drained, medium and fine textured soils on the floodplain. The vegetation resources in the area are described in paragraphs 2.054 - 2.075.

2.028 Unique Geologic Features - The Pembina River basin is comprised of major land forms such as the Pembina Delta that may be considered unique on a continental basis. The size of the land forms is so great that their classification as unique on a basin-wide scale is questionable. However, the exposure of the Carlile shale in the Pembina River Valley, the oldest bedrock exposed in the State, makes the valley unique in this respect. Numerous small land forms such as beach ridges, sand dunes, eskers and various types of moraines exist within major physiographic sections but none is known to have regional acceptance as unique or unusual.

2.029 - Problem Elements - Problems relating to the natural geology of the Pembina River basin are not great. Unstable riverbanks along the Pembina and Tongue Rivers on the plain of the Red River Valley are common. Bank failures in the form of small slump blocks are numerous but are little more than a nuisance except where cultivated fields or structures encroach on the rivers. Conspicuous unstable shale slopes are present along the valley walls of the Pembina River and its tributaries within the Drift Prairie. The most impressive unstable areas occur in the lower part of the Pierre Formation where large masses of shale are actively, but slowly, slumping. The unstable shale areas are not presently a problem, however, due to the limited use of the area.

2.030 Problems relating to the geology of the area that involve the alteration of natural conditions by the works of man, on the other hand, can be severe. The thick deposit of silts and soft clays present throughout the Red River Valley are notoriously unstable in excavations or as foundations for earth fills, bridges, or large structures. The clay shales underlying the Drift Praire and exposed in the Pembina Escarpment and river valleys are well known for their undesirable engineering properties.

2.031 Geology of the Proposed Pembilier Damsite - The site of the proposed Pembilier Dam is within the Pembina Delta on or near the Pembina-Cavalier County Line. The highland bordering the river in this area is the smooth, gently-sloping surface of the delta. The valley of the Pembina River is cut approximately 200 feet below the delta surface.

2.032 The general stratigraphic distribution of material at the damsite is 20 to 30 feet of recent river deposits of clay, sand and gravel on top of Cretaceous Carlile shale under the floodplain and 60 to 100 feet of deltaic sand and gravel resting on 40 to 60 feet of glacial sediments in the dam abutment area. The glacial sediments are underlain by shale of the Carlile Formation.

2.033 Mass movement is prominent in the form of slumping in the downstream area of the south dam abutment and downstream a short distance from the north abutment. The proposed reservoir would be confined to the lower portion of the river valley. Steep valley walls cut in the Carlile shale would contain the reservoir throughout most of the valley.

SURFACE WATERS

2.034 Drainage Areas - The total gross drainage area of the Pembina River above its confluence with the Red River of the North is 3,950 square miles. Of this total area, 1,989 square miles, or slightly over 50 percent, are in Canada, while the remaining 1,961 square miles are in the United States. It has been recognized for many years that prairie watersheds are characterized by large areas of depressional storage which may or may not contribute to streamflow depending on preceding precipitation. Shallow depressions are usually dry and the water surface in deeper depressions may be several feet below their outlet level. To include such areas as a portion of the basin contributing to streamflow, except in the very wettest of years, is not considered appropriate.

2.035 To assist in the determination of runoff and in the analysis of hydrometric (water measurement) records, the drainage basin above the Pembilier site, has been separated into contributing and noncontributing areas. The noncontributing drainage area has been defined as that portion of the drainage basin that would contribute to streamflows no more than once in 10 years on an average. The contributing drainage area comprises the remainder of the gross drainage area (exhibit 2 and table 5). The noncontributing area within the total watershed of 3,335 square miles tributary to the Pembilier damsite amounts to 620 square miles or 18.6 percent. Of this 620 square miles, 230 square miles are located in North Dakota and 390 square miles are located in Manitoba. The total contributing area to the Pembilier damsite is 2,715 square miles of which 1,117 square miles, or 41.2, are in North Dakota and the remaining 1,598 square miles, or 58.8 percent, are in Manitoba.

2.036 Lakes, Streams, and Reservoirs - The Pembina River has its source in the Turtle Mountain about 10 miles south of Boissevain, at about elevation 2000. Its total length is about 310 miles. Six lakes and/or reservoirs, all of which are in Canada, are located along the entire length of the Pembina River Valley: Bone, Pelican, Lorne, Louise, Rock, and Swan, all of which are shallow river impoundments and are susceptible

Table 5 - Subbasin drainage areas above Pembilier damsite

Subbasin name	Basin divisions: Percent		Basin divisions: Square miles		Country divisions: North Dakota		Country divisions: Manitoba		Gross drainage areas		
	Contributing	Non-contributing	Contributing	Non-contributing	Contributing	Non-contributing	Contributing	Non-contributing	North Dakota	Manitoba	Total
Pelican Lake	60.6	39.4	161.2	104.7	-	-	161.2	104.7	-	265.9	265.9
Upper Pembina River	66.4	33.6	135.7	68.7	-	-	135.7	68.7	-	204.4	204.4
Whitemud Creek	72.9	27.1	167.7	62.4	13.6	33.2	154.1	29.2	46.8	183.3	230.1
Badger Creek	88.9	11.1	535.3	66.7	360.2	48.3	175.1	18.4	408.5	193.5	602.0
Intermediate area E	77.9	22.1	141.9	40.3	-	-	141.9	40.3	-	182.2	182.2
Long River	75.0	25.0	219.4	73.1	103.5	50.9	115.9	22.2	154.4	138.1	292.5
Crystal Creek	80.3	19.7	62.0	15.2	-	1.8	62.0	13.4	1.8	75.4	77.2
gage at Pilot Mound	76.8	23.2	1,423.2	431.1	477.3	134.2	945.9	296.9	611.5	1,242.8	1,854.3
Intermediate area D	84.1	15.9	187.0	35.4	-	-	187.0	35.4	-	222.4	222.4
gage at Swan Lake	77.5	22.5	1,610.2	466.5	477.3	134.2	1,132.9	332.3	611.5	1,465.2	2,076.7
Intermediate area C	93.6	6.4	140.1	9.6	-	-	140.1	9.6	-	149.7	149.7
Manitou Dam	100.0	0	28.1	-	-	-	28.1	-	-	28.1	28.1
to La Riviere	78.9	21.1	1,778.4	476.1	477.3	134.2	1,301.1	341.9	611.5	1,643.0	2,254.5
Intermediate area B	93.7	6.3	46.5	3.1	-	-	46.5	3.1	-	49.6	49.6
gage at Manitou	79.2	20.8	1,824.9	479.2	477.3	134.2	1,347.6	345.0	611.5	1,692.6	2,304.1
Intermediate area A	84.9	15.1	66.0	11.7	-	-	66.0	11.7	-	77.7	77.7
Snowflake Creek	76.3	23.7	283.7	88.1	271.1	68.6	12.6	19.5	339.7	32.1	371.8
Mowbray Creek	83.7	16.3	97.5	19.0	86.4	14.6	11.1	4.4	101.0	15.5	116.5
gage at Kaleida	79.2	20.8	2,272.1	598.0	834.8	217.4	1,437.3	380.6	1,052.2	1,817.9	2,870.1
Intermediate area F	93.1	6.9	24.3	1.8	4.1	-	20.2	1.8	4.1	22.0	26.1
to Pembina Dam	79.3	20.7	2,296.4	599.8	838.9	217.4	1,457.5	382.4	1,056.3	1,839.9	2,896.2
Intermediate area G	96.5	3.5	116.4	4.2	8.0	-	108.4	4.2	8.0	112.6	120.6
gage at Windygates	80.0	20.0	2,412.8	604.0	846.9	217.4	1,565.9	386.6	1,064.3	1,952.5	3,016.8
Intermediate area H	95.5	4.5	19.0	0.9	10.1	-	8.9	0.9	10.1	9.8	19.9
to border	80.1	19.9	2,431.8	604.9	857.0	217.4	1,574.8	387.5	1,074.4	1,962.3	3,036.7
Intermediate area J	93.9	6.1	109.9	7.1	86.3	4.0	23.6	3.1	90.3	26.7	117.0
Little Pembina River	95.6	4.4	173.6	8.2	173.6	8.2	-	-	181.8	-	181.8
to Pembilier Dam	81.4	18.6	2,715.3	620.2	1,116.9	229.6	1,598.4	390.6	1,346.5	1,989.0	3,335.5

to "winter kill" conditions. Other lakes in the Canadian portion or the basin include Killarney, George, Charlton, William, Freddie, and Waldemar, plus a few unnamed lakes in the Turtle Mountain area. Lakes within the United States portion of the basin include Carpenter and Oak near St. John, Rock near the community of Rock Lake, and Rush near Hannah, North Dakota.

2.037 The principal tributary to the Pembina River lying wholly within North Dakota is the Tongue River. It flows east and northeast to its confluence with the Pembina River at a point 9 river miles upstream from the Red River of the North. The Tongue River, which drains an area of about 479 square miles, is approximately 100 miles long and has an average slope of 7.3 feet per mile. Several small low-head dams have been constructed on the Tongue River and one larger dam which created Renwick Reservoir at Icelandic State Park. Other major tributaries include the Little South Pembina River, which drains approximately 182 square miles wholly within the United States; Long River, with a drainage area of 293 square miles which flows northward through both countries; and Badger Creek, which also flows northward through both countries, draining 832 square miles (including the Whitemud Creek basin). Relatively minor tributaries include the Little North Pembina River and Mowbray, Snowflake, Mary Jane, Pilot, and Crystal Creeks.

STREAMFLOW AND LAKE STAGE DATA

2.038 General - Twenty-six stream-gaging stations and four lake-stage stations are presently in operation in the Pembina River basin. The Environment Canada and the U.S. Geological Survey, with the assistance of other agencies, maintain and operate the stream-gaging program in the two countries.

2.039 Streamflow records on the Pembina River are available for the International gaging station at Neche, North Dakota, from May 1903 to September 1915 and from April 1919 to date; and at Walhalla from October 1939 to date. Streamflow records are available for the Pembina River near Manitou, Manitoba, from 1921 to 1957 for open water periods only. Gaging stations on the tributaries in Manitoba, with the exception of Whitemud Creek west of Holmfield, Manitoba, were not established until 1959. During March and April 1962, 11 gaging stations were established in the Pembina River basin in Manitoba. A summary of pertinent streamflow and lake-stage records is shown in table 6.

2.040 Runoff Characteristics - A review of the streamflow records indicates that the average annual runoff of the Pembina River near Manitou for the 37-year period, 1921 to 1957, was 73,050 acre-feet, which is equivalent to a depth of 0.75 inch on the total contributing drainage area of 1,825 square miles. The average annual runoff of the Pembina River near Walhalla for the 30 years of record, 1940-1969, is 205 cfs (cubic feet per second) or 148,400 acre-feet, which is equivalent to

Table 6 - Stream flow records, lake levels and characteristics, Canadian and United States gaging stations[1]

Stream, lake or reservoir	Location	Drainage area (sq mi)	Lake zero elevation (above msl)	Period of record From	To	Maximum flow data: Date of instantaneous peak	Discharge (cfs): Instantaneous	Mean daily	Maximum gage height (ft)	Minimum flow data: Date of mean daily	Mean daily discharge (cfs)	Average discharge (cfs)	Maximum lake levels: Date of maximum stage	Maximum elevation or stage (1928 adj)[2]	Minimum lake levels: Date of minimum stage	Minimum elevation or stage (1928 adj)[2]
Pembina River	Near Killarney, Man.	114	1567.40	Mar to Oct 1967[3]		Date	10 June 50	870	572							
Pelican Lake	At Ninette, Man.		1900.30[2]	May 1954[4]		Do				Various times	0	15.8	30 May 60 to 4 June 60	1352.59	24 May 1954	1348.65
Pembina River	Above Lorne Lake, Man.	4		Apr 19[illegible]		Do	10 June 50	1,080	900							
Baiger Creek	Near Cartwright, Man.	575		Mar & Oct 19[illegible]		Do	7 Apr 60		1,660		Do	0				
Hidden Island Coulee	Near Hamsboro, N. Dak.[5]	98		Oct 196[illegible]		Do	10 Apr 59	700	600	8.80	Do	0				
Whitemud Creek	West of Holmfield, Man.	91.6		Mar to Oct 19[illegible]		Do	10 Apr [illegible]		72.9		Do	0	2.38			
Whitemud Creek	East of Holmfield, Man.	102		Mar to Oct 196[illegible]		Do	7 Apr [illegible]		558		Do	0				
Wakopa Creek	Near Manitou, Man.	54.7		Mar 19[illegible]		Do	17 Apr [illegible]		138		Do	0	19.4			
Rock Lake	Near Glenora, Man.		1800.00[2]	Jan 1949		Do										
Long River	Near Sarles, N. Dak.[5]	66		19 May 1961		Do	12 Apr 69	1,130	1,100	7.90	Do	0	5.50	15 Apr 60 to 16 Apr 60	1336.80	10 Sep 1958	1326.15
Long River	Near Clearwater, Man.	197	1475.00	Mar to Oct 1954[3]		Do	8 Apr 60		900		Do	0				
Crystal Creek	Near Crystal City, Man.	96.5		Mar to Oct 1919[3]		Do	17 Apr 62	1,120	544		Do	0				
Pembina River	Below Rock Lake, Man.	1,850		Mar 1962		Do	31 Mar 66		814		Do	0	71.8			
Swan Lake	Near Swan Lake, Man.			Apr 1962		Do								18 Sep 68	5.56	1 Apr 62 to 5 Apr 62	0.50
Pembina River	Near Swan Lake, Man.	2,080		Apr 1963		Do	18 May 65		677		Do	0				
Pembina River	At La Riviere, Man.	2,256		Apr 1963		Do	21 Apr 67		751		Do	0				
Mary Jane Reservoir	Near La Riviere, Man.	19	1533.00	May 1960		Do								20 Apr 67	1539.60	5 Feb 1962	1534.45
Mary Jane Creek	At La Riviere, Man.	93.1		Mar to Oct 1960[3]		Do	12 Apr 60		489		Do	0				
Pembina River	Near Manitou, Man.	2,304	1245.00[2]	Oct 1921[6]	Sep 1957	Date	17 Apr 49		5,030		Do	0	100[7]			
Snowflake Creek	Near Snowflake, Man.[5]	348	1222.63[2]	Mar 1961		Date	11 Apr 69		653	7.39	Do	0	9.9			
Mowbray Creek	Near Mobray, Man.	93.9		Mar 1962		Do	24 Apr 67		392	7.88[8]	Do	0	9.3			
Pembina River	Near Kaleida, Man.	2,870	1188.45[2]	Oct 1957		Do	19 Apr 69	10,300	9,400	13.82	Do	0	149			
Pembina River	Near Windygates, Man.[5]	3,020	1102.2 [9]	Apr 1962		Do	19 Apr 69	8,[illegible]70	8,060	17.29	Do	0	165			
Little Pembina River	Near Walhalla, N. Dak.	132	1099.48[10]	Apr 1956		Do	25 Apr 70	6,600	2,390	13.95	Do	0	18.6			
Pembina River	Near Walhalla, N. Dak.	3,330	966.91[10]	Oct 1939		Do	18 Apr 50	20,400	13,800	19.2	Do	0	205			
Pembina River	Near Neche, N. Dak.[5]	3,410	809.69[10]	May 1903[11]		Do	20 Apr 50	10,700	7,700	21.58[11]	Do	0	169			
Tongue River	At Akra, N. Dak.	162	920.90[10]	Oct 1951[12]		Do	18 Apr 50	11,800	5,240	48.7	Do	0	20.7			
Herzog Creek	Near Concrete, N. Dak.	18.9	1108.95[10]	June 1954		Do	2 Apr 55	260	110	9.74[13]	Do	0	2.97			
Tongue River	Cavalier, N. Dak.	153	880.96[10]	Oct 1938	Oct 1951	8	May 50	1,340[14]	1,240	4.58	Do	0	21.3			
Tongue River	Near Pembina, N. Dak.	460	777.30[10]	Oct 1939	Sep 1942	7	Apr 42	1,450	1,400	15.70[15]	Do	0	31.1			

(1) From records up to September 1969 for U.S. Geological Survey and international gaging stations and up to about October 1968 for Canadian gaging stations.
(2) Mean sea level datum, Geological Survey of Canada (1928 adj).
(3) Records available only for period March to October for each year.
(4) Period of record for mainly open water.
(5) International gaging station.
(6) Periods of record for open water 1921 to September 1957 (discontinued).
(7) Average discharge value obtained by correlation of gaging station records for Pembina River at Neche 1921-1939 and for Walhalla 1940-1957 to obtain complete record at Manitou for period 1921-1957.
(8) 29 March 1966, backwater from ice.
(9) Mean sea level datum, Geological Survey of Canada, publication No. 21, 1953 edition.
(10) Mean sea level datum, U.S. Geological Survey (1929 adj).
(11) Period of record - May 1903 to September 1908, June 1909 to September 1915, April 1919 to September 1971. Higher stage on 12 April 1971 (22.22).
(12) Records from April to June 1950 in U.S. Geological Survey Water Supply Paper 1147-B.
(13) Maximum gage height affected by backwater from ice.
(14) Maximum discharge does not include bypass flow. Maximum discharge including bypass flow, 11,800 cfs, 18 April 1950, on basis of contracted opening determination of peak flow at site about 5 miles upstream.
(15) Affected by backwater from Pembina River

1.02 inches on the total contributing drainage area of 2,711 square miles. Usually about 80 percent of this runoff takes place in the months of April, May, and June. The maximum annual runoff at Walhalla during the 1940-1969 period occurred in 1950 and amounted to 461,100 acre-feet. The lowest annual runoff during this same period was 7,100 acre-feet; however, based on records at Neche, the estimated lowest annual runoff for the Pembina River at Walhalla was 2,160 acre-feet in 1939. At Neche, the average annual runoff for 61 years of record, 1903-1908, 1909-1915, 1919-1969, for the Pembina River is 169 cfs or 122,400 acre-feet, which is equivalent to 0.82 inch on the approximate total contributing drainage area of 2,795 square miles. The above variation in the annual runoff is due primarily to use of different periods and to the fact that some high flows are diverted into other basins, as in the reach between Walhalla and Neche. Pertinent data on the floods of record for the Pembina River near Walhalla are given in tables 7 and 8.

2.041 Flood Characteristics - Generally, the topography of the Pembina River watershed is not conducive to the production of high long-term flood flows. The large percentage of the area that is poorly drained, in addition to the areas which have no drainage, reduces the magnitude of the flood flows below that which might normally be expected from a drainage area of this size. However, the steep valley slopes in some parts of the basin along the Pembina River and its tributaries produce a rapid runoff.

2.042 Nearly all the floods in the Pembina River have occurred during the spring season. The floods are usually the result of rapid melting of snow, sometimes accompanied by rainfall, or from heavy spring rains following snowmelt when conditions are favorable for high runoff. Prior to spring breakup, average snow depths of 1 to 2 1/2 feet are common with snow accumulating in valleys and coulees to greater depths. Factors affecting the size of spring floods include the amount of snow on the grounds, the depth of frost in the ground, temperatures during breakup, and spring rains. Spring rains have prolonged some of the snowmelt floods or caused subsequent floods after snowmelt runoff. Summer storms do not often occur over large areas of the basin, and floods are rare in the summer season, although small rises in streamflow occur occasionally. No known floods have occurred in the fall or winter seasons. The lakes in the upper valley tend to retard the runoff from the area above their outlets so that the flood peaks downstream are somewhat modified.

2.043 Floods of Record - The largest flood of record on the Pembina River occurred in April 1950. The flood resulted from the rapid melting of a very heavy snow cover concentrated generally downstream from Manitou. Peak discharges observed were 2,660 cfs on 17 April near Manitou, 20,400 cfs on 18 April at Walhalla, and 10,7000 cfs on 20 April at Neche. Following a recession, additional snowmelt and spring rains caused the second highest peak discharge of record at Walhalla with peak flows of

TABLE 7

Data for floods of record on the Pembina River near Walhalla, N. Dak., 1940-1971

Date of peak	Instantaneous peak stage (feet)	Maximum discharge (cfs)		Duration (days) above 2,000 cfs	Volume (inches) depth on drainage area(1)
		Instantaneous	Mean daily		
18 Apr 50	19.20	20,400	13,800	8	0.681
27 Apr 74	15.19	13,800	13,300	59(9)	
9-10 May 50	17.23	11,000	7,590	21	1.067
11 Apr 71	14.56	10,200	9,320	30	1.372
26 Apr 70	15.08	10,200	7,810	34(2)	1.382
21 May 74	13.38	9,030	7,860	59(9)	
20 Apr 69	14.58	8,440	8,100	30	1.785
19 Apr 48	14.94	7,280	4,340	7(3)	0.260
25 Apr 56	12.89	5,990	5,080	11(4)	0.511
19 Apr 49	13.18	5,840	5,740	26	1.234
12 Apr 60	12.50	5,690	4,360	22	0.795
19 Apr 62	11.74	5,110	3,730	4	0.176
5 Apr 42	12.45(5)	5,000	4,200	11(6)	0.416
11 Apr 65	12.68	4,960	4,050	4	0.159
31 Mar 66	14.82(5)	4,700	4,420	5	0.226
11 Jun 70	9.79	4,600	3,340	3	0.111
21 Apr 67	12.10	4,530	4,170	3	0.123
6 May 67	11.60	4,180	2,800	2	0.072
10 Apr 41	10.5(7)	3,840	3,200	7	0.243
8 May 56	9.92	3,770	3,420	18(4)	0.724
2 Apr 55	11.33(5)	3,400	2,800	7	0.231
16 May 70	8.24	3,100	2,790	16(8)	0.525
26 Mar 45	9.20	3,020	2,780	3	0.106
5 May 66	9.73	2,930	2,420	1	0.033
19 Mar 46	9.24(5)	2,900	2,700	7(7)	0.247

(1) Contributing drainage area = 2,715 square miles.
(2) Not consecutive 3 and 31 days.
(3) Not consecutive 4 and 3 days.
(4) Total consecutive duration days for 1956 were 29 days; 11 in April and 18 in May.
(5) Backwater from ice.
(6) Not consecutive 6 and 5 days.
(7) Estimated by Corps of Engineers.
(8) Volume for 16 days is also included with 34 days duration for highest peak for 1970.
(9) 59 Consecutive days included peaks of both 27 Apr and 21 May.

1,950 cfs on 9 May near Manitou, 11,000 cfs on 9 May at Walhalla, and 5,320 cfs on 12 May at Neche. The reduction in peak flows for large floods between Walhalla and Neche is due to overflow above Neche reaching other basins and to storage in that reach. Downstream on the Red River of the North at Emerson, there was little recession from the April peak when the May rise started. The highest discharge of record, 95,500 cfs occurred on 13 May 1950 while the greatest mean daily discharge was recorded on 14 May 1950 at 94,400 cfs (table 8). However, based on records at Winnipeg, historical floods in 1326, 1852 and 1861 on the Red River of the North reached greater discharges at Emerson than the 1950 flood on the Pembina River. The largest observed discharge of record near Manitou was 5,030 cfs on 17 April 1949. The largest discharge of record for the station established in October 1957 near Kaleida, Manitoba, was the instantaneous peak discharge of 10,200 cfs on April 1969 with a mean daily peak of 9,400 cfs. In addition to the extremely large flood of April and May 1950, large floods have also occurred in the Pembina River basin in April of each of the following years: 1942, 1948, 1949, 1956, 1960, 1962, 1965, 1966, 1967, 1969, 1970, 1971 and 1974. For large floods, the mean daily discharges observed at Neche were smaller than at Walhalla because of the natural breakout and storage between the two stations. The April 1969, 1970, 1971 and 1974 large peak flows were caused by rapid snowmelt of above-normal accumulation of snowfall accompanied by small amounts of rainfall during the snowmelt period.

TABLE 8

Mean daily peak flows at Pembina River gaging station (cfs)

Date	Pembina River near Manitou[1]	Little Pembina River near Walhalla	Pembina River near Walhalla	Pembina River at Neche	Pembina River near Kaleida
Apr 1948	1,190		4,340	3,600	
Apr 1949	5,030		5,740	4,910	
Apr 1950	2,660		13,800	7,700	
May 1950	1,950		7,590	5,170	
Apr 1956	1,440	2,080	5,080	4,800	
May 1956	2,480	408	3,420	3,070	
Apr 1960		2,150	4,360	3,800	2,620
Apr 1962		2,500	3,730	3,600	1,220
Apr 1965		1,590	4,050	3,400	1,240
Mar-Apr 1966		1,350	4,420	4,000	2,050
Apr 1967		1,320	4,170	2,840	1,430
Apr 1969		3,260	8,100	6,940	9,400
Apr 1970		2,390	7,810	6,350	(2)
Apr 1971		2,310	9,320	7,080	(2)
Apr 1974		(2)	13,300	9,950	(2)
May 1974		(2)	7,860	6,120	(2)

(1) Based on once a day gage reading.

(2) Data not available.

2.044 Floods in the lower Pembina River Basin inundate large areas. The river flows through a broad, flat floodplain, and stream banks are often higher than the surrounding floodplain. Once water has overtopped the banks and has left the channel, it often flows overland into the adjacent Tongue River to the south, or to the Aux Marais River in Manitoba.

WATER SUPPLY

2.045 Walhalla, North Dakota, the largest community on the Pembina River, obtains water from shallow wells while Neche and Pembina, North Dakota, use river water as a source of supply. Neche treats the largest quantity of water along the Pembina River, but about 80 percent of the treated water is furnished to the communities of Gretna and Altona in Manitoba. A summary of present water supply data is given in table 9. Present or alternative sources of water supply are expected to be adequate for Walhalla and Pembina under forseeable future conditions. However, Neche, Gretna and Altona are in need of a more dependable supply for present and future needs.

Table 9 - Present municipal water supply data

Town or village	1970 population	Present source of supply	Present average demand (gal/day)	Existing treatment plant capacity (gal/day)
Walhalla, ND	1,417	Wells	50,000	260,000
Neche, N.Dak.(1)	451	Pembina River	334,000(1)	710,000
Gretna, Man.	575			
Altona, Man.	2,026			
Pembina, N.Dak.	741	Pembina River	50,000	634,000

(1) Includes average demand for Gretna and Altona.

2.046 An investigation of possible supplemental or alternative water supplies (Feasibility Study, App. D) identified the following alternatives: (1) a multiple-purpose reservoir on the Pembina River, (2) off-channel storage at Neche, (3) a lowhead dam on the Red River of the North with a connecting pipeline to Neche, (4) a well field at the Fordville aquifer and a connecting pipeline to Neche, and (5) a well field at the Gardar aquifer and a connecting pipeline to Neche. Of the five alternatives, four could adequately supply the present and future needs (Gardar could not). Considering all water resource planning objectives, off-channel storage at Neche would provide the best single-purpose water supply alternative. Upstream reservoir storage, however, is the only water supply alternative which could be expanded to include other purposes commensurate with the other specific water and related land resources objectives of the area.

WATER QUALITY

2.047 Monthly and yearly flow weighted averages were determined for several water quality parameters using U.S. Geological Survey data for the years 1968-72 for the Pembina River near Walhalla, North Dakota (exhibit 3). In many cases, average monthly concentrations are based on less than a 30-day composite sample which may bias the results if the parameters are correlated with stream flow.

2.048 Nitrate concentrations (expressed an mg/1 N) exhibited wide monthly (00.0 to 7.00 mg/1 N) and yearly (0.96 to 3.70 mg/1 N) variations. Monthly averages for the entire period ranged from 0.00 mg/1 N in September to 1.92 mg/1 N in March. Nitrate concentrations appeared to exhibit some positive correlation with discharge with maximum concentrations occurring during spring runoff events. The average concentration for the entire period was 0.92 mg/1 N.

2.049 Dissolved phosphorous concentrations followed a pattern similar to that exhibited by nitrate concentrations. Individual average monthly concentrations ranged from 0.01 mg/1 to 3.90 mg/1 while the monthly averages for the 4-year period ranged from 0.06 mg/1 in early winter to 1.98 mg/1 in April. Average yearly concentrations for the period ranged from 0.15 to 2.90 mg/1. The average concentration for the entire period was 0.75 mg/1.

2.050 Alkalinity (as mg/1 bicarbonate) appeared to be inversely related to discharge with an average for the entire period of about 200 mg/1. Average concentrations of nitrogen, phosphorous, and bicarbonate indicate a nutrient potential capable of supporting a large aquatic plant biomass under the proper set of conditions. Calcium was the principal cation present in the water samples with an average concentration for the period of 54 mg/1. Sodium, magnesium, and potassium were less abundant with average concentrations for the period of 33, 18, and 8 mg/1, respectively.

2.051 The State of North Dakota has developed water use classifications, and associated water quality standards, for waters of the State in accordance with Federal regulations (Exhibit 16). The Pembina River is currently classified as a type I-A stream, i.e. it is supposed to be suitable for the propagation of native aquatic species under natural conditions and should also be suitable for total water contact recreation.

2.052 Examination of data contained in Exhibit 3 indicates that the established nitrate standards for the river (4.0 mg/1 as nitrate) are presently exceeded during spring runoff periods.1/ Phosphate standards (0.1 mg/1 as phosphorous)are presently exceeded during most of the year. Additional water quality data collected by the N. D. State Health Department at their sampling station near Walhalla indicates that phosphorus standards are exceeded about 48 percent of the time. For 27 samples during the period 7-20-71 to 9-10-73, the mean phosphate concentration was about 0.11 mg/1 measured as phosphorous and the concentrations ranged from 0.01 to 0.26 mg/1 as P.

1/ To obtain mg/1 of nitrate from the data in Exhibit 3, multiply the tabular values by 4.4.

2.053 Recommended limits for drinking water quality, for sulfates and total dissolved solids (TDS), as set by the U.S. Public Health Service, are 250 and 500 mg/l, respectively. At concentrations exceeding these values undesirable tastes may occur and cathartic effects may be experienced by some people. Only two average monthly sulfate concentrations exceeded the desirable limit during the 4-year period at Walhalla (exhibit 3), while 31 average monthly TDS concentrations exceeded the desirable limit, i.e. TDS exceeded the limits 65 percent of the time.

2.054 The International Joint Commission (IJC)(1974) in their report on the Pembina River basin stated that the dissolved oxygen (D.O.) and the biochemical oxygen demand (B.O.D.) (presumably these data were from Canadian monitoring stations) values indicated a poor quality environment for aquatic life since D.O. occasionally dropped to zero and B.O.D. was as high as 15 mg/l. However, except for high suspended solids, the mean concentrations of various substances did not exceed drinking water standards recommended by the U.S. Public Health Service. Analysis of sixty-two samples from the N.D. State Department of Health water quality station near Walhalla indicates, that for the period from 7-17-68 to 9-10-73, D.O. concentration in the river ranged from 4.8 to 14.3 mg/l, averaged 10.2 mg/l, and only dropped below the State standard of 85.0 mg/l on one occasion. B.O.D. values for the same period ranged from 0.6 to 12.2 mg/l and averaged 3.1 mg/l.

2.055 The average annual suspended sediment load of the river at Walhalla for the years 1968-72 was 667,000 tons/year and ranged from 269,000 to 983,000 tons/year. This is almost 3 times the long-term average sediment load for the period from 1939-69 of 226,000 tons/year. Average annual flow for the 1968-72 period was 490 cfs which was approximately 2.4 times greater than the average annual flow of 205 cfs for the period 1939-69.

2.056 Occasional heavy algae growths have occurred in the Pembina Valley lakes in Manitoba. Toxic algae blooms occurred in 1962 in Rock and Pelican Lakes which required posting use restrictions in order to prevent serious illness to recreationalists (Rock Lake Experimental Algae Control Program, 1972). The Province of Manitoba is continuing to monitor these lakes and to offer technical assistance in an attempt to control algae blooms.

VEGETATION RESOURCES

2.057 General - The Pembina River basin is the meeting ground for at least three major biomes or major natural plant communities: the Aspen Parkland (Coniferous Forest - Grassland Ecotone) from the north, the Tall Grass Prairie from the west and south, and the Oak Parkland (Deciduous Forest - Grassland Ecotone) and Eastern Deciduous Forest from the east. Trees are present in shelter-belts, other restricted areas, and along streams where they can obtain sufficient moisture and are not subject to clearing for agricultural purposes, and in the past, to prairie fires.

2.058 On moist sites in the upper reaches of the basin, the forest cover in heavily wooded areas is primarily a quaking aspen - paper birch type with mixtures of American elm, green ash, bur oak, and balsam poplar. On the upper slopes are patches of wolfberry, wild rose, and buffalo berry. In the more open sites there is a great variety of shrubs and herbaceous growth such as hazel, chokecherry, wild plum, dogwood, wild rose, and highbush cranberry.

2.059 The Pembina River Valley upstream from the proposed damsite is wide and deep and wooded up to the rim of the upland plain. An understory of native shrubs also exists. In proceeding upstream the valley banks become lower and the forested areas decrease.

2.060 In the eastern section, the steep banks of the Pembina River channel are generally wooded. The vegetation on the valley bottom is chiefly bur oak, quaking aspen, hazel, American elm, birch, cottonwood, basswood, box elder, maple, and saskatoon (also called Juneberry or serviceberry), similar in type, but more vigorous in growth than that of the slopes.

2.061 Although most of the original vegetation has been cleared or plowed on the basin's level and undulating land, a moderate proportion of the steeper river valley land, too sloping to till, supports vegetation relatively undisturbed by human use. The Pembina Escarpment region is one of the few remaining semi-wilderness areas in North Dakota. The rugged wood slopes and bottomlands have an aesthetic scenic beauty. The area contains some of the best ruffed grouse habitat in the State and is considered a high quality deer range which supports a large herd of deer.

2.062 The Canadian portion of the basin and a small percentage of the United States portion are on the southern edge of the Aspen Parkland's eastern limits. This ecosystem is transitional between the grasslands of the Great Plains and the Northern Coniferous Forest. It is typified by areas of poor drainage which support stands of aspen and some bur oak that are intermingled in a mosaic with grassland. In this area of little relief, few other trees grow but a heavy understory of shrub is found in most patches of forest, with usually a modest herbaceous layer.

2.063 The Pembina River Valley has four major natural ecosystems:

a. Bottomland Hardwood (Eastern Deciduous) Forest and nonforested floodplain communities.

b. Upland Mixed Hardwood (Eastern Deciduous) Forest on the moister slopes

c. Upland Oak Savanna Woodland (Oak Parkland) and other dry slope communities.

d. Tall-grass Prairie on relatively undisturbed upland and other fairly level areas.

2.064 Eastern Deciduous Forest Biome - Stands of the Eastern Deciduous Forest Biome reach up into the Pembina River Valley on the moist north-facing valley slopes and floodplain. Not all species found in Minnesota and other States to the east are found in North Dakota, and fewer still are found in the basin area in Manitoba. The bottomland (floodplain) hardwood forest is mainly box elder, American elm, and green ash, with some quaking aspen, basswood, paper birch, and bur oak and a few balsam poplar. Many cottonwood and some peachleaf willow grow on the river-banks. The poorly developed shrub layer is dominated by chokecherry, red osier dogwood, and wolfberry. Floodplain herb vegetation generally consists of species common to frequently disturbed habitats. Herb dominants are smooth bromegrass, woodnettle, and tall coneflower. Tree seedlings are also common. The moist slopes - those facing north and east - also support fairly dense deciduous forest, without the willow and cottonwood, and with an occasional bur oak. Brush understory is well-developed here, shading out many herbs. Abundant groundwater exists in the bottomland ecosystem. The soil is moist and firm.

2.065 Upland Mixed Hardwood Forest - On the moist slopes the fairly dense Upland Mixed Hardwood Forest is found. Its dominant trees are medium to tall basswood, aspen, green ash, and paper birch. The well-developed shrub layer is usually hazel and chokecherry. The poorly developed herb stratum is made up of wild sarsaparilla, wild ginger, poison ivy, sedges, etc.

2.066 Upland Oak Savanna Woodland - Due to the control of prairie fires in recent decades, the Upland Oak Savanna - a grassland dotted with scattered trees - has gradually succeeded to Oak Savanna Woodland on the dry sites of the eastern part of the basin. This type of community includes occasional aspen, box elder, and ash and is often found on dry south- and west-facing slopes and occasionally on the upland areas. This Savanna Woodland is characterized by rather short (15 to 20 feet tall) trees. The shrub layer consists primarily of small wolfberry, saskatoon, and chokecherry. Principal herbs of the Savanna Woodland floor are columbine, Canada anemone, and Pennsylvania sedge, usually with a small percentage of bare ground. The herb layer is usually well-developed. When cleared, this land is used for pasture and some small grains suited to drier conditions. A localized variation of the the dry slope habitat is the small chokecherry or hazel thicket with a closed canopy, very little shrub understory, and an herb layer with Canada anemone, a smooth goldenrod, quackgrass, and wolfberry as dominants. Other dry slope communities, especially those on the powdery unstable slopes, are devoid of trees and large shrubs and consequently have a very different character. They are subject to much greater variations of temperature and moisture, resulting in a lowering of species diversity and ecosystem stability. A much greater percentage of bare ground occurs here, leaving the soil subject to weathering and erosion.

2.067 Tall-Grass Prairie - Non-forested floodplain (tall-grass prairie) ecosystem differences are influenced by the frequency with which they are flooded and thus disturbed. A frequently disturbed area, with very little bare ground, has white and yellow sweet clover, common sunflower,

hedge nettle, and wild buckwheat predominating. Le[illegible] covered areas with chokecherry, wolfberry, and red [illegible] have a prairie-like composition with dominants of Kentu[illegible] r smooth brome and wolfberry. Moderate to great div[illegible] little bare ground occur in these communities. The[illegible] idence that those areas undergo greater silt deposition than [illegible], and the earlier successional species would therefore seem to be favored.

2.068 Vegetation Sampling - Transects were chosen to [illegible] Pembina River Valley perpendicular to the Pembina River downst[illegible] Valley. Herb quadrat locations were chosen first to sample repr[illegible] plant communities expected to be distinct along a trans[illegible] to sample sites which would be permanently inundated and [illegible] would be subject to floodwater storage. Subesquent to the sur[illegible] proposed dam location and water storage levels were changed [illegible], in lieu of better information, the results of the survey are [illegible] in exhibit 4 although the references to elevation 1015 being [illegible] permanent pool, for example, should be understood to be appli[illegible] to an earlier project proposal. The survey indicates there is [illegible] plant diversity in the project area, and several of the species [illegible] and in North Dakota only in the project area.

2.069 In July of 1971, the forest land within the then [illegible] permanent pool area was cruised by the USDA Forest Service, Region [illegible], Division of State and Private Forestry. Other aspects of the [illegible] tation were sampled at the same time on 35 tenth-acre plots whi[illegible] randomly, but systematically, located using a dot grid syst[illegible] The results of the quadrat surveys are presented in exhibit 5, and the results of the timber (cruise) estimates are found in exhibit 6. The results from the ground cover estimates (exhibit 7) were extrapolated to the rest of the 365 forested acres estimated to be in the permanent pool area. Inspection of exhibit 6, however, indicates that the [illegible] are applicable to the earlier project proposal (as regards dam location and/or water levels) and that the survey was conducted without the benefit of a thorough briefing on the project or its operation. The data therefore must not be considered as directly applicable to the current project proposal. However, the data are presented, despite of these problems, because they represent some of the only quantitative information on the project area.

2.070 One of the conclusions resulting from the Forest Service study was that the great variation in timber volume between plots [illegible] the accuracy of estimates of overall timber volume to be low. Nevertheless, it was concluded that very little commercial [illegible] could be placed on the timber resource within the reservoir area because of (1) the small volume, and (2) the lack of existing industry to utilize the material. However, it was noted that the forest resource has more important uses in this case than furnishing the raw material for a wood-using operation. These other uses include:

1. Erosion deterrent for the highly unstable soils [illegible] up the lower Pembina River drainage.

2. Aesthetic or recreational value.

3. Cover for wildlife, protection which is not afforded by the farmed fields on either side of the Pembina River Valley.

2.071 Some of the types of ground cover that would be inundated by the proposed project are shown in exhibit 8.

2.072 Woodlands - North Dakota, with a total of about 400,000 acres of "natural" forested lands, has a smaller percentage of woodland area than any other of the 50 States. With the exception of a narrow fringe of trees along some stream courses, only four or five extensive areas in the State are naturally wooded. The Turtle Mountain in the Souris River basin, the upper Pembina River Valley, and an extensive wooded area around Devils Lake comprise the most important remaining areas of natural woodlands. About 252,000 acres of timber remained in these three areas prior to 1970 (table 10).

Table 10- Woodland in Turtle Mountain, Upper Pembina Valley and Devils Lake Area

Area	Existing woodland (acres)	Publicly owned woodland (acres)	Woodland remaining to be acquired to assure preservation of the area (acres)
Souris River Basin			
Turtle Mountain	125,000	20,700	104,300
Red River of the North basin			
Upper Pembina Valley	84,000	5,770	78,230
Devils Lake area	43,000	1,730	41,270
Total	252,000	28,200	223,800

Source: Souris-Red-Rainy River Basins Comprehensive Framework Study, Field Review Draft, Appendix J, Fish and Wildlife, September 1970.

2.073 Clearing of these forest lands for conversion to agricultural production has been accelerating. A recent survey indicates that about 35 percent of the woodland in these areas has been cleared in the past 20 years. Estimates based on the 1967 Conservation Needs Inventory and on 1958 Soil Conservation Service (SCS) data indicate that the annual rate of clearing of forest land was 1.0 percent for Pembina County, 3.6 percent for Cavalier County, 3.4 percent for Towner County, and 0.1 percent for Rolette County during 1958-1967. As a result, valuable wildlife habitat is being lost, and the aesthetic qualities responsible for general recreation interest in these areas are declining.

Recent legislation in North Dakota has provided a woodland tax abatement for maintaining woodlands, but apparently this is not a sufficient deterrent to clearing. Unfortunately, the native trees produced on these lands have very little market value, and thus landowners have little incentive to save them.

2.074 Based on past clearing trends, incentives to clear woodland areas appear to be more compelling than incentives to retain them. Unless this situation is reversed, public ownership appears to be the only solution to preservation of a substantial acreage of these vital woodlands. Floodplain zoning has been suggested as a means of preserving bottomland timber. (Note that such a program would have a different intent than the floodplain regulation for structures described in the ALTERNATIVES section.) Of the approximately 252,000 acres of forest land remaining in the Turtle Mountain, Upper Pembina Valley and Devils Lake areas, about 28,200 acres are currently in public ownership, leaving about 223,800 acres in private ownership and vulnerable to clearing (table 10). Given the present set of incentives pertaining to woodlands, these privately owned woodlands would have to be acquired to assure complete preservation of the last remaining large blocks of natural timber in North Dakota. The State Forest Service has recommended a 10-year program to acquire the 223,800 acres of land needed to assure complete preservation of the Turtle Mountain, Upper Pembina Valley, and Devils Lake woodlands. The State Forest Service, State Park Service, and State Game and Fish Department would be the principle agencies involved in the recommended land aquisition. Technical, engineering, and legal assistance from the State Outdoor Recreation Agency, State Highway Department, and State Water Commission would be an important part of the program.

2.075 In addition to the specific program recommended to preserve the remaining Turtle Mountain, Upper Pembina Valley, and Devils Lake woodlands, protection of the remaining stream valley woodlands is considered equally important. Bottomland timber does not lend itself to a major acquisition program as do the large blocks of hill timber. The greatest opportunity to preserve a substantial portion of the State's valley woodlands is through a kind of floodplain zoning or river corridor management which would assign a high priority to retaining natural woodlands in floodplains.

2.076 Preservation of the large acreage of woodland discussed earlier would help assure the prepetuation of wildlife associated with the forest environments of the Turtle Mountain, Upper Pembina Valley, and Devils Lake areas. Management of the woodlands by the several State agencies could maintain or improve existing habitat and perhaps greatly increase its present capacity for wildlife production. As a result of maintained wildlife populations and improved access to the woodlands, a major decrease in hunter-day use could be prevented. Equally important environmental benefits related to natural beauty, aesthetics, and outdoor recreation could also be realized.

2.077 In 1962, the North Dakota Deputy State Forester urged that the State concentrate its efforts in forestry in Pembina and Cavalier Counties where the largest contiguous blocks of native forest were found and where the maximum results could be expected. In 1962 these two counties and Walsh and Grand Forks Counties were considered to have the greatest rate of clearing in the State and had lost 27,897 acres, or 27 percent of their 1956 forest land base acreage, to agriculture. This loss has continued at the approximate rate of 3 percent per year and has involved about 76,000 acres, 90 percent of which was in the Pembina watershed. Existing wildlife management acreage and projected goal acreage through year 2020 for Cavalier and Pembina Counties are shown in table 11.

Table 11 - Existing State wildlife management area acreage and goals(1)

County	Existing acreage	Goal acreage (purchase lease, donation)(1) 1980	2000	2020
Cavalier	748	6,400	16,400	16,400
Pembina	2,240	6,400	16,400	16,400

(1) Goal acreages are cumulative. Existing acreage is not included in goal acreage.

Source: Souris-Red-Rainy River Basins Comprehensive Framework Study, Field Review Draft, Appendix J, Fish and Wildlife, September 1970.

2.078 In general, removal of forest cover would contribute to increased streamflow. Overgrazing, which reduces vegetation, would also contribute to increased runoff because water is not held and rapidly accumulates in water courses. The removal of forest cover or the replacement of deeprooted vegetation, such as trees or shrubs, with shallow-rooted forms, such as agricultural crops, increases streamflow and contributes to the smaller, more frequent flood events, erosion, and sedimentation in the watershed. Thus, any reduction of forest or brush cover permits more precipitation to reach the ground and any reduction in the number of plants using water will increase streamflows.

WILDLIFE RESOURCES

2.079 The proposed project site, in the heavily wooded Upper Pembina River Valley, is one of the few remaining wildlife areas of semi-wilderness quality in North Dakota. It is unusually rich in scenic beauty and is high in wildlife values. The hunting afforded by wildlife in the proposed reservoir area contributes significantly to the total hunting opportunity in North Dakota.

2.080 Historically, the project area supported large numbers of mule deer and bison. Today, moose are present, and elk are occasionally reported in the area. A large population of white-tailed deer inhabits the rugged wooded slopes and moderately cultivated bottomlands of the Pembina River Valley. Deer use the flat plateau of the uplands during most of the year and depend on the browse and cover in the vallye for winter existence. Winter aerial survey counts are made to determine the deer population in the area. The actual number of deer is perhaps about five times the winter aerial survey count. The winter aerial survey count was 244 in 1963-64, 288 in 1965-66, and 212 in 1966-67. In 1969-70, a high winter aerial survey population of 1,068 deer was recorded. The survey count for 1971 was 672. From 1952 to 1971 the average survey count was 432 deer. Hunting pressure is heavy, with more than 50 percent hunter success recorded in recent years. During each of the 1963 and 1966 seasons nearly 500 dear were recorded as taken in the Pembina River Valley. Also, there were probably a number of unrecorded kills. Game managers in the area also feel that the illegal kill is substantial and partially responsible for lower than expected populations. The proposed reservoir site is located in the area considered to be the main winter range for deer in the basin.

2.081 The Pembina River Valley supports populations of ruffed grouse that are considered very good by North Dakota standards. This species is dependent on woodland vegetation; intensive agriculture may reduce or eliminate this population. The ruffed grouse is the main species of upland game at the proposed reservoir site. The area is important to ruffed grouse since the reservoir site and associated land are part of the two remaining grouse ranges in North Dakota. The ruffed grouse is by far the most important upland game species in the area and is considered a "choice" game bird by North Dakota sportsman. Other upland game species include Hungarian partridge, sharp-tailed grouse, snowshoe hare, squirrel, and cottontail rabbit. Upland game hunting pressure is moderate to high within the area of reservoir influence. Substantial numbers of mourning doves are also present in the project area.

2.082 Other upland game birds found in the basin are pheasants and wild turkeys. Stocking programs for pheasants and wild turkeys have been carried out with the expectation that harvestable populations will be available at a future date. Sharp-tailed grouse supply a limited hunting opportunity and are found in some grassland areas where livestock grazing is limited.

2.083 Furbearing mammals common to the area include racoon, beaver, mink, muskrat, skunk, weasel, red fox, and coyotes. Limited observation of "sign" suggests that otter may be present. Wolves, black bear, bobcat, and Canada lynx are occasionally reported. Mink and beaver are considered the important furbearers, with beaver considered numerous. The Upper Pembina Valley is considered one of the best beaver habitats in the State. Beaver populations in the Pembina River Valley ranged from about 420 animals in 1962 to about 630 animals in 1968. The proposed reservoir area includes about 40 percent of the river habitat used by beaver.

2.084 Slackwater areas along the Pembina River and its tributaries provide brood cover for a few mallards, pintails, and blue-winged teal. Of greater importance is the value of the area to wood ducks. The general project area supports one of the few significant natural breeding populations of wood ducks in North Dakota.

2.085 Waterfowl are also an important wildlife resource of the Upper Pembina River basin. The fringe marsh encircling Swan, Lorne, Louise, Rock, and Bone Lakes furnishes good nesting cover for waterfowl and shore birds. Waterfowl also make heavy use of these lakes during migratory flights. Swan Lake, in particular, is a favorite fall resting area for mallards and Canada geese, while Bone Lake is a popular resting area for scaup. To improve the water fowl habitat in the Pembina Valley, Ducks Unlimited (Canada) has constructed water level control structures at Bone Lake and also at Grass Lake, a marsh area about 2 miles downstream of Swan Lake.

2.086 Unlike the Upper Pembina area, aquatic habitats west of the excarpment in the Pembina basin in North Dakota are limited to streams, farm ponds, and some natural wetlands. Waterfowl use of the lower Pembina River basin is mainly during migration periods but some mallard, pintail, and blue-winged teal occasionally nest along the larger ditches of the lower floodplain. Rush Lake, located in the uplands of the basin about 35 miles west of the Pembilier damsite, receives heavy use by waterfowl (blue-winged teal, mallard, pintail, and wood duck). It is one of the largest deep freshwater marshes remaining in North Dakota. The area has been considered for purchase and development as a wildlife area.

2.087 Endangered Species - One designated endangered species, the eastern timber wolf, is occasionally reported in the project area. The American peregrine falcon and black-footed ferret could also be present in the project area, perhaps on a transient basis. The lynx, a regionally rare species, may also be present in the project area.

2.088 Aquatic Biota - The Pembina River currently supports a poor quality fishery due to low flows and poor water quality, and particularly high sediment loads. The situation is worsened by the silt-laden spring flood flows. Rock and Pelican Lakes, in the Canadian portion of the watershed, which could possibly supply fish to downstream areas, exhibit only marginal game fish production because of winter and summer fish kills of varying severity that result from shallow waters and high B.O.D. Other lakes on the Pembina River are very shallow and are, under present condition, generally incapable of supporting a year-round fish population.

2.089 A lack of adequate permanent summer flows in the Pembina River limits the population of game fish which contributes to a very limited fishing pressure. Collection records indicate at least 12 species of harvestable fish have occurred in the river (exhibit 8); these include northern pike, sauger, walleye, channel catfish, black crappie, black

and brown bullheads, white sucker, bigmouth buffalo, northern redhorse, carp, and plains carpsucker. There are also 16 species of forage fish. Three additional minnow species are reported from the Tongue River. Rainbow and brown trout have been stocked in Renwick Reservoir and below the dam, however, recurring winterkill conditions presently prevents the success of such a program.

2.090 Downstream from the escarpment, limited fishing for bullheads occurs during periods of low flow, primarily in pool areas. Two low-head dams between Walhalla and the mouth of the Tongue River prevent upstream movement of fish during periods of normal and low flow. Improved fishing conditions occur during periods of high water due to spring runoff. Low-head dams are submerged during this period and fish move upstream from the Red River of the North and lower reaches of the Pembina River.

2.091 The lack of aquatic vegetation in the river, noted in the habitat description of exhibit 8, is apparently due to high flows, silt deposition, and scouring during the spring and low flows at other times during the year.

2.092 Information on aquatic organisms present in the Pembina River is very limited. A survey of mussel species collected in the basin is presented in exhibit 9. No known information exists on invertebrate species. A cursory inspection of the Little North Pembina River at its confluence with the Pembina River revealed only a few waterboatmen (family: Corixidae) and waterstriders (family: Gerridae). A few waterboatmen were also observed near the Vang Bridge in September 1975. No other aquatic invertebrates were found. Periphyton was nearly absent from the rocks which were instead coated with silt.

NATURAL AREAS

2.093 A listing of "natural areas" in Cavalier and Pembina Counties was obtained from the Preliminary List of Natural Areas in North Dakota by Harold A. Kantrud (The Prairie Naturalist. 1973. 5(3): 33-39) (table 12). Both areas in Cavalier County and all sites, except number 6, in Pembina County are within the Pembina River basin. This report defined natural areas as "tracts containing representative biotic communities that are relatively undisturbed."

Table 12 - A listing of natural areas in Cavalier and Pembina Counties, North Dakota.

Cavalier County

1) Pembina - Little North Pembina Gorge Area. 3 mi. N. of Vang. Scenic grandeur amid bur oak-American elm-green ash-basswood forest. Orange-crowned warbler, eastern rufous-sided towhee, white-throated sparrow, lynx, and moose. 9,600 acres.

Table 12 (Cont.)

2) Tongue River Gorge. 1 mi. SW of Concrete. Wood anemone, scarlet tanager, ovenbird, and northern waterthrush. 1,920 acres.

Pembina County

1) Tetrault State Forest. 3 mi. S. of Walhalla. Mixed deciduous forest. 420 acres.

2) Icelandic State Park (Gunlogson area). 1 mi. S.W. of Walhalla. Mixed deciduous forest. Yellow ladyslipper, Bishop's mitre, ferns. 10 acres.

3) Clifford Game Management area. 2 mi. S., 1 mi. E. of Leyden. Mixed decidous forest and native shrubs. 80 acres.

4) Black Ash Woods. 2 mi. S. of Leyden. Mixed deciduous forest in low, sandy soil. Black ash and many ferns. Mourning warbler and northern waterthrush. 1,280 acres.

5) Tongue River Game Management Area. 3 mi. N., 3 mi. E. of Hallson. Scattered tracts, mostly mixed deciduous forest. Showy ladyslipper and other orchids. Moose. 3,033 acres

6) Joliette Woods. 2 1/2 mi. E., 1/2 mi. S. of Joliette. Largest remaining tract of bottomland forest on Red River of the North. Scarlet tanager. 200 acres.

7) Foxen Grove. 4 mi. SW of Neche. Riverine forest with 7-ft. DBH cottonwood. 10 acres.

8) St. Joseph Woods. 2 mi. NE of Leroy. Bottomland Hardwood forest along Pembina River. Possibly lynx and timber wolf. 1,000 acres.

9) McLartly Grove. 7 mi. SE of Neche. Bottomland hardwood forest along Pembina River. Contains American elm up to 4 1/2 ft. DBH and 100 ft. tall. 300 acres.

10) Akra Grove. 3 mi. NE of Akra. Rich, mixed deciduous forest. False spikenard, ruffed grouse, scarlet tanager, and indigo bunting. 15 acres.

2.094 Population - In general, the population of the Pembina River basin and immediately adjoining areas in both countries has decreased slightly in the past 30 to 40 years. The pattern of migration throughout the region indicates a decrease in farm population and an increase in the population of many of the urban communities. The total population of the basin and contiguous areas is approximately 63,000, with about 38,000 residing in Manitoba and about 25,000 residing in North Dakota. In 1970, 10,728 persons resided in Pembina County and 8,123 in Cavalier County. Approximately 60 percent of the population of Pembina County resides in the basins of the Pembina and Tongue Rivers. The population of Pembina County reached a peak in 1940 at 15,671 (table 13). Since that time, the population has declined because of reduced demand for farm labor and a shift from rural to urban areas. In 1970 the county's entire population was classified as rural by the U.S. Census Bureau, pursuant to the definition for census purposes of "urban" as a place with at least 2,500 inhabitants. Except for the relatively few population centers, population densities of less than 10 persons per square mile occur throughout the area. The pattern is one of an agricultural area with scattered "urban" areas which function as service centers.

2.095 In Cavalier County, the largest city is Langdon, the county seat, with a 1970 population of about 2,182 persons. The population of Langdon has increased quite steadily at the rate of about 2 percent per year for the last 25 years while the county population has decreased about 18 percent since 1960.

2.096 The U.S. Army is constructing defense installations in and near Pembina County. Since the 1970 census, a permanent population increase has been noted due mainly to the recent inclusion to the defense system development in the area. This trend is currently expected to continue, however, there is a possibility of this development being abandoned in the near future (current funding is only through July 1976). If this occurs, the projected populations would probably show a decrease. Because of this uncertainty, projected populations have been assumed to maintain existing levels in the future. Population projections would be reevaluated during post-authorization studies.

Table 13 - Population of Pembina County and five principal towns

Place	1930	1940	1950	1960	1970
Pembina County	14, 757	15,671	13,990	12,946	10,728
Five principal towns					
Walhalla	700	1,138	1,463	1,432	1,471
Cavalier	850	1,105	1,459	1,432	1,682
Drayton	502	688	875	940	1,095
Pembina	551	703	640	625	741
Neche	502	565	615	545	451
Total	3,105	4,199	5,052	4,965	5,440
Percent of county population	21	27	36	38	48

SOURCE: U.S. Census Data.

2.097 None of the five towns listed in table 13 is sufficiently large for a meaningful projection of its population in future years. However, the combined population of the towns has been increasing at a modest rate, even while the county's total population has declined.

2.098 The projections of Pembina County's future population (table 14) are based on the assumption that past trends will continue largely unchanged in the future except for adjustments caused by the defense installations. However, it is possible that economic development will change the trends. For example, one or two new industries in the county could create more new jobs and lead to population growth. It is also possible that an increase in the number of large corporate type farms could result in lower populations for the counties.

Table 14 - Projected population of Pembina County, 1980-2030

Area	1980	1990	2000	2010	2020	2030
Non-SMSA portion of BEA area 092(1)	205,400	200,000	192,400	188,900	185,400	181,900
Population of Pembina Co. without defense installation	10,000	9,700	9,300	9,200	9,000	8,900
Population of Pembina Co. with defense installation(2)	13,000	12,700	12,300	12,200	11,900	11,700

(1) 1974 series E, Bureau of Economic Analysis, OBERS projections.

(2) Received 14 May 1975, 1974 estimates of population of North Dakota from U.S. Census Bureau in cooperation with North Dakota listing 1974 population for Pembina County at 12,200.

2.099 Employment - Employment in agriculture in Pembina County amounted to 2,888 farmers and farm workers in 1940, 2,413 in 1950, and 1,627 in 1960. The number of farmers and farm workers in 1960 was only 224 more persons than the number of farms, indicating that a majority of farms were operated without any input of hired labor. The decline in farm jobs will probably continue due to the decreasing number of farms and increasing substitution of machinery for farm labor.

2.100 Employment in trade, manufacturing, and other nonfarm activities increased from 1,855 workers in 1940 to 2,271 in 1950 and decreased to 2,158 in 1960. In spite of the decline from 1950 to 1960, the number of nonagricultural workers in 1960 was considerably larger than in 1940. Between 1940 and 1960 the growth in nonagricultural employment and the coincident decrease in farm employment combined to increase nonagricultural workers as a percentage of all workers from 40 to 57 percent. Conversely,

farm employment dropped from 60 percent of all workers in 1940 to 43 percent in 1960.

2.101 Trade accounted for the largest number of nonagricultural jobs in 1960, followed in order of importance by services, transportation, government, and construction. In 1960, only 85 out of a total of 3,785 jobs in Pembina County were in manufacturing. The value added to raw material inputs by manufacturing amounted to only $211,000 in 1963. Along with agriculture and mining, manufacturing is considered as one of the three basic producing sectors of the national economy. The minor importance and incipient stage of manufacturing, together with the absence of any mining due to lack of mineral resources, emphasizes the importance of agriculture as the basic producer and "export" industry of Pembina County.

2.102 Agricultural - The lower reach of the Pembina River reenters the United States at Cavalier County in North Dakota and continues to flow eastward toward the Red River of the North through Pembina County. Extensive agricultural flooding occurs in the Pembina County portion of the study area. Both Pembina and Cavalier Counties are primarily agricultural and exhibit the national trend toward consolidation of farms. The number of farms has decreased by 33 and 27 percent in Pembina and Cavalier County over the last 15 years while over the same time period the average farm size has increased for the respective counties by 42 and 32 percent. The most significant change over the past 15 years has been the increase in the percentage of cropland harvested and the increasing role cash cropping plays in the income of farmers. Currently, cash crops account for 95 and 96 percent of all farm products in the two counties. A breakdown of this information is given in table 15. As the Pembina River enters Cavalier County, it flows through a fairly steep valley. This valley is used primarily for livestock purposes or is designated natural woodland. When the river leaves the escarpment and continues into Pembina County and substantially different terrain, the floodplain in Pembina County is for the most part all cropland of high quality. Approximately 72 percent of the 1950 floodplain is classified by the North Dakota Public Service Commission as prime farmland.

2.103 The principal crops in Pembina County in terms of acres cultivated are wheat, barley, and sugar beets. Oats, flax, and potatoes are also grown. Livestock and other noncrop production are of secondary importance. Potatoes and sugar beets are the most profitable crops followed by wheat, barley, hay, oats and flax, at 1971 prices. The acreage of sugar beets has doubled in recent years, partially due to a new processing plant located in the county. It is considered probable that the trend toward greater emphasis on more profitable crops will continue in the future. The lower Pembina River basin is noted for its high percentage of excellent or good soils and absence of poor soils. A strip of bottomland one half to more than 1 mile in width along the lower Pembina River is classified as excellent cropland.(1) Farther away from the river, soils between Walhalla and Neche, North Dakota, are mainly excellent soils and the remainder are good. Excellent soils also predominate in the general vicinity of the town of Pembina, North Dakota. Between Neche and Pembina, several soil associations exist which are rated as excellent, good, medium to good, or fair for crops.

(1) General Soil Map of Pembina County and Soil Survey Report, North Dakota State University, 1963.

Table 15 - Characteristics of agriculture in Pembina and Cavalier Counties, North Dakota

Item	Pembina County, Year 1959	Pembina County, Year 1964	Pembina County, Year 1969	Pembina County, Year 1974	Cavalier County, Year 1959	Cavalier County, Year 1964	Cavalier County, Year 1969	Cavalier County, Year 1974
Number of farms	1,403	1,234	1,065	936	1,584	1,412	1,274	1,152
Average size of farms (acres)	503	549	630.4	716	587	661	751	780
Land in farms (acres)	690,735	677,999	671,477	670,512	929,113	932,891	956,596	899,033
Cropland harvested (acres)	432,582	376,150	399,024	442,706	510,885	483,362	462,840	487,936
Cropland harvested as percent of all farmland	62%	55%	59%	66%	55%	52%	48%	54%
Crops sold as percent of all farm products	91%	89%	93%	96%	85%	86%	87%	95%
Average value per acre of farms (prices prevailing in year of census)	115	135	165	329	62	94	130	247
Farm products sold per acre of farmland								
Prices prevailing in year of sale	28.52	27.24	34.78	100.76	14.85	16.28	18.64	47.55
1971 prices	31.45	28.00	37.87	51.19	16.39	16.77	20.30	24.15
Crops sold per acre of harvested cropland								
Prices prevailing in year of sale	41.50	43.70	53.60	147.12	23.10	26.94	33.18	83.34
1971 prices	45.77	44.92	58.37	74.74	35.50	27.75	36.13	42.34
Value of all crops ($ million)								
Prices prevailing in year of sale	18.0	16.4	21.4	65.1	11.8	13.0	15.4	40.7
1971 prices	19.8	17.0	23.3	33.1	13.0	13.4	16.8	20.7
Value of all farm products ($ million)								
Prices prevailing in year of sale	19.7	18.5	23.4	67.6	13.8	15.2	17.8	42.8
1971 prices	21.7	19.0	25.4	34.3	15.2	15.7	19.4	21.7

Source: U.S. Census of Agriculture, 1959, 1964, 1969 and 1974.

2.104 Trade and Industry - Since agriculture flourishes in the basin, industries are almost entirely those engaged in processing of foods. Several small plants are located within the North Dakota portion of the basin, primarily east of the escarpment. The largest manufacturing facility in the United States portion of the basin is a motor coach assembly plant at Pembina. Employment other than that related to agriculture is chiefly in service enterprises such as retail outlets, repair shops, grain elevators, and creameries. A new plant for processing sugar beets is the only major industry established in the basin since 1960.

2.105 Trends - If conditions do not change, the population of the basin can be expected to continue to decrease gradually, although the villages and cities would probably show a small net increase. This population movement from the area may be attributable in part to mechanization of farming operations whereby larger acreages can be handled by fewer men. Although the number of farms may decrease, the major industry will continue to be agriculture. The total value of farm products has increased in recent years due to greater yields resulting from technological advancements. Little future gain can be expected for other industries, since the lack of dependable water supplies retards both industrial and urban growth. The limited water supplies and probably market conditions have caused industries normally associated with processing agricultural products to look elsewhere for plant locations.

2.106 Because of the agricultural base of the regional economy, agricultural trends are also of interest. Historically, efforts at plant breeding have strived to optimize the balance among level of production, resistance to disease, and ease of harvest. While the period of time required for maturing of the crop has also been of interest, it apparently has been within the context of growing season length, and the problem of dealing with delayed planting due to floods has not been dealt with in breeding programs. The solution to this problem has historically been to plant an alternate crop or resort to structural modifications.

FLOOD DAMAGES

2.107 Loss of Farm Income - Pembina River floods do not normally cause direct damage to growing crops because the floods occur prior to planting. However, inundation of cropland delays planting until the water recedes and the soil dries. A portion of the season normally available for crop maturation is lost. Delay in planting is highly damaging to crop yields (and consequently farm income) in the Pembina River basin because the growing season is naturally short. In addition, early floods are damaging to perennial forage crops and cause losses of fertilizer applied prior to planting. At best, inundated fields lead to reduced crop yields. At worst, the delay in planting may be so prolonged that not enough of the growing season remains for any crop production to be possible. The damages from the 1950 flood amounted to several million dollars, due principally to loss of farm income. Similar agricultural damages occurred from the recent floods of 1969, 1970 and 1974.

2.108 Most of the damages caused by Pembina River floods are sustained by farm operators on the floodplain downstream from Walhalla to the confluence of the Pembina River and Red River of the North. This damage area is in Pembina County. Under natural conditions, a portion of the Pembina River floodplain in the Canadian Province of Manitoba is also subject to inundation, however, a road levee has been constructed just north of the International Boundary and parallel with it which reduces some of the inundation due to overflow. High flows of the Pembina River can also inflict damages along the Red River of the North downstream from the mouth of the Pembina River. A small portion of this damage area is in Pembina County, North Dakota, and Kittson County, Minnesota, but most of it is in Manitoba, Canada.

2.109 Average Annual Acreage Flooded - Existing conditions are different from those which previously prevailed mainly with respect to the road-levee just north of and parallel to the International Boundary. Under existing conditions 17,500 acres of the Pembina River floodplain in North Dakota are inundated on an average annual basis. This figure includes 3,740 acres of farmland which sustain soil damages and 13,760 acres which produce sub-standard yields due to a planting delay. An additional 2,050 acres in North Dakota and Minnesota are subject to inundation on an average annual basis by floods of the Red River of the North. Depending upon the degree of coincidence between spring snowmelt flood crests on the Pembina River and the Red River of the North, the Pembina River can be one of the primary causes of high water condition on the Red River of the North below its confluence with the Pembina River.

2.110 Losses Due to Soil Damage - On the average, 3740 acres of farmland are damaged annually by Pembina River floods. Losses in this damage category are second in order of magnitude after losses due to inundation of cropland. Soil damage in the lower Pembina River basin includes bank erosion, sheet erosion, sediment deposition, supersaturation, and degradation of composition and texture.

2.111 In the year in which soil damage occurs, no crop production is possible. In the year following the flood, land damaged by supersaturation will probably be ready for regular production, and much of the cropland affected by sedimentation will be restored within 1 or 2 years. Sheet erosion, which affects more cropland than any of the other types of soil damage, requires the most time to correct; three to five crop seasons may elapse between the last normal yield before the flood and the next normal yield thereafter. Some of these problems would be ameliorated under soil conservation programs which emphasize minimum tillage and crop residue management. (Changes in agriculture which affect susceptibility to floods can be forseen within the period of economic analysis. For example, the St. Paul Pioneer Press of 25 January, 1976, Focus Section page 7, relates a U.S. Department of Agriculture prediction that more than half of U.S. cropland will be farmed using no tillage mulch management techniques within the next 30 years. The technique is expected to be accepted more slowly in the study area, however.) Average annual damages due to soil erosion were estimated to be about $725,000 under 1975 conditions for the Pembina River reach.

2.112 Damage to Farm Property and Other Agricultural Damages - This category includes all losses sustained by farm operators, except crop and soil damages. Types of farm property damaged include residences, barns, and other structures; tractors, machinery, and equipment; crops being held in on-farm storage; wells; fences; private roads and driveways; and improvements such as tiles or ditches for land drainage. Under 1975 conditions, average annual losses were estimated to be $101,600 and $15,900 for the Pembina River and Red River reaches, respectively.

2.113 Transportation Damage - Flooding causes damages to State, county and township roads and to culverts and bridges. Much of the damage is incurred at once, in connection with repairs which cannot be delayed; other damage may be deferred, such as higher maintenance costs or shorter project life. Detour costs add considerably to transportation damage, especially with long-duration flooding. Data pertaining to road, bridge, and culvert damage since 1950 were obtained from State and local government officials. Damage data were also obtained from railroads, including the cost of lost business, delays, spoilage, storage, rerouting of trains, and repairs to tracks, bridges, and embankments. Average annual transportation damage amounts to $103,800 in the Pembina River reach and $71,000 in the Red River of the North reach.

2.114 Urban Damage - Most of the community of Neche is susceptible to flood damage, although emergency measures prevented major damage during some floods. Residential property sustains the most damage. Public and institutional property such as schools, churches, and the water treatment plant are affected by floods. As Neche is primarily a residential community, business losses account for a small portion of the total urban damages. Neche has a degree of protection provided by levees which were built as emergency works. However, residual average annual damages at Neche currently amount to $83,500. Approximately two-thirds of the urban damages caused by Pembina River floods are incurred by residents of Neche. St. Vincent and Noyes rank second and third in the amounts of their damages, among the four communities where damages may occur, with combined average annual damages of $32,800. Nearly all of Walhalla is on high ground, but the recreational facilities at a municipal park and a sewage treatment facility are on the floodplain and are susceptible to flood damage. Average annual damages for Walhalla amount to only $9,100. The town of Pembina, at the confluence of Pembina River and the Red River of the North, was previously susceptible to flood damages, but permanent levees built by the St. Paul District now eliminate the possibility of damages from high flows on the Pembina River and give a very high degree of protection against Red River of the North floods. Total average annual urban flood damages, considering future floodplain growth, amount to $92,600 along the Pembina River and $32,800 on the Red River of the North between the mouth of the Pembina River and the International Boundary.

2.115 Canadian Damages - Pembina River floods also cause considerable damages in Manitoba, Canada. One of the Canadian damage areas is along the north perimeter of the lower Pembina River basin, in the general vicinity of the towns of Gretna and Altona, Manitoba. Although the area is ostensibly in the basin of the Aux Marais River, the levelness of the land causes a shift in the drainage pattern under flood conditions. Once Pembina River water has overtopped its banks and left the channel, some of the water may flow overland via the Gretna-Altona area to the Aux Marais River basin. This area sustained heavy damages during the 1950 flood and other large floods, but it now has a degree of protection provided by an earthen embankment just north of and parallel to the international boundary.

2.116 The second Canadian damage area is the Red River of the North floodplain from Emerson, adjacent to the International Boundary, to St. Norbert, Manitoba, which is the site of a control structure to divert Red River of the North floodwaters into a floodway around the Winnipeg metropolitan area. During the record 1950 flood, 316,500 acres of farmland and several small towns were inundated in the Emerson-St. Norbert reach. The extent to which flood damages in this reach are caused by water entering the Red River of the North from the Pembina River depends upon the coincidence of high flows on the two rivers. Agricultural damages predominate in the Emerson-St. Norbert reach, especially since local protection works were built around some of the towns in recent years.

TRANSPORTATION

2.117 The Pembina River basin and adjacent areas are well supplied with rail and highway transportation facilities. Several railway branches of the Burlington Northern railroad serve the lower basin, traversing Pembina County in a north-south direction and continuing into Canada. All lines link the county with Grand Forks. A network of primary and secondary all-weather highways is adequate for commercial trucks in the area. Interstate Highway 29, generally parallel with the Red River of the North, along the east side of Pembina County, is the main connecting link between Winnipeg, Manitoba, and Grand Forks, North Dakota. The nearest commercial air travel terminal is at Grand Forks, approximately 80 miles south of the basin. There is no commercial navigation on the Pembina River or its tributaries. The entire area is well serviced with telecommunications.

HISTORIC AND PREHISTORIC RESOURCES

2.118 Prior to 1803, the Pembina-Cavalier County area had been ruled by England, France, and the United States. Pembina and Walhalla, founded in 1845, are North Dakota's most historic towns. Fur trapping was excellent and the area was a natural rendezvous for Dakota's buffalo hunting expeditions which occurred west of the Red River of the North. By 1856, Walhalla had a flour mill, power dam, fur trading post, and a printing press. Langdon, North Dakota, became the county seat in 1887 when the two counties were established. The site of Langdon was established in 1883 with the first building being erected in 1884. Grain was raised in the Pembina area as early as 1820. However, the fur trade was the main source of revenue until the 1850's when wheat, oats, barley, and field peas were introduced from Fort Selkirk, Canada. Cavalier County did not become important agriculturally until the late 1880's. The county was settled and sod was broken between 1884 and 1894. Wheat was the principal crop at the time. In 1909, the North Dakota Agricultural Experiment Station established an experimental substation at Langdon. The first flour mill and the Mayo Brick and Tile plant were located along the Pembina River between the Little Pembina River confluence and County Road 55 crossing (Vang Bridge).

2.119 The mixing of early French traders and the Indians created an entirely new commonwealth known as the "mixed bloods" or metis. One of the more prominent of these people was Charles Bottineau, who farmed in the Hyde Park area and was known as the first real farmer in North Dakota. He exported the first wheat from the United States to Canada by oxcart and owned the first wagon in the State.

2.120 In 1844, Antoine Gingras erected a trading post and store northeast of Walhalla. These buildings, although still standing and in need of restoration, are the oldest in North Dakota. The State Historical Society is now in the process of restoring the buildings on the Gingras historic site. In 1843, Norman W. Kittson, an American Fur Company agent and an associate of James J. Hill, built a trading post at the confluence of the Pembina and the Red River of the North. During the 1850's, Kittson moved his establishment to Walhalla. The building stands well preserved in the State Park at Walhalla. Kittson and Gingras worked with one another for many years through the 1840's and 1850's. When Kittson retired, he built a $100,000 home in St. Paul from his earning of his fur business. Charles Cavalier, who was the first permanent settler in the Dakota Territory, took charge of the trading post in Walhalla in 1854 and was appointed postmaster by President Abraham Lincoln.

2.121 The project area was dominated by the Ojibwa Indians in the late historic period. Dakota and Assiniboine Indians were also present at one time. An archaeological reconnaissance of the proposed project area has been conducted (Ames, 1975). The survey recorded 19 lithic sites. A thorough archaeological investigation of the area will be undertaken before work begins on the project and salvage operations will be conducted if necessary.

2.122 The Nation Register of Historic Places, 1 April 1976, has been consulted and there is one historic site recorded which is in the general project area. This property is the Gingras House and Trading Post located near Walhalla, North Dakota.

RECREATION AT PEMBILIER LAKE

2.123 The counties of Pembina and Cavalier have established 68 scenic and historic sites along a designated route within the Pembina River Basin. These include the Walhalla Rifle Club, the Walhalla Country Club Golf Course, the Walhalla State Historical Park, and Riverside Park (swimming, picnicking, and camping). The two counties, however, lack well developed recreational facilities. Most people must drive 50 to 100 miles to enjoy fishing, boating, skiing, and other recreational facilities in spite of the fact that Cavalier County has some of the State's prime undeveloped areas. The beautiful and scenic Pembina River Valley upstream from Walhalla offers regionally outstanding recreational development opportunities. Development of skiing slopes, toboggan runs, riding trails, camping facilities, picnic areas, and hunting lodges are a few possibilities. Also, the South Pembina River, the Tongue River, and the North and South Branches of the Park River offer possibilities for development. Rush Lake and its surrounding 5,000 acres of marshes, potholes, and sloughs offer some of the best waterfowl hunting in the northeastern area of the State.

2.124 The Johnson and Goschke Dams on the Tongue River both provide boating and water-skiing opportunities; the former also has provisions for picnicking and swimming, and the latter provides duck hunting. Mount Carmel Dam on the Little South Pembina River provides recreation in the form of fishing, swimming, boating, water-skiing, picnicking, camping, nature trails, ice skating, and tobogganing. Icelandic State Park is located on the Tongue River, 7 miles west of Cavalier, North Dakota. The park, adjacent to Renwick Reservoir, has camping pads with electricity and a central bathhouse with showers and provisions for water-skiing, swimming, and fishing. Also in the park is the Gunlogson Arboretum while the Cavalier Country Club abutts the west end of the lake. The city of Cavalier has a city park for swimming, picnicking, and skating. Cavalier's centennial celebration was held in 1975. Numerous fairs are held in the area each year, primarily during the summer months. Other recreation developments are, Homme Reservoir about 35 miles south of the proposed Pembilier site, Lake Bronson State Park and Old Mill State Park in Minnesota, 65 miles and 80 miles distant, respectively; Turtle River State Park, 75 miles to the south; the proposed Devils Lake recreation 80 miles to the west. Killarney, Pelican and Rock Lakes and Morden Reservoir in Canada also offer recreation activities.

2.125 Lake Bronson State Park has 54 modern and 54 primitive campsites, a picnic ground, swimming, fishing, boat rentals, a 6-mile hiking and snowmobile trail, and a sewage pump station. Old Mill State Park has 60 tent/trailer campsites, a picnic ground, swimming, fishing, a 5-mile hiking trail, and a 6-mile snowmobile trail. Icelandic State Park has 50 tent/trailer campsites, a picnic ground, swimming, fishing, boating, playgrounds, and a sewage disposal station. Lake Metigoshe State Park has 148 tent/trailer campsites, swimming, fishing, boating, playgrounds, picnic grounds, and a sewage disposal station. Turtle River State Park has 100 tent/trailer campsites, swimming, fishing, playgrounds, picnic grounds, and a sewage dump station. In addition to the publicly owned recreation facilities, numerous privately owned and operated recreation areas are located in the vicinity of the proposed project.

2.126 Recreation Demands of Market Area Residents - The North Dakota State Outdoor Recreation Agency has prepared a State outdoor recreation plan and a booklet entitled "North Dakota Outdoor Recreation Trends." The majority of the project market area lies within regions 3 and 4 as defined in these publications.[1] Based on the supply and demand projections for 1985, as shown in the 1975 State Comprehensive Outdoor Recreation Plan, there is a need for camping, picnicking, snowmobiling, boating, fishing, swimming, skiing, nature interpretive, and sightseeing facilities in these regions.

2.127 Recreation Market Area-Recreation Zone of Influence - The recreational development and scenic beauty associated with the proposed Pembilier Lake will attract visitors from throughout the region. In North Dakota, visitation for day use activity is primarily anticipated from Cavalier, Walsh, Pembina, and Ramsey Counties. Approximately 15 percent of total visitation is anticipated from Southern Manitoba, Canada, and a small amount of use will be attributable to Kittson County, Minnesota.

2.128 It is estimated that 80 percent of day uses and 50 percent of the overnight use will originate from within this zone of influence.

2.129 Population statistics and projections for the recreational zone of influence are shown in table 16. In addition to the people actually within the zone of influence, 2,000 persons are expected to reside in the zone of influence through 1980 due to missile base construction.

---

1 Planning Region 3 is comprised of Rolette, Towner, Cavalier, Benson, Ramsey, and Eddy Counties. Region 4 is comprised of Pembina, Walsh, Nelson, and Grand Forks Counties.

Table 16 - Historic and projected population, recreational zone of influence, 1950-1987.

Year	Population
Historic	
1950	44,689
1960	41,007
1970	35,192
Projected	
1987	47,700

apability of Project to Meet Future Needs - Based on the ly established needs and trends, the recreation facilities for construction in connection with Pembilier Lake would not ate to satisfy the future recreation needs of those persons ithin the zone of influence. However, the recreational development to be provided at Pembilier Lake would aid in meeting these needs.

rtain limitations, inherent at the Pembilier site, have a effect on the development of recreational facilities. Of portance is the steep slope of the valley walls. The segment embina River in which the proposed project would be located is pest portion of the entire Pembina River Valley. Slopes generage from 20 to 70 percent and are heavily wooded. Soil characies in the valley are fragile and large amounts of soil are eroded slopes and into the river. With any type of construction or uncontrolled public activity, severe erosional difficulties ely to result unless proper precautions are taken. The costs, etary and environmental, are likely to be so great that no ndations have been made for developing any facilities on the slopes. Development in the proposed plan has been limited to eas which are relatively flat and wooded. Flat areas within ley are scarce and would be utilized whenever practical. Access areas is also difficult due to the steep valley slopes. Flat ove the rim of the valley are plentiful but are not as desirable of their distance, both vertically and horizontally, from the and their lack of tree cover. The majority of the flat areas the valley rim are currently in agricultural production and, ntly, their conversion to forested public use areas would take ars.

ased on preliminary analysis, sufficient suitable land exists vicinity of the proposed lake to develop quality recreational ities without excessive damage to existing area resources. Such se development is needed to meet the projected recreational or the market area and to properly provide a balanced use of urce which would be created by the proposed project.

Importance of Project In Meeting Identified Needs Not Likely to Through Other Programs - The importance of developing public-use ilities in conjunction with Pembilier Lake should not be underestimated. both the North Dakota Forest Service and the North Dakota Game and Department have been acquiring lands in the Valleys of the Pembina and its tributaries, a level of development normally associated with Corps of Engineers projects is not likely to occur due to budget and policy restrictions placed on these two agencies.

2.134 Full Development of Recreation Areas - Table 17 summarizes recreational facility development needs to meet anticipated recreational visitation with the proposed project. In addition, basic supportive facilities, including vault toilets, water supply, fireplaces, trash receptacles, control station, overlooks, launching ramp and dock, parking areas, access roads, and landscaping, would be developed.

Table 17 - Recreational Development Needs

Item	Amount
Camping	168 camp pads
Picnicking	50 picnic sites
	1 shelter
Sanitary facilities	4 vault comfort stations
Boat launching	1 ramp
Wash buildings	4 in camp area

2.135 Recreation facilities would be located on suitable lands to be specifically determined after intensive field and office review at a later planning stage.

2.136 Minimal Development - Should non-Federal participation not be obtained under the provisions of Public Law 89-72, the minimum facilities that could be provided for public health and safety would be located at existing road ends at five points around the lake. Generally, minimum facilities would consist of a parking area and turn around, vault-type toilets, and trash containers. These facilities would be consistent with existing regulations concerning minimum development. The quality of the facilities to be provided would be above average in order to keep maintenance and replacement to a minimum. No additional lands beyond those required in connection with the project would be needed for the minimum facilities. However, the separable lands recommended for acquisition to support the normal recreation development would be acquired in accordance with the provisions of the Federal Water Project Recreation Act (Public Law 89-72) for development at a later date.

2.137 Forest Resource Program - It is anticipated that a reforestation program would be implemented on recreation lands, especially on lands currently in agricultural production. The lands to be acquired outside of the normal fee-taking lines are almost all cleared. Openings would be left to provide "edge" which is critical to wildlife. Native tree species would be planted along with certain exotics which would provide desirable characteristics such as rapid growth and wildlife cover. Recreation areas would be landscaped with nursery stock of large size in order to provide quicker rehabilitation of construction areas. Any plantings outside of recreation areas would be primarily seedling and transplant stock and would be based on an extended program so as to provide a diversity in tree age and size.

2.138 Coordination with Other Agencies - The recreational plan of development has been coordinated with the North Dakota State Park Service, the North Dakota Game and Fish Department, and local recreation interests. Past proposals have been coordinated with the Pembina Basin Planning Committee of the North Dakota Division of Parks.

2.139 Special Problems and Recommended Solutions - During construction, special provisions would be made to protect the existing environment. The contractor would be required to repair any turf damages caused by his activities. Provisions would also be made during construction to establish or construct facilities such as overlooks and access points for the enjoyment of the visiting public. Depending upon the time of establishing the permanent pool, only construction of overlooks may be necessary.

2.140 In accordance with existing regulations and criteria, special consideration would be given to the type of facilities necessary to accommodate the handicapped and the elderly.

2.141 The State of North Dakota has furnished a letter of intent to participate in the recreational development. It can be assumed that their operation and management policies, organization, and staffing would be comparable to that found in the various State parks under the administration of either or both of their Division of Parks or Fish and Game. In either case, ranger activities and law enforcement would be provided. Because of the limiting size of the project water area, the Fish and Wildlife Service and the Corps of Engineers would, in the preparation of the required general plan, assign the responsibilities for fish management to the State.

2.142 Environmental Quality - The proposed lake on the Pembina River southwest of Walhalla presents an unusual opportunity to preserve and interpret a historic area rich in the lore of early fur trappers and settlers. Every effort would be made in planning the public-use facilities to insure that the development would complement the natural beauty of the area. This goal can be accomplished by a unified planning effort incorporating natural or native construction materials along with earth tones and rustic looking structures to blend in with the theme of the area. Areas marred by construction would be reshaped into natural appearing land forms and revegetated. Surfaced walkways would be provided where traffic warrants; other types of walkways would be utilized where traffic is less heavy. In addition to metal and chrome play structures, timber-type play equipment would be considered. Landscape plantings would stress indigenous species in order to blend man's development into the natural setting. The architectural theme or style of the various buildings would be of a rustic variety and extensive use would be made of natural local materials.

2.143 Necessary precautions would be required and enforced during construction so that pollution and degradation of the environment would be minimized. Such measures would include the use of stilling basins to avoid unnecessary scarring of the landscape. Borrow areas and agricultural lands acquired for the project would be evaluated for planting in either timber or wildlife food species. Reforestation is especially important above the valley rim where most of the ground has been cleared for agricultural purposes.

3.001 Agriculture is the dominant land use in Pembina and Cavalier Counties. Approximately 93 percent of all land in Pembina County is in farms,(1) and 178,000 acres of farmland lie within the intermediate regional floodplain. The predominant use of this land is for crops (table 18). Eighty-two percent of the land is used directly for crop production and an additional 10 percent is summer fallow or cropland temporarily vacant. Only lands where sustained economic returns are questionable because of various factors such as topographic, drainage, and frequent flooding problems, retain some assemblance of natural vegetation. The areas which currently are of low agricultural value are the valley walls along the Pembina River and its tributaries, wetlands, and areas within the river corridor downstream from Walhalla.

Table 18 . Agricultural land use in intermediate regional floodplain

Item	Crop	Summer fallow	Other(1)	Total
Acres	146,000	17,800	14,200	178,000
Percentage of land use	82	10	8	100

(1) Includes nonproductive land; i.e., farmsteads, riverbeds, roads, urban areas, etc.

3.002 In the United States portion of the Pembina River basin above Walhalla, major land use categories include cropland, pasture, forest, and other. Cropland accounts for 84 percent of the land utilization while pasture, forest, and other constitute the remaining 16 percent.

3.003 The amount of wooded area within Pembina and Cavalier Counties is small in comparison to the amount of agricultural land. The fact that North Dakota has the smallest percentage of wooded lands of any of the 50 States, with about 400,000 acres of natural timber, emphasizes the importance of these areas. In recognition of these facts, the Deputy State Forester for North Dakota in 1962 recommended that State forestry efforts be concentrated in Pembina and Cavalier Counties. Clearing of wooded lands has been occurring in these counties at a rather alarming rate (about 2-3 percent per year) over perhaps the last 20 years. However, an estimate of the degree to which the remaining wooded areas in the Pembina Valley would be subjected to significant amounts of additional clearing would be subjective. Most areas, in this rugged valley, suitable for agricultural crops, i.e. relatively flat terrain with adequate access, have already been cleared. The existing trees in the valley have low value as lumber and development of the timber resources would probably be better suited for products such as particle boards, although no utilization along these lines are presently foreseen.

(1) U.S. Bureau of the Census, 1969 Census of Agriculture, Pembina County Data; U.S. Bureau of the Census, Census of Population, 1970.

3.004 The flood prone portion of Walhalla consists of 33 acres of parkland and other public property. Land use in the 205-acre village of Neche is primarily residential. Approximately 27 percent of the land in Neche is undeveloped or in public use. Commercial use is primarily confined to a narrow strip of land adjacent to the Burlington Northern right-of-way.

3.005 In compliance with the Flood Disaster Protection Act of 1973, the village of Neche passed a floodplain zoning ordinance. Growth is restricted in the 100-year floodplain to those buildings that can be flood proofed to the 100-year flood elevation. The entire village of Neche lies within the 100-year floodplain. Ground elevation at Neche ranges from approximately 827 feet to 831 feet above mean sea level elevation, and the water surface for the 100-year flood at Neche is 834.2 feet. Dirt fill or flood proofing to a height of 3.2 to 7.2 feet above the existing ground level would be required for development. The additional expense incurred would make floodplain land within Neche unprofitable for development as residential land. The floodplain lands offer no advantage over lands located outside the floodplain, and the additional cost to comply with the zoning laws makes it unlikely that commercial and industrial development would locate there. Land use in Neche is not expected to change significantly.

3.006 Walhalla's flood prone lands are set aside for public use and land for development is plentiful out of the floodplain. Thus, no change in land use is foreseen.

3.007 The proposed reservoir would significantly reduce downstream flood damages, especially from the more frequent flood events. Although the downstream areas currently are subjected to intensive agricultural use, it would seem probable that the agricultural land base in this area could be increased,although a relatively small amount, following construction of the reservoir. To the extent that the reduced probability of flooding of woodlands along the river and wetlands results in these lands becoming economically suitable for agricultural practices, clearing and drainage of these lands could be expected. The reduced flood hazard could also result in crop changes, i.e. to crops with higher economic yields such as potatoes and sugar beets. Changes of the above nature, while increasing economic returns to downstream residents, would reduce existing wildlife production through the reduction of existing habitat.

3.008 In more recent years, drainage of wetlands in the Pembina River basin has become a concern to downstream landowners, environmental interests, and the State of North Dakota. The concerns relate to the loss of valuable wildlife habitat and to possible increases in downstream flood problems. A moratorium on drainage by government bodies currently exists for the upper Pembina River Basin in North Dakota. However, because the moratorium does not apply to private drainage, wetlands in the upper part of the basin are continuing to be drained. It is not expected that this trend in wetland drainage in the upper basin will continue at its present rate for the following reasons:

a. The majority of small shallow wetland areas in the upper basin have already been drained and converted to agricultural uses.

b. Pressure by various interest groups will probably cause existing water management board, who are responsible for providing permission for all drainage projects, including private drainage, to exercise their responsibility more conscientiously on the remaining wetland areas.

c. A cooperative approach to drainage problems similar to that being applied to the adjacent Devils Lake basin[1] has been suggested by several interests.

d. For the most part, drainage of U.S. lands in the upper Pembina River basin crosses the International Border into Canada. The general rule governing these drains and creeks is that they may be maintained but not enlarged.

e. The above points indicate the increasing importance of land use planning which should have a significant influence on future changes in existing land use.

3.009 Immediate land use effects would occur upstream from the proposed dam where about 365 acres of woodland and 355 acres of croplands would be committed to a conservation pool. The productive capabilities of these lands, both for agriculture and wildlife, would be permanently lost. Land within the project take-line (5,800 acres) would be removed from future uses other than those compatible with the wildlife management objectives proposed for the area. Of this area, about 3,200 acres (including 200 acres in the conservation pool) would be within the flood pool and would suffer some degree of degradation, the degree dependent upon the timing, extent, and duration of floodwater storage. An additional 12,800 acres of land within the river valley, north of the Vang Bridge, are proposed for wildlife mitigation. Inclusion of these lands in the project authorization would insure that a large portion of this unique river valley was protected from future adverse land use changes for the general public welfare and specifically for the people of North Dakota.

3.010 A bill introduced in 1971 for consideration by the 42d North Dakota Legistative Assembly by the State Outdoor Recreation Agency would have resulted in a study of the State's wild, scenic, or recreational river classification potential. The bill was, however, defeated early in the legislative process. Although specific rivers were not identified in the bill, four rivers were discussed in preliminary

---

(1) A Devils Lake basin advisory committee was established by House Bill No. 1587 of the Forty-fourth Legislative Assembly, State of North Dakota to develop a basin plan of water and related resource conservation and orderly development.

studies as having some potential for inclusion. One of these was the Pembina River from the downstream face of the proposed dam to the mouth of the river.(1) The North Dakota classification criteria would have closely paralleled the wild, scenic and recreation river classifications contained in Public Law 90-542, the National Wild and Scenic Rivers Act.

3.011 In general, the proposed project would enhance agricultural land use, through reduced flood frequency and intensity, while reducing wildlife habitat in the area, either directly or secondarily.

(1) North Dakota State Comprehensive Outdoor Recreation Plan (Draft Proposal). North Dakota State Outdoor Recreation Agency (no date).

4.000 ENVIRONMENTAL IMPACT OF THE PROPOSED PROJECT

AQUATIC RESOURCES

4.001 General - Creation of the proposed Pembilier Reservoir would have significant effects on the aquatic environment of the area. The quality of the new environment would depend to a large extent upon: climatic and land-use patterns which would affect the quality of the inflow water; physical and chemical controls within the aquatic medium; morphometric factors (such as the amount of shoreline, depth, volume, relation of shallow to deep areas); biological interactions; and operation and management practices imposed on the reservoir. Changes in a reservoir system can be attributed to broad category effects of residence time of the water in the reservoir, season, and aging.

4.002 The "lake"[1] formed by the proposed dam would permanently innundate approximately 9.5 miles of free flowing stream while under floodwater storage conditions (at a pool elevation of 1080) up to an additional 11.5 miles of stream would be inundated.

4.003 Physical and Chemical Aspects - The area occupied by the conservation pool would be abruptly changed from a riverine (lotic) to a lake (lentic) environment. Along with a reduction in current, changes in physical and chemical parameters would also occur, most of which would have profound effects on the aquatic biota.

4.004 Temperature is probably the single most important factor affecting the biotic and abiotic components of a lake ecosystem. Temperature affects almost every other physical, chemical, and biological process within the aquatic system from mixing, to solubility relationships to metabolic reactions. Of prime importance is the affect of temperature on the density of materials, in this case water.

---

1 Terms such as reservoir, lake, permanent pool, and conservation pool are used throughout the text in reference to the initial body of water impounded by the proposed Pembilier Dam. It should be noted that the resulting "lake" differs from naturally occurring lakes in several significant respects. Many of these differences are discussed in the text in connection with the possible environmental impacts of the reservoir. The differences are primarily related to greater sedimentation and water level fluctuations within the reservoir and the discharge controls possible through multi-level outlet structures. A natural lake is a dynamic system. Various physical processes which affect the rating of aging (nutrient additions, sedimentation, circulation, etc.) differ in flood control reservoirs, as opposed to natural lakes, i.e. they are usually increased in reservoirs.

4.005 Because water has a maximum density at 4° C (approximately 39° F), water that is warmer or colder than this temperature will "float" on top of the denser water. In a lake this phenomenon is manifested by the fact that a lake freezes from the top down, thus preventing the lake from becoming one huge "ice cube". A second effect of this behavior, the formation of thermal stratification within the lake, is most pronounced during the summer.

4.006 Summer thermal stratification in a lake results in three, more or less distinct, water layers: the epilimnion, or a warm surface layer, which is usually several feet thick; the hypolimnion, or the bottom layer of cooler, denser water; and the metalimnion, or middle layer, exhibiting a pronounced temperature gradient between the upper and lower layers referred to as the thermocline.

4.007 Thermal stratification in a lake is important not only because it separates the lake into "warm" and "cold" layers, but probably of more importance, it represents a physical discontinuity between these layers that impedes mixing of the water layers and so reduces the rate of exchange of solutes and gases between the layers.

4.008 Because the hypolimnion is usually below the euphotic, or lighted zone in most lakes at the latitude of the proposed project, photosynthesis does not contribute a supply of oxygen to this layer, and since oxygen produced in the epilimnion cannot reach the hypolimnion in sufficient amounts, respiration and other biochemical oxidations in productive lakes quickly eliminate the oxygen from this layer, resulting in "stagnant" (reducing) conditions.

4.009 The question of whether a lake will stratify is of considerable importance. Many variables, however, including insolation, fetch, form, size, area-volume relationships, flushing rate and pattern, surrounding topography, and the lakes orientation to the wind affect the thermal stratification process in a body of water.

4.010 The conservation pool of the proposed Pembilier Reservoir would be about 800 acres and would be elongate in form with the long axis running WNW to ESE. The conservation pool would be approximately 7.0 miles long with a mean width of about one-fourth mile. The mean depth would be about 19 feet. The lake would be incised into a steeply walled canyon with the surrounding uplands lying about 100 feet above the water surface. The maximum straight-line fetch would be about 2.5 miles (approximately 4.0 km).

4.011 Data obtained from inspection of the surface area-capacity curves that were developed for the proposed reservoir are tabulated in table 19. The volume of the conservation pool would be about 15,000 acre-feet. Based on an average daily discharge of 205 cfs (table 6), an average residence time of about 40 days would be expected.

Table 19 Relationship between cross-sectional area and depth.

Elevation (feet)	Depth (feet)	Area equal to or greater than depth (acre)	Percent total
1010	0	800	100
1005	5	680	85
1000	10	570	71
995	15	450	56
990	20	350	44
985	25	260	32
980	30	180	22

4.012 Results obtained by applying a method proposed by R.A. Ragotskie (personal communication), which was developed for predicting thermal stratification of lakes in forested areas, indicated that the proposed reservoir would stratify during the summer and that the thermocline would be found at increasing depths during the course of the summer, being found at about 26 feet in August. The amount of lake bottom below this depth would be about 30 percent of the total permanent pool surface area. The volume of the hypolimnion at this time would be about 2,500 acre-feet (about 17 percent of conservation pool volume).

4.013 Future studies would be needed to consider the thermal and nutrient properties of the proposed reservoir in much greater detail with the objectives of identifying the types and degrees of various potential problems relating to water quality and to developing operational plans consistent with reservoir and downstream water quality requirements, i.e. temperature and nutrient concentrations. These studies would explore the effects of discharging water from one level, several levels simultaneously, and various levels throughout the season. Consideration would be given to quality and quantity of water in the downstream reaches and in the reservoir. In relation to the operation and maintenance plans for the reservoir, consideration would also be given to other potential functions such as water supply, low-flow augmentation, water level fluctuations for fishery and habitat management, and pool stability for recreational and aesthetic purposes. The final operating plan would probably require a compromise between conflicting objectives. (Refer to paragraph 1.027 for discussion of postauthorization study needs.)

4.014 Because of the continual emphasis placed on phosphorus as the nutrient with the greatest potential for causing excessive algal growths in freshwater environments, an attempt was made to assess the phosphorus loading of the proposed impoundment. The method used was similar to that presented by Richardson (1974), for the proposed La Farge Reservoir in Wisconsin. No mathematical expressions were developed to represent the relation between dissolved phosphorus and other parameters such as flow and specific conductance. Instead, several methods were used to calculate monthly mean concentrations for the period of record (exhibit 11).

4.015 The results of these analyses can be considered only the crudest approximation of phosphorus loading rates. Statistically, calculations based on such few grab samples would be expected to have low precision while their accuracy (closeness to the true monthly mean) is unknown, and may be high or low. Also, the relatively high flow years of 1968-1972 may not be representative of long-term loading rates. Methods employed for calculating "flow-weighted" average concentrations are thus subject to questioning because the data were not conducive to standard statistical procedures due to unequal sample sizes and infrequent sampling.

4.016 On the other hand, the use of long-term average flows to estimate loading rates and residence times may underestimate recent and future runoff resulting from wetland drainage, land clearing, and "modern" agricultural practices, e.g. increased use of fertilizers. Finally, only dissolved phosphorus was reported by the U.S. Geological Survey. Data presented for La Farge Reservoir indicates that inorganic phosphorus (mostly as dissolved ortho-phosphate) was approximately one-half the total phosphorus values (Keeney, et al., 1974). Considering the high suspended sediment concentrations of the Pembina River, it is probable that total phosphorus concentrations would be greater than those presented in exhibit 11.(1)

4.017 Dissolved phosphorus loadings for the Pembilier site were calculated by four different methods (exhibit 12). Three of the methods (a, b, and c) resulted in values that were greater by about one order of magnitude than those for the La Farge site while the method d result was about 2 g/m^2/ year greater than for the highest La Farge estimate. The cluster of lakes in exhibit 11 (Monona, Erie, Redstone, Cox Hollow, etc.) were considered "mildly to grossly eutrophic" while La Farge Lake was classified as "hypereutrophic" (Richardson, 1974).

4.018 Determination of the phosphus loading at Lake Ashtabula, North Dakota, was also made using U.S. Geological Survey water quality data from the Sheyenne River near Cooperstown, North Dakota, for the period October 1970 to September 1972. Results of these calculations (exhibit 13) indicate that Lake Ashtabula falls in the range of the above-mentioned eutrophic

(1) The significance of the non-dissolved phosphorus fractions is difficult to interpret because of adsorption-desorption equilibrium reactions. (Refer to paragraph 4.024.)

lakes. The points on exhibit 11 labeled Ashtabula (Peterka) and Ashtabula (Owen & Duerr) are based on additional studies of the area. Peterka (1970) estimated that 5.8 metric tons of ortho-phosphate were retained in Lake Ashtabula for the year starting in June 1967, while Owen and Duerr (1974) estimated that as much as 1,250 tons of phosphate could accumulate in the reservoir. The two points estimated were then calculated by using these loading levels and the average annual flow for the 1970-72 period.

4.019 Lake Ashtabula exhibits no, or only ephemeral, thermal stratification because of its shallowness and because it is subjected to almost daily wind action. This results in a rather uniform distribution (top to bottom) of oxygen and temperature within the reservoir. This isothermal condition also results in higher turbidity values than in a stratified reservoir with similar physical and chemical properties. In addition, during isothermal periods, non-mobile phytoplankton would be continually transported from the lighted-euphotic zone to deeper waters where the light was insufficient for photosynthesis. This would reduce the potential production of these photosynthetic phytoplankton. In spite of this mixing phenomenon, Lake Ashtabula experiences blooms of blue-green algal during the summer (Johnson, et al., 1974).

4.020 The following facts indicate that Pembilier Reservoir would be eutrophic and would experience most or all of the problems associated with a eutrophic lake (including algal "blooms", low dissolved oxygen, fish kills, and "excessive" weed growth during some periods): (1) Lake Ashtabula does not thermally stratify; (2) its calculated phosphorus loading rate is about 10 to 100 times less than that determined for Pembilier; (3) algal blooms do occur annually at Lake Ashtabula; and, (4) phosphorus loading for the proposed Pembilier Reservoir is probably greater than that determined for La Farge. In light of these preliminary results, the advisability of conducting an extensive water quality survey of the proposed Pembilier Reservoir and an evaluation of the data to determine the probable quality of the impounded and release waters to a more precise degree than is possible from the data presently available becomes evident. (Reference paragraph 1.027).

4.021 Under anaerobic conditions, nutrients, previously unavailable because they were adsorbed on exchange complexes or were present as insoluable forms, could be released from the bottom sediments and dissolved in the overlying waters. Nitrogen, phosphorus, carbon dioxide, bicarbonates, iron, and manganese are but a few parameters that would be expected to increase in an anaerobic hypolimnion while pH would decrease. Hydrogen sulfide could also be expected to occur in the hypolimnion, considering the high sulfate concentrations present in the inflow waters.

4.022 During the release of water from the reservoir (hypolimnion and/or epilimnion) the dissolved oxygen content of the water would approach or exceed saturation due to the turbulent mixing during discharge. The dissolved oxygen concentration, would, however, begin to decline immediately due to biochemical and chemical oxidations. These oxidation processes would reduce the dissolved oxygen concentration in the stream, for some undetermined reach, and to an extent dependent upon the oxygen demand, temperature, and dissolved oxygen concentration after turbulent mixing.

(The release of nutrient enriched, hypolimnetic waters that contained large quantities of reduced compounds would exert a greater oxygen demand than epilimnetic waters.) The oxygen demand of the release waters could, under certain conditions, be great enough to produce septic conditions for a reach downstream which could preclude all but specially adapted life forms.(1) Under conditions of lowered temperature (the actual stream temperature would depend upon the reservoir outlet design, operating plan, and the ambient air temperature), the reach of stream subjected to lowered dissolved oxygen could be extended because biochemical reactions would proceed at a reduced rate. As the oxidations continued, the B.O.D. would be reduced, and instream aeration and photosynthesis would eventually increase the dissolved oxygen to levels capable of supporting more desirable aquatic species.

4.023 It is probable that the dissolved oxygen would not be completely reduced to zero concentration.

4.024 Average annual solute concentrations of the Pembina River, although indicative of a high nutrient supply, are somewhat misleading since runoff from the watershed is irregular during the year. December, January, and February are the months with the lowest average stream discharge while April, May, and June are the months of maximum discharge. During periods of high runoff, concentrations of most solutes decrease as evidenced by the lower total dissolved solids and specific conductance values. However, it is during the months of maximum runoff that nitrates and phosphates, probably the most important plant nutrients, exhibited maximum concentrations in the stream water (exhibit 3). In addition, total suspended solids increased dramatically during the high runoff periods. As an example, for the period October 1968 to September 1972, total suspended solids for the months of April to June averaged 210,394 tons/month, while for the remainder of the year the average was only 3,966 tons/month. Suspended material, depending upon its size, origin, and composition (organic or inorganic) can include appreciable quantities of nutrients in adsorbed and/or combined forms. Once deposited in the reservoir, microbial action and desorption could release some of the nutrients into the water providing additional growth stimulus to aquatic plants and increasing the biochemical oxygen demand. Nutrient may also be removed from the water column by adsorption onto suspended solids that later settle out in the reservoir. The equilibrium between adsorption and dissolution of materials from dispersed particles is due to a multiplicity of factors and is generally not well understood. Further studies would be needed to determine the magnitude and direction of the adsorption-dissolution reactions that might occur in the proposed reservoir.

4.025 Water with a high nutrient content would have a less then average residence time in the reservoir because this water occurs during periods of high runoff. However, following release of any temporarily stored floodwater, the remaining water could have a nutrient concentration sufficiently high enough to provide the necessary requirements for high

---

(1) Organisms (mostly bacteria) that are able to obtain oxygen under anaerobic conditions by reducing oxygen containing compounds. Bautsch, 1948.

levels of plant production. Sawyer (1947), in studying Wisconsin lakes, predicted that nuisance blooms of algae could be expected if spring concentrations of phosphorus (as ortho-phosphate) and nitrogen of 0.01 mg/l and 0.30 mg/l, respectively, occurred. At the time of release of stored floodwater, the reservoir should have many times these concentrations (based on river water concentrations). Whether or not algal "blooms" would occur in the reservoir would depend on many factors in addition to nutrient concentration, e.g. temperature, turbidity, operation plan.

4.026 A beneficial function of high flows on the Pembina River is the dilution effect it provides for effluents from downstream waste stabilization lagoons. Although the North Dakota State Department of Health has established standards for effluent discharges (Regulation 61-28-05.2, IV), the discharges in the basin must be controlled, i.e. they need to be released during periods of adequate flow. Releases during low flow conditions could result in certain parameters exceeding State standards. By reducing the normal high flows in the river, the rate and duration of effluent discharges may be modified as a result of the project. This should not present a significant problem for the treatment plants operations.

4.027 Biological Considerations - With the change from a lotic to a lentic environment, communities of plants and animals would exhibit more vertical stratification than existed in the stream environment. Thermal stratification would excentuate this stratification, but even in its absence, stratification of the biological components would occur, although to a more limited extent. The reservoir would contain a trophogenic region where organic production occurs and a tropholytic region where decomposition predominated. Species of plants and animals that are capable of directed motion may exhibit daily migrations to and from the euphotic zone. Horizontal stratification would also be more pronounced in the lentic environment. There would be a transition of both plants and animals species as one proceeded from the shallow, littoral zone of a lake to the deep benthic zone.

4.028 The effects of this stratification would be to increase the diversity of aquatic habitat, over existing conditions, and thus the potential for a more diverse biota. Pollution and/or eutrophication tends to reduce the diversity of organisms by excluding them from certain areas of the environment (e.g. an anaerobic hypolimnion). Typically, in such cases, the total diversity of organisms is decreased while the numbers of those species that are able to exist in the altered environment is increased because of a reduction in competition.

4.029 Based on previous experiences with eutrophic lakes in the general geographical area, a seasonal pattern of algal growth would be expected. During and following spring drawdown, diatoms (Chrysophyta) and green algae (Chlorophyta) would probably dominate the algal populations. Depending on the temperature and turbidity at this time, "bloom" conditions may be experienced. Algae of these phyla are generally considered inoffensive even at high biomass levels. Subsequent peaks of algal population from July through September would probably contain large

quantities of blue-green algae (Cyanophyta). It is this phylum of algae that is generally responsible for most algal nuisances. Many species of blue-green algae produce foul odors and may liberate toxic substances during large die-offs that generally make the water unsuitable for recreational uses. Algal "blooms" also represent a considerable B.O.D. potential during die-offs. Oxygen concentrations can be reduced to levels below that required by many organisms, and can result in "summer kill" conditions. Also, blue-green algae are not generally important in the foodwebs which lead to the production of desirable fish species, and in fact, may interfere with such webs through competative exclusion of more desirable algal species.

4.030 'Blooms" of blue-green algae (probably Aphanizomeon Flos-aquai) occurred in 1962 in Rock and Pelican Lakes in Manitoba and required the posting of these lakes to prevent the possibility of serious illness to recreationists. Data from Homme and Ashtabula Reservoirs in North Dakota (Farmer, et al., 1974; Johnson, et al., 1974) indicate that algae problems occur in these reservoirs with inflow concentrations of nitrogen and phosphorus lower than those expected at the Pembilier site. More serious problems at these reservoirs are probably obviated by the fact that they do not thermally stratify and thus maintain a degree of turbidity that reduces the potential for excessive algal growth.

4.031 Rooted aquatic plants would probably not represent a serious initial problem in the proposed reservoir because of its relativity steep sides, although about 20 percent of the total surface area of the conservation pool probably would be at a depth suitable for their growth, i.e. 8 feet or less. However, as the reservoir began filling with sediment, the amount of shallow area would increase, providing more areas suitable for rooted aquatic plants and creating marsh-type areas dominated by bulrushes, arrowhead, and cattails. As the sediments accumulated, more open water areas of suitable depth would be colonized by pondweed, coontail, and water lilies because of the rich nutrient source provided by the sediment. The development of rooted aquatic plants would also be effected by reservoir operating plans and by "shading" from dense algal populations.

4.032 Dense growths of emergent aquatic plants would provide seasonal habitat for many wildlife species, particularly waterfowl. Submergent plants would also provide cover for fish. However, the protection of small fish from predation, as well as reduced angler success that can occur due to dense growths of aquatic plants, could contribute significantly to the creation of stunted fish populations that would generally be unacceptable to anglers.

4.033 "Weed" beds would also reduce the recreation potential of the affected areas by interfering with most water related activities and could reduce and eventually prevent the utilization of facilities such as boat docks in these areas. Adverse recreational aspects attributed to excessive plant growth would be obviated to some extent by locating recreation facilities at the deep end of the impoundment and through manipulation of bottom contours and materials.

4.034 Rooted aquatic vegetation would be beneficial in reducing shoreline erosion and would act as a sediment and nutrient trap, reducing the contribution of nutrients to the reservoir during certain periods. Increased sedimentation in these areas would, however, tend to increase plant production in the littoral zone by increasing the amount of area with suitable substrate and depth.

4.035 It is not known at this time whether hypolimnetic discharge from the reservoir during the summer would have a significant effect upon algal biomass in the reservoir. It is possible that by decreasing the volume of the nutrient-rich hypolimnion prior to the fall overturn that the nutrient concentrations in the reservoir during the winter might be lowered, thus reducing the chance of a "winter kill" problem. It is unlikely, however, that such an operation would affect spring-summer nutrient concentrations in epilimnion of the lake due to the high concentration of nutrients in the runoff inflow at that time.

4.036 Hypolimnetic discharge would probably have significant effects on a reach of stream below the dam. At worst, septic conditions could be experienced for some undetermined stretch followed by a gradual return to pre-dam conditions. At the other extreme, a stream with an abundant plant community could exist due to decreased turbidity, increased nutrients, and increased stability. This type of situation could lead to night-time dissolved oxygen problems due to the B.O.D. of the release waters and the additional respiration demand of the large plant community.

4.037 There would probably be a dramatic change in the numbers and diversity of invertebrates in both the reservoir and the downstream reaches of the river. Following construction of an impoundment, downstream invertebrate populations generally increase in numbers but species diversity declines. However, because of the poor environment that presently exists, species diversity would probably also increase below the dam. The reservoir would probably experience an increase in both numbers and diversity. Invertebrate production downstream would increase over the present condition because of more stable flow conditions, reduced turbidity, and increased plant growth (due to higher nutrient concentration of the water) which would provide additional food and living space. Types and species of invertebrates occupying the new lake environment would be more or less characteristic of other lakes in the area with their distribution dependent upon turbidity, oxygen concentrations, and current.

4.038 Fish production in the reservoir and in the downstream reaches would be significantly increased over that in the existing stream. At present, fish production is limited by both acceptable living space and food supply. The shifting bottom sediments, high turbidity, and variable flow conditions that presently exist in the Pembina River are not suitable for production of plants and invertebrates. With more stable flows and less sedimentation, the downstream reach of the Pembina River would support a higher fish population. It may be possible, through selective withdrawal, to provide temperature and dissolved oxygen conditions that would be amenable to some species of game fish. This would be investigated under post-authorization water quality studies and would be coordinated with the agencies having fishery management expertise.

4.039 Fish production within the reservoir should be high. Species such as bluegills, perch and bullhead, should do well in the reservoir with little active management. Walleye and northern pike could probably exhibit good growth in the reservoir but their success would depend on a stocking plan as spawning sites would be limited. Largemouth bass could probably exhibit early success in the new environment until over production of other species

(sunfish and perch) exerted pressure on them through predation on eggs and fry. As the reservoir aged, fish production should stabilize at a fairly high level. Due to sedimentation and excess cover provided by littoral zone plants, much of the fish production would probably be provided by a very large biomass of small, stunted fish because predator pressures would be insufficient to keep their population size under control. It is possible that by management techniques, such as drawdown and poisoning, that some control could be exerted over the fish populations. These management techniques, along with possible downstream management, would be examined in greater detail during a postauthorization phase of the project. It should be noted, however, that the North Dakota Game and Fish Department has expressed no interest in managing the reservoir fishery but would offer professional advice regarding reservoir operations.

VEGETATION

4.040 Productivity - Productivity of the land would be adversely affected through the foregoing of part of the periodic enrichment caused by the siltladen floodwaters. However, this conclusion does not consider the (generally controllable, depending upon agricultural practices) erosion losses to agricultural land during flooding. The distinction is drawn here between reduced basic productivity and project-induced increased average crop yields which the farmer would realize in his lifetime through reduced flood losses.

4.041 One of the most obvious effects of the proposed reservoir on the present environment of the reservoir area would be the direct loss of about 800 acres of bottomland community types. These communities lie below the 1010-foot contour interval and would be permanently inundated by the conservation pool. An additional acreage would be affected by the reservoir clearing operation (to 3 feet above permanent pool elevation or within 100 yards of the pool, whichever is less), for placement of the structures themselves, and for the procuring of borrow material. (borrow areas would be identified during later phase studies).

4.042 Well developed bottomland vegetation is not restricted to the immediate area of the proposed reservoir. It occurs below the proposed dam as well as upstream of the reservoir. This community type would not be unaffected in spite of its location away from the reservoir pool area. Studies have shown that the presence of a reservoir on a river can have a significant effect on the existing pattern of vegetation, even though it is not in the immediate vicinity of the dam.

4.043 In studies along the Missouri River in North Dakota, a decided change in the vegetation of the floodplain was observed immediately below Garrison Dam following its closure (Hibbard, 1972). Investigations in the late 1950's indicated that the floodplain contained a dense growth of herbaceous vegetation and that the various species of trees showed a typical healthy growth. By 1968, after at least 15 years without a flood, many cottonwood and box elder trees had dead branches and appeared to be dying. The herbaceous vegetation also showed the effects of drier conditions with some mesic species having been eliminated in the time interval. Johnson (1971) later quantified these phenomena through increment borings. He found that "measurements of numerous cores extracted from the six tree species indicate a substantial reduction in the growth of most species since the cessation of flooding in the bottomlands along the Missouri River. The major tree

species in the floodplain (cottonwood, American elm, green ash, and box elder) exhibited marked decreases in the total radial growth between the period of high flood frequency (1940-1955) and the period of flood protection (1955-1970)."

4.044 Lago (1971) studied floodplain vegetation in north-central Minnesota along the Upper Mississippi River. Stands located above a power dam constructed in 1909 were compared with stands below the dam. The major tree species in the upstream stands were green ash, American elm, and silver maple. Green ash was also a dominant tree in the downstream stands although its average importance value was less than in the upstream areas. American elm, another dominant in the downstream as well as the upstream stands, had a slightly higher average importance value below the dam. The distribution of silver maple, a species which apparently is not present at the Pembilier damsite, was significantly affected by the construction of the reservoir. This species was almost entirely restricted to upstream stands. Box elder responded in a similar fashion.

4.045 Green ash, a species which was more abundant above the dam, has been shown to be more tolerant of flooding than many tree species including American elm and silver maple (Green, 1947). Green also found that green ash exhibits a positive growth response following a flood, an observation confirmed by Lago.

4.046 Germination, seedling establishment, and early development are also affected by flooding (or lack of it) and the period of inundation. Hosner and Minckler (1960) found that box elder seedlings tolerated flooding quite well while green ash was only slightly less tolerant. American elm was less tolerant than either box elder or green ash but more tolerant than most other deciduous tree species which occurred in the study area. Lago (1971) found that among the tree species present in this study area, green ash exhibited the highest density, both above and below the dam, but its density was significantly less in the downstream stands relative to upstream green ash stands. A similar pattern existed for box elder. Not all the differences could be attributed to the direct effects of the flooding regime, however, since some of the species, notably balsam poplar and trembling aspen, exhibited significant responses to disturbance of the forest canopy. Disturbance of the canopy could be a direct effect of an altered flooding regime, however.

4.047 A definite difference was also observed by Lago in the shrubby species. The lack of a well developed shrub layer in vegetated areas which are frequently flooded has been noted in several studies (Wanek, 1967; Yeager, 1949). Lago found that overall, there were approximately four times as many shrubs per acre below the dam as above it, and nearly all the shrub species had higher densities in the downstream stands.

4.048 In addition to the rather obvious differences in the woody species above and below the dam, Lago also observed differences in the herbaceous species composition of the two areas. The general pattern below the dam was again that of increased numbers of more mesic deciduous forest herbs and a decline of those more typical of wet bottomlands.

4.049 This vegetation pattern was a reflection of differences in the physical environment that could be attributed to the presence of a dam and reservoir. The floodplain environment above the dam was wetter than below and was subject to periodic flooding and to longer periods of inundation. Lago (1971) observed standing water in his upstream stands as late as August.

4.050 Disruption in vegetation patterns similar to those described above can be anticipated for the proposed Pembilier Reservoir. The flood tolerant timber species, such as green ash and American elm along with box elder, would be dominant in areas upstream from the dam provided that the trees are not killed by silt deposition and excessive moisture. Effects found by Lago (1971) are expected to be more pronounced in the case of Pembilier Reservoir because Lake Bemidji, in Lago's study, has relatively insignificant floodwater storage and the inflowing water is much less turbid than the Pembina River. A significant decrease in the density of flood tolerant timber species in downstream locations can be expected as the drier environment results in conditions more favorable to upland species such as balsam poplar, aspen, bur oak and paper birch.

4.051 Over a time span of perhaps two decades, as the floodplain timber species would decline in vigor or die out and be replaced, a dense downstream shrub layer could establish itself below the dam. The increase in most of the shrubby species below the dam would be the result of reduced frequency of flooding and the absence of prolonged periods of inundation.

4.052 Forest herbaceous species can also be expected to parallel the herbaceous communities discussed by Lago (1971). The composition of the bottomland stands upstream from the conservation pool may remain unchanged and typical of wet bottomland types, or may show an increase in wet-adapted species. The herbaceous vegetation may also become more sparse due to siltation from floodwater storage. Below the damsite the hydric (wet-adopted) species would die off and be replaced by the mesic (moderate moisture-adapted) species.

4.053 These conclusions are generally consistent with the work of Burgess, et al. (1973), who found that foregoing of flooding causes the productivity of floodplain stands to decrease. Those workers also found the productivity of the lower forest levels to decrease, which appears to be inconsistent with the findings of Lago (1971), and which would indicate a greater adverse effect than suggested by Lago's work.

4.054 While most of these effects would accrue to wooded areas, the productivity of the occasional wetlands below the dam (such as in old oxbows) could also be adversely affected through some foregoing of the nutrient enrichment and water recharge associated with frequent flooding.

4.055 The dam would probably affect vegetation downstream until major tributaries, such as perhaps the Tongue River, were reached. Effects would be moderated below the major tributaries, and it may be assumed that the impacts would occur to a degree similar to the reduction in flood damages in downstream areas. Although floods greater than the once in 36-year flood would not be completely controlled by the proposed project (they would, however, be attenuated somewhat), these vegetational changes are claimed because a review of the literature suggested that much of the effect was associated with the more frequent flood events.

4.056 While bottomland types represent the largest vegetation types that would be permanently inundated by the conservation pool, floodwater storage would occasionally inundate vegetation to elevation 1086 (during the 100-year flood even with surcharge storage). This means that communities not now subject to periodic flooding would occasionally be flooded if the reservoir were constructed. Slope characteristics and edaphic factors seem to be the factors responsible for the existing vegetation types on the valley walls. Many of the plant species now restricted to the slopes or the uplands are probably there because they cannot tolerate flooding. If these environments are periodically flooded, these species may be eliminated. They would not be eliminated from the general area, however, since they also occur on the level uplands. On the other hand, there may be some species presently characteristic of the bottomland which might be able to occupy certain of the slope sites for the same reason that others are eliminated. Species likely to be affected most dramatically would be herbs and shrubs. There would probably be a significant decline in the diversity of shrub species below the upper limit of the design pool.

ANIMAL RESOURCES

4.057 The impact of the proposed reservoir on terrestrial animal resources is perhaps more dramatic and, hence, more easily interpreted than it is for the aquatic organisms. While certain aquatic species would gradually be eliminated as the reservoir fills, other species would become more abundant. They would probably not be rapidly eliminated as would many of the terrestrial species.

4.058 Several authors have reported on the effect of permanent flooding upon wildlife and vegetation. Yeager (1949) has studied the effects of an impoundment created by the Alton Dam in Illinois. He found that terrestrial species of mammals were eliminated while in the shallow, upper end of the reservoir mink populations remained stable and muskrats increased. These effects cannot be directly compared with the effects of Pembilier Reservoir, however, because of a different regime of water level fluctuations. There was also a great increase in several species of herons. With the appearance of marsh vegetation, red-winged blackbirds increased, while woodpeckers became temporarily more abundant in the flooded and dying timber.

4.059 A report written at the time of the initial filling of Garrison Reservoir (Hibbard, 1954) illustrates impacts on terrestrial animals: "Two beaver colonies had already been eliminated, for water covered their lodges... The lower or primary floodplain is entirely covered with water to a depth of approximately 3 to 4 feet, causing harmful effects on several species of animals. Cottontails have been forced out of the brushy bottomland and are now very abundant where the ice of the reservoir meets the foot of bluffs on the west side of the river.

Porcupines and squirrels have not been greatly affected as yet for they move over the ice from tree to tree, utilizing cottonwoods and box elders considerable distances from shore. With this sudden increase in prey species, mainly cottontails, large numbers of predator species apparently moved in, for in about a 1 mile stretch of the present reservoir shoreline five fresh cottontail kills were found. Most of these kills appeared to be made by coyote or fox while one was definitely an avian predator, probably a horned owl. No other trace of any furbearer except skunk was noted." Other mammals, such as mink and raccoon, had apparently already vacated the area, for none were evident.

4.060 Large reduction in the numbers of terrestrial birds also occurred due to the impoundment of Garrison Reservoir. An estimated 400,000 pairs of breeding birds, consisting of 30 to 35 forest dwelling species and probably a greater number of forest edge and open country birds, contributed to this total.

4.061 In contrast, populations of a number of terrestrial species were increased by the formation of the reservoir. Chief among this group were waterfowl. Use of the unimpounded Missouri River by these species was negligible except for minor use by late-season mallards and geese. By 1963, 10 years after the closing of the dam, waterfowl use on the reservoir had reached a high estimated at 460,000 birds (Enyeart, 1964). Several other bird species dependent upon fish or aquatic invertebrate populations also increased. Included among this group were great blue herons and double-crested cormorants which soon formed large colonies on inundated timberland. Several species of gulls and terns also became numerous as the reservoir filled. Eagles have also concentrated along the Missouri River reservoirs which may or may not be to the detriment of the species. Pembilier Reservoir may show some of these effects although the magnitude would be smaller, or some of these effects may not occur because the areal extent of altered habitat would be too small.

4.062 Woodland bird species would be one of the major groups of animals affected should the reservoir be constructed. Based on a conservative population estimate of 300 breeding pairs per 100 acres, the habitat of about 2,400 pairs of breeding birds would be eliminated by the proposed 800-acre conservation pool. An undetermined additional acreage would be sufficiently disturbed to eliminate the breeding of typical terrestrial woodland species from the affected area. Thus, the reservoir might be expected to reduce by about several thousand pairs, the number of breeding birds currently utilizing the area. Additional pairs would be eliminated from upland sites due to dam building operations and parking site construction. This loss would be somewhat counterbalanced by the addition or redistribution of water-oriented species which are now infrequent in the area.

4.063 Most species would lose all or nearly all of their present population within the conservation pool area and some of the adjacent land area within the reservoir flood pool. In some cases losses of certain species would be offset by the addition of new species. As indicated in the reservoir studies cited earlier, several heron species and other fish-eating birds would probably become more abundant than they are now. Chief among these species may be the great blue heron.

4.064 Increased use of the reservoir area by migrant waterfowl may compensate to some extent the loss of wood duck habitat. However, the loss of wood duck habitat is of particular concern because it is a rare bird in North Dakota. Since the reservoir is largely surrounded by woodland and/or steep slopes, it is doubtful that a substantial increase in breeding waterfowl would occur, as flooded timber and the surrounding forest lands would not generally provide good waterfowl nesting habitat. The reservoir may be an asset to waterfowl by providing temporary migration habitat, especially for diving ducks. This would not necessarily cause an increase in population levels, however. Rather, the waterfowl populations would probably be merely redistributed with the Pembilier birds coming from other migration stop-over areas.

4.065 Although most of the true woodland bird species would be eliminated from the area through the loss of preferred habitat, some species which frequent forest-edge or water-edge habitats, could increase, e.g. kingbirds, several species of sparrows such as the song sparrow, and several of the warblers, provided that floodwater storage allows suitable habitat to exist. It is possible that birds using a sparse, tree-covered shoreline may increase while those requiring low, brushy growth would not find suitable habitat. Some "streamside" species such as the kingfisher, bank swallow and rough-winged swallow, which make nest burrows in high banks, should experience population increases because erosion along the reservoir shoreline should provide the high cut banks needed for nesting habitat. The most conspicuous population increases, however, should accrue to the shorebirds which frequent mud-flat types of habitats.

4.066 The ruffed grouse, the primary upland game bird of the area would be affected through a loss of habitat. The most important mammalian game species in the Pembina River watershed, and the one that would be most affected by rising reservoir waters if the dam were built, is the white-tailed deer. Although loss of year-round deer habitat would occur, of more significance would be the loss of winter habitat for deer spending the summers on the surrounding uplands. At least one recognized deer "yard" would be adversely affected by the reservoir. In the case of some species, such as white-tailed deer, moose, lynx, and coyotes, human activity and habitat changes would create a "zone of influence," having negative effects, beyond the zone of physical changes caused by the project. Also, the project would interrupt the movement of some terrestrial species up and down the valley.

4.067 The effects of the reservoir upon the remaining groups of terrestrial animals would be similar to that just discussed. Larger vertebrate animals would leave the area, although it is recognized that the loss of habitat would ultimately cause a corresponding decrease in populations. Smaller vertebrates, including some of the smaller species of amphibians, reptiles and mammals, may be caught on temporary islands within the pool area and be eliminated. To the extent that the habitat of these various species become unsuitable due to permanent or intermittent inundation, the population levels would decrease. The decrease would be permanent for practical purposes for many of these species. Certain other species may

repopulate the area of the flood storage pool after intermittent inundation. Due to the changes in habitat, it is certain that their population levels would change, but the extent and duration of change has not been determined. Terrestrial insects and other invertebrates inhabiting the area of the proposed conservation pool would be replaced by aquatic representatives of those groups.

4.068 Endangered Species - As noted in paragraph 2.087, the only endangered species reported to occasionally frequent in the project area is the eastern timber wolf. However, there are several other species occasionally found in the valley which are rare on a regional basis; these species include the lynx and moose. Reservoir construction and operation would remove and adversely affect the habitat or potential habitat for these species. The present project plans do provide for avoiding certain additional adverse effects, however, since the recreational facilities are planned only for areas near the dam, in part so that as great an area as possible can be preserved in an undisturbed state.

4.069 Natural Areas - Several designated natural areas would be affected by the reservoir; however, accurate assessment of effects must await more detailed date on location than is presented in table 12. The Little North Pembina Gorge Area, judging from its description and acreage, would be partially within the flood pool limits. Although storage would back up only into about the lower sixth of the Little North Pembina Gorge, the large designated acreage suggests that this lower area, and perhaps part of the main gorge, is part of the natural area and would be affected as discussed earlier under effects on vegetation and animal resources. Natural areas which would be downstream of the dam and affected through partial foregoing of flooding, as discussed earlier, are the Tetrault State Forest, Foxen Grove, St. Joseph Woods, and McLarthy Grove. From the descriptions of these natural areas in table 12, it is apparent that the project's effects would be adverse and would consist of reduced productivity, loss of vigor and/or death of certain vegetational components, and a change in species composition. A change in species composition is of particular significance for a natural area since the area would no longer exhibit the range of conditions which qualified it for designation originally.

4.070 Wetland Areas - Some wetland areas in old oxbows would be directly affected by inundation during reservoir creation. Some wetlands downstream of the dam would also be adversely affected as noted earlier. Of greater interest, however, is the possible effect of the project on upstream wetlands. There is a concern by local State, and Federal interests that providing some degree of flood control would allow upstream interests to drain wetlands with less concern for the consequences on downstream landowners. There is presently a moratorium on drainage by Governmental bodies in the basin, and there is some concern that creation of the reservoir would result in lifting of the moratorium. However, because the moratorium does not apply to private drainage and because of a lack of clarity in certain parts of the law applying to drainage, wetlands in the upper part of the basin are presently being drained regardless of the moratorium. It is not expected that this trend in wetland drainage will continue at the present rate for the reasons presented in paragraph 3.008.

GEOLOGY

4.071 General - Those items considered in the evaluation of the impact of the proposed dam and reservoir on the geology of the basin are as follows: seepage and reservoir leakage problems, effect on groundwater conditions, downstream erosion, reservoir slope stability, effect on mineral resources, and effect on unique geologic features.

4.072 Seepage and Reservoir Leakage - Seepage from a reservoir is generally considered to involve the slow migration of water through pervious materials and, although it may at times be a nuisance, is generally not dangerous. Some seepage is expected at most reservoirs. Leakage, on the other hand, implies the rapid loss of water from a reservoir and is considered potentially dangerous or sufficient to render a reservoir inefficient for storing water. Both types of water loss may be caused by an inadequate embankment design, buried channels, fissured rock at abutments or narrow divides, or pervious reservoir walls and floors combined with a low regional water table. Seepage is expected at the abutments of the proposed Pembilier embankment and must be accounted for in the embankment design. The reservoir would be set in the impervious Carlile Formation so that a water loss through the valley walls and floor is not considered a problem. No elements at the site have been discovered which would indicate that water loss from the reservoir would be a problem.

4.073 Effect on Groundwater Conditions - The general geology of the area suggests that the portion of the river valley in which water would be impounded is neutral in the groundwater system. This means that the impervious shales of the valley walls act as barriers to the migration of water. They would, therefore, merely act as a container for a reservoir and not allow the effects of a raised water level in the river valley to be transmitted away from the immediate vicinity of the valley.

4.074 An impervious cutoff under the proposed embankment would retard the downstream migration of water through the sediments underlying the floodplain at the embankment. Due to the thin and narrow cross-sectional area of pervious soils at the dam, it is not likely that any significant amount of water passes through the soils to recharge downstream aquifers. Robbing downstream aquifers in the Pembina River Valley of discernible recharge is therefore not considered a problem.

4.075 Downstream Erosion - Erosion of channel banks downstream from a reservoir due to the increased erosive potential of the water, from which the normal load has been removed, is recognized as a potential problem. Increased control of discharges and elimination of seasonally excessive flows should, however, offset the problem to a great extent.

4.076 Reservoir Slope Stability - The stability of the slopes bordering the reservoir is recognized as a problem. It has been suggested that landsliding along the reservoir would be of such a magnitude that the reservoir would be filled with debris to the extent it would be ineffective for flood control and that the valley walls would be badly scarred. A preliminary study of the problem was made by the Corps and was addressed to a determination of the magnitude of the problem rather than identification of specific problem areas. The conclusions derived from the study are as follows:

> Some slope failures along the reservoir after inundation are expected, but they would have no more than a nuisance effect on the operation or efficiency of the reservoir. The types of slides expected are shallow slumps and debris slides which would leave scars on the landscape. Massive slides that would be considered hazardous to the embankment, boaters or persons on the shoreline are considered extremely improbable.

4.077 Effect on Mineral Deposits - The reservoir would not inundate any known economic mineral deposit. The only resource with any economic potential that would be flooded by the reservoir is part of the Carlile Formation which was once used as a source of clay for bricks. The probability of renewed extraction of this material for any purpose is so low that its inundation cannot be considered an adverse effect.

4.078 The construction of the dam would not deplete mineral resources in the basin. Earth fill for the embankment is locally abundant. Based on present criteria, local aggregates could not be used for concrete; therefore, all materials for concrete would be obtained outside of the basin. It is anticipated that rock for stone protection would be obtained outside of the basin; however, some fieldstone piles west of the damsite may be used resulting in a reduction of the number of piles present in that area.

4.079 Unique Geologic Features - The conservation pool would permanently inundate the valley to elevation 1010 and would cover a portion of the Carlile Formation, the oldest exposed bedrock in the State. Information obtained from the North Dakota State Geological Survey placed the top of the Carlile Formation at 1100. Based on this information, a significant portion of the Formation would remain exposed and, in this regard, the unique character of the valley would be retained.

SOCIAL IMPACTS

4.080 During the past years, conflicts between Canadian and American floodplain residents have arisen over attempts by residents of both countries to reduce flood damages to their own interests. The seriousness of the confrontations are generally related to the severity of the floods. The conflicts have surfaced because of levees constructed on both sides of the Pembina River and along the Canadian side of the International Boundary which prevent overflow drainage of floodwaters and prolong the period of inundation and increase the damage sustained by the North Dakota residents. This is the situation as it now stands.

During an earlier time, land use and meteorological conditions apparently did not result in levels of flood damages which were of sufficient concern to prompt extensive structural controls in the watershed. In recent years, changing flooding regimes have prompted basin interests to undertake structural controls which largely protect their own interests but which also led to adverse effects in other areas. The "overflow drainage" is therefore a relative term, is somewhat speculative, and is meant to apply to the period before levee construction along the Pembina River and the international border. The proposed reservoir would contribute significantly to a reduction of these border disputes to the advantage of area residents of both countries.

4.081 The extent of economic losses suffered by urban communities in the floodplain is minor in relation to agricultural losses. However, the relatively frequent occurrence of large floods in recent years has resulted in increased concern of urban residents, particularly at Neche.

4.082 Construction of the reservoir would require the purchase of about 5,800 acres of land in the river valleys upstream of Walhalla for flood control and an additional 13,200 acres for wildlife mitigation. In addition, 2 farmsteads within this area would be acquired. Acquisition of project lands would be made in accordance with provisions of Public Law 91-646, the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. Residents forced to sell their property would be compensated at appraised full market value and would receive additional compensation for moving and related expenses. Relocation would be considered an adverse impact of the project as it would represent a hardship. Relocation would sever long-standing social ties while areas of possible relocation would probably not have the same amount of intangible qualities, such as general setting and scenic view, as present sites. In order to provide flood protection to a major sector of the public, a small sector, i.e. those subjected to relocation and/or acquisition of their lands, would be forced to assume the major portion of the adverse social impacts.

4.083 With increased flood protection downstream, some changes in land use and/or intensity of use would be anticipated. These changes could result from more intensive agricultural utilization of existing crop lands and development of lands that previously proved uneconomical for agricultural uses. Sectors of the economy, other than agriculture, would also be stimulated due to a reduction of flood frequencies and the prospect of a more dependable water supply. These secondary, or induced, benefits would have undefined social, economic, and ecological impacts associated with them.

4.084 Current and foreseeable conditions in the Pembina basin, east of the escarpment, indicate that existing water supplies would be sufficient to meet the needs of Walhalla and Pembina but not for Neche. With the current and future commitments of the Neche water treatment facilities, i.e. the Canadian towns of Gretna and Altona and rural areas, an unsatisfied need exists for a larger and more dependable water supply. Inclusion of water supply storage in the proposed reservoir would eliminate the need to develop an alternate water source. In addition to direct social and economic benefits associated with a more dependable water supply, secondary impacts would occur from future economic development that was stimulated due to the assurance of an adequate water supply.

4.085 The proposed Pembilier Dam would provide protection from a flood with a recurrence frequency of about once every 36 years and would redefine the floodplain area for the larger, less frequent flood events The protection afforded would result in a reduction in anxiety and misery of floodplain residents and would produce a considerable economic gain to floodplain enterprises (mainly agriculture) through a reduction of damages resulting from frequent floods. Social and economic benefits would also accrue, but to a lesser extent, to areas along the Red River of the North downstream from its confluence with the Pembina River. Reduced expenditures for repair of flood-induced damages to roads and bridges would benefit county taxpayers.

4.086 Recreational utilization of the permanent impoundment behind the proposed dam would contribute to the social well-being of area residents. Preliminary evaluation of the potential trophic condition of the impoundment has, however, created doubts whether the lake would be capable of supporting high quality water contact recreation. These doubts are based on a preliminary examination of water quality parameters which indicate that the potential for a highly eutrophic situation exists. As a result, the quality of the fishery would depend upon natural conditions, and to some degree the selected reservoir operating plan. It would be expected that after a few years the trophic status of the lake would result in nuisance growths of algae and rooted aquatic vegetation and a fishery composed of "rough" fish and stunted game fish. When such conditions begin to occur it would be expected that local pressure groups would attempt to obtain governmental assistance for some form of lake rehabilitation. Such events would result in a new series of social problems. It should be noted, however, that lake rehabilitation projects dealing with non-point problems generally fail to achieve their desired goals.

4.087 Impact of Project on Existing Recreation - The impact resulting from creation of Pembilier Lake on the existing recreational utilization of the project area would not be large. This is due to the fact that the types of recreation activities presently performed along the Pembina River would generally also be performed at Pembilier Lake (including fishing, hunting, sight-seeing, etc.). However, there would be a change due to the project's inducing generally greater recreational participation in the project area and due to a shift among the types of recreation, e.g. the area available for upland game hunting would be reduced while the impact on existing water-based recreation would be minimal due to existing low levels of participation and opportunity for this type of activity in the project area.

4.088 Impact of Recreation Development on Lands - Impacts to the land would be minimized through a conscious effort to eliminate adverse effects of recreational development on the land and water. This would include the preservation of existing native vegetation wherever possible, the utilization of stringent design standards for sewage disposal, and the development of optimal facilities not exceeding the carrying capacity of the site.

4.089 Project Impact on Cultural Resources - As stated in section 2, one property on the National Register of Historic Places is located in the general project area, the Gingras House and Trading Post. It is unlikely that this site or any other historic sites would be affected by the project. However, should any information to the contrary come to our attention, compliance with all relevant regulations would continue. Coordination has been initiated with the National Park Service, the North Dakota Historical Society, and the North Dakota State Archaeologist (exhibit 14) to insure compliance with section 106 of the National Historic Preservation Act of 1966 in accordance with procedures of the Advisory Council on Historic Preservation and Executive Order 11593, "Protection and Enhancement of the Cultural Environment."

4.090 A reconnaissance of the project area has indicated that at least 19 lithic archaeological sites are present and would be inundated or otherwise adversely affected by the project. A complete survey of the area of project influence would be undertaken before construction begins and salvage operations would be conducted if necessary. If additional archaeological sites were discovered during construction, work would be halted until a professional archeologist could inspect the sites. The proposed project would affect no other known federally or non-federally owned districts, structures, or objects of historical, architectural, or cultural significance.

4.091 Although salvage of archaeological sites in the project area would increase man's knowledge of the prehistory of the valley and thus be of some benefit, the net result of salvage would be decidedly adverse for several reasons. Due to time constraints, those sites which are salvaged may be hastily and incompletely excavated and hence some of the data collected and the resultant interpretation must suffer. In addition, salvage in lieu of preservation is not recommended as it is expected that excavation techniques will improve. Salvage does not allow the opportunity to return to a site in the future to gather additional data or use refined techniques as they become available. A less than desirable aspect of salvage is that gathering of field data can be done only once. If the area is inundated, the opportunity will be foregone to thoughtfully investigate the complex of sites in the project area. Lastly, the survey program would sample but part of the area, and some archaeological sites could escape detection. While it is true that the salvage program would uncover some of the significance of the Pembina River Valley prehistory, some knowledge would necessarily be lost. However, preservation is preferred to salvage excavation while salvage is preferable to the destruction of a site without adequate research being done.

5.000 PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

5.001 General - Temporary and unavoidable adverse impacts include dust and siltation of the river as well as noise and unsightliness generated by construction activities of the project. Specific long-term adverse impacts relate to the elimination of valley vegetation, cropland, wildlife, 9.5 miles of free flowing river, and to the creation of a lake with potential water quality problems. Certain impacts, if not permanent, can be considered prolonged for the life of the project. The previous section of this document noted the uncertainty surrounding the nature of many impacts; some of these would ultimately prove to be adverse.

5.002 Aquatic Resources - Approximately 9.5 miles of free flowing stream would be supplanted by the conservation pool of the proposed reservoir. The existing aquatic environment in this area would be subjected to an abrupt vertical and horizontal expansion, with associated changes in physical and chemical parameters, all to the detriment the stream system within that reach.

5.003 Preliminary estimates of the trophic status of the proposed reservoir, based on existing stream water quality data, indicate that the lake would be eutrophic. The reservoir would probably exhibit thermal stratification and would experience problems associated with oxygen depletion in the hypolimnion. Nutrient concentrations in the reservoir would be conducive to the production of large numbers of blue-green algae. Die-offs following periods of algal "blooms" could potentially create serious problems for recreationists, as well as fish populations, due to offensive odors associated with the accumulation of decaying plant material, release of toxic substances, and depletion of dissolved oxygen. The potential for the production of aquatic macrophytes would also be great. Extensive "weed" beds would contribute to stunting of fish populations in the lake and would limit angler access in some areas of the lake.

5.004 The dam would restrict or eliminate normal upstream and downstream movements of fish and other aquatic organisms. The quality of the waters discharged from the reservoir would impact on downstream aquatic systems. The magnitude and direction of the impacts would depend upon the quality and quantity of the discharge waters.

5.005 Vegetation - Approximately 800 acres of unique river valley; of which about 365 acres are wooded, would be destroyed due to permanent innundation. This would bring about the elimination of the current ecological balance between the vegetation and other physical and biological systems. Adverse impacts extend to the imposition of unnatural changes in species diversity and hence community stability. These disruptions of communities would not be limited to the perimeter of the reservoir alone but would extend downstream, upstream and landward from the reservoir for varying distances.

5.006 Plant communities not generally subject to flooding would be periodically submerged within the design flood pool up to an elevation of approximately 1080. The adverse impacts associated with periodic inundation would be proportional to the timing and duration of submergence. In general, a decline in the herbaceous and shrubby species below the upper level of the flood pool would be expected. Changes in the patterns of slope vegetation would occur as floodplain species become established in areas not normally suitable for hydric species. Upland timber may be adversely affected by minor changes in the groundwater levels. As downstream areas are deprived of periodic inundation, productivity and numbers of wet-adapted plant species would decrease and they would be replaced by those that are adapted to a drier environment.

5.007 Animals - Adverse impacts would extend to disruptions of current community stability through the elimination of animal species requiring the terrestrial habitat (food and cover) provided within the river valley. Animals experiencing the greatest population losses would be white-tailed deer, ruffed grouse, fur bearers such as beaver, and numerous bird species that utilize the area as breeding habitat. While immediate losses would occur within the area of the permanent pool, adjacent flood-pool areas would experience losses related to the frequency, timing, and duration of periodic flood storage. In the case of some species, such as white-tailed deer, moose, lynx, and coyotes, human activity and habitat changes would create a "zone of influence," having negative effects, beyond the zone of physical changes caused by the project. Also, the project would interrupt the movement of some terrestrial species up and down the valley.

5.008 Recreation - Elimination of a scenic section of a free flowing river and alteration of additional upstream areas would represent an adverse impact to active forms of recreation, such as fishing and canoeing, and to passive recreation pursuits. Current active recreation utilization of the river is, however, limited because of low flow conditions during the summer. The quality of the upland game hunting experience would be adversely affected as reservoir encroachment into wildlife habitat and use of the recreational facilities would discourage wildlife utilization of those areas.

5.009 Deteriorating water quality and excessive plant production within the reservoir would adversely impact on the recreational utilization of the lake. The decline in the quality of the lake fishery would also constitute a negative impact on lake-oriented recreation.

5.010 Social Effects - The project would require that some lands presently used for agriculture be converted to flood damage reduction purposes. This would constitute an adverse impact to those so affected and a corresponding adverse economic impact. Purchase and relocation of two farms within the floodpool area would also constitute an adverse effect even though compensation of economic resources would be based on a fair market appraisal.

6.000 ALTERNATIVES TO THE PROPOSED ACTION

6.001 Formulation was undertaken to develop an overall plan which would provide the best uses, or combination of uses, of water and related land resources to meet the identified needs of the Pembina River basin. The formulation process therefore involved identification and development of alternative measures, evaluation and comparisons of alternative plans, and the selection of an overall plan.

6.002 A set of planning objectives was used as a general guideline for the formulation process. Components of the planning objectives are identified as they apply to the two national objectives of national economic development and environmental quality. This is done through an analysis of the various problems, needs, concerns, and opportunities within the basin area. The following is a list of the planning objectives used in this study:

a. Provide protection from and prevention, reduction or compensation of flood losses for the flood prone areas of the basin.

b. Development of any plan should preserve to the maximum extent possible the quality of the existing riverine environment, enhance the environmental and/or recreational potential of that environment where possible, or provide reasonable compensatory measures for losses incurred.

c. Identify the water supply needs and plans for providing a future source for water supply in the basin.

6.003 In addition to the above objectives, various indirect social objectives guide development of the plan within the formulation process. For this study the indirect social objectives include:

a. Developing a plan which is responsive to the local people's desires and needs and which is acceptable to the local sponsor.

b. Enhancing the social well-being of the basin, which includes local interests on both sides of the International Border.

6.004 Alternatives are developed by considering the list of planning objectives. Since this list serves as a guideline, the alternatives developed must be capable of satisfying at least some or all of the objectives. It is important to note that the alternatives developed should be realistic and not so remote as to be purely speculative.

6.005 The various impacts of the alternatives developed are identified by comparing the existing or base condition without any alternative to that of the estimated condition with an alternative. For this

study the base condition is defined as one of floodplain regulation coupled with flood insurance. For the analysis and comparison of alternatives and for eventual selection of the basic plans, a standard set of criteria is used to compare the alternative considered with the base condition. Criteria were considered under the major catagories listed below:

a. Technical

b. Economic

c. Environmental

6.006 Technical criteria consist of appropriate engineering standards, regulations, and guidelines. Since such a list would be extensive, it is not included.

6.007 Economic criteria consist of identifying and comparing benefits and costs of an alternative. Generally, tangible economic benefits of a selected plan must exceed costs; however, in certain instances, consideration of appropriate gains in environmental quality, social well-being, and regional development could reverse this condition and result in a plan with a benefit-cost ratio of less than one being authorized. Annual costs and benefits are based on an interest rate of 6 1/8 percent and price levels and conditions existing in October 1975. A 100-year amortization schedule was used for all features considered.

6.008 Environmental and other considerations call for the selected plan to minimize any objectionable or adverse environmental effects and to maximize environmental benefits prior to, during, and following construction. Also, consideration will be given to plan modifications based on coordination with State and Federal agencies, the citizens advisory committee, and other interested local citizens. The public's acceptance of the proposed plan and its ability and willingness to meet local cooperation requirements are essential considerations.

6.009 The most important water resource needs of the basin were identified as primarily flood control, and secondarily water supply. Possible solutions to satisfy these needs are evaluated in the following paragraphs.

6.010 Solutions considered to meet the flood damage reduction needs of the basin were classified as either nonstructural or structural. Each alternative in these classes was compared against the base condition using the criteria previously mentioned.

6.011 Based on the effectiveness of the existing water supplies in satisfying the water needs, and the possibility of a potential increase in the water use of the basin, supplemental or alternative sources of water supply will be needed. Potential water supply alternatives for the basin include both surface and groundwater sources.

6.012 Various nonstructural and structural measures could reduce the potential for flood damage in the Pembina River basin. Nonstructural alternatives include: base condition (assuming floodplain regulation and flood insurance); flood warning and forecasting services and emergency protection; and permanent floodplain evacuation and flood proofing. Structural alternatives include: multiple-purpose reservoirs, a "dry" dam, floodways, channel modifications, levees, and various combinations of these. In this study, 14 alternative measures for alleviating flood damages in the Pembina River basin were considered. These measures and a brief synopsis of the related economic, biological, and social impacts are discussed in following paragraphs.

6.013 Since Federal and State laws and regulations pertaining to many nonstructural measures are based upon the intermediate regional flood, this flood frequency is used in discussing nonstructural alternatives. The nonstructural alternatives primarily provide for reductions in flood damages to buildings, ancillary facilities, and contents. The structural alternatives provide for reduction of flood damages principally to agriculturally-related flood problems. Since the intermediate regional flood is not a practical flood to consider when dealing with agricultural flood problems and "level of protection" is not so constrained by existing laws and regulations, the structural alternatives were evaluated at levels of development where the optimum degree of flood protection would be lower and as could be provided with each particular alternative. These various plans represent the most practical level of development for each alternative and recognize that the degree of flood protection provided by each would be different.

NONSTRUCTURAL ALTERNATIVES

ALTERNATIVE 1: BASE CONDITION (NO ACTION)

6.014 The base condition consists of floodplain regulation and flood insurance, as currently required by Federal policies and encouraged by the State of North Dakota. Floodplain regulation consists primarily of regulating new development or redevelopment in existing floodplain areas, thus preventing or reducing future flood damages. Flood insurance by itself does not prevent or reduce flood damages, but does assist in reimbursing affected property owners of existing development for losses sustained from flooding. Flood insurance affords the individual affected some economic protection from flood loss by spreading his losses over a larger portion of the population and/or over several years.

6.015 The State of North Dakota encourages flood prone local governmental units to adopt, enforce, and administer sound floodplain management ordinances in their respective jurisdictions whenever sufficient technical information is available for delineation of floodplains and floodways on their watercourses. Based only on preliminary technical

information (flood hazard boundary map), the city of Neche and townships in Pembina and Cavalier Counties have adopted, or will adopt, resolutions controlling land use. Currently, there are some problems over which governmental bodies in North Dakota will assume the responsibility of administering rural floodplain regulations; however, persons living in floodprone rural areas will soon be eligible to participate in the flood insurance program.

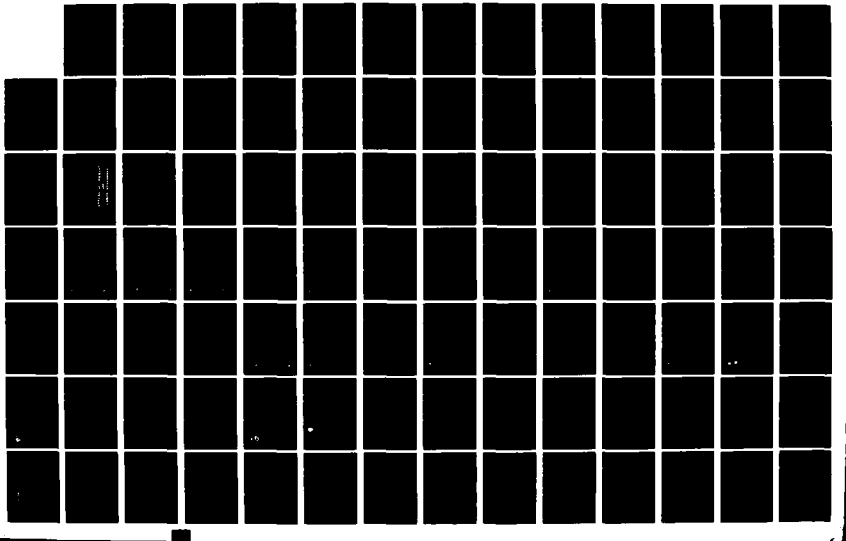
6.016 The deadline for a local unit of government to participate in the flood insurance program is 1 July 1975 or 1 year after the date of issuance of the flood hazard boundary map, whichever is later. These resolutions controlling land use are only temporary, but will remain in effect until a flood insurance rate study is completed. Once this is accomplished, permanent land use controls must be adopted by the community within 6 months. Individual properties in violation of these permanent land use controls will not be eligible for subsidized coverage under the flood insurance program. For structures already existing in the floodplain, a high percentage of the flood insurance premium is paid by the Federal Government. When necessary engineering data become available, actuarial rates are established, and new structures would be insured at the actuarial rates. Coverage can also be obtained on contents of the buildings, and higher coverage than prescribed by regulation is available at actuarial rates. Current prescribed limitations for subsidized flood insurance coverages are $35,000 for single family residential, $100,000 for multifamily residential, $100,000 for non-residential, $10,000 for residential contents, and $100,000 for non-residential contents. Unsubsidized crop insurance is also available under the U.S. Department of Agriculture Federal Crop Insurance Program which covers all natural disasters including floods.

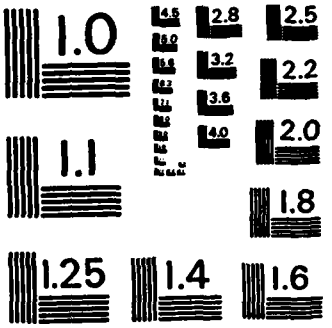
6.017 In the future, under floodplain regulations, the existing flood prone developments would be considered nonconforming uses which would be eliminated or upgraded over a period of years; however, this process would be a protracted one. Although it remains a decision of property owners whether to participate in the flood insurance program, owners located in the flood hazard areas must obtain flood insurance coverage to qualify for mortgage or home improvement loans or disaster assistance loans. Over a long period of time virtually all homes and businesses subject to flood damage will be covered as properties change hands. Because flood prone home and business owners can, by purchasing flood insurance, obtain home improvement loans, and because residential and business contents values can be expected to increase, flood damages due to large floods are expected to increase even with floodplain regulations in effect.

6.018 The Flood Disaster Protection Act of 1973 (Public Law 93-234) requires that the local unit of government adopt adequate floodplain regulations with effective enforcement consistent with Federal standards before Federal or federally-related financial assistance is available for any building located in a flood hazard area. The two areas of

AD-A121 523 FINAL ENVIRONMENTAL IMPACT STATEMENT PEMBILIER LAKE AND 2/3
DAM PEMBINA RIVER BASIN NORTH DAKOTA(U) CORPS OF
ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 77

UNCLASSIFIED F/G 13/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

thrust of the regulations would be: (1) preventing backwater effects of more than 0.5 foot during a one percent flood, assuming other encroachments in the floodplain (the floodway would not be designated for rural areas, but rather the evaluation would be on a case by case basis); and (2) preventing damages to new structures by, for example, requiring construction to be on sites raised above the level of the one percent flood.

6.019 Floodplain regulation measures include zoning regulations, subdivision regulations, building codes and bridge construction regulations.

6.020 One of the major problems with this alternative is a general unwillingness of property owners to participate in the program. In the project area, only a few residents seem to be taking advantage of the available insurance program. The lack of acceptance is due to differences between State and Federal laws and to the nature and intent of the program. The payment of insurance premiums would in many cases be prohibitively expensive. The intent of the actuarial rates is to internalize the economic risk of floodplain development, that is, make those who develop in the floodplain pay the full costs of that development (instead of having Federal subsidies through some other type of program such as disaster assistance or structural flood damage reduction). In order to participate in the program, the local unit of government must adopt appropriate floodplain regulations. Actuarial rates for new structures damageable by a one percent flood would theoretically not be applicable, then, since the regulations should prevent such construction. Incentive for participation in the program when constructing new structures is strong since flood insurance is required for Federal or federally-related financial assistance for any building located in areas identified by the Department of Housing and Urban Development (HUD) as having special flood hazards (i.e. in areas on a HUD flood hazard map or, when engineering data are available for delineation, within the one percent floodplain).

6.021 The economic and social impacts for residents of the floodplain would probably be great under flood insurance since it would internalize the costs of floodplain development more than any other plan. The public not residing in the floodplain would correspondingly experience the smallest adverse social and economic impacts with this plan. The small impacts for the larger public would be due to the nature of the program which, for example, does not allow Federal disaster relief for insured properties. This would reduce Federal costs to Federal subsidy of insurance payments until the existing structures became obsolete and were replaced, at which time Federal participation would theoretically end. Therefore, this plan could be very acceptable to the larger non-resident public. Because the recommended plan would not provide complete protection against the one percent flood, this alternative would be applicable regardless of project construction, although the area of applicability would be somewhat reduced.

6.022 Strict floodplain regulations also have some adverse effects. An example is the situation of owners of flood-prone property who want to sell or extensively repair or remodel property to increase its longevity, utility, and/or value. It may be difficult to borrow money from a bank or other loan institution for a mortgage on a home located in a flood-prone area. Likewise, it may be nearly impossible for the owner of that property to sell it at what would be an acceptable price to him, and this in turn can result in financial losses to some individuals, particularly at a time when they may be forced to relocate elsewhere for personal reasons.

6.023 The initial effects of an effective floodplain zoning program would generally be adverse to those people owning flood-prone property. However, this alternative would primarily affect those individuals that have developed in the floodplain and would not cause extensive effects on the human or natural environment at some distance removed from the problem area.

6.024 Biological impacts of this alternative would be, in balance, positive, particularly in the long term and to the extent that adverse effects of other alternatives are foregone. A problem with this alternative is that damages to crop production and existing developments rather than potential increased damages to future structures and facilities constitute the major flood problem under study.

ALTERNATIVE 2: FLOOD WARNING AND FORECASTING SERVICES AND EMERGENCY PROTECTION

6.025 Flood warning consists of reasonably predicting the time and magnitude of a flood to allow for evacuating the flood prone areas or erecting emergency flood protection measures. Flood warning and forecasting services for the Pembina River basin are provided by the National Weather Service Forecast Area Office, located in Fargo, North Dakota. Daily stage readings and when appropriate, crest forecasts, are available at that office for dissemination to the general public through local weather wire and telephone to newspapers, radio and television stations, and the St. Paul District Corps of Engineers.

6.026 In general, warnings of flood stages and crest forecasts from snowmelt runoff are provided about 7-10 days in advance. Providing this amount of time is available, emergency protection works could be upgraded, made higher, or built for Neche and other flood prone areas having valuable structures. The spring snowmelt flood can be reasonably predicted by methods currently available. Large major floods that result from excessive summer rainfall can also be predicted, although the occasion has not arisen in the basin to date. However, the time interval between rainfall occurrence, issuance of a flood warning, and beginning of flooding is relatively short. A more extensive network of rainfall and runoff gages might improve the flood warning system for floods from excessive rainfall; however, the time element between rainfall and flooding would still be very short. Emergency evacuation of persons and belongings or construction of emergency flood protective measures might well be undertaken for the spring snowmelt floods.

However, these emergency measures would be much less effective in preventing damages from floods resulting from excessive rainfall runoff. Emergency protection may be adequate for smaller floods; however, floods of larger magnitude could create structural stability problems due to hasty construction and allow an uncomfortably high probability of failure, and a potential for loss of life.

6.027 Use of this alternative alone would mean continued anxiety for the residents during flood seasons and community disruptions during actual floods. Damages would remain high since fixed developments, particularly in the rural areas, such as homes, businesses, utilities, schools, and agricultural lands would remain subject to damages and only the most portable personal belongings could be saved. However, flood damages would remain even after implementation of any of the plans considered, although the levels or river stages and flood damages would vary among the plans.

6.028 These measures would intermittently disrupt the biological system and scenic quality of the flood prone areas of Neche. The environmental impacts of this alternative are essentially the same as for the base condition.

6.029 Flood forecasting and warning and subsequent emergency actions are considered important features of any flood protection plan but individually are felt to be unacceptable long-term solutions.

ALTERNATIVE 3: FLOODPLAIN EVACUATION AND FLOOD PROOFING

6.030 Permanent evacuation of developed floodplain areas would involve acquisition of lands, removal and relocation of improvements, evacuation and resettlement of population, and permanent conversion of lands to uses less susceptible to flood damage. Lands acquired in this manner could be used for agriculture, parks, "natural" areas, or other purposes which would not interfere with flood flows. Flood proofing would consist of a combination of structural changes and adjustments to properties subject to flooding primarily for reduction or elimination of flood damages. Adequate landfill to raise building foundations, and control of basement construction and structural strength to withstand high water pressures, can also be elements of effective flood proofing. Although best applied to new construction, it is also, in certain instances, applicable to existing facilities.

6.031 This alternative would mainly involve the evacuation of the city of Neche and either evacuation or flood proofing of the rural farmsteads located in the flood prone areas of the basin. For this alternative the depth of flooding was used to determine whether evacuation or flood proofing of the identified flood prone farmstead buildings would be undertaken. All buildings which had less than 2 feet of flooding above the existing ground level from the 100-year flood or were located within 100 feet of the 100-year flood outline would be flood proofed. All other flood prone structures, except most farm buildings, would be evacuated. Using these criteria 263 homes and 14 businesses

in Neche and 303 farmsteads would be either evacuated or flood proofed, although the majority of farmsteads would be flood proofed. Care would have to be taken to assure that flood proofed farmsteads would not become isolated during major floods. However, social effects of flooding during severe floods, such as disruption of transportation and isolation of residents from their homes, businesses, and farming operations would probably largely remain.

6.032 The area in and around Walhalla would probably represent the primary relocation site for evacuated residences. This site is located approximately 17 miles west of Neche and consists primarily of cropland. Relocation to this site would remove about 450 acres of land from crop production.

6.033 After structures were removed from the hamlets and farmsteads to be evacuated, many of the evacuated sites would probably be cleared and converted to agricultural uses. This would probably involve clearing of several farmstead windbreaks since the primary purpose of a windbreak would no longer be applicable if the farmstead were removed. The land at the evacuated sites would presumably be of some agricultural value and would be used for agricultural purposes since one commonly sees old farmsteads being converted to tillable land. This would counteract to some extent the loss of cropland at the relocation site(s).

6.034 Social effects of the evacuation/flood proofing alternative would differ on a case-by-case basis and would depend upon individual points of view. As evacuation or flood proofing becomes imminent, the level of concern of the floodplain resident typically rises, and peaks during the construction period. During this period, evacuation or flood proofing would usually be viewed as decidedly adverse due to apprehension or the disruption in family life. After relocation or flood proofing is complete, the level of concern would ordinarily drop, and the effect could come to be viewed as negative or positive as the family becomes accustomed to the new situation. Some would see a gain if their new situation was better than the old; however, even if in retrospect they saw evacuation or flood proofing as desirable, they may still judge it to be adverse before or during the relocation. Others would see the post-construction situation to be less desirable because, for example, they may have to commute greater distances to conduct their farming operations. Evacuation or flood proofing may therefore be viewed as either negative or positive before construction, and one's viewpoint may change after becoming adjusted to the new situation. In any case, however, the temporary disruption during construction would be viewed as adverse.

6.035 On the overall scale, community patterns and some farm-to-market relationships would be substantially changed. There would be gains to public health and safety since the plan would constitute a very hazard-free solution to the problem to the degree desired. Flood damages to structures would also be essentially eliminated. However, agricultural damages, which are a substantial part of the problem, would remain. Economic disadvantages would accrue to floodplain resi-

dents through greater commuting costs or increased costs for any floodplain developments they chose to build in the future; however, this increased cost would not necessarily be a net cost but rather it would be borne more completely by the floodplain residents themselves. They would also have to contribute substantially to the initial project cost, unlike the situation for a major reservoir, for example, for which there is no local cost-sharing pursuant to the Flood Control Act of 1936. Local interests are understandably reluctant to accept the larger costs, and they would prefer a locally less costly project and would rather define a project as a "major reservoir" instead of a "reservoir in lieu of local flood protection". The local cost implications of the decisions can be large. The benefit-cost ratio for this alternative is 0.12 to 1.00.

6.036 With the evacuation and flood proofing alternative there would also be economic effects for the Canadian cities of Gretna and Altoona. These cities depend on Neche for their domestic water supply. The evacuation of Neche would, unless the water treatment facilities were maintained, require the development of an alternate water supply source for these Canadian cities.

STRUCTURAL ALTERNATIVES

ALTERNATIVE 4: MULTIPURPOSE PEMBILIER DAM AND LAKE (PROPOSED PROJECT)

ALTERNATIVE 5: PEMBILIER "DRY" DAM

6.037 The "dry" dam would occupy the same site as that recommended for the proposed Pembilier Reservoir alternative, i.e. the area about 2 miles southwest of Walhalla. There would be no permanent pool with this plan as water would be stored only as needed to prevent flooding downstream. The stored water would be released as quickly as possible without exceeding the downstream channel capacity.

6.038 The "dry" dam would have a lower trap efficiency than the "wet" dam (about 15 percent less) with more sediments passing through the pool. With the absence of a permanent lake and a reduction in the amount of sediment trapped by the dam, the size of the dam could be reduced without reducing the degree of flood protection. The total storage behind the dam would be 141,000 acre-feet, of which 128,000 acre-feet and 13,000 acre-feet would be assigned to flood storage and sedimentation, respectively. The degree of protection provided by this plan would be the same as for the proposed reservoir, i.e. a flood with the probable occurrence of once in 36 years.

6.039 Elimination of the permanent pool and a reduction in sediment storage would mean that, at the flood elevation, the volume would be 6,000 acre-feet less and the vertical extent of the full flood would be approximately 2 feet lower than with the "wet" dam.

6.040 No water supply and only limited recreation benefits would be attributed to this plan. Average annual benefits attributed to this alternative are estimated to be about $2.4 million, yielding a benefit/cost ratio of about 1.5 to 1.00.

6.041 The "dry" dam alternative was selected by the Ecological Advisory Sub-Committee of the Pembina River Basin Planning Committee as the highest priority structural alternative for solving the basin's flood problems.[1] Although the committee concluded that the boundary floodway plan (alternative 7) "would not have an adverse environmental impact on the Pembina Valley and would remove the flood waters to the Red River," it represented their second choice because it would have removed a larger amount of land from agricultural production than would the dam alternatives.

6.042 Long-term environmental effects associated with the "dry" dam alternative would depend, to a large extent, upon the degree and frequency with which the storage capacity was utilized. For any given flood, a lesser acreage would be innundated by the "dry" dam. However, since storage of a given flood behind a "wet" dam occurs on top of an existing water surface (in this case an 800-acre conservation pool), the amount of additional land inundated for a given amount of storage would be less with a "wet" dam. The "dry" dam would then impact upon a smaller area initially, but it would affect an incrementally greater area during floodwater storage.

6.043 With a lower trap efficiency, the "dry" dam would pass more sediments downstream. However, the major period of sediment transport would probably occur during periods of high flows and the difference between the "wet" and "dry" dam alternatives in this regard would probably be insignificant. During periods of high flow but no storage, however, the river could pick up some of the sediments that were previously deposited at lower elevations (nearer to the original river channel), and transport them to downstream areas. If the overall effect were to increase sedimentation downstream, then this would impact negatively upon the aquatic biota in those reaches. The suspended sediment load of the river during non-flood flow periods would probably be greater below the "dry" dam (closer to natural conditions) than below the "wet" dam.

6.044 The conspicuous difference between the "dry" and "wet" dam alternatives is the presence or absence of the 800-acre conservation pool. While the "dry" dam would result in less immediate deterioration of the terrestrial and riverine system of the valley, the long-term effects on these systems would be similar to those of the "wet" dam. On the other hand, various benefits attributed to the creation of a lake would be foregone. Water supply and lake oriented recreation

---

1 Report of the Ecological Advisory Sub-committee to the Pembina River Basin Planning Committee, p. 27. Nov. 8, 1971.

could not be provided with this alternative, and the ability to regulate downstream aquatic conditions would be abrogated, although the efficacy of this factor depends upon the quality of the water which would be released from the "wet" dam and upon the ultimate balancing of management goals for the lake and for the river downstream.

6.045 The Pembina River Valley receives heavy use by deer as a wintering area. Creation of a permanent pool would reduce the areas available for yarding and would eliminate, or render inaccessible, many normal travel lanes for the deer populations. The "dry" dam would permit the continued use of this area by deer populations although the quality of the habitat would be reduced.

6.046 As mentioned above, the biological impacts to the terrestrial environment of the flood pool would depend upon the amount and frequency of storage that occurs. It is conceivable that, after several years of operation, the effects of the "dry" dam on the terrestrial systems of the valley would be similar to those of the "wet" dam (with the exception of permanent losses in the conservation pool), and that the aesthetic degradation would be even greater with this alternative. It is also conceivable (or probable), that following a few years of operation, basin residents would realize the negative environmental effects of the "dry" dam and the benefits it precludes (water supply, water-based recreation) and would request conversion of the structure to a "wet" dam.

ALTERNATIVE 6: SMALL RESERVOIRS ON MAINSTEM TRIBUTARIES

6.047 The dams proposed under this alternative would be smaller than the proposed project and would be located upstream from Walhalla on the Little South Pembina, Little North Pembina, or main stem of the Pembina River. The Little South and Little North Pembina Rivers together constitute about 10 percent of the total of 2,715 square miles of contributing drainage area at the proposed Pembilier damsite. Accordingly, the tributary reservoirs would contribute little in the way of flood control to the lower Pembina basin. Similarly, a small reservoir on the main stem of the Pembina River would have no significant effect on flood reduction downstream.

6.048 Environmental impacts associated with this alternative would generally be similar in nature to those discussed for the proposed reservoir although at a much reduced level. The "lakes" created by this alternative would have less recreation and fishery benefits associated with them than with the large reservoir because of their small surface area and shallowness. Thermal stratification would probably not occur or would be of an ephemeral nature. Siltation would represent a major problem in these shallow reservoirs. Sedimentation would soon reduce their recreational potential as they "silted in" and evolved to a marsh-type environment. This, however, would increase their value to waterfowl and aquatic mammals such as beaver, mink, and muskrats.

6.049 Although no exact sites have been proposed for this alternative, the fact that flood damages would not be significantly reduced eliminates this alternative from further consideration as a significant solution to the basin's identified water resource problems. The benefit-cost ratio for this alternative was 0.42 to 1.00.

ALTERNATIVE 7: BOUNDARY FLOODWAY

6.050 The boundary floodway alternative would consist of the construction of a small diversion dam about 3 miles downstream from Walhalla which would permit normal flows in the natural river channel but would divert flood flows into a floodway. The floodway would extend 32.6 miles from the diversion dam generally north to the International Boundary and then directly east, south of the International boundary to the junction with the Red River of the North just downstream from the city of Pembina. The floodway would be designed to pass a flow of 3,300 cfs with 3 feet of freeboard. The slope would vary with the depth and width of the channel to maintain non-erosive velocities in the channel. The design velocities generally are at 3.5 feet per second with a maximum velocity of about 4.5 feet per second. Four drop structures would be necessary throughout the length of the floodway, including one drop structure where it empties into the Red River of the North. The channel depth would vary from about 5 to 12 feet, and the right-of-way width would vary from about 160 to 340 feet.

6.051 A diversion dam would be constructed across the Pembina River at the beginning of the floodway. At the design flow of 6,300 cfs, 3,000 cfs would be allowed to pass down the normal river channel and the remaining 3,300 cfs would be diverted into the floodway channel. For the design flood, operation of the diversion structure would necessitate flooding approximately 600 acres directly upstream from the structure. In the event of a 100-year flood, approximately 900 acres would be needed to impound floodwaters. To accommodate this temporary water storage, flooding easements on approximately 1,100 acres of land would be obtained at and upstream of the diversion structure. The combined existing Pembina River channel and floodway capacity of 6,300 cfs would provide protection against about an 11 percent chance flood. In addition to the flooding easements, 1,000 acres of land would be obtained in fee title for the channel and associated structures and easements on an additional 1,400 acres would be needed to place the excess excavated material from the floodway channel. Almost all of the land affected would be agricultural land. Road and railroad bridges would be replaced with this alternative and several structures would be needed for outlets of existing drainage systems in order to prevent unnecessary flooding of adjacent farmland and to reduce erosion in the channel.

6.052 A study was conducted to determine the effects of the floodway upon flood stages along the Red River of the North into Canada. For one of the past floods of record (1971 flood), there exists about a 2-percent chance of the floodway contributing to the peak flood stages along the Red River of the North into Canada. Generally, however, the floodway would have little or no effect on peak stages along the Red River of the North in Canada.

6.053 Construction of the diversion structure would result in unavoidable short-term impacts such as increased turbidity downstream from the site and increased noise and dust levels. Impacts to vegetation in the area would be of longer duration.

6.054 The suspended solids concentration of the Pembina River is normally very high and the probable addition of material from the diversion construction site should result in only minor, if any, impacts to either downstream water quality or the aquatic biota in this reach of the river. The diversion structure would be located in a sparsely populated rural area so that the noise and dust associated with its construction would affect only a very small number of people.

6.055 Terrestrial vegetation in the area of the diversion structure and ponding area consists of well developed overstory, shrub, and ground vegetation layers. Wooded areas in the ponding area are interspersed with cropland, marshes, oxbows, and grassed areas. The bottomland hardwood forests are comprised mainly of basswood, cottonwood, green ash, American elm, willow, and aspen. Trees exhibit various stages of development and the forest canopy has many openings. The shrub layer in these areas is well developed and contains chokecherry, red osier dogwood, Juneberry, hazel, and abundant tree reproduction. The ground vegetation is also well developed with assorted grasses, forbs, and ferns in addition to an accumulation of litter.

6.056 Construction of the diversion structure would remove some of this vegetation. However, the area proposed for the diversion structure and tie-back levees is more sparsely vegetated with bottomland hardwoods than other areas, either up- or downstream. The loss of wooded areas directly attributed to construction activities would be quite limited and would not represent an important loss of this habitat type for the watershed. In addition, disturbed areas would be revegetated within the regulations pertaining to levee construction and maintenance.

6.057 Probably the most serious environmental effects of the boundary floodway would result because of the necessity to pond floodwater. Storage of floodwaters behind the diversion structure would be necessary for two reasons: to direct the flood flows into the floodway; and, to permit flow releases that would not exceed the capacity of either the existing river channel or the floodway channel, i.e. 3,000 cfs and 3,300 cfs, respectively.

6.058 The diversion structure would, in effect, function in a manner similar to that of a "dry" dam. Floodwaters would be stored for a period of time, being released at flows not exceeding the capacities of the channels. However, a "dry" dam located at this site and resulting in the same degree of protection, would not be feasible because the larger storage required (channel capac-

ity would only be 3,000 cfs), would inundate too large an area, and would require more extensive wing dikes. For these reasons, the only feasible damsites are located upstream of Walhalla in the valley area.

6.059 Effects of impounding water on the vegetation of the area would be related to the timing and duration of the flooding. The vegetation that presently occupies the ponding area does because of its ability to adapt to a particular set of physical and chemical parameters. One of the parameters is a certain amount of flooding. For this reason, the effects of inundation on the vegetation in this area would not generally be considered serious. This should not be construed to mean that there would be no effects but that, under conditions of minor early spring floods, the effects of temporary inundation could be minimal. Under less frequent flood conditions, such as those of long duration and those occurring later in the growing season, the effects on the vegetation would be more severe. Effects on animal populations in the ponding area would depend to a large extent on the damage incurred to the vegetation. In this regard, the amount of food and cover destroyed would be items of major concern as the immediate loss of many forms of animal life would be minor because of their relative mobility which would allow them to evacuate the area during periods of water storage.

6.060 The floodway corridor would require the purchase of approximately 1,000 acres for the channel proper and an additional acquisition of easements on about 1,400 acres for the deposition of excavated channel material. The floodway would traverse highly productive agriculture land over its entire route. Because of the current intensive agricultural utilization of the land within the floodway right-of-way, vegetation other than row crops consists mainly of shelter belts, grassed road ditches (which are burned frequently) and water-ways, and vegetation around farm buildings. Because of the minimal cover provided by the existing vegetation, the resident animal populations are mainly limited to small mammals. Numerous bird species utilize the area, mostly for food, and some nesting does occur in the shelter belts and grassed areas. Larger animals such as deer and coyote also utilize the area during certain times of the year.

6.061 Construction and operation of the floodway would have almost no net negative impacts on natural vegetation and animal populations in the floodway area. The floodway channel would be replanted with grass and would probably result in a net increase in habitat of the area, although the balance of types would change. The operation of the floodway could destroy nests constructed in the area prior to its use for removal of floodwaters but this would have no significant effect on populations of the area, as most bird species utilizing the area at this time would not as yet be nesting and/or would be capable of renesting following floodway operation (although the quality of nesting habitat would be diminished).

6.062 The floodway would increase the physical stability of the terrestrial system through reduced soil and bank erosion.

6.063 Aesthetically, the floodway and diversion structure would probably not have a serious impact on the area. The area has an extremely low relief with major breaks in the topography provided by raised roads, aeolian deposits along shelter belts, and flood control levees. The floodway would produce no more distortion of the existing landscape than occurs with the other structures.

6.064 About 1,000 acres would be removed from agricultural production in the area of the channel. The remaining areas of the floodway corridor and ponding area would be obtained through easements. Once excavated channel material had been disposed of, the disposal areas would again be available for agricultural utilization. Topsoil would be replaced on the disposal areas and their productive capacities would experience little permanent changes due to the deposition of excavated material.

6.065 The floodway would result in some inconvenience to local farmers where it divided continuous land holdings as the floodway would probably be too steep to cross in most areas other than at designated road crossings. Present road traffic patterns would be somewhat disrupted although provisions would be made for major highway crossings in the area.

6.066 Secondary, induced effects of the floodway (as well as with other alternatives that significantly reduce flooding) are anticipated. These may result in greater environmental impacts than the primary impacts associated with this alternative. Because the chance of flooding from small events would be essentially eliminated with this plan, it could result in intensified agricultural practices. These practices might include increased use of fall plowing, changes to more valuable crops such as sugar beets, and drainage of marginal lands and clearing of wooded areas along the rivers to increase the amount of arable land. All of these practices would reduce the value of the existing land as wildlife habitat and as such would impact on the environmental and aesthetic quality of the area.

6.067 The Pembina River Valley west of Walhalla is a unique natural resource in North Dakota. It represents one of the few wooded and relatively unspoiled areas of the State. Deer and ruffed grouse are plentiful, and even an occasional moose and timber wolf can be observed within the confines of this secluded valley.

The beauty and unique environmental qualities of the valley are irreplaceable in North Dakota. The alternative of the boundary floodway was selected as the most environmentally sound solution to the flooding problems of the basin because it would permit the character of the valley to remain in its present condition, would provide flood protection (although not complete), and could be achieved with almost no serious environmental consequences. However, it has a lower economic efficiency than the proposed project (B/C = 1.17), is socially unacceptable to the local populace (local costs are higher than with a dam) and would not present as complete a solution to the International Border problem as would a dam.

ALTERNATIVE 8: FLOODWAY IN THE LOWER REACH OF THE PEMBINA RIVER

6.068 This alternative was considered only briefly. The plan would consist of a floodway, similar to that described in alternative 7, that would be constructed from a point near the confluence of the Tongue and Pembina Rivers and would extend east about 3 miles to the Red River of the North. Environmental impacts associated with this plan would be similar to alternative 7 but on a much reduced scale because of the much smaller area of influence. Because this plan would not materially reduce the major water resource problem of the basin, i.e. economic losses due to flooding, and because it lacked economic feasibility (benefit-cost ratio = 0.13), it was given no further consideration.

ALTERNATIVE 9: CHANNEL MODIFICATIONS

6.069 This alternative involves enlarging and straightening approximately 42 miles of the Pembina River from Walhalla to its confluence with the Red River of the North. The considered modifications could be designed to contain a 3 percent chance flow.

6.070 This alternative, of all the alternatives considered, while offering economic benefits to the area, probably represents the greatest potential for adverse environmental effects over the widest area. According to the "Report on Channel Modifications" by the Council on Environmental Quality (1973), significant negative environmental impacts of channel modifications are related to: draining of wetlands; cutting of bottomland forests; cutting off oxbows and meanders; alteration of water-tables and stream recharge; erosion and sedimentation; downstream effects; and channel maintenance.

6.071 The general quality of a riverine environment is related to the diversity and interspersion of a wide range of physical and chemical parameters that result in a variety of more or less discrete habitats. These habitats provide the conditions necessary to support a diverse assemblage of plants and animals with a high production potential. The diversity of habitats in a riverine system is related to such factors as gradient, riparian vegetation, water depth, and watershed practices. These factors and others, in turn, affect such factors as current velocity, light patterns, the sequence of riffles, pools, and slack-water, nutrient loading, and suspended materials which in turn exert control over plant growth, debris

accumulation, sediment deposition, and substrate type. The above factors interact through various associations to increase the diversity of the system. The channel modification alternative would have adverse impacts through detrimental change to many of these parameters.

6.072 Although this reach of river would be considered by most persons to be of lower aesthetic quality than the reach above the escarpment, the river, by its very existence, does impart aesthetic and scenic qualities to the downstream area. The river reach from upstream of Walhalla to its mouth was considered enough of a significant natural resource to be proposed for investigation as a possible wild, scenic, or recreational river during the 1971 Legislative Assembly (paragraph 3.010). The modifications associated with this alternative would cause an irreparable loss of the existing aquatic and terrestrial habitat and aesthetic qualities now associated with this reach of the river.

6.073 Straightening and enlarging of an existing river channel to increase its capacity to transmit peak flows, cuts off oxbows and meanders from the main channel, thereby reducing flows to these areas.[1] These areas are important feeding and breeding areas for many animal species. By reducing the production of forage species in these areas, a resultant decrease in the production of species at higher trophic levels would occur.

6.074 Current diversity is also reduced by channelization. The existing sequence of riffles and pools is altered and the resulting channel bottom exhibits less roughness than before.

6.075 Sediment production would be great during the initial construction operations and could result in serious impacts to aquatic organisms downstream from the channelized area. Similar effects would be expected during periodic channel maintenance work. During low flow periods, the river would attempt to meander within the new banks and could result in bank erosion and shifting of bottom sediments. The resulting unstable substrate would be detrimental to most benthic biota and would reduce the production within the modified channel.

6.076 Clearing of riparian vegetation would result in water temperatures that respond more quickly to ambient air temperatures, especially during low flow periods. Bank vegetation is also important because it reduces erosion, results in varied light patterns, and contributes allochthonous material to the stream which is a major food source for secondary producers. Removal of associated bottomland forests would also result in increased nutrient losses from these areas which could affect the trophic status of the aquatic system. Riprarian vegetation represents important habitat for many species of birds and animals. Vegetation changes in these areas, from cutting and/or alteration of the water regimes, would affect the existing animal populations.

6.077 Secondary effects due to weland drainage and changes in agricultural practices would also be expected although the degree has not been determined. Deepening the river would provide outlets for surface drains from the surrounding area which could result in an undetermined amount of wetland

[1] The following discussion draws heavily from the information contained in the report to the C.E.Q. cited previously.

drainage. Such practices would result in the elimination of many plants and animals associated with these habitats. Drainage could also have some affect on groundwater levels in the area by reducing the residence time of the water in the watershed, thus affecting recharge rates. Groundwater is a major contributor to low water flows in many streams. By reducing this water source, lower flows, higher stream temperatures, and lower dissolved oxygen concentrations could occur.

6.078 Agricultural utilization of previously unexploited or under exploited areas (wetlands, bottom-land forests) could increase nutrient and sediment inputs to the stream with effects similar to those discussed above.

6.079 Because of the serious impacts on the aquatic and terrestrial ecosystem, on the aesthetic qualities of the river, because the economic benefits associated with this alternative did not exceed costs (benefit-cost ratio = 0.67), and because flood control could be achieved by other plans with less environmental consequences, the channel modification alternative was not recommended as a solution to the water resource problems of the Pembina River basin.

ALTERNATIVE 10: LEVEES AT NECHE

6.080 Levees at Neche, North Dakota would consist of a ring levee around the entire town. The levees would be earth embankments except for the part at the west end of Neche which would be a road raise. Interior drainage facilities would be included to prevent flooding behind the levees in the event of heavy rain occurring simultaneously with Pembina River flooding. The construction of the levees and road raise would alter some natural vegetation and reduce a small amount of wildlife habitat. Landscaping and tree and shrub plantings would be included to partially offset these habitat losses. In addition, these plantings could improve the aesthetic appearance of the levees and aid in their stabilization. This alternative would provide Neche with protection against a 100-year flood but would not provide flood protection for the other flood prone areas of the basin. This alternative provides partial flood damage reduction in the basin, but is not economically feasible (benefit-cost ratio = 0.64).

ALTERNATIVE 11: LEVEES AT NECHE AND AGRICULTURAL LEVEES

6.081 This alternative would incorporate levees at Neche (alternative 10) with about 70 miles of agricultural levees (about 35 miles along each side of the river) to the mouth of the Tongue River. This alternative would provide Neche with protection against a 100-year flood while providing protection from a 10-percent chance flood in the rural flood prone areas of the basin. A majority of the existing temporary levees plus about 17 farmsteads would be removed with this alternative.

6.082 During construction and until revegetation occurred on the disturbed sites, increased turbidity and siltation (mainly during non-flood periods) would have negative impacts on the aquatic community of the river. Sediment would cover sedentary organisms such as mollusks, periphytic algae, and some insect forms. The increased sediment would also cover eggs of various aquatic organisms and would fill interstitial spaces in gravel areas, reducing circulation to eggs and/or organisms that may utilize this type of area. Suspended sediments can also irritate the body surface and gill membranes of aquatic organisms which can result in reduced respiration efficiency and/or sites for invasion of bacteria.

6.083 Longer term ecological effects would result from removal of riparian vegetation which moderate temperatures, provides variations in light patterns, contribute important allochthonous food sources and habitat for various aquatic and terrestrial forms.

6.084 The system of levees would also seriously affect aesthetic qualities that are attributed to this section of the river (see paragraph 3.010). In addition, increased flood protection could result in changing agricultural patterns (more land in production, production of crops with greater economic return) which could increase surface runoff and nutrient additions to the river. Many of the impacts associated with this plan would be similar to those expected with the channel modification alternative.

6.085 Although this plan would significantly reduce flood damages in the basin, damages would remain in the lower portion of the basin. Perturbations resulting from this alternative would be damaging to the environmental quality of the riverine system and, as with several other alternatives, would require mitigation to offset the expected losses. This alternative is also unacceptable to local residents because it would require the relocation of 17 farmsteads and would utilize some agricultural land for placement of the levees. In light of these factors and because it lacks economic feasibility (benefit-cost ratio = 0.72), this alternative does not offer an acceptable solution to the basin's flood control problems.

ALTERNATIVE 12: COMBINATION OF LEVEES AND BOUNDARY FLOODWAY

6.086 This alternative would consist of agricultural levees flanking the river from Walhalla to Neche. At Neche a small diversion dam would transfer flows, in excess of channel capacity, into a 16-mile floodway that parallels the International boundary and empties into the Red River of the North near the city of Pembina. Several farmsteads in the area of the agricultural levees would require relocation.

6.087 Biological, cultural, and economic impacts of this alternative are similar to those discussed for alternatives 7 and 11 except that the physical lengths of agricultural levees and floodway are about one-half the length in those alternatives. This alternative is unacceptable from the environmental and social viewpoints and because the economic costs outweigh the benefits (benefit-cost ratio = 0.85).

ALTERNATIVE 13: COMBINATION OF LEVEES AND REDUCED-SIZED PEMBILIER DAM

6.088 This alternative would involve construction of flanking agricultural levees from Walhalla along the Pembina River to the vicinity of the Tongue River in conjunction with construction of a dam and lake at the Pembilier site. The dam would contain an 800-acre conservation pool which would provide for downstream water supply and water-based recreational developments; however, the flood control storage behind the dam would be minimal because of the increased channel capacity downstream. The reservoir would have a conservation pool of 4,000 acre-feet plus a reserve of 13,000 acre-feet for sedimentation and a flood control storage of 4,000 acre-feet.

6.089 With the existence of a permanent lake, the potential for a limited lake fishery and associated recreational facilities exists. Also, a more assured source of water supply would be provided to meet downstream needs, while at the same time improve desired river flows.

6.090 The environmental effects of this alternative would be similar to those discussed for the proposed action and alternative 11, although the adverse effects on the valley environment would be reduced because of the smaller flood pool The minimal amount of flood protection provided, as compared to the cost, makes this alternative lack economic feasibility (benefit-cost ratio = 0.65).

ALTERNATIVE 14: COMBINATION OF BOUNDARY FLOODWAY AND REDUCED-SIZE OF PEMBILIER DAM

6.091 This alternative includes the construction of a small diversion dam downstream from Walhalla and an associated 32.6 miles of flood diversion channel along the International boundary in conjunction with a reduced-size Pembilier Dam. The Pembilier Dam of this alternative would be identical to the dam in alternative 13 in size, function, operation and economic value.

6.092 Environmental impacts of this alternative would be similar to those discussed for the boundary floodway (alternative 7) with additional impacts associated with the permanent lake and flood control pools of the dam. Although providing a high degree of flood protection for the flood prone areas of the basin, this alternative is not economically feasible (benefit-cost ratio = 0.79).

ALTERNATIVES CONTRIBUTING TO NATIONAL OBJECTIVES

6.093 The Water Resources Council in 1971 adopted the Principles and Standards for Planning Water and Related Land Resources. The principles and standards were developed in response to the 1965 Water Resources Planning Act that directed that "plans for the use of the Nation's water and related land resources will be directed to improvement in the quality of life through contributions to the objectives of national economic development (NED) and environmental quality (EQ)." The Principles and Standards recognize NED and EQ as co-equal national objectives and as such they must be considered along with other alternative plans.

6.094 National Economic Development (NED) Alternative - The NED plan attempts to address the range of planning objectives for an area while maximizing the net economic benefits. These benefits result from increases in the output of goods and services derived from the plan. Alternative 4, the proposed multi-purpose reservoir had the highest net benefits and benefit-cost ratio and thus constitutes the NED plan.

6.095 Environmental Quality (EQ) Alternative - The EQ plan, like the NED plan, attempts to address the range of planning objectives while emphasizing contributions to aesthetic, ecological, and cultural values. Beneficial environmental quality contributions are made by preserving, maintaining, restoring, or enhancing the significant environmental attributes of the Pembina River basin. The various structural and non-structural alternatives previously discussed were evaluated in an environmental context to develop an implementable EQ plan. From this analysis it was determined that the EQ plan would include:

a. Boundary floodway (alternative 7).

b. Off-channel storage at Neche for water supply.

c. Floodplain regulation and flood insurance at flood prone communities and rural reas in the basin (alternative 1).

d. Flood warning and forecasting (alternative 2).

e. Modifications to existing levees at Neche (alternative 10).

f. Land management practices consistent with environmental quality objectives.

The benefit-cost ratio for the EQ alternative is 1.15.

7.000 THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

7.001 We, the present generation, are the trustees of existing environmental resources for future generations. Current actions can restrict the options available to future generations for utilization of these resources and mitigation of problems. We should, therefore, justify our present commitment of these resources.

7.002 The proposed Pembilier Lake and Dam is not seen to be a short-term use of the environment. Although economic benefits accruing in the floodplain are often perceived to be a short-term use of the environment, this view is based on philosophical viewpoints and economic theory, not on physical phenomena. The reason for this is that flood control capabilities of the structure can be maintained far beyond the period of economic analysis. For example, when the allocated sediment storage is exhausted, flood control storage could be maintained to a somewhat more limited extent by reservoir flushing or a somewhat lesser degree of flood control could be accepted. Consideration of future economic factors at the present time would be of little significance because the nature of compound interest renders remote capturing of benefits and incurring of costs of little consequence, and thus would have no appreciable results on project design. However, it is appropriate to consider long-term environmental factors which extend well beyond periods significant for analysis of effects on national or regional economic development. For the environmental quality planning objective, a legitimate goal would be to achieve a desirable level of environmental quality during or at the end of the period of analysis and to maintain this level into the indefinite future.

7.003 Implementation of the proposed reservoir would, over the period of economic analysis, result in regional and national economic returns in excess of project costs, i.e. the project has a favorable economic benefit/cost ratio. Benefits would accrue through reduction of damages for almost all but the very rare floods; although most of the economic benefits would accrue through control of the smaller, more frequent floods. Although non-quantifiable benefits and costs, such as social benefits resulting from reduced anxiety and creation of recreational opportunities, and destruction of parts of natural ecological systems, are recognized, and to some extent identified during the planning process, they are not amenable to a concise type of economic analysis - the principal method used to determine project feasibility. Qualitative factors, for this reason, must receive serious consideration when determining the acceptability of an economically feasible project.

7.004 Creation of Pembilier Dam and Lake would result in the permanent loss of about 800 acres of a unique terrestrial system. It would also alter the productivity of the remaining components of the basin's ecosystems either directly or indirectly. Because of our limited understanding of the intricacies of biological systems and our inability to accurately predict environmental consequences of specific actions, much of this environmental impact statement is filled with speculations of possible consequences. Hopefully, this speculation is based on empirical data and represents a "current best estimate" of these consequences. Changes in plant and animal communities would occur both in the river valley and downstream as a result of the project. Providing the level of flood protection at the present time, by the recommended plan, would limit the flood control options available in the future. Loss of 9.5 miles of free flowing stream would further reduce an already diminishing supply of this environmental category.

7.005 When deciding between two or more economically feasible plans, non-quantifiable environmental and social factors may result in the selection of a plan that is not the one with the maximum benefit/cost ratio. Additionally, social pressures from certain citizen groups, i.e. local residents and environmental organizations, can influence the final recommendation between economically feasible plans.

7.006 Principles and Standards of the Water Resource Council requires the formulation of two plans with generally conflicting objectives. One, the NED (National Economic Development) plan is developed with the objective of maximizing economic concerns. The other required plan, the EQ (Environmental Quality) plan, attempts to maximize the environmental quality of the project area. It is the purpose of this procedure to develop a compromise plan that gives equal consideration to both of the above objectives. It is during this procedure that tradeoffs should be identified. The proposed project is viewed as a compromise plan that meets, to various degrees, the identified water resource objectives of the basin. The inclusion of lands in addition to those required for the project purpose of flood storage can be viewed as a tradeoff. These lands, however, should be considered as a form of compensation (given as an equivalent for losses suffered) for the wildlife production lost within the flood pool area. Aspects of the project operation, such as multiple gated discharge facilities and low flow augmentation, are considered as possible mitigation factors, i.e. features that would reduce the severity of project effects. Although the production lost on project lands can, to some extent, be compensated for by increasing production on similar lands in other areas, the loss of the ecological system that evolved on the project lands cannot be compensated. The effects of the loss of this

natural system should be considered a non-quantifiable cost of the project. Future generations would forego the environmental benefits associated with this system and would therefore suffer the environmental costs of our decision.

7.007 A realistic estimation of the economic worth of the existing river valley as a biological system is not feasible at the present time. An attempt to place a monetary value on the environmental effects of the project can, however, be accomplished by comparing the boundary floodway with the proposed project. The proposed reservoir and the floodway provide flood protection from events with expected frequencies of 36 and 11 percent, respectively. The difference in benefits between the two plans that would be attributed to the reduction in U.S. flood damage is approximately $522,000 per year. It could be assumed that the difference between the environmental impacts, both social and biological, of these plans would have a value equal to or less than the monetary difference. The value of the environment could therefore be reflected as a maximum of $552,000 which represents a tradeoff between environmental and economic factors, but does not take into account the societal factors within the region and the international area.

7.008 It is not presently possible to accurately predict the concerns and attitudes of future societies, particularly as the more distant future is considered. They may view the natural environment of their period with much more concern than we do and may be able to implement their concerns more effectively than we presently are capable of doing. This view is not unreasonable based on the recent trends in "environmental awareness" and the continued depletion of environmental resources. It is also possible that future societies, because of the inability of technology to keep pace with population increases, would place less emphasis on environmental concerns and more emphasis on economic worth.

7.009 It remains for society to decide on the acceptability of the project based on past experience, economic feasibility, urgency of the situation, and environmental consequences.

8.000 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

8.001 Certain irreversible commitments of aesthetic, biological, and archaeological resources have been mentioned earlier. While some positive effects on these resources may be considered as irreversible and irretrievable, it is the negative effects which are of most concern, and the reader is referred to the earlier listings of negative effects which are not identified as being temporary. Most of these commitments would be irreversible and irretrievable for practical purposes (as when recovery would require the long time spans involved in biological succession), while commitments of archaeologic or historic resources would be irreversible in the absolute sense since the stratigraphy of the site could only be investigated once.

8.002 Of long-term social significance would be the present commitment of the site to reservoir development. In this regard, it is appropriate to consider that a site having the regionally unusual engineering qualities necessary for development of a large reservoir would be committed at this time to uses for flood damage reduction, recreation and water supply. Alternate uses, or another scale of uses for present purposes, would be foreclosed to varying extent. One of the problems is trying to foresee future needs and demands and incorporating the basic structural features at this time in a justified, economical manner. Examples of such features are provision for a multiple-gated outlet structure of adequate size (which is included in the plan) or an embankment design which allows for operation as a "dry" dam or "marsh". It may be technically feasible to alter the structures in the future to meet other needs and demands, but once the site is developed, economic justification for changes may be lacking. In this regard, underdevelopment of the site is considered more serious because of the relatively greater costs of project modifications and because most of the economic benefits are captured during the smaller-scale, but more frequent events. Greater development, or overdevelopment of the site, is also of concern, but this is usually constrained by economic factors, extensive relocations or other impingements on property rights, or geographical constraints such as when water cannot be backed into Canada.

8.003 The utility of the site for multi-purpose reservoir development would decrease with time in the order: fish, recreation, low-flow augmentation, wildlife, and flood damage reduction. The reason for this order is that sedimentation, for example, would decrease the utility of the site for low-flow augmentation before flood control storage is significantly reduced. Recreation is near the head of the above list because water-based recreation comprises a large portion of the recreational benefits of the proposed reservoir and because this type of recreation would be one of the first to be adversely affected by sedimentation, poor fish production and water quality. Some economically less important recreational endeavors, such as waterfowl hunting, would remain viable for a longer period of time.

8.004 Of some concern for those who are convinced of the merit of the reservoir is the desire to commit the site to reservoir development before an unforeseen social need or demand renders such use unavailable.

9.000 COORDINATION WITH OTHER AGENCIES AND INTERESTS

9.001 The Pembina River basin study was initiated in 1950 and evolved into a joint United States-Canadian investigation conducted by the International Pembina River Engineering Board and interested Federal and State or Provincial agencies of both countries. Several reports have been completed on the Pembina River flood problem. One of the more recent was completed by the International Pembina River Engineering Board for the International Joint Commission in 1964 and was followed by a separate Commission report in 1967. These reports recommended construction of two dams, one in each country, for flood control, irrigation, water supply, and recreation. Because of high cost, Canada was unable to participate in the recommended project.

9.002 Subsequently, because of the local interest expressed for construction of flood protection works to prevent a recurrence of the damages caused by the 1966, 1969, and 1970 floods, the Corps of Engineers initiated a feasibility study of the Pembina River basin in the interest of flood control, water supply, and recreation.

9.003 Upon assignment of the feasibility study in 1971, all agencies which might have an interest in the study were notified. Of particular note was the establishment in the spring of 1971 of a Pembina River Basin Planning Committee. This committee held several meetings and provided substantial input as the work progressed. Two subcommittees, on ecology and recreation, were also very active. The committee and the subcommittees were selected by local interests and were composed of State and Federal officials and interested area residents. Several conferences, meetings, and conversations were held in the course of the investigation with residents and officials at all governmental levels. The Fish and Wildlife Service made important recommendations and contributions as did the Manitoba Department of Mines, Resources, and Environmental Management. A draft report was completed in May 1972. Recommendations of this report, which included construction of a dam and related works, were contingent upon Canadian participation in proportion to the benefits received by that country. Since that time, continuing negotiations, through the Departments of State of the two countries, have led to the establishment by Canada of a Pembilier Dam Review Committee. This committee completed a report in 1974 on the procedure for cost sharing, subject to an updating of cost and benefit data presented in the report. Since this report, several meetings have been held between the Department of State, State of North Dakota, and local interests to resolve problems associated with project cost sharing and the existing levee road constructed along the border.

9.004 A status report was prepared and distributed to interested agencies and individuals in April 1975 to inform those involved of the anticipated schedule for completing the feasibility study. This report also summarized present conditions, problems and needs, the study history, and recent study and coordination efforts. Comments and questions were requested from all agencies and individuals contacted.

9.005 Coordination with the Fish and Wildlife Service and the North Dakota Game and Fish Department regarding a satisfactory plan to compensate wildlife habitat losses which would be incurred with construction of the selected plan is continuing. Mutual agreements have been reached concerning total acreage requirements, purchase, fencing and operation and maintenance of the proposed mitigation areas based on preliminary analyses. Information relating to the proposed mitigation is included in the revised draft environmental statement as exhibit 17.

9.006 The draft environmental impact statement was distributed to the various International, Federal, State, and local agencies and interested individuals for their review and comments as listed below.

U.S. Environmental Protection Agency
U.S. Department of Agriculture
  Forest Service
  Soil Conservation Service
U.S. Department of Commerce
U.S. Department of Health, Education, and Welfare
U.S. Department of Housing and Urban Development
U.S. Department of the Interior
  Bureau of Indian Affairs
  Bureau of Land Management
  Bureau of Mines
  Bureau of Outdoor Recreation
  Fish and Wildlife Service
  Geological Survey
  National Park Service
U.S. Department of Transportation
Federal Energy Administration

Canadian Department of the Environment
International Pembina River Engineering Committee, Canadian Section

North Dakota Department of Agriculture and Labor
North Dakota Game and Fish Department
North Dakota Indian Affairs Commission
North Dakota Natural Resources Coordinator
North Dakota Park Service
North Dakota Soil Conservation Commission
North Dakota State Archaeologist
North Dakota State Department of Health
North Dakota State Geological Survey
North Dakota State Highway Department
North Dakota State Historical Society
North Dakota State Outdoor Recreation Agency
North Dakota Water Users Association

Minnesota Department of Natural Resources
Minnesota Environmental Quality Council
Minnesota Pollution Control Agency
Garrison Diversion Conservancy District
Upper Mississippi River Basin Commission

Cavalier County Board of Commissioners
Pembina County Water Management District
Pembina River Basin Planning Committee
Mayor, Neche, North Dakota
Mayor, Walhalla, North Dakota

Ducks Unlimited
Friends of the Earth
Lewis and Clark Environmental Association
National Audubon Society
National Farmers Organization
National Wildlife Federation
North Dakota Association of Soil Conservation
North Dakota Farmers Organization
North Dakota Water Users Federation
North Dakota Wildlife Federation
Pembina River Flood Control Association
Sierra Club
The Wildlife Society
Wildlife Management Institute

9.007 After distribution of the draft environmental impact statement, and the draft feasibility report several meetings were held with many local, State, and Federal interests to review the proposed project and to fully identify, evaluate, and respond to the expressed areas of concern. Local interests and representatives who reviewed the proposed plan included the Pembina River Basin Association, the cities, counties, and township

governmental units, the county water boards, and the interested public. North Dakota State Agency representatives of the Water Commission, Fish and Game, and Park Service regularly attended and participated in the local meetings.

9.008 In addition, meetings were conducted with the various local and State recreation interests to assure that the proposed recreational plan was acceptable. As a result of these meetings and subsequent refinements of the proposed recreational plan, the North Dakota State Park Service has agreed, by letter, to work closely with the local recreation entities to develop arrangements prior to construction of the project for cost sharing the allocated recreation costs.

9.009 The proposed project also includes a provision for supplying an additional water source to meet the current and projected water supply demands of the basin and in a small portion of the bordering Province of Manitoba. In this regard the North Dakota State Water Commission has provided a resolution of intent to assume the allocated non-Federal water supply costs of the proposed project.

9.010 In addition to certain State agencies maintaining constant involvement in the study, other State agencies were kept informed by involvement in the meetings of the Natural Resource Council. This council, is comprised of representatives from all State agencies.

9.011 Since establishing a schedule for completion of the final feasibility report in April 1976, almost continuous coordination has been maintained with the U.S. Fish and Wildlife Service (U.S. F&WS) in development of a justified compensation area for the proposed project. The coordination program involved many meetings held in both the Bismarck Area Office of the U.S. Fish and Wildlife Service and in the St. Paul District Corps of Engineers office. Other meetings regarding development of the compensation area have been conducted in the proposed project area with local interests. An Interagency Field meeting was also accomplished in June 1975. The purpose of this meeting was to familiarize agency representatives of the U.S. Fish and Wildlife Service, the North Dakota State Game and Fish Department, and the Corps of Engineers with the project area; to gather data for the "Ecological Planning and Evaluation Procedures" which were developed by the joint Federal-State-private conservation Organization Committee (January 1974), and to exchange views. U.S. Fish and Wildlife Service meetings concerning the ecological planning and evaluation procedures were also attended by Corps of Engineers personnel in Denver, Colorado, and Green Bay, Wisconsin. The overall results of this extensive coordination program are identified in the final U.S. Fish and Wildlife Service report (copies are on file in the District Office). This report analyzes, by use of the ecological planning and evaluation procedures, the effects of the proposed Pembilier Dam and Lake project on the fish and wildlife resources in

the area of the project influence. Additional information regarding mitigation may be found in exhibit 17. Also, the main report contains a coordinated study program of detailed compensation evaluation investigation proposed to be undertaken during the initial phases of post-authorization studies.

9.012 More recent coordination has been maintained with the U.S. Environmental Protection Agency regarding a cooperative approach to the water quality problems expected with the proposed project. Three meetings were held with the Environmental Protection Agency. The first meeting, which was held in Chicago, helped to define the water quality criteria that would be acceptable for any project. Environmental Protection Agency representatives indicated they might still express concern but would not object to a project on the basis of water quality if the following conditions were met:

a. The project provided a beneficial use for the area.

b. The State did not object to the project.

c. The expected water quality conditions with the project could meet or be modified to meet the State Water quality standards.

Based on the results of the Chicago meeting, a second meeting with the Environmental Protection Agency was held in St. Paul, Minnesota, to discuss more specifically the expected water quality problems of the proposed Pembilier project. Representatives of the North Dakota State Department of Health, the North Dakota State Water Commission, and the Manitoba Water Resources Division also participated in the meeting. All agencies agreed that the proposed lake would become eutrophic; however, additional water quality analyses are needed to completely assess the degree of eutrophication and to evaluate various types of nutrient control measures for reducing the frequency and intensity of the expected water quality conditions. At this time sufficient water quality data do not exist to make these analyses. A monitoring program to collect the necessary water quality data has been established and will be initiated in April 1976.

9.013 Another meeting was held in Corvalles, Oregon, with representatives from EPA's Environmental Research Laboratory. The purpose of this meeting was to exchange technical information and to further develop the coordinated approach to future water quality studies.

9.014 Comments on the draft environmental statement were received from the following:

U.S. Environmental Protection Agency
U.S. Department of Agriculture
  Forest Service
  Soil Conservation Service
U.S. Department of Commerce
U.S. Department of Health, Education and Welfare
U.S. Department of the Interior
  Bureau of Indian Affairs
  Bureau of Land Management
  Bureau of Mines
  Bureau of Outdoor Recreation
  Bureau of Reclamation
  Geological Survey
  Fish and Wildlife Service
  National Park Service
U.S. Department of Transportation - Federal Highway Administration
Federal Power Commission
Upper Mississippi River Basin Commission
North Dakota Forest Service
North Dakota Game and Fish Department
North Dakota Highway Department
North Dakota Outdoor Recreation Agency
North Dakota State Department of Health
North Dakota State Park Service
North Dakota State Planning Division
North Dakota State Water Commission
State Geologist, North Dakota
State Historical Society of North Dakota
Pembina County Commissioners
North Dakota Water Users Association
North Dakota Wildlife Federation

9.015 Letters of comments on the draft impact statement appear on the following pages of this report, with Corps responses juxtaposed. All comments referring directly to the feasibility report are answered in that report.

9.016 Copies of the revised draft impact statement were mailed to all known interest in June 1976, prior to review by the Board of Engineers for Rivers and Harbors and the Office, Chief of Engineers. This review resulted in no changes to the revised draft report, and it was filed with the President's Council on Environmental Quality in May 1977.

9.017 Letters of comment on the revised draft impact statement were received from the following.

U.S. Department of the Interior
U.S. Environmental Protection Agency
U.S. Department of Agriculture
U.S. Department of Health, Education, and Welfare
U.S. Coast Guard
U.S. Department of State
North Dakota State Water Commission

Copies of these letters along with Corps responses begin on page 174 of this document.

LETTERS of COMMENT
and
CORPS RESPONSES

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
860 LINCOLN STREET
DENVER, COLORADO 80203

OCT 31 1975

Ref: 8W-EE

D-COE-J35000-ND

Colonel Max W. Noah
District Engineer
Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

The Region VIII Office of the Environmental Protection Agency has reviewed the draft environmental impact statement (EIS) for the proposed Pembilier Lake and Dam project in North Dakota. As you requested, our review has also included consideration of the material presented in the Feasibility Report and appendices.

Water Quality:

1. Perhaps the most disturbing aspect of this project from an environmental standpoint is its impact on water quality. In view of the past history of high nutrient contents, low levels of dissolved oxygen, high biochemical oxygen demand, and algal blooms in shallow Pembina River lakes and during low flow conditions on the river, the water quality outlook for the project is extremely poor. As the EIS notes, the reservoir created by the Pembilier Dam will undoubtedly become eutrophic in a relatively short period of time. To some extent, this condition could be avoided (or at least postponed) through a variety of eutrophication control techniques. However, major deficiencies of the EIS are that none of these techniques are discussed, the impact of a eutrophic reservoir is not assessed, and operations plans for the reservoir are not firm. 1.

2. From information presented in the draft EIS and the Feasbility Report, it is impossible to completely assess the impact of the project on water quality. In fact, little more can be said than, "water quality will suffer", or, "the reservoir will be eutrophic." The main reasons for this are: a) insufficient water quality data are available, and b) no final 2.

CORPS RESPONSES TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

1. Although specific lake rehabilitation techniques are not mentioned in the revised draft EIS, they will be considered during post-authorization water quality studies (paragraph 1.027) as suggested by your 19 February 1976 letter. To discuss specific techniques at this time, without more information as to anticipated water quality conditions in the reservoir, would not be appropriate. In addition, it is our opinion that if water quality standards were exceeded by a large amount, it is probably unrealistic to assume that the condition could be corrected in an economical manner.

2. We agree that, based on the available water quality data, it is difficult to completely assess the trophic condition of the proposed reservoir. Steps have been taken to obtain additional information that would permit a more precise evaluation of present and future water quality conditions (see paragraph 1.027). The proposed water quality studies will allow an evaluation of various operating plans (including the marsh alternative) in an effort to reduce the potential for water quality problems. Although the operating plan is more defined in the revised draft EIS (see paragraph 1.003) for the "lake" alternative, the "marsh" alternative is included and will be evaluated in future studies. The "marsh" concept was originally developed as a possible means to reduce potential water quality problems and to postpone losses of terrestrial and aquatic resources associated with the "lake" operating plan. At the present time, however, the local people object to the "marsh" operating plan.

operating plan for the facility has been made. A particularly disturbing statement is found on page E-8 of Appendix 1 to the Feasibility Report: "Also, operation of the reservoir as a marsh will be considered during postauthorization studies when more detailed information on water quality is available."

3. 3. In predicting water quality conditions for a reservoir, foreknowledge of management controls and operations is as important as such factors as the quality of incoming water, morphometry, climate, etc. Comparisons offered in the EIS with such nearby lakes such as Ashtabula, and the use of existing data to calculate nutrient loads to the reservoir are very helpful. However, without knowing how the reservoir will be operated (e.g., release levels, marsh vs. lake), it is impossible to offer a firm prediction of water quality in the reservoir or the river.

4. 4. The draft EIS does not discuss the possibility of eutrophication controls for the reservoir, such as aeration, or precipitation of phosphorous compounds with Aluminum Sulphate. Will the possibilities of their use remain unknown until "postauthorization studies" are complete?

5. 5. No monitoring program for water quality is discussed in the EIS, although a major project purpose is water supply. The final EIS should discuss whether the reservoir's poor water quality will make it difficult for downstream municipalities to comply with the provisions of the Safe Drinking Water Act.

6. 6. If releases from the reservoir will be made at low levels (i.e., from the hypolimnion), it is likely that dissolved oxygen levels will be low when the reservoir is stratified. Can mitigation for this effect be built into project plans?

7. 7. Will existing vegetation in the permanent pool area of the reservoir be removed prior to filling? If so, this could reduce the initial loads of nutrients and BOD to the system.

8. 8. On page 57 (paragraph 4.026), the draft EIS notes that, "The reduction in peak flows caused by the dam may necessitate a more rapid upgrading of existing sewage treatment facilities in the basin...." It should be noted that the chemical and biological assimilative capacities of the river may be reduced after impoundment, further compounding this problem. The North Dakota Department of Health should be consulted concerning this "external" cost of constructing and operating the dam. Have these costs been included in the calculation of the project's benefit/cost ratio?

9. 9. Any decreases in water quality in the Pembina River caused by the Pembilier Dam will affect quality in the Red River of the North, which flows into Canada. The adverse impacts of the project to the Canadians should be considered in the EIS.

CORPS RESPONSES TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
(Continued)

3. Concur. The operating plan is only tenative at this project phase and would be reevaluated based on future water quality studies (refer to response 2).

4. Appropriate rehabilitation techniques would be evaluated, if results from the proposed water quality study indicate that indeed water quality standards would be exceeded (refer also to response 1).

5. A monitoring program has been established as indicated in response number 3. Based on available water quality data, it is estimated that downstream communities will not have difficulty in complying with the Safe Drinking Water Act.

6. During postauthorization studies, if thermal routings and ecomodel studies indicate that dissolved oxygen levels would be low, hypolimnetic aeration and other measures as appropriate would be considered to maintain oxygen in the reservoir bottom water and in the river downstream. Much of the aeration of release waters could be accomplished, however through design of the reservoir outlet works (although it is recognized that biochemical oxygen demand would again lower the oxygen concentration downstream.

7. The large woody vegetation would be cleared.

8. It is expected that the three small downstream communities will upgrade their waste treatment facilities to meet the 1977, 1983, and 1985 target dates of Public Law 92-500. Therefore, the cost for such external construction has not been identified in the report. Earlier changes which could be caused by the dam to these targets would have a negligible impact on the benefit-cost ratio. Also, State standards require controled discharge of effluent from the downstream stabalization lagoons. The major effect of the lagoon reservoirs would be to extend the period required to empty the lagoons..

9. Because of the small contribution of the Pembina River to the normal flows of the Red River of the North, any decrease in the water quality in the Pembina River would negligibly affect Red River of the North water quality in Canada. However, a more precise description of possible effects will be possible after completion of postauthorization water quality studies.

10. As the draft EIS notes, adverse water quality conditions in the reservoir, such as algal blooms, will reduce the attractiveness of 10. the facility for recreational uses. Since the project has monetary recreational benefits assigned to it, it follows that poor water quality conditions in the reservoir would reduce the value of these benefits. Has this consideration been included in the calculation of the project's benefit cost ratio?

Alternatives:

Alternatives to structural means of reducing flood damages on the Pembina River should be considered more seriously. Upon reading the feasbility report it is evident that non-structural measures, such as flood plain regulation, flood insurance, flood warning, and emergency protection measures are already effectively reducing flood damage in some parts of the study area. The justification for rejecting many of these, however, is that each alternative by itself is not sufficient to solve the problem of flood damages. This approach overlooks the potential synergisms that a thoughtful combination of non-structual measures has to offer. Flood insurance, warning and forecasting services, and emergency measures, for example, can greatly 11. reduce losses due to flooding while long term solutions, such as flood plain regulation, flood proofing, and evacation are implemented.

The feasibility report also overlooks other advantages of nonstructural approaches to reducing flood losses, including:

a. The non-structural approach addresses the root cause of the problem, which is not flooding, but development of flood prone areas;

b. Non-structural measures allow flood plains to be used for activities that are compatible with their role as an occasional floodway (e.g. open space, recreation, etc.);

c. Non-structural measures provide a permanent solution to flood damage problems, with little or no maintenance required; and

d. Non-structural measures can eliminate the anxiety about the possibility of catastrophic flooding caused by failure of flood control structures.

Water Supply

Many times the proposed solutions to a problem are constrained by the way the problem is defined in the first place. This is the case in 12. the feasibility report's analysis of water supply alternatives, where the problem is narrowed down to the question of how Neche can maintain its

CORPS RESPONSES TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
(Continued)

10. The recreational benefits have been adjusted to include the expected water quality conditions of the reservoir.

11. Although nonstructural measures often provide a permanent solution to flood damage problems, this usually does not apply to an agricultural flood prone area. For example, only about 9 percent of the present average flood damages sustained in the Pembina River basin are urban related. Of the remaining annual damages (91 percent), only about 5 percent could be considered physical damages to agricultural-type structures. This means that 90 percent of the average annual damages in the basin are either agricultural, soil or transportation oriented. Flood warning and forecasting services and emergency measures would not eliminate or even significantly reduce these damages; however, emergency measures might partially reduce some transportation damages (i.e. bridges, etc.). Flood proofing and evacuation of the basin would thus provide a permanent solution for only about 9 percent of the flood damages. In addition, floodplain evacuation would separate farm buildings from the farmlands, creating economic and social hardships for the rural residents. The Canadian communities of Gretna and Altona would have to find another source of water which would cause economic hardships.

Floodplain regulation primarily regulates new development in the floodplain and does little to reduce existing flood damages. [illegible] flood damages are primarily agricultural, implementation of floodplain management ordinances would not be effective in reducing basin flood damages.

The only nonstructural alternative which would assist in reimbursing landowners for flood losses sustained in the Pembina River basin is flood insurance, but this measure by itself does not prevent or reduce existing flood damages. Since the Pembina River basin has mostly agricultural flood damages, none of the nonstructural alternatives or measures would offer a significant reduction of the existing flood damages. Nonstructural measures are the most practical and complete solution for [illegible] however, local interests are encouraged to [illegible] floodplain ordinances and flood [illegible]

... The Pembina River basin has a [illegible] water supply problem in that the [illegible] the poor quality and quantity [illegible] users (Neche and North Valley systems) recognized this as a [illegible] problem for the area and developed for themselves the most [illegible] alternative which provided for the best water supply at a reasonable cost. Also, because of the lack of a water supply the Canadian communities of Gretna and Altona, they also developed the best and least costly supply system (i.e., from the Red River at Neche). Therefore, because of the existing water supply problems within the basin, local interests have already established that the reasons of cost and water availability that the city of

position as a supplier of water to the North Valley System and towns in Canada. All of the alternatives considered focused on ways of getting water to Neche so that it could be sold and redistributed to other places. Instead, the water supply question should be expanded to ask how the water needs of the various water users in the area can best be met. Perhaps the Canadians could develop their own water supplies at less cost to the taxpayer than the costs of the proposed dam and reservoir assigned to water supply storage. Before the water supply aspects of the project can be justified a more thorough analysis of the need to have Neche be a principle water supplier to the surrounding area should be undertaken, and alternative ways of satisfying the needs of other communities should be studied.

Multiple Objective Planning:

The planning for the proposed project does not comply with the Water Resources Council's Principles and Standards for water resources planning. The Principles & Standards were designed to assure balance between the national objectives of economic efficiency and environmental quality and
13. to display alternative and selected plans in four accounts (National Economic Development, Environmental Quality, Regional Development and Social Well Being) so that the tradeoffs involved in any given plan or alternative can be compared. The feasibility report for the project is deficient in this regard because most of the requirements of the Principles and Standards are not satisfied.

116

Additional Comments:

1. Section H of Appendix 1 refers to potential problems with soil and rock instability at the dam site and along the banks of the reservoir.
14. This section also mentions that special measures might be required in order to stabilize slopes and prevent seepage through the embankment. The costs of these measures are not listed in the tables containing detailed costs of the project.

2. Another matter related to the design and cost of the project concerns the allocation of 15,000 acre feet of storage in the reservoir
15. for sediments. This figure was arrived at using a 552 square mile effective drainage area instead of the 2715 square mile drainage area referred to on page H-15 of Appendix 1. The procedure used to determine the amount of storage needed for sediments should be clarified.

Conclusions:

Information presented in the draft EIS indicates that water quality conditions in the proposed Pembilier Reservoir will be extremely poor, and that studies to determine the exact nature and extent of water quality

CORPS RESPONSES TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (Continued)

Neche should serve as a water supply distribution center for the area. Since the existing system does not provide an assured source of water supply for the area, we investigated five water supply alternatives which would serve the distribution center. Of these alternatives, off-channel storage at Neche is the most economical. Development of the water supply benefits identified in the feasibility report is based on construction by local interests of the least costly water supply alternative. Thus, local interests are not paying any more for the water supply features of the proposed reservoir than they would if they developed the off-channel storage alternative. In fact, local interests are paying much less because they only have to pay the allocated cost of the project water supply features.

13. The plan formulation analysis presented in the feasibility report conforms to the policies and procedures of the Corps of Engineers in implementing the Water Resource Council's principles and standards for water resources planning. These procedures are identified in the formulation analysis section of the feasibility report. Also, section 6 of the revised draft EIS has been expanded to reflect the National Economic Development (NED) and the Environmental Quality (EQ) plans.

14. The specific measures which might be required to stabilize the slopes or prevent seepage or the costs for such measures are not specifically identified in the report. Although inclusion of any special measures in the proposed project is dependent on more detailed studies, the overall costs of such measures are assumed in the contingency factor applied in the detailed cost estimate. It is possible, however, that treatment of slope stability problems in some areas adjacent to the reservoir pool may not be economically feasible.

15. The procedure used to determine the amount of storage needed for sediment is specifically identified on pages H-13, H-15, H-38, and H-39 of Appendix 1 of the feasibility report.

degradation will not be undertaken until after project authorization. Unless gradation will not be undertaken until after project authorization. Unless information is presented in the final EIS which indicates that effective mitigation of these water quality problems can and will be undertaken, we do not believe that Congress should be asked to authorize the project at this time. Our primary reason for this conclusion is that more detailed studies, now scheduled for post-authorization, may demonstrate that poor water quality conditions in the reservoir may impair project purposes (especially recreation and water supply) for which benefits have been claimed. This situation is especially important considering the narrow margin between project benefits and costs (1.02 to 1).

In accordance with EPA's procedures to categorize the nature of our comments on the environmental impacts of a proposed action and the adequacy of the EIS at the draft stage, the proposed Pembilier Dam and Reservoir has been rated in Category ER-2. This means that we have serious environmental reservations about the implementation of this project, and that additional information, in the form of more detailed water quality analyses, should be included in the final EIS. The benefits attributed to recreation and water supply should be reassessed in view of these more detailed pre-authorization water quality studies, and the range of nonstructural alternatives considered for flood control and water supply should be expanded.

Sincerely yours,

John A. Green
Regional Administrator

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
1860 LINCOLN STREET
DENVER COLORADO 80203

FEB 19 1976

Ref: 8W-EE

Colonel Forrest T. Gay
District Engineer
Department of the Army
St. Paul District
Corps of Engineers
1135 U.S. Post Office and
Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

Pursuant to a meeting held in your offices on January 14, 1976, concerning the water quality impacts of the proposed Pembilier Dam project in North Dakota, I want to clarify my views on the potential water quality impacts of this project. I am sensitive to the flood problem in the Pembina River basin as well as the international complications and I look forward to working with your office and the state of North Dakota in seeking a resolution of the water quality issue.

From the preliminary studies conducted by your staff and our evaluation, it is apparent that eutrophication of the proposed Pembilier Lake is inevitable and that there is a strong potential for resultant water quality degradation in and downstream of the reservoir. Your office pointed out this potential water quality problem in the preliminary draft environmental impact statement (EIS) which I reviewed. Your office has also expressed the need and desire to conduct more detailed water quality monitoring and studies to better define the magnitude of the water quality problem and examine options for preventing or mitigating potential degradation. It is essential that water quality constraints be considered as an early and integral part of your project planning to influence the selection of alternatives and mitigating measures. I support your intention to conduct additional water quality studies for this proposed project. These studies should include the following:

118

16. 1. A water quality monitoring program as outlined in Major Hintz's letter to me dated December 19, 1975.

CORPS RESPONSES TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
(Continued)

16. The proposed water quality studies are presented in paragraph 1.027 of the revised draft EIS. We concur with the recommended inclusions in the study.

2. Additional studies to evaluate the eutrophication potential of the proposed reservoir and related water quality problems. These studies should evaluate and quantitate to the extent technically possible the degree of water quality degradation in the reservoir and downstream, and identify potential violations of North Dakota water quality standards.

3. An evaluation of possible measures for mitigating water quality problems. This should include possible point and non-point controls and a reservoir management plan for controlling reservoir and downstream water quality (including measures such as mechanical aeration and multi-level discharge).

Representatives of your office and my office met with personnel from the EPA Corvallis Environmental Research Laboratory on January 29, 1976, to discuss the nature and scope of your water quality studies for this project. The EPA Corvallis lab has been conducting a nationwide lake eutrophication survey for several years and is very familiar with state-of-the-art methodologies for analyzing eutrophication problems.

As you know, this reservoir is located in an agricultural area with only minor point sources discharging above the reservoir. Nutrient 17. sources are non-point in nature resulting from soil disturbances, land use activities and agricultural operations. While it is difficult to formulate a non-point source control program, you should examine measures that are possible.

For example, the protection of remaining wetlands and woodlands from conversion to other land use activities can prevent further water quality degradation. Your preliminary draft impact statement points out that incentives to clear woodland areas are more compelling than incentives to retain them and that North Dakota's woodland tax abatement legislation is apparently not a sufficient deterrent to clearing. This North Dakota woodland tax abatement program, however, is a positive step in the right direction and the State and local governments should consider other legislation such as floodplain zoning to protect and if necessary, acquire, the remaining unique woodland and wetland areas in the Pembina drainage.

Your office is also working with the Fish and Wildlife Service for the acquisition of lands in the project area to compensate for project imposed habitat losses under the Fish and Wildlife Coordination Act. It should be emphasized that this compensatory land

CORPS RESPONSES TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
(Continued)

17. Concur.

acquisition not only has important fish and wildlife benefits, but also has significant water quality benefits by preserving natural habitat and preventing further land disturbance.

EPA will be working closely with the State of North Dakota and the Soil Conservation Service to identify best farm management practices for controlling non-point water quality problems. We will be working with the farmers through local soil conservation districts to implement these best management practices.

18. I realize that implementation of many mitigating measures is outside the legal authority of the Corps and that you have to reply on other entities to follow-through. It is important, however, for the Corps to enumerate possible mitigating measures in your environmental impact statements (as you did to some extent in the preliminary draft EIS for Pembilier) and to identify the entity most responsible for implementation.

19. As a result of discussing this project with your staff, it is now apparent to EPA that non-structural measures such as flood plain regulations will not provide the desired level of flood protection for agricultural flood prone areas. A structural measure such as a wet or dry dam or the "marsh" alternative presented in the preliminary draft impact statement may be appropriate. The "marsh" alternative has many good features and I urge you to give strong consideration to this alternative.

120

EPA prefers that water quality studies be completed early in the project planning process so that the water quality factor can be given appropriate weight in determining project feasibility. As a result of our discussions, you indicated that additional funding will be needed to complete the necessary water quality studies. Accordingly, EPA has no objections to the Corps of Engineers pursuing the next phase of the proposed Pembilier project, with the understanding that the water quality studies and evaluation of alternatives mentioned above will be completed before a final project determination is made. It is also my understanding that supplements to the environmental impact statement will be prepared as needed.

Sincerely yours,

John A. Green
Regional Administrator

CORPS RESPONSES TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY
(Continued)

18. Numerous programs, many of which would contribute to the control of non-point pollution sources are currently available through various Federal and State agencies. These programs are listed in the Feasibility Report.

19. Concur. Discussion of the "marsh" operating plan is presented in Exhibit 1. Post-authorization studies will consider this alternative in greater detail (refer to response 2).

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

ND Coordinator, Custer NF
Bismarck, ND 58501

REPLY TO 8400 Environmental Statement August 26, 1975

SUBJECT Pembilier Lake and Dam

TO Colonel Max W. Noah
U.S. Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel:

I was very pleased to receive the Draft Environmental Statement on the Pembilier Lake and Dam.

The U.S. Forest Service *does not have any* land within the Basin or impact area so we would not have any direct involvement with the project.

We do have responsibilities in North Dakota for cooperation with the State Forester on forestry matters on state and private forest lands. I would like to raise a question for clarification in regard to the forested land.

I felt the discussion of the three natural ecosystems containing timber was very thorough. However, the question is with North Dakota the smallest percentage of
20. woodlands of the fifty states it is very important to the state that as much woodland as possible should be kept in our state. My question, would it be possible to have some mitigation lands for forestry purposes delineated to replace those lost because of the project similar to wildlife mitigated lands.

This would do two things: (1) It would hold our timber producing base in North Dakota for future wood supplies and; (2) It would be maintaining timber producing lands within one of the areas best suited for timber production in North Dakota.

CORPS RESPONSE TO THE PEMBILIER STATE DEPARTMENT OF AGRICULTURE - FOREST SERVICE

20. A habitat evaluation procedure, recently developed by the U.S. Fish and Wildlife Service, was used on the proposed project to determine the amount and types of habitat needed to mitigate fish and wildlife losses that would result as a result of the proposed project. Several habitat types, including bottomland hardwood and upland hardwood, were evaluated. The amount of land (habitat) required to mitigate the wildlife production lost was determined by evaluating potential mitigation areas and determining the difference between existing production and potential production on these areas assuming an intensive wildlife habitat management plan. In this manner, various habitat types would be replaced with similar habitat. Mitigation of vegetation lost as a result of the project would not be accomplished, per se, but could be offset to some extent depending upon the wildlife management plan that would be developed.

Management of project lands other than those identified for wildlife mitigation would offer a potential for mitigation of additional *terrestrial* vegetation. Management of these lands would be coordinated with interested public agencies.

In addition, there would be some tree planting associated with the recreational developments, however, these would not have a significant forestry value.

I again wish to thank you for the opportunity to review and comment on your Draft Statement.

Bernard W. Alt

BERNARD W. ALT
ND Coordinator

Enclosure

cc: Walt Pasicznyk, Bottineau, ND

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

Box 1458, Bismarck, North Dakota 58501

September 12, 1975

Mr. Max W. Noah
Colonel, Corps of Engineers
District Engineer
St. Paul District, Corps of Engineers
1135 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

We have reviewed the draft environmental impact statement for Pembilier Lake and Dam, Pembina River Basin, North Dakota, and have the following comments:

21. 1. A description of the dominant soils in the proposed project take areas would assist in evaluating alternatives.

2. The proposed Pembilier Dam (wet or dry) does not conflict with any planned or installed project assisted by the SCS and would provide the most protection to high producing agricultural land.

The only alternative that Canadian officials have expressed necessary to remove the border dike is the installation of the Pembilier Dam. As long as the dikes remain in their present condition the threat of argument and disagreement between local people would continue.

We appreciated the opportunity to review and comment on the draft environmental impact statement.

Sincerely,

Allen L. Fisk
State Conservationist

cc: Council on Environmental Quality (5)

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

21. The extent of the proposed take area is described in paragraph 1.008. No soil survey has been made of this area; therefore, no detailed description of soil types can be provided. Most of the land will lie either on the floodplain or steep valley slopes. The soil types in these areas can be generalized as well drained, shaly alluvial soils on the valley slopes with moderately drained, medium and fine textured soils on the floodplain. The vegetation resources in the area are described in paragraphs 2.057 through 2.078.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE CENTRAL REGION
Room 1836
601 East 12th Street
Kansas City, Missouri 64106

September 8, 1975

WFC2x2

Colonel Max W. Noah
District Engineer
Corps of Engineers
1135 U. S. Post Office
and Custom House
St. Paul, MN 55101

Subject: Draft Environmental Impact Statement - Pembilier Lake and Dam, Pembina River Basin, ND

Reference: NCSED-PB, August 5, 1975 date

Dear Sir:

Reference is made to your letter which transmitted a copy of the Draft Environmental Statement on the Pembilier Lake and Dam, Pembina River Basin, North Dakota, and requested our comments.

In accordance with agency policy, the Draft has been forwarded to our Washington Headquarters for review and comments as necessary.

22. It should be noted that the evaporation station at Devils Lake (2.006) was moved to Langdon Experimental Farm in June 1971. The following publications are attached for your information:

1. Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1941-70.

2. Technical Paper No. 37, Evaporation Maps for the United States. This TP is in the process of being updated but it will be about a year before it is available.

Sincerely,

Elroy C. Balke
Regional Hydrologist

Enclosures

124

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF COMMERCE

22. This information has been included in the revised draft, see paragraph 2.006.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

September 15, 1975

Colonel Max W. Noah
District Engineer, St. Paul
District
Corps of Engineers
1135 U.S. Post Office and
Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

It appears that the impacts of the proposed Pembina Lake and Dam project (North Dakota), and the reasonable alternatives have been adequately addressed.

Thank you for the opportunity to comment on the Draft EIS document.

Sincerely yours,

Rulon R. Garfield
Regional Director

cc: Charles Custard, OEA

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS

ABERDEEN AREA OFFICE
115 FOURTH AVENUE S.E.
ABERDEEN, SOUTH DAKOTA 57401

IN REPLY REFER TO
Trust & Nat. Res.
Envir. Qual. Coord.

SEP 29 1975

District Engineer
Department of the Army
St. Paul District Corps of Engineer
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Sir:

We have reviewed the draft environmental statement and feasibility report for Pembilier Lake and Dam, Pembilier River Basin.

126

23. The Aberdeen Area Office of the Bureau of Indian Affairs has only one concern with regard to the project. A single tract of Indian trust land described as Lot 2, Sec. 6, T. 162N., 57W., S½SE¼ of Sec. 31, T. 163N., 57 W., in Cavalier County is under the jurisdiction of the Turtle Mountain Indian Agency, Belcourt, North Dakota. The project description in the statement does not permit a determination as to whether or not the tract is within the compensation area of the project. It can be determined that it is in the vicinity of the proposed work. If during plans for construction it becomes evident the tract will be involved, it would be necessary for the Bureau of Indian Affairs to approve any acquisition or right of way easements.

I wish to express my appreciation for giving us the opportunity to review the assessment.

Sincerely yours,

Area Director

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF INDIAN AFFAIRS

23. Although the final taking line for the proposed project has not been established, it appears that this tract of land would not be affected by the proposed project.

IN REPLY REFER TO

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
316 North 26th Street
P.O. Box 30157
Billings, Montana 59107

911:1792
ER 75/792

OCT 8 [illegible]

Department of The Army
District Engineer
Army Corps of Engineers
St. Paul, Minnesota 55101

Dear Sir:

The Bureau of Land Management has no land that would be affected by the proposed action. Consequently, our comments are related to the general impact on the environment as a whole.

Documentation of the potential impact on water is not exhaustive, but it seems to be adequate. The possibility of eutrophication of the reservoir is frankly identified and discussed, and the lack of concrete data on which to base predictions is acknowledged. Chemical quality of the surface water has been noted and discussed in terms that are readily understandable. Surface-water sediment load and flood frequency have been discussed in detail, as would be expected. Ground water has been examined in terms of sources, yield, general quality, and impact upon it.

24. The description of the dam site is adequate, but a more detailed discussion of the potential impacts--particularly the possibility or remoteness of dam failure--would be helpful. A dam that is installed with shale as foundation and abutments does not seem as reliable as one in a more substantial site.

The draft statement and accompanying feasibility report provide useful tools for evaluation of the proposed project. The table of segments of the environment that would be impacted versus the alternative actions is an excellent summary; unfortunately, the reduced size makes it unduly hard to read. Use of two pages without reduction would solve this problem.

Sincerely yours,

Bill D. Noble
Acting State Director

cc:
[illegible]0 (260)

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF LAND MANAGEMENT

24. As noted in Section H of the Feasibility Report, the stability of the embankment and foundations of the dam were analyzed and developed using an assumption that structural failure of the dam would occur for certain conditions. Based on these results, the minimum factor of safety permitted was used to develop the structural design of the dam. Therefore, a discussion of these impacts is not included in the revised draft EIS.

United States Department of the Interior

BUREAU OF MINES

BUILDING 20, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

Office of
Chief

Intermountain Field Operations Center

September 15, 1975

Your reference:
NCSED-ER

District Engineer
St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Sir:

We have reviewed the draft environmental statement for Pembilier Lake and Dam, Pembina River basin, N. Dak., as you requested on July 30. Subsequently, we received a second copy of the statement, plus the draft feasibility report on the Pembina River basin, for review and comment from the Director, Office of Environmental Project Review, Department of the Interior (ER-75/792). Thus, our comments about both reports are included here, and your quality control rating sheets are attached.

128

The reports concern a proposal to construct a dam and lake about 2 miles southwest of Walhalla, Cavalier, and Pembina Counties, N. Dak., for purposes of flood control, water supply, recreation, and sedimentation. Lands to be acquired for the project include 5,800 acres within the take-line, and acquisition of 9,200 acres outside the take-line is proposed for mitigation purposes. Incidentally, a large-scale map of the project area, such as Plate 2 of the feasibility report, also should be added to the environmental statement so that readers can better visualize the extent of the proposed dam, lake, and land for mitigation.

25.

Our primary interest in these reports, and in the proposed dam and lake, is involvement of mineral resources and mineral operations. We note that two key elements of such involvement are discussed in the environmental statement; known and potential mineral resources in the project

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

25. Concur. This has been included as exhibit 2.

area are described adequately in paragraphs 2.018-2.021, and the effect of the project on mineral resources is assessed in paragraphs 4.078-4.079. However we are concerned about project impacts on mineral resources
26. in two respects. First, the type or quality of the assessment is not specified, and we are not aware of any detailed on-site study of mineral resources at the Pembilier site. Second, the assessment (para. 4.078)
27. seems to understate the full effect on mineral resources, for it addresses only those areas that would be inundated. What would be the effect on mineral resources and operations, such as the several shale pits that are near the 1,450-foot contour, in the rest of the project area (including lands proposed for mitigation)?

The feasibility report and Appendix 1 (Technical Report), on the other hand, contain very little information about mineral resources and operations, except for a line in a tabular "comparison of alternatives." Information about mineral resources, similar to that suggested for the environmental statement, should be included in sections B and F of the technical report (App. 1).

129

Thus, we recommend that mineral involvement be considered more completely
28. in the environmental statement and, especially, in the feasibility report, before lands in the project area are dedicated to uses that would preclude future development of mineral resources. We believe that a survey to assess mineral resources at the Pembilier project should be made by qualified personnel, and the results of such a survey should be included in the revised reports.

Sincerely yours,

Raymond L. Lowrie, Chief
Intermountain Field Operations Center

Attachment

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES (Continued)

26. Although a complete assessment of the mineral resources has not been undertaken, based on available information, it is expect that the project would not have a significant impact on the mineral resources of the area. A detailed assessment would be undertaken during post-authorization studies.

27. Because a definite taking line for the propose project has not been established, it is difficult to identify precisely the impacts on the resources and operations (e.g. shale pits) and operations within the area. These would be considered in greater detail during Phase I studies.

28. Refer to responses 26 and 27 above.

United States Department of the Interior

BUREAU OF OUTDOOR RECREATION
LAKE CENTRAL REGION
5600 RESEARCH PARK DRIVE
ANN ARBOR, MICHIGAN 48104

IN REPLY REFER TO:

D6427

October 8, 1975

Colonel Max W. Noah
District Engineer
U.S. Army Corps of Engineers,
St. Paul District
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

This is in response to your request for our review of the draft environmental statement and feasibility report for Pembilier Lake and Dam, Pembina River Basin, Cavalier and Pembina Counties, North Dakota (ER-75/792). We have reviewed these documents relative to our areas of jurisdiction and expertise and have provided the following comments for your consideration in preparing the feasibility report. Official Department of the Interior review comments will be provided when the Department is requested to make a formal review.

130

Feasibility Report

The recreation benefit of $50,000 per year consisting of 40,300 recreation days at $1.25 per visit appears reasonable. The sparse population in the area plus the possibility of impaired water quality makes higher visitation doubtful.

The 1975 North Dakota State Outdoor Recreation Plan indicates the Pembina River downstream from the proposed project has potential for inclusion in a State wild, scenic, and recreational river system. This proposal should be discussed in the report along with the impacts the proposed water releases from the reservoir would have on this stretch of river.

Draft Environmental Statement

The statement appears to be generally adequate in its coverage of outdoor recreation and related environmental impacts. There are several areas where the statement could be strengthened. The table

on page 48 refers to the recreation needs in Planning Regions 3 and 4 where the project is located. The figures shown are not in accord with the 1975 North Dakota State Comprehensive Outdoor Recreation Plan (SCORP). For example, the table shows a need of 42,000 acres of water
29. for boating and water skiing in Region 4 by 1985. The 1975 SCORP indicates a need of only 1,940 acres for boating needs in 1985 in Region 4. All activities should be updated to be in accord with the 1975 SCORP.

30. Under Section 6, "Alternatives to the Proposed Action," there should be a discussion of the State wild, scenic, and recreational proposal for the Pembina River in conjunction with the project proposal and the other alternative proposals. Several of the proposals could affect river flows and, in the case of channelization, the river environment would be greatly impacted.

Sincerely yours,

John D. Cherry
Regional Director

131

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF OUTDOOR RECREATION

29. Concur. The recreation analysis has been ammended to reflect the 1975 SCORP.

30. Concur. The RDEIS has been ammended to include a discussion of the State wild, scenic, and recreational proposal for the Pembina River.

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Missouri Region
P.O. Box 2553
Billings, Montana 59103

IN REPLY REFER TO: 160
125.1-

SEP 24 1975

Colonel Max W. Noah
District Engineer
St. Paul District Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

We have been asked to respond to your letter to Assistant Secretary Larson requesting comments on your Draft Environmental Impact Statement and Feasibility Report on Pembilier Lake and Dam, North Dakota.

The proposed project will have no effect on activities of the Bureau of Reclamation.

The statement is readable and informative; however, we have noted some apparent discrepancies.

112

31. In the summary on page i, paragraph b states the project will permanently inundate 9.5 miles of river and will inundate an additional 12 miles of river at design flood pool elevations for a total of 21.5 miles. Paragraph 1.006 describes the reservoir as being about 24 miles long at flood pool elevation. The miles of river inundated should be equal to or larger than the length of the reservoir.

32. Paragraph 4.088 describes the project impact upon recreation, including fishing, hunting, sightseeing, etc. as being minimal. Paragraph 2.075 describes the valley area as being unusually rich in scenic beauty and is high in wildlife values. Paragraphs 5.007 and 5.008 state there would be an adverse impact on animal species requiring terrestrial habitat (namely deer, ruffed grouse and fur bearers) and the project would eliminate a scenic section of free flowing river.

33. On pages 24 and 25, the text implies that Neche, North Dakota, and Gretna and Altona, Manitoba, can use downstream water for municipal and industrial purposes but data to analyze the quality of water is not provided. An indicator that the water may be of marginal quality is mentioned in paragraph 1.011, where potential downstream problems are discussed. The hydrogen sulfide content may cause corrosion problems and the biological quality may be poor due to nutrient content, low D.P. and temperature.

AMERICAN REVOLUTION BICENTENNIAL 1776

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF RECLAMATION

31. The RDEIS has been modified to reflect this comment. See paragraph 1.006.

32. The project as currently proposed would have minimal adverse impacts on existing recreational opportunities and would create future recreation opportunities which are considered to be beneficial. This determination is based on the fact that no specialized recreation opportunity (such as whitewater canoeing or wilderness camping) would be lost as a result of project construction. Simultaneously, general recreational opportunities, such as fishing, camping, picnicking, boating and sightseeing would be increased. The acquisition of compensation land to mitigate the project impacts on wildlife production would theoretically offset project induced losses. Therefore, the project's impact on hunting opportunities would be minimal. The assessment of the projects impact on the scenic qualities of the Pembina River Valley are subject to individual interpretation. However, it is recognized that some areas would be adversly affected. It is noted that an impact upon recreation can be somewhat different than an impact upon the base resource.

33. Water quality data for the period 1968-1972 is presented in Exhibit 3 of the DEIS. Although existing water quality and potential changes resulting from the project may adversely affect aquatic organisms, stream water quality standards for domestic and industrial water supplies are generally less stringent than standards for aquatic organisms. The reason is that some minimal degree of treatment is assumed for the former.

Paragraph 4.013 indicates additional water quality studies are required. Canadian and other interests have raised numerous questions regarding the impact of return flows from our Initial
34. Stage Garrison Diversion Unit irrigation project on waters of the Red River and Lake Winnipeg. Your studies should include a comparison of the biological quality of impounded water with the historic water quality in the Pembina River and the effects on the Red River if the biological or chemical quality is below the historic average.

Sincerely yours,

Ronald W. Krueger
Acting Regional Director

cc: Commissioner, Attention: 150
Director, Office of Environmental Project Review, Office of the Secretary, Washington, D.C. 20240

CORPS RESPONSES TO UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF RECLAMATION (Continued)

34. Concur. A detailed water quality study of the proposed reservoir and river is proposed during the initial post-authorization phase (refer to paragraph 1.027).

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Area Office - North Dakota
1500 Capitol Avenue
P. O. Box 1897
Bismarck, North Dakota 58501

NOV 5 1975

Colonel Max W. Noah
St. Paul District, Corps of Engineers
Department of the Army
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

This replies to Major Hintz's letter of October 3, 1975, to Regional Director Loveless and your letter of August 5 to the Department of Interior transmitting a draft of your Feasibility Report and a draft EIS om Pembilier Lake and Dam, North Dakota.

We have reviewed these documents and our comments are enclosed. Also attached is the completed quality control rating system as you further requested.

Draft Feasibility Report

Section A

Scope of the Study. The Draft Report assesses water and related land resource problems in the North Dakota portion of the Pembina River Watershed. This planning effort was promoted by local interests in Pembina and Cavalier Counties and by the North Dakota State Water Commission to counteract the failure of the International Joint Commission proposal for a Canada-United States project. In biological terms, however, an assessment of problems in the U.S. portion of the watershed needs to include basin-wide parameters. Water management planning on the Pembina River is still a function of total watershed hydrology and land use, irrespective of political boundaries. We recommend the final report display the hydrology and land use data that were used in watershed modeling and discuss any data that were unavailable due to the international features of the watershed.

Occasionally in the Draft Report the word basin is used when referring to the Pembina River Valley. From our point of view basin is synonymous with watershed. We recommend you define your terms to avoid confusion.

Section B

Vegetation. Please note that tall grass prairie does not exist as a major natural ecosystem of the Pembina River Valley. Disturbed areas dominated by herbaceous plant communities do exist and are important terrestrial habitat components. Species you mention such as sweet clover, sunflowers, hedge nettle, Kentucky bluegrass and smooth brome are indicators of a disturbed grassland situation.

Fish and Wildlife. Our report to you on the Pembilier project will amplify this topic which is summarily treated in your Draft Report.

Section C

Flooding. Major spring floods along the Pembina River cause delays in crop seeding until the water recedes and the soil dries. During flooding, a portion of the season normally available for crop maturation is lost. At best, inundated fields lead to reduced crop yields; at worst, current year crop production may be prevented and soil fertility damaged for future years. Flood damage to crops has been considerable over the years, but has varied according to the timing of the flood.

Flood damages include both tangible and intangible losses. Tangible losses suffered during floods include: inundation damage to structures, utilities and transportation facilities; flood fighting costs; business losses; and increased expenses for normal living during a flood situation. Intangible losses include the threat of loss of life, human misery, disruption of community activities and potential health hazards from contaminated food and water supplies.

Flooding is not new to the Pembina River in Pembina County, but does seem to be occurring more frequently in recent years. At the same time the price of farmland in Pembina County has increased dramatically as has the cost of farm commodity production. Flooding in Pembina County reduces the efforts of producers to work some of the best farmland in North Dakota. We concur that spring runoff water dispersing across the wide Lake Agassiz plain poses a real problem to Pembina County farmers. We further believe the first step to finding a solution to the problem is an understanding of annual hydroperiod, weather and human alterations of natural runoff in the entire Pembina Watershed. This information should then be correlated with known flood occurrences and modeled against each of the structural flood control alternatives discussed in your Draft Report. For example, readers of your report should be able to discern exactly what would have happened in the spring of 1974 if the Pembilier Dam had been in place.

Existing Projects. It would be helpful to an understanding of watershed hydrology to present data showing the extent of State Water Commission and privately sponsored water management projects in the North Dakota portion and similar data for Manitoba.

Section 3

The Draft Report includes a listing of realistic flood control alternatives. Omitted from this listing is the alternative of a basin-wide water management plan similar to one now being formulated under legislative mandate for the Devils Lake Basin. Some of the Pembina Basin's problems parallel Devils Lake problems. Recognizing the parallel, local citizens in the Pembina River Flood Control Association and North Dakota REC have expressed support of a cooperative approach to solving interrelated water management problems in the Pembina Basin. The Association has requested the Governor's Office to look into the possibility of a basin-wide planning effort. In light of this expressed local interest and coupled with the Corps' enlarged responsibilities under Section 404 of the FWPC Act, a basin-wide planning concept should be considered as a viable alternative for flood control. The various impacts of the alternatives developed were identified in the Report by comparing the existing base conditions to that of the estimated condition with an alternative. For the Report, the base condition was identified as floodplain regulation together with flood insurance. For the analysis and comparison of alternatives and for selection of the plan, a standard set of criteria was used to compare the alternatives considered with the base condition. Technical, economic and environmental criteria were considered. The Draft Report includes summaries of conclusions reached for each alternative on the basis of the above mentioned criteria. This may be an acceptable level of detail for the average citizen to comprehend. However, a summary format provides us with no basis for understanding how conclusions were made. Intelligent comment on your decisionmaking process is therefore difficult. From our point of view it would be helpful to know exactly what evaluation criteria were used, how they were interpreted, and what data were used to support the interpretations.

The chart "Comparison of Alternatives", page D-27 and D-28, is a case in point. Aside from being difficult to read, it does summarily present a useful list of impact parameters. We would like to know more about these parameters and about the supporting technical data behind them.

Of the alternative solutions investigated in the Draft Report, we concur that several alternatives or combinations of alternatives merit further consideration. These are listed here as presented in the Draft Report.

1. No action
2. Floodplain evacuation and flood proofing
3. Multipurpose Pembilier Dam and lake
4. Pembilier dry dam
5. Boundary floodway

6. Levees at Neche

7. Combination boundary floodway and reduced size Pembilier Dam

Numerous laws, policies and regulations have been developed over the years for the purpose of protecting fish and wildlife resources. In 1973, the Principles and Standards for Planning Water and Related Land Resources adopted by the Water Resources Council established a "full environmental partnership" in planning for water and related land resource development. An essential ingredient is the assurance that fish and wildlife and their related habitats receive adequate consideration in plan formulation and plan evaluation.

The Principles and Standards recognize two coequal National objectives in water and related land resource planning: National Economic Development (NED)--that is, increased production of goods and services--and Environmental Quality (EQ)--the enhancement or protection of physical, ecological and esthetic characteristics of the natural environment. In addition, for each plan formulated to meet these planning objectives, four evaluation accounts are prescribed to display the beneficial and adverse effects of each alternative plan on Regional Development (RD) and on Social Well-Being (SWB), as well as on National Economic Development and Environmental Quality. These four evaluation accounts give planners, the affected public, Congress and others an opportunity to compare fully the projected effects of any given plan and its alternative plans.

True multi-objective planning occurs as an orderly series of actions in the planning process set out under the Principles and Standards. To place the NED and EQ alternatives futures in perspective in a given planning area, to aid in scoping each alternative plan, and to avoid extraneous materials creeping into the planning process that are possibly to achieve Regional Development or Social Well-Being or other planning objective, the study area component needs should be immediately identified and classified as to whether they are National Economic or Environmental Quality in nature. This is step one of P & S planning.

As a second step, a plan should be formulated for the EQ objective and a separate plan should also be formulated for the NED objective. Certain complementary features of the opposing objective should be used in formulating both plans. Once an EQ plan and an NED plan of the above description have been formulated and the effects of each plan evaluated against the four accounts listed in the standards, then and only then should the multi-objective plan formulation be started (Figure 1). To collapse the planning process into multi-objective plan formulation from the beginning would be like dumping all the component needs of a planning area into a bowl of jello, shaking it a little, and tagging one side EQ and the other side NED. This does not give the decisionmaker any significant insight into the potential alternative futures in terms of the two national planning objective nor does it give the decisionmaker insight into the full range of trade-offs being made.

Our understanding of the conceptual framework of NED and EQ planning indicates a clear distinction that environment does not include the human environment in the EQ plan. This is necessary to show the real future alternatives between an EQ plan and an NED plan in the first cut stage.

The Draft Report presents the Corps' interpretation of an NED plan and an EQ plan. In our judgment, the data as presented reflect multi-objective planning; i.e., an example of collapsing the planning process. The inherent danger of this practice is that planning can become rigid and unresponsive and the full range of future alternatives remain unknown. An alternative in this case might be a basin-wide water management plan to solve the Pembina and other problems.

Plan Selection. The Draft Report indicates that the multi-purpose reservoir has the highest degree of flood protection, has the highest net benefits and offers guaranteed effective water supply for the lower Pembina Valley. To offset at least in part the adverse environmental impacts of the selected plan, an estimated 16,000 acres are needed as a compensation measure to offset the loss and degradation of terrestrial and aquatic habitat. Of this total, all of which would be located above the Vang Bridge, approximately 2,800 acres would be acquired for flood control purposes, leaving 13,200 acres to be acquired solely for wildlife compensation. The compensation area needs to be surveyed and fenced at project cost and will be operated by the North Dakota Game and Fish Department on an annual budget of $25,000 to be provided at project cost.

Environmental Development. Sixteen thousand acres of land are needed to compensate for direct habitat loss and degradation and partially meet local citizen expectations for preservation of semi-wilderness values.

Operation and Maintenance. The Draft Report presents data on proposed pool operation. A clearer picture of operations could be shown by displaying a model of the 1974 flood using the proposed pool operation criteria. Local citizens are vitally concerned that the 1974 flood might recur. The same apprehension is held for the floods of 1950, 1971, 1970 and 1969. We feel the Corps should write narrative scenarios explaining how the Pembilier Dam would have handled each flood.

Section E

Fishery Development. The Draft Report assesses fishery aspects of the selected plan as good over the initial years, then declining over the life of the project. We agree that this is the optimum condition that can be hoped for considering the water quality limitations of the Pembina River. It should also be pointed out that the North Dakota Game and Fish Department considers the proposed reservoir as very low priority for fishery management. They expect to put no resources into fishery management on the Pembilier Lake.

Section F

Environmental Impacts of the Proposed Reservoir. The selected plan would have significant effects on the environment. The Draft Report summarizes major environmental impacts. We feel the following effects are probable:

- Modifications to ground water levels could occur upon filling of the permanent pool and these in turn will change plant community composition in the immediate vicinity of the pool. Floodwater storage may have similar effects but to a lesser extent.

- Surface water and stream flow characteristics of the Pembina River would be affected by the proposed reservoir.

- High nutrient levels of the Pembina River water entering the reservoir could have profound effects on eutrophication of the proposed reservoir.

- With the change from a flowing stream to a lake type environment, different habitats will be created at the expense of others, thus indirectly changing the species and density of biota occupying these habitats, both in the reservoir and downstream.

- "Tidal wave" effect - infrequent catastrophic inundation of short duration creating long lasting disruption. Disrupting biological patterns which are evolutionarily adapted to slow successional transition and effectively negating current year biomass production.

- Permanently creating discontinuity in previously continuous blocks of terrestrial habitat, thereby creating disadvantageous conditions for gene pool maintenance.

- Permanently eliminating or degrading the life requirements for some species that are in short supply statewide and substituting conditions tolerated by species that are common to abundant statewide or have the potential of being so.

Section H

Drainage Areas. Kloett (1971) conducted a study in the Pembina Watershed to evaluate how much water a wetland stores and to determine if drainage has noticeably increased flood peaks in the watershed. For the first phase of the study a comparison was made of the potential runoff of two similar geographic regions. Region one, the Pembina Watershed above Walhalla, contained 183,680 acres of natural wetlands remaining in 1971. Region two, located in the Lake Plain of Pembina, Walsh and Grand Forks Counties, has been extensively drained for agriculture so that few

natural wetlands remain. The difference in wetland base was determined to be the basic feature separating surface runoff capability of the two study areas. Modeling a range of runoff potentials, Kloett found runoff quantities within the two study regions are most similar when the model assumes elimination of natural basin storage in Region One and a wetland flood storage capacity of 12 inches in depth per wetland surface acre. Kloett's phase one study conclusion is that 12 inches is a conservative estimate of wetland flood storage capabilities in the Pembina Basin.

In phase two, Kloett noted that drainage in the Pembina Basin commenced at a rapid rate sometime during the period 1945 to 1955. To test his hypothesis that drainage has increased flood peaks, he compared the water discharges at Neche for two periods of time having equal numbers of events and similar annual precipitation patterns. These two periods were 1904 to 1941, a pre-drainage era; and 1942 to 1970, a period when drainage removed over 20 percent of the wetland acreage in the North Dakota portion of the Pembina Watershed above Walhalla. Kloett showed that discharges in period one were significantly lower than in period two. His figures show that the 4,000 cfs peak flow level had an exceedence probability of 10 percent in period one and 26 percent in period two.

In conclusion, he said that flood peaks after 1942 are significantly higher than those prior to 1942, even though overall average precipitation is similar for both time periods. The higher peaks in period two could result from either wetland drainage or changes in agriculture practices or both.

The Draft Report says, "It is recognized that prairie watersheds are characterized by large areas of depressional storage which may or may not contribute to streamflow depending on antecedent precipitation. Shallow depressions are usually dry and the water surface in deeper depressions may be several feet below outlet level. To include such areas as a portion of the basin contributing to streamflow, except in very wet years, would be in error." The Report also states, "The large percentage of the area that is poorly drained, in addition to areas that have no drainage, results in flood flows of a lesser magnitude than might normally be expected from a drainage area of this size."

Data presented here and in a more general way by Eisenlohr (1972) led us to conclude the hydrologic precepts stated above are in need of revision. First, the watershed acreage converted from non-contributing or secondary contributing to primary contributing plus soil infiltration capacity are important to streamflow. Antecedent precipitation is the sole factor you mentioned. Second, areas that are poorly drained or have no drainage are diminishing as land use intensifies, thereby gradually removing a physical constraint to the magnitude of flood flows.

It should be stressed here that while precipitation is an act of nature, the conversion of acreage to primary contributing is an act of man's land use and soil infiltration capacity is a function of soil property plus man's use of the soil. The upshot is that a plan designed to deal with

alleviating flooding should recognize the man-caused features of flooding and treat them as part of the problem to be solved.

In summary, we find the Draft Feasibility Report to be generally good in defining traditional alternatives for flood control. Our suggestions for improvement are to: 1) consider basin-wide planning; 2) recognize man's land use as a contributing factor to flooding and suggest ways to reduce this impact; and 3) recognize that our evaluation shows a need for 16,000 acres of land to compensate for the adverse effects of the selected plan on the terrestrial habitat. Our forthcoming detailed report on this project will amplify this final point.

Draft Environmental Statement

35. Item 1.012. We wish to point out that the 12,000 acres of land for mitigation purposes cited here are based on past operating plans and previous analysis by the Fish and Wildlife Service. Since that time, a habitat evaluation was recently completed with your staff using the system outlined in the new Principles and Standards for Planning Water and Related Land Resources. The amount of funds needed for mitigation will likely increase and will be reflected in our forthcoming report.

36. It is our understanding that the operating plan outlined in item 1.020 and elsewhere is only tentative and may be changed. Should changes occur, it would be essential to inform this office of such changes so we may analyze environmental impacts resulting from such changes.

37. The language in item 2.027 is unclear.

38. Item 2.034 is incomplete. This section does not discuss the amount of water being contributed from drained wetlands in the basin. Neither does it reflect the loss of flood water retention foregone due to wetland drainage. We suggest that a hydrologic model of the watershed is needed to answer these points.

39. Items 3.003 and 4.071 both indicate that drainage of wetlands may increase in the watershed following construction of Pembilier Dam. It thus is evident this project will cause unwarranted secondary adverse effects. We suggest that a comprehensive basin plan is needed. Such a plan should include a zoning plan to limit drainage and clearing. Further, Canada should be urged to do the same. Restoration of wetlands and reforestation should be part of a basin plan. As is now proposed, the flood control benefits being claimed will be somewhat negated by inducing clearing and drainage.

40. 4.031-4.034. Blooms of blue-green algae and/or fluctuating water levels may preclude or limit the establishment of rooted aquatic plants in the proposed reservoir.

41. 4.037. " The reservoir would probably experience an increase in both numbers and diversity." This is not likely to be the case since silta-

CORPS RESPONSES TO THE U. S. DEPARTMENT OF THE INTERIOR - [illegible] AND WILDLIFE SERVICE

35. The RDEIS has been modified to reflect the results of the preliminary habitat evaluation study (RDEIS, paragraph 1.012).

36. The proposed operating plan will be developed in greater detail during Phase I studies. The results will be furnished to F&WS for evaluation of effects on habitat mitigation requirements.

37. Paragraph 2.028 has been modified to note the geological significance of the area.

38. Attempts to quantify (segregate) the influence of wetland drainage are very difficult because of the complex drainage patterns that exist for small, on-farm type projects. The hydrologic analysis has been updated through 1974, however, and the effects of drainage that have occurred to date should be included in the total analysis.

39. Paragraph 4.008 of the revised draft EIS indicates that the drainage of wetlands in the upper Pembina River basin in North Dakota has become an urgent concern to both environmental interests, because of habitat losses, and downstream interests, because of potential increased flood flows. The paragraph also indicates that the present trend is not expected to continue for the reasons presented. It is recognized that the proposed plan cannot completely satisfy these concerns. However, the Feasibility Report does present a list of existing Federal and State programs and contacts which are available as possible solutions and urges those interested to contact the various agencies regarding the programs should the identified concerns remain in the basin.

40. This section of the RDEIS has been changed to reflect these possible effects.

41. In comparison to existing lotic habitats, we feel the reservoir would result in an increase in habitat diversity due to changes in the reservoir and downstream. Diversity would be increased by horizontal and vertical zonation, by substrate changes, and by changes in the types of aquatic macrophytes present. Under existing conditions the Pembina River is subjected to high sediment loads, fluctuating water levels and unstable substrate, all of which reduce species diversity and standing crops.

tion will tend to reduce the diversity of habitats that were formerly available to invertebrates. Silt should be regarded as a form of pollution which adversely affects invertebrates by limiting both species diversity and total populations.

42. Items 4.038-4.039 state, "Fish production in the reservoir and in the downstream reaches would be significantly increased over the existent stream production". This statement is strictly speculation and is biased in favor of the proposed reservoir. Over the life of the project, the existing stream in its present condition with unstable flows, may actually be several times more productive than the reservoir.

43. As siltation of the reservoir proceeds, game fish production can be expected to diminish with a corresponding increase in the production of rough fishes. The effect of the proposed reservoir on fish production in downstream reaches is questionable. Should the reservoir release water of poor quality, adverse effects of fish production will result downstream. The release of anaerobic water from the hypolimnion may be potentially toxic to fish and their food organisms. The distance affected downstream will vary and is dependent on many factors.

44. Item 6.000 does not treat the possibility of a comprehensive basin plan which could address the problems cited in Items 3.003 and 4.071.

In summary, we find the draft EIS to be basically complete and correct. Because of time constraints and overriding personal reasons we were unable to provide a detailed review of the EIS. Our main concern is that mitigation land requirements will be changed from previous studies. Our forthcoming detailed report on this project will elaborate on this matter. We suggested our forthcoming report will be invaluable for your use in preparing the final EIS. We sincerely hope our delays have not imposed undue hardships on the planning efforts of this project.

142

Sincerely yours,

James C. Gritman

James C. Gritman
Area Manager

Attachments

cc: N. D. Game and Fish Department
Regional Director, Denver (ES, FR, Special Asst. Secretary)

CORPS RESPONSES TO THE U. S. DEPARTMENT OF THE INTERIOR - [illegible]
AND WILDLIFE SERVICE (Continued)

42. It is unlikely that the production of fish in the proposed reservoir would be less than in the existing stream area either on a volume or area basis because of the poor conditions that presently exist in the river. The total fish production would not, however, consist entirely of desirable (game fish) or harvestable (size) fish. Much of the production would probably be channeled into rough fish, undersized game species, and forage species.

43. As a general statement we concur. The effects of reservoir operation, which will include operation of a multilevel intake structure, will be evaluated during the Phase I studies. A more detailed description of potential downstream effects would then be possible.

44. Refer to response 39.

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

ER-75 792

OCT 9 1975

Colonel Max W. Noah
District Engineer
1135 U. S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

We have reviewed your draft environmental statement and feasibility report for Pembilier Lake and offer the following comments.

One point in regard to ground-water resources needs clarification. At the dam site (p. 17, EIS; pl. H-1, Feas. Rpt.) 20 to 30 feet of recent river deposits (clay, sand, and gravel) reportedly lie on top of the shale of the Cretaceous Carlile formation under the floodplain. Also, 20 to 100 feet of sand and gravel and 40 to 60 feet of glacial sediments are said to lie on shale of the Carlile formation in the abutments. The proposed dam is to have an impervious core to retard the downstream migration of impounded water through the sediments underlying the floodplain. Paragraph 4.07b on page 67 of the environmental statement concludes that under existing conditions there is negligible underflow parallel to the axis of the valley or stream; that is, roughly normal to the alignment of the proposed dam. The final environmental statement should indicate the normal ground-water gradients in the area, preferably by means of water-table contours and should give typical or average
45. permeabilities of the saturated materials. The text of the draft statement suggests that the aquifer involved does not extend far upstream from the project site (p. 1, 1°). If the dam is actually located near the upstream limit of the aquifer, this point should be clearly expressed.

Thank you for the opportunity to comment on the environmental statement and feasibility report.

Director

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY

45. A joint study of the geology and groundwater of Pembina and Cavalier Counties has been completed by the North Dakota State Geological Survey, North Dakota State Water Commission and the United States Geological Survey. The groundwater portion of this study should be available for public distribution some time in 1976. The groundwater discussion in the draft EIS was based in part on communication with the persons working on this study. The published report should contain water-table contour maps, delineation of aquifer boundaries and descriptions of aquifer characteristics. This information, if available, will be used to update the final EIS and cited as a reference. The Pembina River alluvium mentioned in paragraph 2.07a does not extend to the dam site. The valley alluvium at the dam and slightly upstream is considered to have only limited potential as an aquifer capable of yielding water sufficient for normal domestic use.

United States Department of the Interior
NATIONAL PARK SERVICE
ROCKY MOUNTAIN REGIONAL OFFICE
655 Parfet Street
P.O. Box 25287
Denver, Colorado 80225

IN REPLY REFER TO
L7619(RMR)CS

ER 75/792

SEP 30 1975

Colonel Max W. Noah, District Engineer
Corps of Engineers, St. Paul District
U.S. Department of the Army
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

In response to your inquiry of July 3, 1975, we offered comment concerning the proposed undertaking by letter of July 30. Several of our comments have been addressed in the draft environmental impact statement. We also note that this document reflects an awareness of the importance of any cultural resources that may be affected and of the need for compliance with Section 106 of the National Historic Preservation Act of 1966 and the Advisory Council on Historic Preservation "Procedures for the Protection of Historic and Cultural Properties."

144

46. Page 70 of the statement advises that coordination with the State Historic Preservation Officer through the North Dakota Historical Society was initiated. The final environmental impact statement should include his letter of comment concerning the proposed undertaking. He is Mr. James E. Sperry, Superintendent, State Historical Society of North Dakota, Liberty Memorial Building, Bismarck, North Dakota 58501.

47. The statement on page 70, that a reconnaissance of the project area for the purpose of identifying archeological sites was made, is not clear as to its extent. It would be highly desirable for the final environmental impact statement to include an archeological report of the promised complete survey of the area of project influence. Hopefully, it would also reflect a more complete assessment of the significance of any archeological sites found than is presently available. The identification of any sites eligible for inclusion in the National Register of Historic Places will necessarily require compliance with the legislative and executive authorities cited above.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - NATIONAL PARK SERVICE

46. Concur. A letter of coordination has been furnished in the revised dratt EIS (exhibit 14).

47. Concur. The RDEIS has been amended to reflect the results of the historic/archaeological reconnaissance of the project area. The archaeological report has been furnished to your office for review.

We have only one further comment and that concerns the Natural Landmark Program sponsored by the National Park Service. While our review comments relate to the impact of a given project upon any cultural resources that
48. may be present in the project area, we also look during our review for any potential impact upon Natural Landmarks listed in the National Registry of Natural Landmarks. In this connection, we note on page 46 of the statement a reference to Rush Lake. This site was recently designated a Natural Landmark. The land description as taken from the U.S. Geological Survey Quadrangle Hannah, North Dakota, places the boundaries in T. 163 N., R. 62 W., sec. 28; E½, sec. 32; sec. 33.

Just as cultural resource sites are to be protected against adverse project effects, so too are the Natural Landmarks. The program is implemented pursuant to authority contained in the Act of August 21, 1935. Moreover, all Federal agencies should take cognizance of the sites included in the National Registry of Natural Landmarks to fulfill the intent of Section 102 of the National Environmental Policy Act of 1969 (83 Stat. 852; 42 U.S.C. 4331).

Sincerely yours,

Lynn H. Thompson
Regional Director
Rocky Mountain Region

145

2

CORPS RESPONSES TO THE UNITED STATES DEPARTMENT OF THE INTERIOR - NATIONAL PARK SERVICE (Continued)

48. Rush Lake is outside the project boundaries and is located on Snow Flake Creek, a tributary to the Pembina River, the confluence of which is located in Canada.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION EIGHT
BUILDING 40 DENVER FEDERAL CENTER
DENVER, COLORADO 80225

September 19, 1975

08-00.21

Colonel Max W. Noah
Corps of Engineers
District Engineer
Department of the Army
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Your Reference
NCSED-PB, dated
August 5, 1975

Dear Colonel Noah:

Subject: Feasibility Report and DEIS for Pembilier Lake and Dam on the Pembina River in North Dakota

We appreciate the opportunity to review the subject report and DEIS.

The highway impacts have been satisfactorily discussed. We have no additional comments.

Sincerely yours,

F. S. Allison, Director
Office of Environment and Design

FEDERAL POWER COMMISSION
REGIONAL OFFICE

Federal Building - 31st Fl.
230 South Dearborn Street
Chicago, Illinois 60604

September 29, 1975

Colonel Max W. Noah
District Engineer
Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

Your Reference: NCSED-PB

We have reviewed the Draft Environmental Impact Statement for the Pembilier Dam and Reservoir on the Pembina River, North Dakota, which was forwarded for our review with your letter of August 5, 1975.

147

The comments which follow are made in accordance with the National Environmental Act of 1969 and the August 1, 1973 Guidelines of the Council on Environmental Quality. However, they are those of the Chicago Regional Office, and therefore, they do not necessarily reflect the views of the Federal Power Commission itself. Our principal concern with developments affecting land and water resources is the possible effects of such developments on bulk electric power facilities, including potential hydroelectric power developments, and on natural gas pipeline facilities. Our comments consequently are confined to these functions.

By letter of September 26, 1975, our comments were forwarded on the Draft Feasibility Report for flood control and related purposes on the Pembina River, North Dakota, which proposed the Pembilier Dam as the best alternative for fulfilling the specific needs of the basin. As part of our review of the feasibility report, we considered the possibility of including conventional and pumped storage hydroelectric power at the project. Our studies indicated that it would not be economically feasible to include conventional power facilities as part of the project, unless proposed storage allocations could be modified in the interest of hydroelectric power. A review of small scale topographic maps indicates that there are areas of elevation differentials, possibly near enough to the project, which would be conducive to the development of pumped storage plant on the perimeter of the reservoir. The plant's upper reservoir

49.

CORPS RESPONSES TO THE FEDERAL POWER COMMISSION

49. Any change in the storage allocations of the reservoir would significantly alter the flood control allocations and thus are not acceptable. A review was made of more detailed topographic information of the reservoir site to determine if a perimeter-type pumped storage was possible. This review indicated that sufficient elevation differential does not exist in close proximity to the conservation pool to warrant a permiter-type pumped storage project. This review was coordinated with the regional office of the Federal Power Commission.

could be on adjacent land of higher elevation and the impoundment created by the Pembilier Dam could serve as the lower pool. The pumped storage development would be an essentially nonpolluting source of peaking capacity but it would be dependent on base load forms of generation for pumping energy required to refill the upper reservoir during off-peak periods. However, the pumping energy could be obtained from base load plants which may already be in existence or which may be constructed as a result of normal load growth. The installed capacity and the economic feasibility of constructing the pumped storage plant would be predicated to a large extent on the volume of water which could be recycled between the upper and lower reservoirs without causing adverse environmental effects. The economic feasibility of constructing the plant in the future would also be partly dependent on the existence of the lower pool. However, the pumped storage potential of the site would not be negated if the proposed Pembilier Dam is not constructed and another impoundment created as the lower pool.

According to the Draft Environmental Impact Statement, the only public utilities that will be affected by the proposed project are highway facilities. A review of information in this office also indicates that existing bulk electric and natural gas pipeline facilities will not be affected and it is not anticipated that the proposed project will pose serious obstacles to the construction or operation of such facilities.

148

Thank you for the opportunity to review the report. The completed quality control rating form for the report is attached.

Yours very truly,

Lenard B. Young
Regional Engineer

Encl.
as stated

UPPER MISSISSIPPI RIVER BASIN COMMISSION
FEDERAL BUILDING, ROOM 510, ROBERT STREET, TWIN CITIES, MINNESOTA 55101 PHONE 612 725 4690
REG. OFFICE ROOM 342 FEDERAL BLDG. P.O. 657 2ND AVE N. FARGO N.D. 58102 PH: 237 5771 EXT 5355
Regional Office

October 7, 1975

Major Norman C. Hintz
Acting District Engineer
St. Paul District
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Mr. Hintz:

Thank you for your letter of October 3, 1975, concerning the draft feasibility report on the Pembina River Basin and draft EIS on the proposed Pembilier Dam and Lake Project. I appreciate your invitation to review and comment on these documents, but that responsibility has not been delegated to the Regional Office Staff. Therefore, I am transmitting a copy of your letter to Mr. Don Rye, Chairman of the Souris-Red-Rainy Regional Committee, for his consideration as a possible agenda item for the next Regional Committee meeting.

I personally represented the Souris-Red-Rainy Regional Office at the Walhalla, North Dakota, public meeting on September 25, 1975. I was impressed by the unanimous support for the proposed project as expressed by the various state and local interests. No comments were furnished for the record since the Souris-Red-Rainy Regional Committee has not taken action on the proposed project.

Sincerely,

Floyd Fischer

Floyd Fischer
Director

cc: Don Rye

NORTH DAKOTA FOREST SERVICE

DEPUTY STATE FORESTER
STAFF AND FIELD SERVICES FORESTER
STAFF AND NURSERIES FORESTER

October 3, 1975

Colonel Max W. Noak
Corps of Engineers
St. Paul, MN

The Draft Feasibility Report and the Draft Environmental Statement on the proposed Pembilier Dam have been reviewed. We believe the reports are satisfactory as written. However, there are several points
50. that need clarification. First, the State Forest Service is in a position to offer technical assistance in tree planting, clearing, and utilization of forest products in the conservation pool and assisting in the vegetative management on Corps lands in the project area.
51. Second, the State Forest Service owns approximately 425 acres near the dam site and if this area is needed by the Corps, we would expect to have the land replaced as required in the 6-F review process. Third,
52. we are concerned with the revegetation of all disturbed areas and want to be involved in this revegetation work. We are in a position to offer tree seedlings to help out in the revegetation effort. Forth, it
53. is essential to retain the water quality of the natural springs below the dam site (and on our land). We would prefer this area not be disturbed at all by equipment travel or be used as a "barrow" area.

I might add, we do have a forester stationed at Walhalla who could be of service to the Corps. Please call on our office at any time.

Sincerely,

Walter Pasicznyk
Deputy State Forester

WP/mfs
c.c. Dr. R.E. Johnson
Albert Esken
Dick Gilmore

150

CORPS RESPONSES TO THE NORTH DAKOTA FOREST SERVICE

50. The State Forest Service would be contacted regarding tree plantings, clearing, utilization of forest products and management plans associated with the proposed project.

51. Based on an approximate taking line, the number of acres of State Forest Service lands within the project area cannot be accurately determined. If the project is authorized, the extent of lands necessary for the project would be identified. Any State Forest Service lands included in the project area would be replaced through appropriate procedures in accordance with the provisions of Section 5(F) of the Land and Water Conservation Fund Act of 1975 (Public Law 88-578).

52. Concur. Refer to response number 50.

53. Locations of the springs would be considered when detailed plans for the dam are undertaken during post-authorization studies.

NORTH DAKOTA GAME AND FISH DEPARTMENT

December 3, 1975

Colonel Max W. Noah
St. Paul District, Corps of Engineers
Department of the Army
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

151

This constitutes the North Dakota Game and Fish Department's comments on the Feasibility Report and the draft EIS on the proposed Pembilier Dam and Reservoir.

Before commenting on the Environmental Impact Statement, it may be well to review some of the tentative agreements reached by Corps personnel, Fish and Wildlife Service, North Dakota Game and Fish Department and local citizens such as Grant Trenbeath and Paul Crary. It was my understanding that these proposals would be incorporated into the Corps report presented to Congress as supporting data to obtain authorization for the Pembilier project.

Essentially the agreement called for the acquisition of at least 16,000 acres of land above the Vang Bridge for wildlife mitigation. It was understood that of this 16,000 acres, 2,800 would serve as flood control storage. The Corps also agreed to provide a perimeter fence on the mitigation area and also provide the North Dakota Game and Fish Department with a $25,000 annual operating and maintenance budget.

54. I note that in both the Feasibility Report and the Environmental Impact Statement the proposed mitigation acreage has been reduced to 12,000 acres and that their is no mention made of fencing the area nor providing the Game and Fish Department with a $25,000.00 operation and maintenance budget. It would be appreciated if you would revise the acreage upwards to 16,000 and incorporate the fencing and the maintenance fund into the report.

55. I also suggest that you attribute very little fisheries values to the proposed reservoir as the water quality is not going to be high enough to sustain a good sport fishery.

Sincerely,

Russell W. Stuart
Commissioner

RWS:ge
cc: Grant Trenbeath
Mr. James Gritman

CORPS RESPONSES TO THE NORTH DAKOTA GAME AND FISH DEPARTMENT

54. The 12,000-acre figure was included in the draft EIS because it represented the proposal of the USFWS pending the outcome of their preliminary habitat evaluation procedures. The revised draft EIS has been modified to incorporate the new mitigation acreage requested by the FWS and by your agency (16,000 acres). Fencing costs and annual operation and maintenance costs of $25,000 have been included in the revised cost figures.

55. Recreation benefits have been adjusted to reflect the potential that exists for poor water quality. The USFWS has indicated a small increase in the average annual aquatic habitat units that would occur as a result of the proposed project. These values represent benefits resulting from the project but they are presently not reflected in the benefit/cost analysis.

North Dakota Highway Department

CAPITOL GROUNDS,
BISMARCK, NORTH DAKOTA 58505

R. E. BRADLEY
Chief Engineer

ARTHUR A. LINK
Governor of North Dakota

WALTER R. HJELLE
Commissioner

PS

September 25, 1975

Col. Max W. Noah
District Engineer
Corp of Engineers
1135 U.S. Post Office & Custom House
St Paul MN 55101

Dear Col. Noah:

We have reviewed the Draft Environmental Impact Statement for the Pembilier Lake and Dam, Pembina River Basin, North Dakota, dated June, 1975.

No State Highways will be affected by the proposed action. Alleviating flooding at highway crossings downstream from the dam should lessen roadway damages.

In reviewing the effects on transportation the following comments are offered for consideration.

56. 1. Statement should indicate cost and responsibility for relocating FAS Route 720. The road has recently been improved by Cavalier County.

57. 2. Provisions should be included in project to restore service to roadways which will be inundated.

3. The effects of anchoring one bridge could be determined more easily if information were given relating to the length of time it would be inundated.

58. 4. Discussion on development of recreational facilities and the consequent impact on the need for road access should be included. For many areas where no road access is provided now, a demand will occur after reservoir construction and provisions for access and access roads should be included in the overall plan.

59. 5. A general comment for your consideration would be a suggestion for use of a more detailed map showing the boundaries of the design conservation pool stage of 800 surface acres and at design flood stage.

We appreciate the opportunity to review and comment on this Draft EIS.

Very truly yours,

R.E. Bradley
Chief Engineer

fas

CORPS RESPONSES TO THE NORTH DAKOTA HIGHWAY DEPARTMENT

56. Acknowledged. This has been included in the economic analysis.

57. Future anticipated traffic volumes do not appear to warrant the high costs associated with raising or restoring service to the other secondary road crossing located near the Little South Pembina River. The bridge at the upstream end of the flood pool has already been removed.

58. Traffic patterns and access to project lands would be an integral part of our Recreation planning efforts.

59. Concur. This has been included as Exhibit 2 of the EIS.

Environmental Health
and
Engineering Services

DIVISION OF WATER SUPPLY
AND POLLUTION CONTROL
HERMAN L. PETERSON, P.E.
DIRECTOR
(701) 224-2366

North Dakota State

W. VAN HEUVELEN, Chief

Department of Health

State Capitol
Bismarck, North Dakota 58505

December 30, 1975

Colonel Max Noah
District Engineer
St. Paul District
Corps of Engineers
1210 U. S. Postoffice and Courthouse
St. Paul, Minnesota 55101

Dear Colonel Noah:

Our office has reviewed the draft environmental impact statement for the proposed Pembilier Dam in North Dakota. The following comments and questions are offered.

60. 1. The E. I. S. notes that a reduction in peak flows may result in a need to upgrade waste treatment facilities in the basin. The Department has established effluent discharge requirements and requires approval of treated waste water (effluent) quality prior to discharge. These requirements for those cities in the basin are not dependent upon stream flows. All waste treatment systems in the basin are waste stabilization lagoons.

154

61. 2. The Department agrees with the E. I. S. draft relative to the probability that the reservoir will have eutrophication problems which will affect the uses of the reservoir. Historically, eutrophication is a problem in almost all man-made reservoirs in the state. Additional data and studies are desirable to more accurately determine or predict the reservoir water quality. Reservoir operation practices (drawdown levels, depth at which discharge waters are taken, etc.) are factors which have bearing on the reservoir water quality as well as downstream water quality.

62. 3. Has any studies or consideration been given to the possibility of the reservoir acting as a settling or holding basin for nutrients? If so, what effect would this have on downstream water quality?

Respectfully,

W. Van Heuvelen

W. Van Heuvelen
Chief
Environmental Health and
Engineering Services

LP:lrr

CORPS RESPONSES TO THE NORTH DAKOTA STATE DEPARTMENT OF HEALTH

60. Paragraph 4.02b has been amended to indicate that waste treatment facilities would not need to be upgraded because of the proposed projects influence on high flow conditions. However, efficient standards for Neche are based on controlled discharge conditions and as such, the timing of discharges may have to be modified so that instream standards would not be violated.

61. Concur. Refer to responses 64 and 65.

62. At the present time no studies have been conducted. However, the nutrient "sink" capability of the proposed reservoir is recognized and its effects would be analyzed in the proposed Phase I water quality studies.

Environmental Health
and
Engineering Services

DIVISION OF WATER SUPPLY
AND POLLUTION CONTROL
NORMAN L. PETERSON P.E.
DIRECTOR
701- 224 2366

North Dakota State Department of Health

State Capitol
Bismarck, North Dakota 58505

W. VAN HEUVELEN CHF

January 29, 1976

Mr. J. R. Calton
Chief, Planning Branch
Engineering Division
St. Paul District, Corps of Engineers
1135 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Mr. Calton:

Reference is made to the proposed Pembilier Dam in North Dakota.

155

Following our review of the draft environmental impact statement, and the meeting at the office of the Corps of Engineers in St. Paul on January 14, 1976 with other state and Federal agencies concerned with the water quality in the proposed reservoir, this Department offers the following comments:

63. 1. The Corps of Engineers should establish and carry out the water quality monitoring program at the stations on the Pembina and Little Pembina Rivers as proposed by the Corps of Engineers at the St. Paul meeting.

64. 2. That the data from this study, supplemented by data already available, be used to more specifically evaluate and assess water quality and eutrophication problems which may occur in the reservoir and the affect of the reservoir on downstream water quality.

65. 3. A plan for reservoir management should be developed. This should include measures for nutrient control in the reservoir and capability for multi-level discharge from the reservoir. This plan should be based on the results of the additional water quality studies and the resulting evaluation of possible eutrophication problems. Also, the State's water quality standards for the Pembina River must be considered.

Corps Responses to North Dakota State Department of Health

63. Concur. A water quality monitoring program has been developed by our office. Collection and analysis of water samples will be conducted by the U.S. Geological Survey (refer to para. 1.027).

64. Concur. Water quality data will be evaluated and will be utilized in simulation modeling efforts to predict various physical, chemical and biological parameters both within the proposed reservoir and downstream from the structure.

65. Concur. The ultimate purpose of the additional water quality studies is to develop an operating plan for the reservoir that would result in the least impact on water quality while satisfying identified project objectives. A multi-level intake structure is already planned for the proposed reservoir and its capabilities for regulating water quality would be evaluated using an actual scale model of the structure and applying these results to an Eco-model.

The Department recognizes the need for flood protection in the basin, including areas in both the United States and Canada, and that this proposal is part of a joint United States-Canadian effort to solve the problem. The Department is also of the opinion that with proper management and control of the reservoir and the discharge, water quality problems can be minimized without adversely affecting the primary flood protection and control purposes of the reservoir.

This Department concurs with the Corps of Engineers requesting Congressional authorization for the next phase of this proposed project as the initial activities in this next phase would include the above-mentioned studies and evaluations.

Respectfully,

W. Van Heuvelen

W. Van Heuvelen, Chief
Environmental Control Services

156

WVH/is

NORTH DAKOTA STATE OUTDOOR RECREATION AG

September 12, 1975

Colonel Max W. Noah
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Noah:

The North Dakota State Outdoor Recreation Agency has had an opportunity to review the draft Environmental Impact Statement regarding the Pembilier Lake and Dam proposal. We offer the following comments.

The reviewing agency was impressed by the completeness of the report and the factual data presented. The negative aspects of the proposal were presented in a realistic manner.

157

66. Pages 48 and 49 relate to recreation need projections for the area. These projections were based on the 1970 State Comprehensive Outdoor Recreation Plan. A new plan has been developed by this agency with updated recreation need projections. The Army Corps of Engineers has been supplied with the draft North Dakota SCORP and updated projections for the area should be utilized in the final Environmental Statement.

67. We must also express our concern with the probable changes in vegetation in both the upstream and downstream areas surrounding the impoundment. This concern is especially directed at the Tetrault State Forest area as well as the Icelandic State Park natural area.

68. The North Dakota State Park Service has expressed its concern regarding a 1,300 acre tract of land which was purchased with Land and Water Conservation Funds and which is currently being administered by the State Park Service. The 6(F) provision of the Land and Water Conservation Fund Act must be addressed should a conversion of land use affecting this property be realized.

Sincerely yours,

Gary Leppart
Executive Officer

cls

CORPS RESPONSES TO THE NORTH DAKOTA OUTDOOR RECREATION AGENCY

66. Concur. Projections based on the 1975 SCORP have been used in the RDEIS.

67. Potential effects of the proposed project on downstream habitat have been discussed. During post-authorization studies, these affects will be reexamined based on improved imagery and current operating proposals for the dam, as well as more detailed information on the location of high value natural area.

68. Concur. Also see response number 73 to the North Dakota State Park Service.

NORTH DAKOTA STATE PARK SERVICE
FORT LINCOLN STATE PARK
ROUTE 2 BOX 139
MANDAN, NORTH DAKOTA 58554
PHONE 663 9571

August 29, 1975

Colonel Max W. Noah, District Engineer
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

69. The North Dakota Park Service does not feel that recreational impact of the proposed Pembilear Dam has been accurately assessed.

Changes that need to be made to the report are:

70. Section 2.119 Page 47 The Cavalier Country Club is a municipal golf course and is not located within Icelandic State Park.

71. Section 2.120 Page 47 Icelandic State Park has only 59 tent/trailer sites, not 100. Turtle River State Park has 100 tent/trailer sites.

72. Section 2.122 Page 48 Canadians are using North Dakota recreation facilities. At the present time Icelandic State Park, 30 miles from the project site, is experiencing considerable Canadian visitation. During 1974, of the total visitation of 71,593, between 20-25% was Canadian visitation with 8-10% being day-use. To the best of our knowledge, border crossings have not presented a nuisance to Canadians entering North Dakota for recreational purposes. It should also be pointed out that currently Icelandic State Park's load capacity is being exceeded by 25% with visitation increasing yearly.

73. The North Dakota Park Service has 1333.43 acres of land within the project line which will need to be compensated for.

Sincerely yours,

Neal A. Shipman
Assistant Director

NAS/kmm

69. [illegible] See paragraphs [illegible].

70. The revised draft [illegible] has been changed to reflect this comment. See paragraph [illegible].

71. Appropriate revisions have been made. See paragraph [illegible].

72. The recreational zone of influence has been revised to include the lower portion of Manitoba, Canada. The Canadian visitation now included in the recreational demand for the area compares quite favorably to that at Icelandic State Park.

73. Based on an approximate taking line, the number of acres of State Park Service lands within the project area cannot be accurately determined. If the project is authorized, then the extent of lands necessary for the project will be determined. If any park service lands are included in the project area, they will be replaced through appropriate procedures and in accordance with the provisions of Section 3(1) of the Land and Water Conservation Fund Act of 1965 (Public Law 88-578). The existing State Park Service lands have been identified and are on file.

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

Date Received

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Mr. Dwight Connor
% Governor's Office
Bismarck, North Dakota 58505

ISSUED BY: _____

DATE: September 29, 1975

NAME OF PROJECT: Pembilier Dam

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

☐ No comment
☐ Meeting desired with applicant
☒ Comments submitted herewith

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: Dwight Connor Date: 9/29/75

Title: _____ Tele: 224/2200

159

PEMBILIER DAM

Public Involvement

The public, local and statewide groups, should be involved in all phases of the plan development.

1. 1971 - Pembina River Basin Planning Commission. (Public Involvement)

2. Plan Implementation

b. Review and comment by Governor, Feasibility Report - Page 72. Will the public be involved?

74.

a. Appropriate review and hearing, Feasibility Report - Page 73. Will the public be involved?

Question: Have local and statewide groups had a chance to investigate and comment on the project as it is now proposed?

Mitigation

The water quality of reservoir is not known at the present time. "Future studies need to be done to consider nutrient and thermal properties." Feasibility Report - Page 61; Draft Environmental Impact Statement - Pages 3, 25, 51 and 56.

160

75. Question: 1. What will the water quality of the reservoir be?

76. 2. What affect will this water have on mitigated acres?

Cost Benefits

Local Employment - $82,000 (only during construction, Feasibility Report - Page 82.

Water Supply - $61,000 (water quality not known).

Recreation - $50,000 (how will water quality affect recreation)? Draft Environmental Impact Statement, Pages 58 and 59.

77. Question: Have these points been taken into account in determining cost benefits of 1:02?

NORTH DAKOTA STATE PLANNING DIVISION (COMMENT FROM MR. DWIGHT CONNOR, GOVERNOR OF NORTH DAKOTA OFFICE, BISMARCK, NORTH DAKOTA)

74. A description of public involvement to date can be found in section 9 of the report. A list of those receiving copies of the draft EIS is also given (see page 108). All comments on the draft EIS are printed in the revised draft EIS with Corps responses. Coordination will continue through all phases of the study.

75. A general discussion of the expected water quality that would occur with the proposed reservoir were included in the EIS (paragraph 2.047). A detailed investigation of water quality will be conducted during the post-authorization project phase. This will include physical and mathematical modeling efforts and will evaluate the effects of various operating plans on reservoir and downstream conditions.

76. The mitigation acreage is based on mitigation of terrestrial habitat. The aquatic evaluation supplied by the USFWS indicates that the reservoir would result in annual aquatic habitat benefits. The resulting W.Q. would not affect the terrestrial mitigation acreage proposed by the USFWS. However, the mitigation lands are recognized to have some small, localized water quality benefits to the impoundment.

77. These factors have been included in the benefit-cost analysis. For a discussion of this analysis refer to the Feasibility Report, Appendix F.

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

Date Received

RECEIVED SEP 24 State Planning Division

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Austin Engel
State Planning Division
Bismarck, ND

ISSUED BY: Department of the Army

DATE: August 26, 1975

NAME OF PROJECT: Draft EIS: Pembilier Lake and Dam

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

☐ No comment ☐ Meeting desired with applicant

☒ Comments submitted herewith

161

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

78. The basis for acquiring 12,000 acres to mitigate loss of land, wildlife, timber aesthetic values, etc., must eventually be spelled out to substantiate this large acreage for the loss of some 800 acres to inundation. Hopefully, the continuing evaluation by the U.S. Fish and Wildlife Service and the ND Game and Fish Department will clearly substantiate this proposed acquisition as a legitimate part of the project cost.

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: Austin Engel Date: 9/24/75

Title: Director, State Planning Division Tele: 224-2818

CORPS RESPONSES TO THE NORTH DAKOTA STATE PLANNING DIVISION

78. Exhibit 17 has been included to discuss the habitat evaluation procedures utilized by the USFWS to determine the acreage necessary to mitigate wildlife losses resulting from the proposed project. In addition, post-authorization studies would be initiated to refine the mitigation requirements for the project (refer to paragraph 1.027 for additional details).

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

Date Received

RECEIVED
SEP 3 1975
State Planning
Division

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Vern Fahy
Water Commission
Bismarck, ND

ISSUED BY: Department of the Army

DATE: August 26, 1975

NAME OF PROJECT: Draft EIS: Pembilier Lake and Dam

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

192

☐ No comment ☐ Meeting desired with applicant

☒ Comments submitted herewith

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

79. We generally concur in the project proposal. We do have some concern in proposed discharges and suggest that they be reanalyzed in the final design and make consideration given to future downstream channel changes & improvement.

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: Dale D. Schaf Date: 9/2/75

Title: Director - Engineering Division Tele: 224-2750

CORPS RESPONSES TO THE NORTH DAKOTA STATE WATER COMMISSION

79. Concur. The operating schedule would be examined more extensively during post-authorization studies in an attempt to maximize benefits and minimize impacts associated with the proposed project.

...SIC FORM B (9/74)

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

Date Received

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Dr. Ed Noble
State Geologist
Grand Forks, ND

ISSUED BY: Department of the Army

DATE: August 26, 1975

NAME OF PROJECT: Draft EIS: Pembilier Lake and Dam

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

☐ No comment
☑ Comments submitted herewith
☐ Meeting desired with applicant

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: B. Michael Arndt Date: _____

Title: _____ Tele: _____

80. Sect. 2.027 - The Pembina River trench is in itself a unique geologic feature for North Dakota because of the fact that the oldest bedrock exposed at the surface is there.

81. Sect. 2.028 - The massive slumping of the valley walls west of Walhalla would seem to be a major concern. The Walhalla-Vang road is one of the few that crosses the valley north of Highway 5.

82. Sect. 2.032 - The sand and gravel lying on the valley walls in the area of the proposed damsite are fluvial in origin. Any glacial sediment found on the valley walls would have been slumped down from above rather than deposited there.

83. Sect. 4.076 - The valley walls immediately downstream of the proposed damsite are composed of thick alluvium which is already subject to extensive slumping. It would seem that any increased discharge, even though controlled, would further aggravate the bank erosion there.

84. Sect. 4.077 - The presence of the reservoir will cause a rise in the water table which will eventually saturate much of the Carlile Formation which has heretofore been in an unsaturated condition. The Carlile shale does contain montmorillonitic clays that may swell upon saturation. Is this a problem that needs further consideration?

85. Sect. 4.080 - Disagree! The fact that the Carlile shale is exposed in the river trench makes it unique.

CORPS RESPONSES TO THE STATE GEOLOGIST, NORTH DAKOTA

80. The revised draft EIS has been amended to note the significance of the exposed Carlile shale formations. (See paragraph 2.028.)

81. The use of the land in the areas of unstable shale slopes is compatible with the existing natural condition; therefore, the statement that the slopes are not a problem is accurate. The estimated effect on slope stability by a reservoir is discussed in paragraph 4.076.

32. Your statement is correct for the area upstream from the damsite. The characteristics of the valley walls change at the damsite, however, as the valley downstream is carved in the sediments of the Pembina Delta.

83. The paragraph recognizes erosion problems due to a reservoir. The reservoir would not increase discharges as you suggest but would provide a more uniform downstream flow. The problem of erosion due to a sustained moderate flow of water with relatively little sediment and bed load is recognized.

84. This problem needs further consideration only where structural foundations may be involved such as at the damsite.

85. See response number 80 above.

State Historical Society
of north dakota

September 25, 1975

Colonel Max W. Noah
District Engineer
St. Paul District Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Re: Pembina River Feasibility Report and
Draft Environmental Impact Statement:
Pembilier Lake and Dam

Dear Sir:

165

The review of these documents shows that the consideration of historic and archaeological values in the area of this project is adequate. Yet there are some errors in fact and implication that should be corrected in the final draft of the environmental statement and the feasibility report.

I. Draft Environmental Impact Statement
A. "Historic and Prehistoric Resources"

86. 2.113, Line 4. The buffalo hunts occured west of the Red River and not necessarily in the western part of North Dakota.

2.115, Research undertaken in the last three years has changed our understanding of the Fur Trade Period of Walhalla's history. Norman Kittson built his post at the confluence of the Pembina and Red Rivers in 1843. Whereas,

87. Antoine Gingras built his post outside of Walhalla in 1844.

The Kittson building in Walhalla dated from the 1850's at which time Kittson moved his establishment to Walhalla.

The buildings on the Gingras historic site are the oldest buildings in North Dakota, and the implication that Gingras established his post after Kittson's retirement is also wrong. They worked with one another for many years through the 1840's and 1850's

The State Historical Society is now in the process of restoring the buildings on the Gingras historic site. Both the buildings on the site were built by Antoine Gingras. There is no documentary evidence to support the belief that one of the Gingras buildings was a Northwest Company Fur Post.

CORPS RESPONSES TO THE STATE HISTORICAL SOCIETY OF NORTH DAKOTA

86. This correction has been made, see paragraph 2.118.

87. This information has been noted in the revised draft EIS, see paragrapn 2.120.

B. "Social Impacts"

88. 4.090. Line 6. There is a reference to "exhibit 13" at the end of this sentence. Exhibit 13 is irrelevent. It is entitled "Phosphorus Loading estimates for Lake Ashtebula..."

89. 4.092. This statement may be misinterpreted, to mean that salvage provides too little information to be of value. It should be made clear that although preservation is preferable to salvage, salvage excavation is preferable to the destruction of a site without research being conducted.

II. Feasibility Report

A. "Development and Economy"

Paragraph 1, Line 6. The main colony of the Selkirk settlers was near the present Winnipeg, Canada. Just a segment of the colony settled near Pembina to hunt buffalo to provide the main colony with food.

B. Appendix 1

1. Archaeological Impacts Report:

Item "D" in paragraph 1: A comparison with the archaeological site survey report indicates that "found" should be "faunal."

166

90. The Historical Society endorses the recommendations made by Kenneth M. Ames in the report of the preliminary archaeological site survey of the Pembilier project area entitled Archaeological Site Survey of the Pembilier Project Area. It is recommended, that the detailed survey be expanded to locate and record historic structures, buildings and sites which are located within the project area. I would also like to request copies of the three maps (U.G.S. Walhalla Quad, U.S.G.S. Vang Quad and U.S.G.S. Olga NW Quad)listed as being

91. in the pocket in the back of the report. We did not receive the maps with the report.

Sincerely yours,

Nick G. Franke
Research Archaeologist

James E. Sperry
State Historic Preservation
Officer, North Dakota

NGF/je

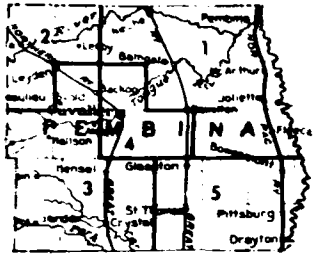
CORPS RESPONSES TO THE STATE HISTORICAL SOCIETY OF NORTH DAKOTA
(Continued)

88. We have changed this reference to exhibit 14.

89. We have included this information in the revised draft EIS, see paragraph 4.091.

90. Concur. A more detailed investigation of the project area would be accomplished during the post-authorization phase to determine if identified or unrecorded sites should be preserved, avoided, or salvaged.

91. The three maps did not have any information on site locations, transect routes, etc., presented on them. Accordingly, they have not been sent.



OFFICE OF COUNTY COMMISSIONERS

PEMBINA COUNTY

Wm J Shirlaugson
Auditor

Emily Marrean
Deputy

District

1	Milfred D Hart	Pembina
2	Eugene O Keette	Walhalla
3	J Oliver Johnson	Edinburg
4	Leslie Askew	Cavalier
5	Harrison A Theston	St Thomas

CAVALIER, N.D.

September 4, 1975

Max W. Noah
Colonel, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minn. 55101

Dear Colonel:

We submit this letter in explanation with specific comments, as a substitute for your brief questionaire. These comments will likely be broadened in our testimony at the coming public meeting September 25th at Walhalla. We note there are some minor errors in the Report that will likely be brought to your attention from orher sources, and we do not possess the knowledge to analyze the highly technical data in the Report.

167

General Viewpoint

1. *In general we wholeheartedly support the approach taken in asking all local private and public interests for their inputs into the Project Study before completion of the Preliminary Report.*
2. *We appreciate the presentation of alternative construction proposals to the local interests before completion of the Study, and have examined these proposals with the strong belief the considered reservoir construction and its modifications will result in the best flood and enviromental protection, preservation of the wildlife and asthetic values, and have the most beneficial impact for the Pembina and Red River Basin and its people.*

Major Deficencies

1. *We do not believe enough significance is attached to the "delta" formation characteristics of the lower basin and the unique problems it presents to the area. If the Pembina had been left unattended the past 15 years we would have had new river channels cut across country to the Red River, both to the northeast and southeast of the Pembina. Private and local political subdivisions do not have the resources to cope with this situation any longer.*

92.

Buy North Dakota Products

CORPS RESPONSES TO THE PEMBINA COUNTY COMMISSIONERS

92. During periods of overbank flooding, Pembina River waters flow both to the northeast and southeast of the main channel. Under natural conditions, the lower basin was very level and presented few obstructions to flood flows. However, during recent years, levee and road construction have caused floodwaters to be "channeled" through certain areas which if not attended to following the floods could eventually have created new channels.

93. 2. Nothing was included in the Report setting forth the tremendous losses presently ocurring in the thousands of acres of wooded plant life and "browse" in the 40,000 acres flooded every other year downstream from the proposed dam site, including substantial rodent and wildlife losses that play an important part in our ecosystem.

Statements we do not agree with.

94. 1. On page A-1 we do not agree that a smaller "marsh" type pool of 300 acres would be a more suitable reservoir.
   (a) Cavalier County and property owners in the acquisition area will not approve or sell with this small a recreation area.
   (b) The added 11,500 acre feet to the flood pool would be a very insignificant help. That would only be equal to a 5,000 cfs flow for one day, and in the 1974 flood there were over 17 days that exceeded a 11,500 acre foot flow volume.

95. 2. We do not agree with the projected population decline for the area. This area had a 5,000 population increase in the past six years. Experts tell us rural areas are going to increase in population. Suburbanites of Winnipeg will be consistent users of the recreation area, and this city of over a half million is growing in population as well as the rural communities immediately adjacent to the Border.

96. 3. We do not agree with the statements on Recreation on Pages 48 and 73. Our recent experiences at the Icelandic State Park proves otherwise. Access and convenience for Canadians crossing the Border is contrary to the statement in the Report. The State Park Service will refute the recreation statement with facts and figures to substantiate.

97. 4. We do not agree with the negative attitude toward fishing. Upstream lakes on the Pembina in Canada are satisfactory for fishing.

98. 5. On page A-5 we do not agree that the displaced wildlife from the permanent pool will be forced into an area already supporting wildlife to its maximum. Until recent terrific hunting pressure, the area supported two to three times as many white tail deer with relatively the same habitant area intact.

16x

CORPS RESPONSES TO THE PEMBINA COUNTY COMMISSIONERS (Continued)

93. As is suggested at several points in the EIS text, the floodplain ecosystems owe their character to flooding and its effects. There is little doubt that flooding has adverse effects, such as when trees are damaged by bank erosion or ice action. However, flooding also has beneficial effects on floodplain vegetation through nutrient and water enrichment of the site as well as reducing competition from non-floodplain adapted species. Flooding can be detrimental to floodplain vegetation if man's activities greatly change the natural flooding regime, or if corrective measures (and subsequent developments) are undertaken which adversely affect the floodplain stands. Without studying a specific stand and the forces influencing it, one can therefore not claim that flooding is adverse. The contrary is usually assumed to be true.

On the other hand, the effect of flooding on many wildlife species is adverse in the short term. Effects may range from the animals' being driven from the site to their being drowned. Of course, there are also species which would benefit from flooding. In the long term, flooding may be considered as neutral or beneficial since it maintains the basic character of the floodplain habitat (see also the ideas on vegetational effects above).

The overall conclusion is that flooding should not automatically be considered adverse to terrestrial ecosystems. It may be in certain cases; it may not in others; but each site must be considerably individually and in light of its influencing factors. Often, a positive case is demonstrated.

94. The "marsh" alternative presented as exhibit 1 was not described as "a more suitable reservoir" but only as an alternative operating plan that could reduce some of the impacts associated with the proposed operating plan, i.e. water quality and terrestrial habitat.

95. Population estimates were based on the 1970 census data.

96. Additional studies have confirmed this and appropriate revisions have been made to the EIS.

97. The North Dakota State Department of Game and Fish indicated that very little value should be attributed to the fishery in the proposed reservoir.

98. Concur. Appropriate revision has been made in the EIS. See page A-5.

99. 6. We do not agree with the very poor water quality statement on Page A-6. Renwick Dam reservoir is an example. We were told the same thing about it ten years ago, and it is only one fifth the size and has a nil summer flow compared to the Pembina River.

100. 7. We find maximum flow releases of the dam are not enough to present the severe flood damages we sufffered in the Spring of 1974.

Sincerely yours,

Wm. J. Sturlaugson
County Auditor
on behalf of the Board of the County Commissioners

km

CORPS RESPONSES TO THE PEMBINA COUNTY COMMISSIONERS (Continued)

99. Information to date indicates that poor water quality would be expected in the reservoir. State and Federal agencies responsible for water quality evaluation agree. The estimated degree to which the proposed reservoir will eutrophy and the rate at which this would occur are at present largely subjective. More detailed water quality studies will be conducted during the post-authorization phase of the project.

100. The proposed operating plan for the reservoir will be developed in more detail during post-authorization and will attempt to maximize benefits to all project purposes and minimize adverse impacts. It must be recognized that site limitations would not allow the project to control all floods.

NORTH DAKOTA
Water Users Association

ROOM 416 FIRST NATIONAL BANK BUILDING
P O BOX 1934 MINOT NORTH DAKOTA 58701

September 4, 1975

Colonel Max W Noah, District Engineer
St. Paul District, Corps of Engineers
1135 U S Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel:

This is in response to your invitation to comment on the Draft Feasibility Report for Flood Control and Related Purposes, Pembina River, North Dakota, and the Draft Environmental Impact Statement accompanying the report.

As noted on the completed form you mailed, the report is satisfactory, in many ways excellent, but we do have certain reservations.

170

101. As is normal with Environmental Impact Statements, much is said about "adverse, unavoidable or irretrievable" impacts on the environment. Too little is said about the projected improvements in man's environment. We wonder if it would not be possible to better compare the current use of the river with projected use--better management of the waters, desiltation benefits and recreation use.

102. In Appendix 1, pages F-6 and F-9, it is stated that current normalized prices published by the Water Resources Congress Act of 1974 for North Dakota are used to represent the long-term agricultural prices. The "weighted gross income per acre" of $88.01 is much lower than returns to farmers, we believe.

Relative to the release rate (Appendix 1, Page E-8), "From elevation 1050, the release rate would not be allowed to exceed 3,000 cfs up to and including design stage" seems rather low in view of the fact that the channel capacity below the dam is larger. It seems illogical to place a limit on the releases in periods when there is a good prospect of second flood crests and the need for reservoir capacity at that time.

CORPS RESPONSES TO THE NORTH DAKOTA WATER USERS ASSOCIATION

101. Section 4 of the EIS discusses both positive and negative impacts of the proposed project on the natural and human environment. Quantification of many project benefits are accomplished through the economic analysis and require little more than presentation in the benefit/cost analysis. Quantification of environmental impacts are, however, largely subjective and as such require a greater amount of discussion to identify assumptions and possible consequences of a particular action.

It is not the purpose of the EIS to make value judgements as to whether or not a particular alternative is "good" or "bad". The EIS should present, as objectively as possible, the probable impacts associated with a particular alternative. We feel that this has been largely accomplished.

102 As indicated in paragraph 9.015, responses to comments directly pertaining to the feasibility report will be contained in that report.

101. Your estimate of recreation benefits may be too conservative, particularly in eliminating the possibility of visitations by Canadians (Appendix I, Page F-31 "The nearby areas of Manitoba are excluded from the zone of influence due to the dominant competition provided by existing lakes x x x.") Certainly, the history of visitations at Icelandic State Park in Pembina County disproves this statement.

We appreciate the opportunity of commenting on these reports and again express our solid support for Pembina Dam as expressed in the resolutions adopted at our annual meetings over the past several years.

Sincerely,

R. L. Dushinske
Executive Vice President

RLD/kvh
encl
cc: Grant Trenbeath

171

CORPS RESPONSES TO THE NORTH DAKOTA WATER USERS ASSOCIATION

101. See response numbers 69 and 72.

North Dakota Wildlife Federation

Publishers of FLICKERTALES
North Dakota's Leading Environmental Publication

200 West Main
P. O. Box 1686
Bismarck, North Dakota 58501

Phone 223-8741

September 4, 1975

Max W. Noah, Colonel
District Engineer
Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota

Dear Colonel Noah:

Enclosed are comments of the North Dakota Wildlife Federation on the DEIS, Pembilier Lake and Dam, Pembina River Basin, North Dakota.

We understand there will be a public hearing in Walhalla later this month. Would you please send us information regarding time, place etc.

Sincerely,

NORTH DAKOTA WILDLIFE FEDERATION, INC.

Betty Morgan
Executive Secretary

encl: statement

172

North Dakota Wildlife Federation

Publishers of FLICKERTALES

200 West Main
P O Box 1694
Bismarck North Dakota 58501

North Dakota's Leading Environmental Publication

Phone 223 8741

September 4, 1975

NORTH DAKOTA WILDLIFE FEDERATION, INC.
Review
Draft Environmental Impact Statement
Penbilier Lake and Dam, Pembina River
Basin, North Dakota. June 1975
U.S. Army Engineer District, St. Paul

The North Dakota Wildlife Federation, Inc. wishes to make the following comment upon the Draft Environmental Impact Statement of the proposed Penbilier Lake and Dam.

The North Dakota Wildlife Federation is a non-profit, non-political organization made up of some 6,500 citizens concerned with the utilization and management of the state's natural resources and their effect upon the environment.

The Federation is pleased to learn that, after years of negotiations, Penbilier Dam appears nearer to reality.

We are concerned primarily with protection of the wooded corps above the impounded area. This should be in a manner which would not place an unwarranted burden upon the agency of state made responsible for the management of such area.

The Federation urges the Corps of Engineers to acquire sufficient lands above the proposed impoundment to adequately provide for natural habitat which would be lost to wildlife, including game species, as a result of impounding waters over presently existing habitat. It further urges that compensation, through acquisition of lands adjacent to the aforementioned wooded area, be provided for existing wetland areas which will be lost through drainage if flooding of agricultural lands is minimized by construction of the dam. The Federation recognizes that wetland drainage will increase if agricultural land is protected from spring flooding.

We request that these comments be incorporated in the Revised Draft Statement.

[illegible] the proposed project [illegible] adversely affected by the [illegible] 12,500 acres of [illegible] have been requested for authorization [illegible] at through a preliminary study [illegible] Game and Fish Department, and [illegible] would be managed by the North Dakota [illegible] offset wildlife production lost [illegible] In addition to lands acquired, all [illegible] and N.D.G.F. would receive an annual [illegible] all of which are project costs. Mitigation [illegible] north of the Vang Bridge crossing [illegible] and the Little North Pembina Rivers.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

PEP ER-77/434

AUG 15 1977

Lieutenant General J. W. Morris
Chief of Engineers
Department of the Army
Washington, D. C. 20314

Dear General Morris:

The Department of the Interior has completed its review of your proposed report and pertinent papers for the Pembina River Basin, North Dakota. We have comments on both your report and revised draft environmental statement.

Chief of Engineers' Report

1 Wildlife Mitigation Plan

The Chief's Report concurs with the Board of Engineers' recommendation that separable wildlife mitigation lands be excluded from Phase I investigations if they are authorized. The Board of Engineers contends that the Habitat Evaluation Procedures (HEP) used to determine wildlife mitigation needs have not been adopted by Federal water resource development agencies or the Water Resources Council and are currently a subject of interagency testing and further refinement. The Board is concerned about the precedent setting nature of using an unknown technique for wildlife mitigation.

We strongly object to the exclusion of wildlife mitigation lands at the Pembilier Lake and Dam project. The plan recommending 13,200 acres for mitigation is a product of cooperation among the local project sponsors, the North Dakota Game and Fish Department, the North Dakota Governor's Natural Resource Council, the Corps' District and Division Engineers, and the Fish and Wildlife Service.

The District Engineer agreed in advance to use the Fish and Wildlife Service (FWS) procedure as the method of loss evaluation on the Pembina River preauthorization study. The Pembina project is one of three on which the St. Paul Corps District chose to demonstrate use of the HEP procedures. The HEP methodology was applied using the best information available at the

174

Corps Responses to the U.S. Department of the Interior

1. The wildlife mitigation and recreation concerns expressed on the Chief of Engineers' proposed report dated 4 May 1977 will be addressed by separate letter. The purpose of the comment/response section is only to address comments on the environmental impact statement posed by reviewers.

time, and the information in this report is based on hydrologic data generated by the Corps.

The mitigation proposal recommended by the District and Division Engineers agrees favorably with other estimates of wildlife mitigation needs for the project. The local sponsors voted unanimously to support a reservoir-type project including a "wilderness area" of 21,000 acres located in two parcels. The Environmental Resources Branch of the St. Paul District Corps of Engineers conducted their own HEP evaluation and came up with a recommendation for 17,521 acres for mitigation. The same Corps office used monetary evaluation criteria and came up with a range of mitigation needs of 15,750 to 23,100 acres. The FWS mitigation plan is entirely within reason and has been endorsed by the local sponsors, the North Dakota Game and Fish Department, the Governor's Office, and the District Engineer and Division Engineer.

The Board of Engineers determined that the HEP methodology was improperly applied to define "with and without" project conditions. They state that no credit was given for conversion of private lands below Vang Bridge and lands downstream of the project. The Board believes that conversion of 5,800 acres of required project lands from private to public ownership, accompanied by the project-induced increased public access, should result in greater hunting utilization without acquisition of the 13,200 acres of separable mitigation lands.

The concept of "credit" to which the Board refers is not a part of the HEP procedures. No mitigative potential has been assigned to the project lands below Vang Bridge. This area will receive recreation pressure in the future, although the amount of public use and the location of developments are still unknown factors. It should be noted that a site-specific recreation plan has yet to be developed.

The North Dakota Game and Fish Department has some 1,300 acres of State game lands in the vicinity of the proposed project. These lands were purchased with Federal Aid monies under the Pittman-Robertson Act (P.L. 74-415). It appears that all or part of these lands are within the take line of the Pembilier Lake Project. State game lands lost to the project must be replaced with property of equal monetary value having commensurate benefits to fish and wildlife. If replacement lands are not acquired, the

North Dakota Game and Fish Department will become ineligible to receive Federal Aid funds. It is, therefore, absolutely imperative that the Corps acquire replacement lands for the North Dakota Game and Fish Department. These lands are separate from and in addition to any lands proposed for acquisition for mitigation purposes.

The impacts that would occur downstream of the proposed dam are unknown. The present river channel will not handle the proposed reservoir releases and some channel enlargement will be required. The Corps has avoided downstream channel work in its project plan. That project is to be handled separately in cooperation with the North Dakota State Water Commission. This makes evaluation of the cumulative environmental impacts of the project nearly impossible. We will be ready to address downstream impacts when the Corps acknowledges that downstream channel work is necessary as a part of the Pembina project.

In the FWS detailed report on fish and wildlife resources, several recommendations were made that appear to have been left out of the final plan recommended by the Chief of Engineers. The report recommended that water release plans be coordinated with the FWS and the North Dakota Game and Fish Department. It was further recommended that the mitigation lands proposed for acquisition be surveyed and fenced, and that no use permits or leases be issued for project lands used for wildlife mitigation purposes. It was also recommended that a program be developed to deal with the problem of intensive land use and drainage of wetlands in the project area. We strongly urge that these recommendations be included in the Chief's Report.

176

We recognize that further investigations are needed in the areas of plan formulation and engineering feasibility to justify selection of a recommended plan. It is further recognized that refinements in the environmental analysis, including the wildlife mitigation plan, will be based on the improved engineering data developed by the Corps.

Outdoor Recreation

Of additional concern are the issues which have been raised regarding the lack of reservoir storage dedicated specifically to recreation and the location of recreation lands and facilities to meet the expected visitation. These are especially important concerns in light of recent data made available by the State of North Dakota which indicates a substantial and increasing recreation use of similar areas by Canadian citizens.

In view of the above it appears that Phase I planning will require a complete re-study of recreation needs without regard to, or constraints imposed by, previous project studies and reports. Therefore, we recommend that the Chief's Report be revised to specifically require a complete and detailed restudy of the recreation function during Phase I.

Conclusion and Recommendation

If the study is authorized, advanced studies should be initiated to define more precisely the water quantity and quality conditions upstream, within, and downstream of the proposed reservoir. Specifically, more study is needed in the areas of basin hydrology, reservoir size, reservoir operating plans, and downstream channel modifications. Information from these studies will provide the data from which refinements in the wildlife mitigation and other plans can be made.

For the reasons listed above, we find the Chief's Report to be unacceptable, and we oppose the report as now written. We recommend that the Chief's Report be revised to provide for the acquisition of 18,200 acres for wildlife mitigation as well as the other recommendations noted above for the Pembina River project.

Environmental Statement

General

With the exception of the below listed comments, the impact evaluation in the revised draft is consistent with available data and is satisfactory for preauthorization study needs. However, because of the serious questions raised by the Corps reviewing officers concerning hydrology, recreation, land use, wildlife mitigation, benefits and costs, and many other areas, it may be advantageous to consider further revision and reissue of this statement coincident with completion of Phase I studies.

Geology and Groundwater Resources

3 Page 14, Section 2.010, last sentence: It is stated that the Pembina River flows in a valley "slightly over 200 feet deep cut through the thick delta deposits." However, on page 15 (Sec. 2.015) the depth to bedrock of sand and gravel are only indicated to be up to 130 feet thick, with the thickest deposits at the eastern perimeter of the delta. Bedrock of the Cretaceous Carlile Formation crops out near the Cavalier-Pembina County line in the Pembina River valley, essentially at the proposed damsite, and Pierre Shale and Niobrara Formation (shale) are exposed in the valley a short distance upstream.

4 We can only conclude that the figure of 200 feet indicated on page 14 includes not only delta deposits but some underlying till,

Corps Responses to the U.S. Department of the Interior (continued)

2. We concur. In accordance with Corps of Engineers policies and guidelines, the final environmental impact statement on file with the Environmental Protection Agency will be reviewed prior to submittal of the Phase I General Design Memorandum (GDM). If the Phase I studies indicate that the environmental effects of the project as proposed have not changed significantly from the authorized project, and were adequately and fully covered in the impact statement, no changes to the statement will be required. However, if the Phase I studies indicate that there are changes in the project which would significantly affect the quality of the environment, or if the environmental effects of the project were not adequately covered in the original statement, a new impact statement (draft and final) will be prepared to accompany the Phase I GDM.

3. The last sentence of paragraph 2.010, page 14, has been modified to read "The Pembina River flows through a valley ½ to 1 mile wide and has cut approximately 200 feet below the delta surface." This 200 feet does include more than delta deposits.

4. Borings taken in the floodplain indicate that the overburden soils vary in depth from 20 feet near the river channel to about 37 feet near the base of the right abutment. These fluvial deposits are underlain by the Carlile Formation, which is considered firm bedrock and essentially impermeable. However, for the embankment design considerations, several modifications were made in the existing foundation conditions in order to reduce seepage and to provide greater stability for the dam. This included the following:

a. The upper layer of clay and silt of the fluvial deposits would be removed.

b. For the underlying coarse sand and gravels, a clay cutoff to shale would be provided across the valley floor.

c. A small clay parting or a bentonite seam would be added to the Carlile formation to provide additional control of the foundation strength. Also see response number 3.

4 (cont) and that the deltaic deposits at the damsite are much thinner and rest on a bedrock floor of shale essentially at valley floor level. This, in turn, suggests that the floor of the reservoir and the base of the dam are probably impermeable, but the sand and gravel of the delta deposits would be a source of lateral leakage.

5 The geologic character of the proposed damsite should be described more specifically, rather than leaving this type of interpretation to the reader.

A misplaced attempt to do this on page 17 is inadequate. A cross section drawn across the valley at the damsite would be useful. Section 2.033 (page 18) suggests that Carlile Shale extends to the Canadian border as valley wall material, but

6 Section 2.015 (page 15) says, in the last sentence, that Pierre and Niobrara are exposed in the valley walls only a short distance upstream from the dam. Again, this may be simply an imprecise statement in Section 2.033, and the intention was to say that the Carlile Formation would prevent side leakage at the damsite. Clarification is needed.

178

Page 16: The statement indicates that deposits of the Pembina River constitute the best aquifer of the area from a point about 2 miles southwest of Walhalla to 10 miles downstream. Wells in this aquifer produce up to 300 gallons per minute of water of good quality for the City of Walhalla. The proposed dam would also be located at a point about 2 miles southwest of Walhalla (page i), apparently at the upstream limit of the good aquifer.

7 The statement should discuss the recharge to this aquifer and assess impacts of the impoundment on the quality of groundwater, water levels, and recharge.

Page 76: Potential instability has been recognized along the proposed reservoir, in the vicinity of the damsite, and in an emergency levee downstream at Neche; we concur that these conditions be evaluated during the recommended Phase I investigations.

Cultural Resources

By letters of July 30, 1975, and September 30, 1975, the National Park Service had previously offered comment concerning the proposed project. We note further that the revised draft environmental statement has addressed our comments and those made by the State Historic Preservation Officer. However, there are several additional recommendations noted below.

Corps Responses to the U.S. Department of the Interior (continued)

5. The geologic character of the proposed damsite will be described in detail during Phase I studies and will be consistent with Appendix I, Section 14, pages H-1 through H-13 of the Pembina River, North Dakota, *Feasibility Report*, dated March 1976.

6. The slopes along the Pembina River valley are cut in Cretaceous clay shale of the Pierre, Niobrara, and Carlile Formations. The proposed Pembilier Dam and Lake would flood only the lower portion of the valley with all inundated slopes restricted to the Carlile Formation. Even at maximum flood pool, the water level would be below the base of the overlying Niobrara Formation. The Carlile Formation would prevent side leakage, but this type of shale would be susceptible to shallow slope failures, resulting in shallow slumping and debris slides. In addition, at the site of the proposed dam abutments, a clay key up to 25 feet deep would be contined up the abutments, providing an adequate cutoff against any seepage.

7. The Pembina River aquifer mentioned on page 16 does not extend to the damsite. The valley alluvium at the dam and slightly upstream is considered to have only a limited potential as an aquifer capable of supplying sufficient water for normal domestic use. It is recognized, however, that the increase in flood duration caused by reservoir releases may have some effect on downstream groundwater quality, levels, and recharge. This effect would be investigated during postauthorization studies and would be consistent with the 1976 joint study of the geology and groundwater Geological Survey, North Dakota State Water Commission and the United States Geological Survey.

Page 48: the final environmental statement should reflect
8 consultation of the most current listing of the National Register of Historic Places, as published in the Federal Register of February 1, 1977, and all monthly supplements.

Page 79: Here the Gingras House and Trading Post is identified as a property on the National Register of Historic Places that is located within the general area of the project. Moreover, at least 19 lithic archeological sites are reported to be present. Accordingly, further consultation with the State Historic Preservation Officer and the State Archeologist would be highly desirable for the purpose of determining whether any of the archeological sites are eligible for listing in the
9 National Register of Historic Places. If the project developments will have any effect whatsoever upon a National Register of Historic Places property, the Advisory Council on Historic Preservation should be consulted. The actions then taken by an undertaking Agency should be in compliance with the Advisory Council's "Procedures for the Protection of Historic and Cultural Properties" (36 CFR, Part 800).

Pages 79 and F54: The draft environmental statement indicates that a more detailed archeological survey will be conducted prior to project development. The final environmental state-
10 ment should reflect the results of this survey and provide all pertinent support data to facilitate final review of the project. Moreover, to the extent that mitigative measures are needed, these should be thoroughly documented.

179

Sincerely,

LARRY E. MEIEROTTO
Deputy Assistant SECRETARY

Corps Responses to the U.S. Department of the Interior (continued)

8. We concur. The most current listing of the National Register of Historic Places as published in the Federal Register of 1 February 1977 and the March-December 1977 monthly supplements have been consulted, resulting in no new changes to the revised draft environmental impact statement. During Phase I studies, the National Register will again be consulted for any changes.

9. A more detailed investigation of the project area would be accomplished during postauthorization studies in order to locate any additional sites and to assess the impacts on all identified cultural resources. All cultural remains located within project impact areas will be evaluated according to the National Register of Historic Places criteria. Following consultation with the State Historic Preservation Officer and the State Archaeologist, the National Park Service will be contacted regarding determinations of eligibility. Any sites or structures determined eligible will be either avoided or mitigated, following consultation with the Advisory Council on Historic Preservation. The Gingras House and Trading Post is not located within the project impact areas.

10. Should the more detailed archaeological surveys identify a need for changes in the project or a need for appropriate mitigative measures, the final environmental impact statement would be modified in accordance with response number 2 and provided to all interests for review.

NORTH DAKOTA
STATE WATER COMMISSION
900 East Boulevard
Bismarck, North Dakota
701-224-2750

August 10, 1977

Major General John W. Morris
Chief of Engineers
Department of the Army
The Pentagon
Washington, D. C. 20314

Re: SWC Project No. 567

Dear M. G. Morris:

This letter should be considered supplementary to our letter of July 11, 1977, concerning funding for first-phase studies of the Pembilier Dam in Pembina County.

Please be advised that the Governor of North Dakota, Arthur A. Link, and all other state agency officials involved in water resource functions are wholeheartedly in support of early construction of the Pembilier Dam. In addition, local support remains strong in spite of the many delays that have been experienced in the planning and development of the project.

I make this supplemental statement in order to indicate that in spite of some dissatisfaction expressed concerning the Review Board Report, we are confident that first-phase studies will resolve the questions posed by the Reviewer and that the project will merit continued funding.

We look forward to working with you and your District Engineer's office in proceeding with first-phase studies on this most worthwhile project.

Sincerely yours,

Vern Fahy
State Engineer

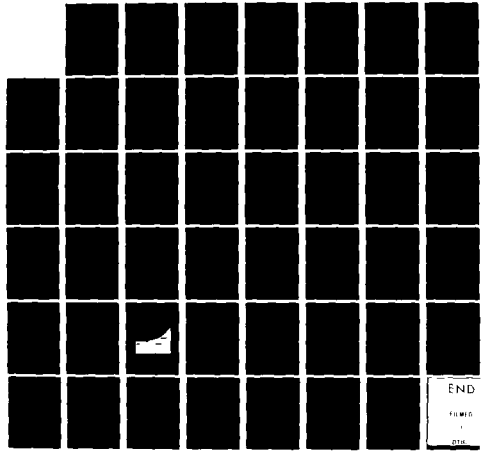
VF:sl

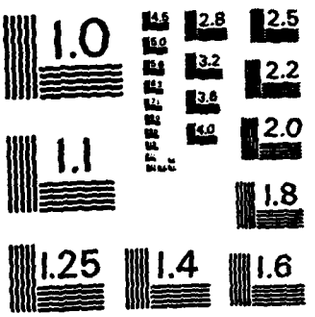
Corps Responses to the North Dakota State Water Commission

Comments noted.

AD-A121 523 FINAL ENVIRONMENTAL IMPACT STATEMENT [illegible]
DAM PEMBINA RIVER BASIN NORTH DAKOTA(U) CORPS OF
ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 77

UNCLASSIFIED F/G 13/2 NL





UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
1860 LINCOLN STREET
DENVER COLORADO 80203

AUG 11 1977

Ref: 8W-EE
RD-COE-J35000-ND

Lieutenant General J. W. Morris
Chief of Engineers
Department of the Army
Washington, D.C. 20314

Dear Lieutenant General Morris:

We have reviewed the revised draft environmental impact statement (EIS) for Pembilier Dam and Reservoir, a project designed for flood control and other purposes by the St. Paul District of the Corps of Engineers. Although we note only minor changes in the concept and design of the proposed alternative, the revised document is substantially improved in its disclosure of the probable environmental impacts of the proposal. 181

We interpret the views and recommendations of the Board of Engineers for Rivers and Harbors in their report of January 27, 1977, and the proposed report of the Chief of Engineers to mean that the Corps of Engineers intends to embark on a thorough study of flood control and other needs in the study area. We assume this would include an analysis of various alternative means of effectively satisfying these needs during preparation of the Phase I General Design Memorandum for which funding is presently being sought. In view of the probability that this may entail substantial modification of the design and operational characteristics of the proposal addressed in the revised draft EIS and the fact that studies will be undertaken during the Phase I investigations which will more clearly elucidate the environmental impacts of a recommended plan and identify feasible mitigation measures, we do not believe that it would be appropriate for EPA to provide detailed comments on the subject documents at this time. We do, however, have some important concerns of a more general nature which we urge the Corps of Engineers to keep in mind during future studies of the flooding problem in the Pembina River. 11

EPA's foremost concern about any proposed project on the Pembina River is the very high probability of adverse water quality impacts owing to eutrophication of impounded waters. Although the degree to which this may occur and the extent to which it can be mitigated are the subject of future

Corps Responses to the U.S. Environmental Protection Agency

11. We concur. The purpose of the Phase I General Design Memorandum is to reevaluate the problems and needs of the area and to reevaluate and reformulate all alternatives to meet the identified problems and needs. This will assure that the Phase I studies conform with the Principles and Standards for formulating water resource undertakings and develop a plan which provides the best uses, or combination of uses, of water and related land resources to best meet the identified needs of the Pembina River basin. (See also comment and response number 2.)

studies, there is no disagreement between our agencies as to the significance of the water quality question. Therefore, in completing the
12 water quality studies and developing a recommended plan, we urge the Corps of Engineers to exercise extraordinary sensitivity to the need to protect water quality and other environmental values of the Pembina River valley. In addition to the primary impacts of any proposed action, we believe that the detailed Phase I planning must also focus on project-induced secondary impacts on water quality. An important example of such impacts is the likelihood of increased drainage of wetlands above and below a proposed flood control project. The revised draft EIS acknowledges that providing a greater degree of flood protection may remove a constraint on the drainage of private wetlands in the basin. In consideration of the services that wetlands provide by attenuating floodwaters and enhancing water quality, and the adverse effects of draining these areas on both water quality and increased runoff, we believe that wetlands protection must be an integral part of any plan to reduce flooding and satisfy other water related needs in the Pembina River basin. EPA believes that section 404 of the Federal Water Pollution Control Act Amendments of 1972 can be a very effective means of protecting these resources,
13 and we need the support of your agency in exercising our shared responsibilities to protect water quality through effective implementation of section 404. In the project at hand an even higher level of wetlands protection could be achieved through conditioning the construction of any projects on implementation of measures designed to protect privately owned wetlands in the area from drainage and encouraging the use of agricultural "best management practices" identified through the state's 208 water quality management planning process.

182

Another matter of importance to this agency is the range of alternatives that will be considered during Phase I investigations. In earlier correspondence on this subject, we recommended consideration of the "marsh" alternative that is discussed in Exhibit I of the revised draft
14 EIS. Although it appears that the ultimate impacts of this alternative on the valley would be similar to those of the proposed reservoir, we believe that this alternative still offers some advantages over a reservoir alternative, largely because the water quality impacts may be less severe and because the ecological change in the valley would occur less precipitously. Of even more interest to EPA, however, is the Environmental Quality Plan identified pursuant to the Principles and Standards for water resources planning. This alternative would entail the least amount of impact on the environmental values of an area that would aptly be described as being among the last of North Dakota's vanishing wildlands, while still providing a reasonable degree of protection against flooding along the lower reaches of the Pembina River. We view the preparation of Environmental Quality plans as being aimed at precisely the kinds of situations that exist in the study area, where the environmental costs of a more
15 conventional approach to providing a public good or service, in this case flood protection, may be unacceptably high due to the nature of a project's impacts and unique characteristics of a proposed site. Even though the

Corps Responses to the U.S. Environmental Protection Agency (continued)

12. We concur. During Phase I studies, every effort will be made to fully coordinate the planning with all concerned Federal, State and local agencies to assure that equal consideration is given to water quality and other environmental values as well as the flood damage reduction and other needs of the Pembina River basin. In order to accomplish this goal on water quality, appropriate identification and consideration will be given to both the primary and secondary impacts of any proposed alternatives. With respect to these impacts, we believe that the ongoing collection of the necessary water quality data in combination with water quality model studies will provide the information to define more precisely the water quality conditions upstream, within, and downstream of any proposed alternative.

13. Appropriate consideration will be given during the Phase I studies to the protection of wetlands as they relate to a given alternative and to concerns expressed by the various Federal, State and local agencies.

14. The marsh alternative will be given equal consideration with all other alternatives during the Phase I studies.

15. The Phase I studies will include a complete reformulation of alternatives and equal consideration of all plans, including the environmental quality plan. All the plans developed will then be evaluated using multiobjective planning, consistent with the Principles and Standards and related policies. Therefore, the merits and any disadvantages of the Environmental Quality Plan will be given appropriate consideration in the planning process.

Environmental Quality alternative may prove to be less economically attractive than other alternatives, we believe that it merits your
15 agency's most serious consideration. Preservation of these wildlands,
(cont) in addition to allowing them to continue to provide the benefits of wildlife habitat and serve as a setting in which present and future generations can enjoy many recreational pursuits, is also highly compatible with the protection of water quality.

Finally, we are somewhat puzzled by the release of the revised draft EIS at a time when many of the detailed studies and formulated
16 alternatives that are needed in order to allow a complete assessment of the impacts of any proposal for flood protection are not yet completed. Because of this, EPA is withholding its judgment about the proposal until it has reviewed draft documents describing finalized alternatives and analyzing their environmental impacts on the basis of the environmental studies that are to be completed during the Phase I investigations. Until such time as we have an opportunity to review the results of the Phase I studies, our previous rating of ER-2 for the project remains in effect. We hope that completion of the Phase I studies will enable your agency to recommend an environmentally acceptable alternative solution to the flood damages occurring in the Pembina River drainage and bring the NEPA evaluation of this project to a satisfactory conclusion.

Sincerely yours,

John A. Green
Regional Administrator

cc: Colonel Forrest T. Gay, III
St. Paul District, Corps of Engineers

Corps Responses to the U.S. Environmental Protection Agency (continued)

16. The Corps of Engineers policies and guidelines governing the preparation and coordination of environmental impact statements as required by Section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190) and the Council on Environmental Quality Guidelines for Statements on Proposed Federal Actions Affecting the Environment, dictate that the revised draft EIS will be circulated for review and comment, with the feasibility report, to the concerned State and Federal agencies at the Washington level. Upon completion of Department review, the final EIS will be prepared and will accompany the Chief of Engineer's final report to the Secretary of the Army. Completion of these requirements is necessary for all proposed projects, including the Pembilier Dam and Lake project, even if they are only authorized for Phase I studies. (See also comment and response number 2.) In this case, the detailed studies will be undertaken during the Phase I General Design Memorandum stage. The purpose of the Pembina report was to evaluate the feasibility of a project.

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

JUL 27 1977

Lieutenant General J. W. Morris
Chief of Engineers
Office of the Chief of Engineers
Army Corps of Engineers
U.S. Department of the Army
Washington, D.C.

Dear General Morris:

This is in response to Colonel Russell J. Lamp's letter dated May 4, 1977, transmitting for our review and comment your proposed report, together with other pertinent reports, and a revised draft environmental impact statement (EIS) on the Pembina River, North Dakota.

The Pembina River Basin is in south-central Manitoba and northeast North Dakota. The plan includes construction of a dam for flood control and contains provisions for water supply and recreation. At October 1975 prices, first costs are estimated at $27,000,000 of which $25,420,000 are Federal. At 6-1/8 percent interest, the benefit-cost ratio is 1.6.

Some of the economic data presented raise questions. Pages 41 and 42 of the draft EIS quote 1969 Census of Agriculture figures. More recent information is available for use. This discussion relates only to Pembina County, North Dakota. If this county is representative of the basin, the information could be expanded to cover the basin. In any event, the EIS should be revised to address agriculture of the total basin.

About 75 percent of the project benefits are attributed to the reduction of agricultural flood damages. Information used regarding current and projected agricultural land uses and yields in the Technical Report are generally consistent with Census of Agriculture information. A comparison of prices used in the report on pages F-3 and F-9, described as current normalized, and 1975 normalized prices issued by the Water Resources Council shows the following differences:

Crops	Price Used in Report	1975 Normalized Price (U.S. Average)
Wheat	$ 3.67	$ 3.48
Barley	1.94	2.49
Sugar Beets	27.70	30.83
Potatoes	3.37	4.34

Future report revisions should be based upon the Water Resources Council normalized prices, or if variations are used, the differences should be explained.

Corps Responses to the U.S. Department of Agriculture

17. Appropriate revisions have been made in the EIS. See pages 41 and 42.

This proposed project does not conflict with any U.S. Department of Agriculture planned or installed projects. However, impacts to agricultural lands, especially to prime agricultural lands, should be discussed in the EIS. Also, the setting aside of 275 acres of agricultural land for recreational use beside a lake expected to become eutrophic (page 6) of the EIS) is a questionable land use change.

Sincerely,

M. RUPERT CUTLER
ASSISTANT SECRETARY FOR
CONSERVATION, RESEARCH, & EDUCATION

185

Corps Response to the U.S. Department of Agriculture (continued)

14. Approximately 31 percent of the Pumpkin River 100-floodplain within the study area is classified as prime farmland. This land also supports a variety of wildlife. Therefore, no prime farmland would be affected by the proposed Pumpkin Reservoir. (This information was provided in a letter of 11 March 1977 from the U.S. Soil Conservation Service.) Your comment regarding the land-use exchange from agriculture to recreation is appreciated, and will be taken into consideration during future studies.

JUL 28 1971

Corps response to the U.S. Department of Health, Education, and Welfare

2b. The discussion of sanitary support facilities associated with the proposed recreation development is general because the plan of development is only conceptual at this study phase. (Detailed planning is not accomplished in the feasibility report.) Detailed sanitary design criteria data will be developed in future study and design phases. The design and capacity of proposed sanitary facilities will meet or exceed State and local standards.

2c. As noted, Corps personnel have an ongoing water quality monitoring program which is collecting measurements on the concentrations of more than 20 different water quality parameters. This information will be investigated during Phase I studies into a water quality model study, which will assess the existing and projected water quality conditions of the Pumpkin Creek basin.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

[illegible]

May 29, 1975

[illegible]
Chief of Engineers
Department of the Army
Washington, D.C. 20314

Dear General [illegible]:

Reference is made to your letter dated 6 May 1975 requesting the views of the Department of Transportation on the Proposed Devils Lake Regional Outlet and Flood Control Project, Ramsey and Benson Counties, North Dakota.

The personnel operating aids to navigation and staff of the Department of Transportation have reviewed the material submitted. The Coast Guard has the following comments to offer:

"Reservoirs such as Devils Lake influence ice formation and breakup processes which could be affected by regulation with operation of this lake.

"If the proposed lake is judged not to be a Recreational Lake as defined in 33 CFR 116, planning should address who would bear enough property and recreational facilities for adequate operation and maintenance of recreational boats.

"If boats fishing facilities are to be provided, the need for prevention and control of sewage effluent be considered."

The Department of Transportation has no other comments to offer nor do we have any objection to this project. The first statement, however, should address the concerns of the Coast Guard.

The opportunity to review this draft statement is appreciated.

Sincerely,

[signature]

[illegible]

Corps Response to the U.S. Coast Guard

[illegible] As part of the Corps' ongoing operations and maintenance activities at public use developments, there would be [illegible] to encourage boated safety through distribution of pertinent literature and through correspondence and presentations. The most [illegible] sewage pumpout and treatment facilities for use by marine vessels will be determined in conjunction with [illegible] studies. Consideration [illegible] to handle potential oil spills will be developed as part of [illegible] management studies (e.g., boating [illegible] opportunities).

DEPARTMENT OF STATE

Washington, D.C. 20520

September 5, 1977

Colonel Pittard C. Ezell
U.S. Army Corps of Engineers
Room 1E-073
DAEN-DWA-D
Department of Defense
Washington, D. C. 20314

Dear Colonel Ezell:

I am responding to your letter to Deputy Assistant Secretary Richard Vine requesting for our comment the proposed report of the Chief of Engineers on the Tombigbee River project.

I regret our tardiness for the delay of our response. We have reviewed the documents which you have presented and have no objection to the report as it stands presently.

The Department of State stands ready to assist the Corps in discussing the matter with Canada at the earliest opportunity.

Sincerely yours,

Mark R. Jacobs
Environmental Officer
Office of Canadian Affairs

GLOSSARY

1. Abiotic: Non-living; pertaining to physical-chemical factors only.

2. Acre-foot: A unit of volume equal to one foot of water covering an area of one acre; equal to about 326 gallons.

3. Actuarial rate: Rate according to probabilities based on statistical records.

4. Adsorption: The adherence of substances to surfaces with which they are in contact, but not as chemical combinations.

5. Algae: Any of a group of chiefly marine freshwater chlorophyll-bearing aquatic plants with no true leaves, stems or roots, ranging from microscopic single-cell organisms or colonies to large macroscopic seaweeds.

6. Algal Blooms: Rapid and flourishing growth of algae.

7. Alkalinity: A measure of the capacity of a solution to neutralize an acid. In most natural waters this is a measure of the bicarbonate (HCO_3) content.

8. Allochthonous: Material produced outside the environment under consideration.

9. Anaerobic: Without the presence of air or free oxygen.

10. Benthic: Of or pertaining to the bottom of the lake.

11. Blue-green Algae: A group of algae with blue pigment in addition to the green chlorophyll. These algae are particularly obnoxious when they appear as "blooms" and are concentrated by wind/wave action. Odor and toxic substances are often associated with their decay.

12. B.O.D. (Biochemical Oxygen Demand): The amount of oxygen required to decompose (oxidize) a given amount of material (usually organic) to simple, stable substances.

13. Composite Sample: Mixing of several individual samples to form a single sample for analysis.

14. Conservation pool: Minimum pool size remaining following the release of stored flood waters.

15. Cretaceous: The last period of the Mesozoic Era from 70 to 135 million years ago; characterized by extinction of dinosaurs and advent of modern insects.

16. Cultural Eutrophication: Eutrophication process hastened by the influences of man; e.g. sewage effluent, encroachment, etc.

17. Design Flood: Flood which the dam (or other structure) would contain without the use of the spillway.

18. Detritus: A non-dissolved product (organic or inorganic) of disintegration or wearing away.

19. Diatom: A class of minute, planktonic or attached unicellular or colonial algae with cases of silica.

20. Dissolution: The process of dissolving.

21. Edaphic: The influence of soil especially on the plants growing in it.

22. Ephemeral: Lasting a very short time, transitory.

23. Epilimnion: The turbulent upper layer of a lake between the surface and a horizontal plane marked by the maximum gradient of temperature and density change, i.e. the metalimnion.

24. Euphotic: Of or pertaining to the upper layers of water in which sufficient light penetration to permit photosynthesis.

25. Eutrophic: Greek meaning "well nourished"; describes a lake of high primary production potential.

26. Floodplain: That portion of a river valley which is covered in periods of high (flood) water, naturally populated by flood-tolerant vegetation.

27. Floodway: That portion of the floodplain normally expected to carry floodwaters.

28. Food web: The pattern of production and consumption in an ecosystem, i.e. forms of specific nutrient sources and predators for each species involved.

29. Fossil: Organic remains.

30. Fuller's earth: An absorbent clay.

31. Green Algae: Algae with pigments similar in color to those of higher green plants, common forms produce algae mats or floating "moss" in lakes. Usually not considered serious problem during bloom conditions as are bluegreen algae.

32. Hydric: Characteristic of pertaining to conditions of abundant moisture.

33. Hypolimnion: In certain lakes, the portion below the zone of warmer water which receives no heat directly from sunlight and no aeration by vertical circulation.

34. Igneous: Rocks produced under extreme heat, as rocks of volcanic origin.

35. Insolation: Sunlight received by a given body or over a given area.

36. Intermediate Regional Flood: The amount of flooding expected to occur once in 100 years. This size flood has a 1 percent chance of happening in any one year. Federal grant loans and mortgage loan programs utilize damage from this size flood as a base.

37. Isothermal: Waters characterized by uniform temperature.

38. Jurassic: A period in the Mesozoic Era from 135 to 180 million years ago; characterized by dinosaurs and conifers.

39. Lacustrine: Originating in and/or inhabiting a lake.

40. Lentic: Still or slowly flowing water.

41. Lithic Sites: Areas containing stone implements, portions of them, or chips formed during their production.

42. Littoral Zone: The shoreward region of a body of water in which light penetrates to the bottom; in lakes or ponds, the area from the shoreline to the lakeward limit of rooted aquatic plants.

43. Lotic: Rapid water situations.

44. Low-flow Augmentation: Release of water from a reservoir during dry periods to supplement the natural river flow.

45. Mesic: Characterized or pertaining to conditions of medium moisture supply.

46. Metalimnion: The zone of water over which temperature drops relatively rapidly with depth (also see Thermocline).

47. Metric ton: A unit of 1000 kilograms; equivalent to about 2205 lbs.

48. Moraine Hills: Hills formed from deposition of material carried in or on a glacier.

49. Morphometry: Measurements of a lake's external form.

50. Multiple-level intake: A reservoir discharge structure capable of withdrawing water from discrete levels within the reservoir.

Ogee Section: A convex shaped spillway extending into the reservoir.

Ordovician: Period of the Paleozoic Era about 440 to 500 million years ago; characterized by advent of ostracods, algae and seaweeds.

Overturn: The complete circulation or mixing of the upper and lower waters of a lake when the temperatures (and densities) are similar.

Paleozoic: Relating to geologic era spanning the period of 220 to 600 million years ago.

Periphytic: Pertaining to organisms associated with surfaces projecting above the bottom (rocks, stems, etc.).

pH: A numerical expression of acidity. Values greater than 7 indicate alkalinity, those less than 7, acidity, while 7 is considered neutral.

Photosynthesis: Synthesis of carbohydrates from carbon dioxide and water, with chlorophyll as a mediator using light as energy with oxygen as a byproduct.

Phytoplankton: Small, mostly microscopic, plants floating in the water column.

Pleistocene: The geological epoch corresponding with the last great ice age. The period ended with the final retreat of the ice sheets which reached their present position about 8300 BC.

Precambrian: Relating to a geologic period prior to the Cambrian which began 500 million years ago.

Primary production: The amount of organic material produced by autotrophic organisms.

Reducing conditions: Conditions present when there is no oxygen; refers to acquisition of electrons by molecules, i.e. they are reduced.

Riparian: Living or located on the bank of a river or lake.

Riverine: Of or pertaining to rivers.

Septic: Conditions in water characterized by no dissolved oxygen, prolific production of sewage fungus, lack of normal biota.

Straight-line Fetch: The straight-line distance along open water over which wind blows.

67. Stratigraphy: Relating to stratification (of rocks).

68. Surcharge storage: Amount of floodwater storage above the spillway that results from backwater effects due to spillway restrictions.

69. Tertiary: The latest period of the Cenezoic Era which began about 70 million years ago and includes the present. The rapid development of mammals took place in this period.

70. Thermal Stratification: The typical seasonal cycle in lakes. During the summer the top waters become warmer than the bottom waters; as a result only the warm top layer circulates, and it does not mix with the more viscous colder water, creating a zone with a steep temperature gradient inbetween called the thermocline. The upper, warm circulating water is the epilimnion, and the colder, non-circulating water is the hypolimnion. With the onset of cooler weather, the temperature of the epilimnion drops until it is the same as that of the hypolimnion. Then the water of the entire lake begins circulating and oxygen is again returned to the depths during the "fall overturn". As the surface water cools below 4° C, it expands, becomes lighter, remains on the surface and freezes, if the regional climate is a cold one, bringing on winter stratification. In winter the oxygen supply is usually not greatly reduced because bacterial decomposition and respiration of organisms are not so great at low temperatures, and water holds more oxygen at low temperatures. Winter stagnation, therefore, is not generally so severe. When stagnation does occur, however, resulting in oxygen depletion for the lake, "winter kill" of fish may occur. In the spring, as ice melts and water becomes warmer, it becomes heavier and sinks to the bottom. Thus, when the surface temperature rises to 4° C, the lake experiences the spring overturn.

71. Thermocline: A narrow (horizontal) zone of water in lakes with a steep temperature gradient, separating a warmer surface layer (epilimnion) from a cooler bottom layer (hypolimnion).

72. Trophogenic: Of or relating to the upper level of a lake in which inorganic matter is converted to organic material through photosynthetic activity.

73. Tropholytic: Of or relating to the deeper part of a lake in which dissimilation (destructive metabolism involving release of energy) of organic matter tends to predominate.

...NCES

..., P. G., 1960. Test drilling in the Walhalla area ...
...t, North Dakota. North Dakota State Water Conservation
..., Open-file Rept.

..., ..., 1977. Geology of Cavalier and Pembina Counties,
North Dakota Geol. Survey Bull. 62, Part I.

..., ..., and Melstad, V. J. 1968. The geology of Northeastern
...ta with Special References to Cement Materials. North
... Geol. Survey 5th Bienn. Rept.

..., ... 1971. Preliminary Map, Depth to Bedrock in North
...ta. North Dakota Geol. Survey, Misc. Map No. 13.

..., Clarence G. 1969. Bedrock Geologic Map of North Dakota.
North Dakota Geol. Survey, Misc. Map No. 10.

..., ... 1971. Geologic Map of Rolette County. North Dakota
Geol. Survey, Bull. 58, Plate 1.

..., ... L. 1956. The Geology of North Dakota. North Dakota Geol.
Survey, Bull. 31.

International Pembina River Engineering Board. 1964. Joint Investiga-
tion for the Development of Water Resources of the Pembina River Basin
...toba and North Dakota, Volume II.

..., Elson M. 1941. Selected Deep Well Records. North Dakota Geol.
Survey, Bull. 1..

..., Elson M. 1956. Guide for Geologic Field Trip in Northwestern
... Dakota. North Dakota State Geol. Survey, Bull. 30.

..., ... 1951. Ground Water in the Neche Area Pembina
..., North Dakota. North Dakota Ground-Water Studies, No. 1...

..., 1960. Industrial Fact Survey, Walhalla, North
... Walhalla Civic Club and Walhalla State Bank, Walhalla,
...

..., ... 1962. Geology and Ground Water Resources of North
... Geol. Survey, Water-Supply Paper 598.

LITERATURE CITED

Ames, Kenneth M. 1975. Archaeological site survey of the Pembilier project area. Moorhead State College. Moorhead, Minnesota.

Bautsch, A. F. 1948. Biological aspects of stream pollution. Sewage Works J. 20: 292-302.

Burgess, R. L., W. C. Johnson, and W. R. Keammerer. 1973. Vegetation of the Missouri River floodplain in North Dakota. Report to the Office of Water Resources Research, U.S. Department of the Interior, Washington, D.C. 162 pp.

Enyeart, G. 1964. Goose and duck use of Garrison and Snake Creek reservoirs, 1955-1963. Proc. North Dakota Acad. Sci. 18: 95-100.

Farmer, et al. 1974. Environmental impact assessment of the Homme Dam and Reservoir, North Dakota. Institute for Ecological Studies Report No. 7. 189 pp. University of North Dakota.

Green, W. E. 1947. Effect of water impoundment on tree mortality and growth. Jour. Forest. 45: 118-120.

Hibbard, E. A. 1954. Reservoir developments and beaver populations. North Dakota Game and Fish Dept. Pittman-Robertson Div., Proj. 36R (Mimeographed.), 4 p.

Hibbard, E. A. 1972. Vertebrate ecology and zoogeography of the Missouri River Valley in North Dakota. Ph.D. Thesis. North Dakota State University, Fargo, North Dakota. 216 p.

Hosner, J. F. 1960. Relative tolerance to complete inundation of fourteen bottomland tree species. For. Sci. 6: 246-251.

Johnson, G. E., et al. 1974. Environmental Impact Assessment of Bald Hill Dam and Lake Ashtabula, North Dakota. Institute for Ecological Studies, Report No. 8. 206 pp. University of North Dakota.

Johnson, W. C. 1971. The forest overstory vegetation on the Missouri River floodplain in North Dakota. Ph.D. Thesis. North Dakota State University, Fargo, North Dakota. 151 p.

Keeney, Dennis R., D.S. Nichols, and K. W. Lee. 1974. Environmental assessment of the sources and availability of nitrogen and phosphorus to Lake La Farge. pp. 1-44. In: Environmental Analysis of the Kickapoo River Impoundment: A Report to the U.S. Army Corps of Engineers. Institute for Environmental Studies, Report No. 28. University of Wisconsin-Madison.

Lago, P. R. 1971. The floodplain forests of the Upper Mississippi River, Minnesota. M.S. Thesis. Bemidji State College, Bemidji, Minnesota. 71 p.

Lindmeier, J. P., J. R. Tester, and D. W. Warner. 1961. Relations between certain vegetational characters and groundwater level in a mixed hardwood community in east-central Minnesota. Minn. Acad. Sci. 29: 199-209.

Owen, J. B., and F. G. Duerr. 1974. Nutrient sources and lake nutrient dynamics as affected by commercial and sport fishery harvests in Lake Ashtabula, North Dakota. North Dakota Game and Fish Department. Division of Fisheries, Report No. 1322. 89 pp.

Peterka, J. J. 1970. Productivity of phytoplankton and quantities of zooplankton and bottom fauna in relation to water quality of Lake Ashtabula Reservoir, North Dakota. Research Project Technical Completion Report WI-221-008-70 FCST: VFG.

Report to the International Joint Commision by the International Pembina River Engineering Board, Dec. 1974. Joint Investigation for Development of the Water Resources of the Pembina River Basin-Manitoba and North Dakota.

Richardson, F. Brandt. 1974. Potential macrophyte production and management-strategies for LaFarge Lake. pp. 211-249. In: Environmental Analysis of the Kickapoo River Impoundment. A Report to the U.S. Army Corps of Engineers. Institute for Environmental Studies, Report No. 28. University of Wisconsin-Madison.

Rock Lake Experimental Algae Control Program. Water Control and Conservation Branch. Winnipig, Manitoba. March 1974. 49 pp.

Sawyer, C. N. 1947. Fertilization of Lakes by agricultural and urban drainage. J. New England Water Works Assoc. 61: 109-127.

Wanek, W. J. 1967. The gallery forest vegetation of the Red River of the North. Ph.D. Thesis. North Dakota State University. Fargo, North Dakota. 211 p.

Yeager, L. E. 1949. Effect of permanent flooding in a river-bottom timber area. Ill. Nat. Hist. Survey Bull. 25: 33-65.

FINAL
ENVIRONMENTAL IMPACT STATEMENT

PEMBILIER LAKE AND DAM
PEMBINA RIVER BASIN
NORTH DAKOTA

TECHNICAL APPENDIX

U.S. ARMY ENGINEER DISTRICT, ST. PAUL
St. Paul, Minnesota
March 1976

TECHNICAL APPENDIX

TABLE OF CONTENTS

EXHIBIT 1: ALTERNATE OPERATING PLAN - MARSH ALTERNATIVE

The "marsh" alternative proposes to operate the Pemblier Dam in a manner that would create a substantial amount of type 5 marsh[1] while still providing water-supply benefits to downstream communities. Presently, 2,000 acre-feet of storage would be devoted to water supply and another 2,000 acre-feet would be reserved for both water supply and recreation. Flood storage capacity would initially be 11,500 acre-feet greater with this plan than for the reservoir alternative. This difference would decrease over the life of the project due to sedimentation.

The initial pool for this alternative would be held at an elevation of 988 (or less). The surface area of the pool at this elevation would be approximately 300 acres. This would result in a mean pool depth of about 11.5 feet and a maximum depth of about 33 feet at the damsite. At this pool stage a considerable, but as yet undetermined, amount of the bottom would be at a depth of 10 feet or less (which can be considered the littoral zone). This area is considered capable of supporting rooted aquatic plants and would be managed with the objective of attaining maximum production of aquatic macrophytes.

Sediment is expected to accumulate in the pool at a rate of about 115 acre-feet per year (assuming a constant rate). Following a period of flood storage, the pool would be drawn down to an elevation that would provide the 4,000 acre-feet anticipated for water supply and recreation plus allowing for the amount of sediment that had accumulated during the previous years. In this manner the pool elevation would be gradually increased over the life of the project in response to sediment deposition. It would be beneficial for this alternative if sediment distribution could be influenced to an extent that a larger amount would be deposited in deep-water areas than in littoral areas. This would produce greater habitat stability in the shallow areas while at the same time increasing the amount of littoral area. Whether it would be possible, through reservoir operations, to produce these effects is presently unknown and the possibilities would be investigated at a later date.

The establishment of submergent and emergent aquatic macrophytes would probably require several years without any intervention by man. The rate of colonization would depend upon such factors as upstream seed sources, bottomtype and texture, water levels, temperature, and wave action. The time span required for plant colonization provides two management options for achieving the marsh environment.

---

[1]Type 5 marsh: "Shallow ponds and reservoirs are included in this type. Water is usually less than 10 feet deep and is fringed by a border of emergent vegetation. Vegetation (mainly at water depths of less than 6 feet) includes pondweeds, naiads, wild celery, coontail, watermilfoils, muskgrasses, waterlilies, spatter docks, and (in the South) water-hyacinth." USDI circular 39. It is realized that the "marsh" would not conform entirely to this definition.

One approach would be to increase the rate of colonization by planting desired species at the beginning of the project. Plant species could be selected for their desirable attributes such as cover and/or food. This would greatly increase the colonization rate of species such as bulrushes and cattails which require specific germination conditions. It would also permit the introduction of certain desirable species that may not presently exist in the watershed. It should be remembered, however, that species composition of the plants could change with time due to the invasion of more suitably adapted species. The displacement of existing vegetation would probably have only minimal, if any, effects on the quality of the marsh environment. Another point is that the earlier the vegetation was established in the littoral areas, the sooner benefits associated with the marsh could be captured.

Another approach to the plant colonization process would be that of allowing the littoral areas to become vegetated by strictly natural processes. This would require a a longer period of time and certain desirable species might never become established with this approach. This approach, however, does present some advantages over the previous approach. It is entirely possible that the delay between first impoundment and the development of a well established marsh could be of sufficient time to permit the development of a good sport fishery for several years. The first few years of a new reservoir are typically the best from a sport fishery viewpoint. Production of sunfish, perch, and northern pike, for example, could provide fishing opportunities until overcrowding and/or water quality reduced the size and/or numbers of desirable species.

Once littoral areas are established with aquatic macrophytes, the colonization of new areas that are inundated from year to year should occur relatively rapidly. These new areas would not be colonized immediately, however, which would result in a relatively vegetation-free area around the pool from the new shoreline to the existing vegetation. Because the elevation increase of the pool would be gradual, the new areas would probably be vegetated long before previous vegetated areas became submerged. The extent to which existing areas of vegetation would be eliminated by the increased water level would depend on the pattern of sediment deposition which would determine whether the bottom elevation was above or below the level of light penetration necessary to support photosynthesis.

Tangible benefits attributed to this alternative would be flood control, water supply, and recreation. Potential, but less quantifiable, benefits are related to wildlife production and water quality. While the more gradual loss of existing terrestrial habitat that would occur with this alternative, as opposed to the immediate loss that would occur with the "lake" alternative, would be considered a less damaging (mitigation of ultimate results) or relatively more beneficial aspect.

The marsh created by this alternative would provide habitat for waterfowl during certain years while providing little or none in other years. The prime determining factor in this regard would be the timing

and duration of flood storage in the reservoir. During some years the flood storage capacity would be used only to a limited degree or not at all. During these years the marsh should provide nesting habitat for waterfowl. During the years when a significant amount of flood storage occurs, waterfowl production may not be increased at all and could even be decreased if storage occurred after nesting commenced. Potential effects on waterfowl production would have to be identified in later studies to determine the magnitude of the production benefits and/or losses. Loss of waterfowl production during flood years may be of relatively little consequence however because natural potholes in the region would have ample water and would be productive during flood years, and conversely.

The marsh would provide habitat for a variety of other wildlife in addition to waterfowl. Shore and song birds, and upland game birds could benefit from increased habitat, while species such as raccoons and birds of prey could benefit through an increase in their food supply. Whether furbearers such as beaver, mink, and muskrats would benefit is questionable because of water level fluctuations resulting from flood storage. They probably would suffer less losses, however, than with the "lake" alternative.

The effects of this alternative on the existing terrestrial system would be less drastic than with the "lake" alternative although the results at the end of the project life would probably be quite similar for the two alternatives. Operation of the marsh would require a much smaller initial pool and would result in a gradual increase in the areal extent of the pool over the life of the project while the "lake" proposal would result in the immediate loss of the terrestrial habitat within the boundaries of the 800-acre permanent pool. Although both alternatives would probably have an 800-acre pool at the end of the project, the gradual loss of terrestrial habitat associated with the marsh would result in higher average animal populations over the life of the project because the populations could exist for a longer period of time for a given pool perimeter. The production of game animals on the land that were not yet inundated could be harvested by sportsmen, a possibility that would not exist with the "lake" alternative.

As an example of the above discussion, consider the hypothetical situation depicted in figure A-1. In this example, the area of the permanent pool increased at a constant rate until at the end of 100 years it occupied 800 acres. A population of 100 individual game animals (deer, grouse, or squirrel, etc.) occupied the original area. This population had increased to 130 individuals by the beginning of the hunting season. It was determined by the local game manager that at this population level 30 individuals could be harvested and still maintain the optimum post-season density. As the initial habitat was reduced through the increased area of the permanent pool the initial animal population would be reduced to a level that would permit maximum utilization of the remaining habitat, i.e. food, cover, living space, nesting sites, etc. An accurate description of the rate of population decrease is not too important for this

FIGURE A-1: PERMANENT POOL INCREASES VERSUS ANIMAL POPULATIONS

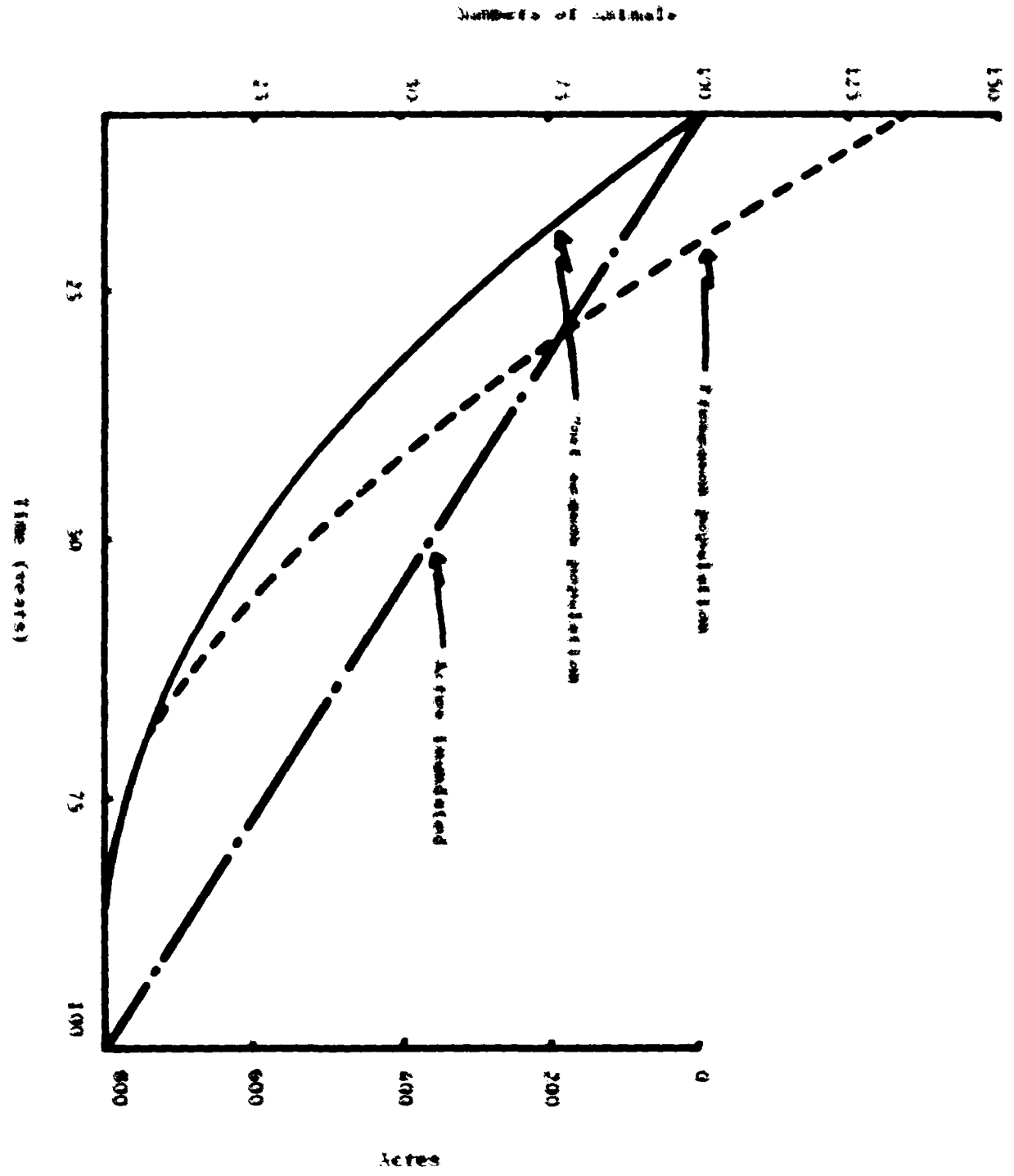


EXHIBIT L (Cont.)

example. Suffice it to say, for a given decrease in the amount of habitat there will be some decrease in the size of the population that can be supported on the remaining area. With a smaller base population, a smaller harvestable surplus would also exist. Eventually the area of the remaining habitat would be too small to support a self-sustaining population. The number of animals that could be harvested from the state of the project until this point was reached (the difference between the dashed line and the solid line) would represent a "gain" for the "natural" alternative over the "lake" alternative.

The individual animals that are displaced by a given flood pool would be forced into areas that already support high populations. This situation would result in some of the animals being assimilated in the existing (resident) population, the eventual loss of the immigrants or loss of those members of the resident population that they are able to displace, the complete assimilation of the immigrants by increasing numbers of animals in the final population size for a level below the current resident population. The latter situation would be more probable with the "Lake" alternative where a large number of individuals were imposed on top of an existing population. With the "natural" alternative the latter situations would probably be more likely to occur. To cause the least disruptive effect on existing populations outside the pool area, the displaced animals would have to be harvested quickly. This would be relatively simple with the "natural" alternative because of the gradual displacement of the area population while the complete harvesting of the displaced animals resulting from the "lake" alternative within a very short period of time would be difficult.

The "natural" alternative would also delay permanent inundation of about 1.5 miles of the Rumbing River compared to the "lake" alternative. Activities of this river reach would exist longer with this alternative than they would with the "lake" proposal.

It has been determined, based on previous chemical analysis of Rumbing River water, that water quality would probably be a serious problem, both in the reservoir and downstream. It is difficult to predict to what extent the discharge water quality would differ from that of the inflow with the "natural" alternative. The total amounts of various nutrients in the inflow and outflow may be approximately balanced (although there would probably be a net loss to the sediment) while exhibiting significant seasonal differences.

During the spring runoff periods, budgets for dissolved materials would probably be balanced because of the high inflow and low level of biological activity during this time of the year. As inflow decreased, water levels in the natural would become stabilized, residence time of the water mass would increase, biological activity would increase, and concentrations of dissolved materials would probably be lower in the discharge water than in the inflow water. This would relate more to nutrients such as nitrogen and phosphorus that to less biologically important materials such as sodium. During the fall and winter there would probably be a release of nutrients from the water with higher

EXHIBIT 1 (Cont.)

concentrations of these nutrients in the discharge water. This could result from the death and decomposition of plant material and from sediment subjected to low oxygen (reducing) conditions.

It is not anticipated that water quality would be as great a problem in the permanent pool with this alternative because the greater the nutrient input the more plant production that could be expected, within limits. It is possible that conditions within the marsh would create water quality problems downstream from the dam. These problems would be similar to those experienced with the "lake" but the magnitude of these potential problems has not been evaluated for either operating plan. Potential problems are also caused by the anaerobic production of hydrogen sulfide and "marsh" gas (methane), color of the discharge waters from the decomposition of organic compounds, taste from the decomposition of rooted plants and algae, and low dissolved oxygen due to the chemical and biochemical oxidation of reduced compounds such as ammonium, hydrogen sulfide, and ferrous compounds. The potential effects of both the "marsh" and "lake" alternatives would have to be investigated during post authorization studies to determine the probable frequency of their occurrence and the magnitude of these effects on downstream water uses of water supply and fishery production.

Another potential problem, that would probably be greater with the marsh than with the "lake" and which would need future study to delineate its effects, is that of evapotranspiration. Present estimates indicate that annual evaporation exceeds annual precipitation in the area by about 9 inches per year, i.e., 19 inches precipitation versus 28 inches evaporation. It is possible that evaporation from the water surface coupled with the increased transpirational losses of the marsh vegetation would be great enough so that the initial pool elevation would have to be raised a significant amount to offset these water losses and still maintain any needed future storage for water supply. Potential problems associated with taste, odor, and color might reduce the desirability of water stored under this operational plan for water supply. In such a case the benefits attributed to this alternative would need to be reevaluated.

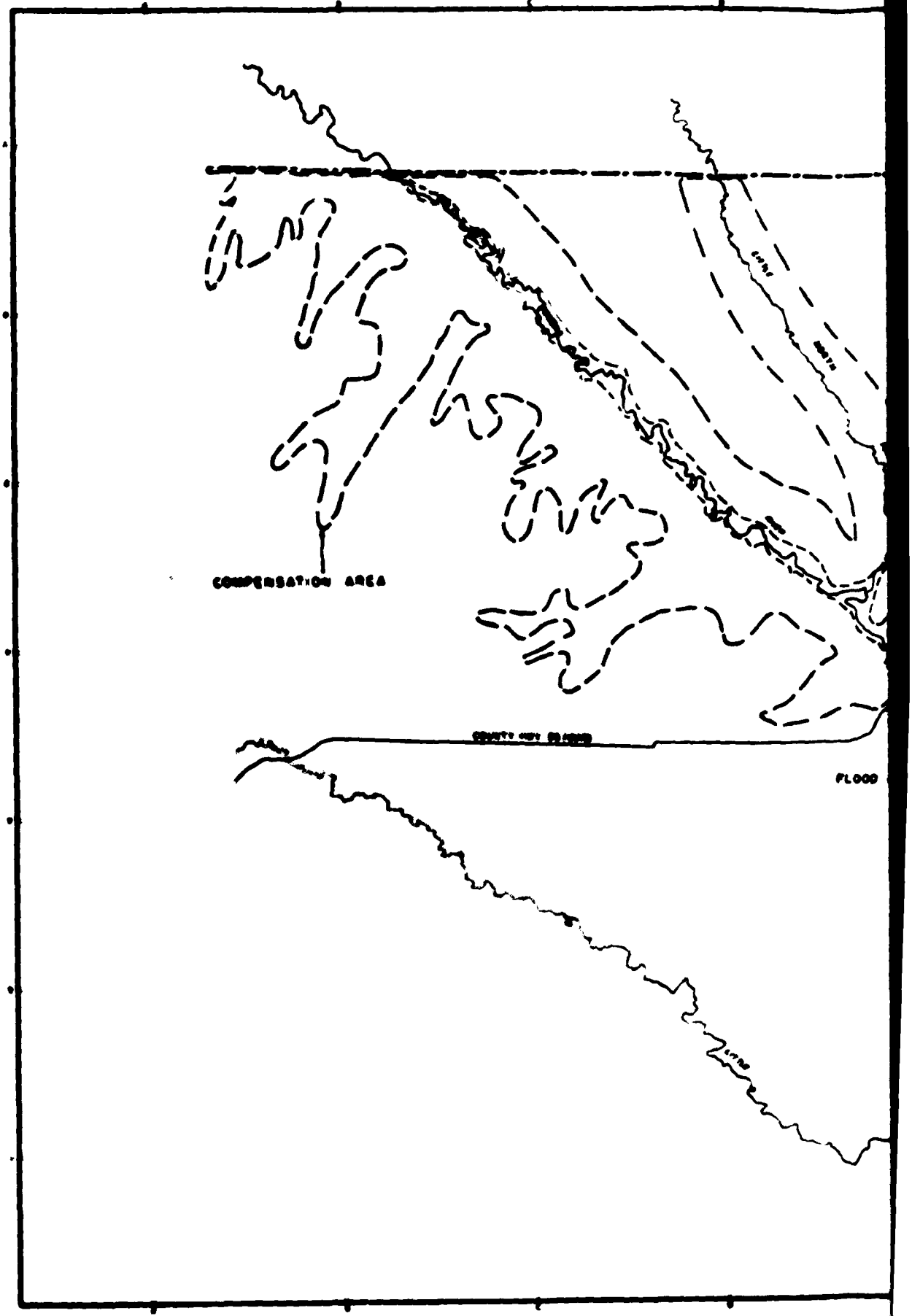
As mentioned previously, the lake resulting from the construction of the Pumbiliet Dam would experience problems associated with very poor water quality. High quality recreational utilization of the reservoir would be reduced in a relatively short time when algae periodically reached "bloom" levels and growths of aquatic weeds rendered large areas of the lake inaccessible to humans. The lake fishery in such a case would also be seriously affected due to stunted populations of desirable fish species and increased production of rough fish. Potential users of the reservoir would probably then request Governmental assistance for some type of lake rehabilitation program. This might consist of aquatic plant control, sediment removal, and extensive fish stockings. At best, such programs would result in very temporary effects and would need to be continued on a regular basis at high costs.

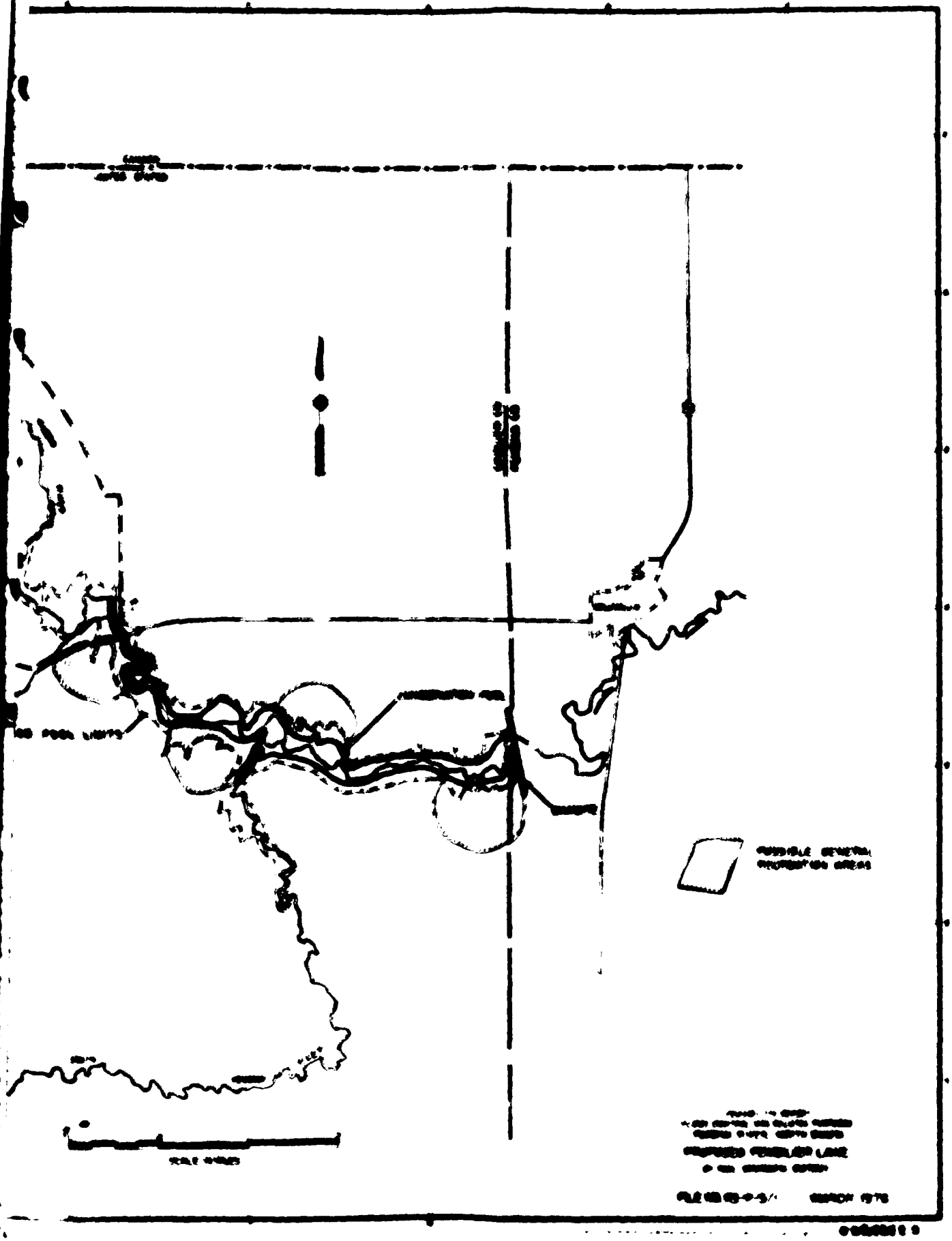
EXHIBIT I (Cont.)

By originally designing the project for operation as a marsh, users would not experience the disappointment associated with the decline in the quality of the lake (recreation) environment. Instead, they would experience a marsh-type environment, with its high degree of biological diversity, that would be improving in quality and increasing in size throughout the life of the project.

Final stages of both the "marsh" and "lake" alternative would probably be similar although the process of achieving that end and the attitude of the potential tenants were would (or could) be quite different. If such perceptions prevailed, a social benefit relating to these differences (although intangible) could be claimed.

The "marsh" alternative has several potential advantages over the "lake" alternative as well as some potential disadvantages. Considering the paucity of environmental data available for evaluating this alternative, as well as the "lake" alternative, further study is [illegible] needed to make a sound water resources decision. If a "dam" alternative were authorized by Congress, it would therefore be desirable to consider the advantages of effective design and operational plans that would create a "marsh" environment as described in this section.


COMPENSATION AREA
FLOOD



...water quality ... Sheyenne River at Valley City, North Dakota, for the period October 1968 - September 1972. ... U.S. Geological Survey, Surface Water Records for North Dakota.

Monthly concentrations for each year are flow weighted using flow at times of sample collection. Average monthly concentrations for the 4-year period were calculated as the product of monthly average concentrations and average flows at time of sampling, divided by the sum of the flows in the numerator.

Nitrate - mg/l N

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	.04	.09	.02	.04	.02	.04	1.22	.36	.09	.00	.02	.02	1.08
1969-70	.05	.03	.03	.40	.30	.01	7.00	.01	-	.03	.08	.00	3.70
1970-71	.00	.00	.30	.00	.70	.00	.80	.10	-	.04	.59	-	0.59
1971-72	.01	.08	.40	.22	.05	2.90	.81	.10	.07	.00	.03	.00	0.96
Average	.03	.06	.17	.23	.18	1.92	1.64	.16	.08	.02	.19	.00	0.92

Dissolved Phosphorous - mg/l P

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	-	-	-	-	-	-	.16	.08	-	-	-	-	0.15
1969-70	.05	.01	.02	.13	.06	.12	.25	.10	-	.28	.19	.12	0.20
1970-71	.01	-	-	.05	.01	.06	3.90	1.80	.20	.20	.19	-	2.90
1971-72	.14	.10	.12	.14	.11	1.03	2.70	.13	.28	.28	.13	.11	1.28
Average	.06	.06	.06	.12	.06	1.01	1.98	.46	.23	.26	.18	.12	0.75

Bicarbonate - mg/l HCO_3

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	286	314	412	405	318	292	168	204	260	275	299	301	206
1969-70	304	314	374	350	360	320	144	182	232	230	289	284	197
1970-71	312	327	365	360	260	266	152	181	248	254	251	264	189
1971-72	279	316	390	433	517	121	175	200	267	260	227	243	203
Average	291	317	390	394	374	140	160	190	244	247	267	273	199

Exhibit 3 (cont.). Water quality, Pembina River, North Dakota

Calcium - mg/l Ca

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	63	73	68	89	94	78	53	47	65	68	63	67	54
1969-70	68	56	88	100	78	80	38	61	-	61	60	75	55
1970-71	85	90	120	110	120	110	52	52	76	65	60	62	56
1971-72	68	82	100	110	130	35	47	49	63	57	44	50	50
Average	68	77	93	101	106	41	50	53	68	63	58	64	54

Magnesium mg/l Mg

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	35	38	49	50	45	45	13	15	25	28	28	31	18
1969-70	31	33	38	41	37	36	12	23	-	26	33	35	22
1970-71	38	35	46	40	40	39	8	20	30	33	34	34	15
1971-72	34	37	44	48	-	12	17	22	30	30	31	32	22
Average	35	36	44	46	40	15	11	19	28	28	32	33	18

Sodium - mg/l Na

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	50	53	68	60	67	69	21	25	38	48	46	49	28
1969-70	50	54	59	57	60	61	29	39	48	44	50	55	40
1970-71	58	56	53	58	49	46	21	30	48	48	48	49	31
1971-72	49	50	64	68	70	22	29	33	41	42	43	45	34
Average	51	53	62	61	62	26	24	32	45	45	47	50	33

Exhibit 3 (cont.)

Potassium - mg/l K

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	9.8	9.3	10.0	9.8	9.8	9.7	8.2	7.9	9.5	9.1	10.4	11.0	8.4
1969-70	10.8	6.9	7.0	9.0	9.6	8.7	6.3	9.5	-	9.7	11.0	10.0	8.8
1970-71	9.0	8.5	9.2	8.5	7.9	8.9	5.5	7.2	10.0	8.2	9.2	-	6.9
1971-72	8.6	7.5	11.0	9.7	12.0	7.3	6.2	11.0	8.0	9.4	10.0	9.7	8.0
Average	9.6	8.4	9.2	9.4	9.9	7.4	6.8	8.7	9.4	9.2	10.3	10.1	8.0

Chloride - mg/l Cl

Month Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	13.0	14.0	18.0	16.0	17.0	18.0	6.8	6.2	9.2	11.0	7.6	11.0	7.6
1969-70	11.4	15.0	5.6	14.0	15.0	12.0	5.4	9.0	-	10.0	11.0	11.0	8.5
1970-71	13.0	13.0	17.0	16.0	17.0	16.0	3.6	4.8	10.0	9.4	11.0	-	5.0
1971-72	13.0	15.0	16.0	17.0	23.0	6.9	5.3	8.8	9.4	9.7	9.8	11.0	7.5
Average	12.8	14.0	14.3	16.0	18.2	7.3	5.1	7.1	9.5	10.1	10.8	11.0	7.0

Iron - µg/l Fe

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	100	0	70	40	50	530	67	0	0	-	45	6	40
1969-70	29	-	-	-	287	296	63	61	-	0	136	86	59
1970-71	190	60	120	70	160	-	-	80	-	-	-	-	86
1971-72	-	-	20	-	-	40	-	-	-	-	-	40	40
Average	109	24	75	51	172	55	66	42	0	0	109	53	52

Exhibit 3 (cont.)

Sulfate - mg/l SO_4

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	140	141	153	224	227	248	82	101	128	171	128	142	103
1969-70	149	184	181	194	187	188	120	164	-	153	179	203	150
1970-71	200	220	280	230	210	210	72	120	190	190	180	-	102
1971-72	180	180	230	250	300	78	72	110	150	150	140	130	98
Average	156	172	206	230	232	83	82	129	153	164	164	166	112

pH

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	7.5	7.9	7.8	8.0	7.6	7.9	8.3	7.5	7.8	7.8	7.9	7.8	8.0
1969-70	8.1	7.6	8.1	7.9	7.8	7.4	7.2	7.4	7.6	7.4	7.6	7.7	7.4
1970-71	9.0	8.0	8.0	8.1	8.2	7.3	7.5	7.6	7.9	7.7	7.8	7.9	7.6
1971-72	7.9	8.0	8.0	8.0	7.4	7.1	7.3	8.0	8.0	8.1	7.7	7.8	7.6
Average	7.8	7.9	8.0	8.0	7.7	7.2	7.7	7.6	7.7	7.6	7.7	7.8	7.7

Specific Conductance - micromhos/cm at 25 C

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	735	814	1010	1010	908	938	424	513	665	727	727	734	524
1969-70	755	822	911	880	884	835	500	621	703	654	789	794	624
1970-71	847	882	1010	949	792	817	432	555	738	762	774	766	555
1971-72	786	909	1019	1100	1260	397	493	563	707	704	636	687	570
Average	762	845	988	998	978	450	451	570	703	696	744	753	569

Exhibit 3 (cont.)

Total Dissolved Solids - mg/l (Residue at 180C)

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	503	558	684	698	629	655	266	341	437	491	501	491	341
1969-70	505	574	629	629	610	560	336	431	501	452	582	577	434
1970-71	614	673	714	670	548	573	298	342	496	530	560	534	374
1971-72	540	588	676	796	800	310	402	394	508	484	442	460	422
Average	526	588	675	707	656	343	308	381	489	480	534	525	390

Temperature - °C

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	8.0	1.0	0.0	0.0	0.0	0.0	5.0	12.0	17.0	22.0	23.0	17.0	8.8
1969-70	6.0	2.0	0.5	0.5	0.0	0.5	3.5	10.5	19.5	22.5	21.5	14.0	8.5
1970-71	8.5	1.5	0.0	0.0	0.0	0.0	4.5	13.0	21.0	21.5	24.0	16.0	9.2
1971-72	9.0	1.0	0.0	0.0	0.0	0.0	4.0	17.0	21.0	22.5	23.0	15.5	9.5
Average	7.9	1.4	0.1	0.1	0.0	0.1	4.2	13.1	19.6	22.1	22.9	15.6	9.0

*Time Weighted Averages

Discharge - cfs

Month/ Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
1968-69	369	174	42	24	14	21	3600	1630	561	320	148	97	582
1970-71	60	45	26	16	15	10	1950	2350	1475	814	287	160	602
1970-71	94	67	21	13	10	12	2730	1588	587	353	262	141	489
1971-72	91	63	28	22	-	352	1300	839	323	185	170	100	290
Average	154	87	29	19	13	99	2395	1602	736	418	217	124	490

*Time Weighted Averages

Transect	Quadrat	Description	Location	Elevation (ft)	Distance from river (ft)	Date sampled	Date	Herb species	Common name	Number of stems	Number of flowering stems	Density (stems/100 sq ft)	Relative density (percent)
1	A	Frequently disturbed floodplain	North river-bank	977	0	40	13 Jul 71	Stachys palustris L.	Hedge nettle	5	-	-	31
								Helianthus annuus L.	Common sunflower	14	12	50	15.5
								Polygonum convolvulus L.	Wild buckwheat	4	3	25	7.5
								Melilotus alba Desr.	White sweet clover	3	-	25	7.5
								Melilotus officinalis (L.) Lam.	Yellow sweet clover	4	2	25	7.5
								Thlaspi arvense L.	Pennycress, fanweed	1	1	50	15.5
								Chenopodium gigantospermum Aellen.	Maple-leaved goosefoot	2	1	25	7.5
								C. album L.	Lamb's quarters	1	1	75	23
								Solidago gigantea Ait.	Tall smooth goldenrod	1	1	75	38.5
								Sisymbrium altissimum L.	Tumbling mustard	1	2	25	7.5
								Convolvulus sepium L.	Morning glory, large bindweed	4	2	25	7.5
								Avena fatua L.	Wild oats	1	1	25	7.5
								Setaria glauca (L.) Beaur.	Yellow pigeon grass, foxtail	4	1	25	7.5
								Ulmus americana L.	American elm (seedling)	6	1	75	31
								Viola rugulosa Greene	Pink wood violet	1	1	25	15.5
1	C	Floodplain forest, open to north	South river-bank	975	0	40	14 Jul 71	Rudbeckia laciniata L.	Tall coneflower	7	10	25	7.5
								Laportea canadensis (L.) Gaud.	Wood nettle	27	12	25	7.5
								Symphoricarpos occidentalis Hook.	Wolfberry	6	10	75	62
								Bromus inermis Leyss.	Smooth brome	34	12	75	23
								Ulmus americana L.	American elm (seedling)	162	6	75	31
								Solidago gigantea Ait.	Tall smooth goldenrod	1	1	75	38.5

EXHIBIT A
HERB SPECIES (Cont.)

Transect	Quadrat	Description	Location	Elevation	Slope (Percent)	Bare (Percent)	Date	Herb species	Common name	Number	Cover (Percent)	Fidelity (Percent)	Constancy (Percent)
								Melilotus sp.	Sweet clover	2	T	25	7.5
								Sanicula marilandica L.	Black snakeroot	3	T	25	31
								Chenopodium album L.	Lamb's quarters	4	T	75	23
								Aster laevis L.	Smooth blue aster	1	T	75	38.5
								Cenp sp.	Avena	16	T	25	7.5
2	A	Open prairie near "singing bridge" near confluence of Pembina and Little Pembina Rivers	Permanent pool	1010	0	5	14 Jul 71	Poa pratensis L.	Kentucky bluegrass	4,600(2)	89	50	38.5
								Bromus inermis Leyss.	Smooth brome	4	T	75	23
								Agropyron repens (L.) Beauv.	Quackgrass	2	T	25	15.5
								Lathyrus sp.	Vetchling	1	T	25	15.5
								L. ochroleucus Hook.	Yellow vetchling	2	T	25	23
								Vicia americana Muhl.	Wild vetch	1	T	25	15.5
								Symphoricarpos occidentalis Hook.	Wolfberry	8	5	75	62
								Aster laevis L.	Smooth blue aster	1	T	75	38.5
3	A	Bottom grassland	Permanent pool(7)	1015	1 facing north	0	15 Jul 71	Bromus inermis Leyss.	Smooth brome	143	70	75	23
								Euphorbia esula L.	Leafy spurge	30	6	25	23
								Cirsium arvense (L.) Scop.	Canada thistle	2	2	25	15.5
								Symphoricarpos occidentalis Hook.	Wolfberry	11	10	75	62
								Erysimum cheiranthoides L.	Wormseed mustard	2	T	25	7.5
								Chenopodium album L.	Lamb's quarters	1	T	75	23
								Equisetum arvense L.	Field horsetail	24	3	25	7.5
								Ribes sp.	Currant or gooseberry	1	T	25	7.5
								Cenp triflora Pursh.	Torch flower	14	T	25	7.5
								Rosa arkansana Porter	Prairie wild rose	1	T	25	31
								Solidago gigantea Ait.	Tall smooth goldenrod	13	T	75	38.5
								Taraxacum sp.	Dandelion	14	T	25	15.5
								Acer negundo L.	Box elder	15	2	25	15.5
								Ulmus americana L.	American elm	418	2	75	31

EXHIBIT 4
HERB SPECIES (Cont.)

Transect	Quadrat	Description	Location	Elevation	Slope (Percent)	Aspect (Percent)	Date	Herb species	Common name	Number	Cover (Percent)	Fidelity (percent)	Constancy (Percent)
								Fraxinus pennsylvanica var. subintegerrima (Vahl) Fern. (1)	Green ash	1	1	33	33
								Stachys palustris L.	Hedge nettle	6	1	50	33
								Viburnum lentago L.	Black haw, nannyberry	1	1	33	33
								Thlaspi arvense L.	Fanweed, penny-cress	2	1	50	15.5
								Helianthus annuus L.	Common sunflower	2	1	50	15.5
								Onalia nervosa Jordan	Lady's sorrel	6	1	33	7.5
								Aster laevis L.	Smooth blue aster	4	1	75	38.5
	1	D	Fairly dense mesic (medium moist) forest	Flood control pool	1065	5 facing north	50	14 Jul 71	Corylus americana Walt.	Hazelnut	5	10	100	33
									Aralia nudicaulis L.	Wild sarsaparilla	6	6	66	15.5
									Carex sp.	Sedge	42	10	66	15.5
									Fraxinus pennsylvanica var. subintegerrima (Vahl) Fernald (1)	Green ash	3	1	66	33
									Prunus virginiana L.	Chokecherry	1	1	66	33
									Ulmus americana L.	American elm (seedlings)	91	5	33	33
									Cerastium arvense L.	Prairie chickweed	2	1	33	7.5
									Menispermum canadense L.	Moonseed (vine)	1	1	33	7.5
									Viola sp.	Violet	2	1	33	15.5
									Fraxinus nigra Marshall	Black ash/swamp ash (seedlings)	45	1	66	33
									Smilax herbacea L.	Carrion flower	1	1	33	15.5
									Actaea rubra (Ait.) Willd.	Baneberry	1	1	66	15.5
									Hieracium aurantiacum L.	Hawkweed	1	1	33	7.5
	2	C	Thick woods with dense shrub layer	Permanent pool	1005	5 facing north southeast	0	14 Jul 71	Asarum canadense L.	Wild ginger	91	50	33	7.5
									Rhus radicans L.	Poison ivy	6	10	66	23
									Carex cephalo Bad.	Bashed sedge	5	10	33	7.5
									Carex pennsylvanica Lam.	Pennsylvania sedge, yellow sedge	900	15	33	15.5
									Prunus virginiana L.	Chokecherry	2	2	66	33

EXHIBIT 4
HERB SPECIES (Cont.)

Transect	Quadrat	Description	Location	Elevation	Slope (Percent)	Aspect (Percent)	Date	Herb species	Common name	Number	Cover (Percent)	Fidelity (Percent)	Constancy (Percent)
								Aquilegia canadensis L.	Canada columbine	1	1	33	33
								Fragaria virginiana Duchesne.	Wild strawberry	2	1	33	33
								Smilacina racemosa (L.)	Black snakeroot	20	1	66	33
								Iris sp.	Dandelion	2	1	33	33.3
								Calla hyemalis L.	Northern bedstraw	2	1	66	33
								Symphoricarpos occidentalis Hook.	Wolfberry	1	1	33	66
								Delphinium depauperum Torrey & Gray.	Tall meadowrue	9	1	33	33.3
								Viola sempervirens Nutt.	Wild vetch	1	1	33	33.3
								Acer saccharum L.	Sugar maple (seedling)	1	1	33	33.3
								Lonicera ciliata L.	Fringed honeysuckle	1	1	33	33
								Lathyrus sp.	Vetch	1	1	33	33.3
								Acer rubra (Ait.) Willd.	Red maple	1	1	66	33.3
								Corylus americana Walt.	Hazelnut	2	1	100	33
								Viburnum lantana L.	Black haw, nannyberry	1	1	33	33
								Ribes cynosbati L.	Dodge nettle	2	1	33	33
								Aralia racemosa L.	Spread-leaved aralia	1	1	33	33
								Rubus strigosus L.	Canada	1	1	33	33
1	C	Understory, wooded west-facing slope, covered by Corylus americana Walt. hazelnut, 7 to 10 feet tall.	Flood control pool		20-25 Percent	10	15 Jul 71	Lathyrus ochroleucus Hook	Yellow vetchling	2	2	33	33
								Aralia nudicaulis L.	Wild sarsaparilla	5	10	66	33.3
								Galium boreale L.	Northern bedstraw	16	2	66	33
								Aquilegia canadensis L.	Columbine	3	1	33	33.3
								Aster laevis L.	Smooth blue aster	7	1	33	33.3
								Corylus americana Walt.	Hazelnut	1	1	100	33
								Viola tomentosa Greene.	Plant wood violet	2	1	33	33.3
								Thalictrum occidentale Greene.	Tall rue-of-the valley	2	1	33	33
								Viburnum rafinesquianum Schultes.	Downy-leaved arrowwood	2	1	33	33

Appendix 1

HERB SPECIES (cont.)

Treatment	Number	Description	Location	Elevation (feet)	Slope (Percent)	Aspect (Degrees)	Date	Plant species	Common name	Number	Cover (Percent)	Field (Percent)	Canopy (Percent)
1	B	Understory, wooded slope, in a stand of Nuttall oak and hackberry	Flood control pool	[illegible]	20 Eastern	90	13 Aug 72	[illegible]	[illegible]	60	20	30	31
								[illegible]	[illegible]	3	2	20	15.5
								[illegible]	[illegible]	1	1	30	0.5
								[illegible]	[illegible]	3	3	20	31
								[illegible]	[illegible]	81	35	25	15.5
								[illegible]	[illegible]	2	20	20	30.2
								[illegible]	[illegible]	2	1	20	30.2
								[illegible]	[illegible]	2	1	20	31
								[illegible]	[illegible]	2	2	20	15.5
								[illegible]	[illegible]	1	1	20	31
1	K	Open, sometime disturbed prairie	Above knob pools	[illegible]	1	0	14 Aug 72	[illegible]	[illegible]	15	1	30	7.5
								[illegible]	[illegible]	65	11	100	0.5
								[illegible]	[illegible]	20	1	100	31
								[illegible]	[illegible]	6	1	100	15.5
								[illegible]	[illegible]	80	1	30	7.5
								[illegible]	[illegible]	86	10	30	7.5
								[illegible]	[illegible]	86	10	100	30.2
2	B	Open prairie on gentle south facing slope 30 yards south of dirt road which runs parallel to and north of Pembina River northeast of deep gully.	Permanent pool edge (P)	[illegible]	2 Percent south	0	14 Aug 72	[illegible]	[illegible]	86	20	100	30.2
								[illegible]	[illegible]	76	15	100	31
								[illegible] [illegible] & [illegible]	[illegible]	15	3	30	15.5
								[illegible]	[illegible]	8	2	30	31
								[illegible] [illegible]	[illegible]	3	3	30	7.5
								[illegible]	[illegible]	0	1	30	30.2
								[illegible] [illegible]	[illegible]	10	2	30	30.2

EXHIBIT 5

Species encountered in quadrats 1-35

Common name	Scientific name	Number
Trees		
American elm	Ulmus americana L.	35
balsam poplar	Populus balsamifera L.	1
basswood	Tilia americana L.	11
boxelder	Acer negundo L.	10
bur oak	Quercus macrocarpa Michx.	21
green ash	Fraxinus pennsylvanica var. subintegerrima (Vahl) Fern.	49
paper birch	Betula papyrifera Marsh.	1
peachleaved willow	Salix amygdaloides Anders	1
quaking aspen	Populus tremuloides Mich.	13
Shrubs and other ground cover		
beaked hazel	Corylus cornuta Mar.	
chokecherry	Prunus virginiana L.	
currant or gooseberry	Ribes sp.	
downy arrowwood	Viburnum rafinesquianum Schultes	
hazelnut	Corylus americana Walt.	
hedge nettle	Stachys palustris L.	
honeysuckle	Lonicera dioica L. or tatarica L.	
ironwood	Ostrya virginiana (Mill.) Koch	
juneberry	Amelanchier alnifolia Nutt.	
poison ivy	Rhus radicans L.	
prairie wild rose	Rosa arkansana Porter	
red osier dogwood	Cornus stolonifera Michx.	
red raspberry	Rubus idaeus L.	
smooth sumac	Rhus glabra L.	
snowberry	Symphoricarpos albus L.	
thistle	Cirsium sp.	
Virginia creeper	Parthenocissus inserta (Kerner) Fritsch	
wild sarsaparilla	Aralia nudicaulis L.	
wolfberry	Symphoricarpos occidentalis Hook.	

Quadrat	Location and description		Number per acre	Average diameter (inches)	Average height (feet)	Cover (Percent)	Fidelity (percent)	Constancy (Percent)
Floodplain bottomland hardwoods forest								
1	Near to and south of Pembina River on floodplain	Green ash	7	4.8	32		53	58
		Quaking aspen	5	6.6	31		20	13
		Bur oak	2	7.6	29		40	52
		Basswood	11	5.7	29		7	13
		Birch	1	4.2	25		7	10
		American elm	2	1.0	20		60	55
		Hazel				50	27	36
		Chokecherry				10	33	36
		Red osier dogwood				30	27	16
		Downy-leaved arrowwood				10	7	3
7	150 yards north of Pembina River	Bur oak	7	7.0	23		40	52
		Green ash	21	6.1	30		53	58
		Box elder	1	5.5	24		73	64
		American elm	2	7.1	28		60	55
		Nettles				90	20	3
		Wolfberry				10	27	29
		Miscellaneous herbs				10		
8	South of and near to Pembina River	Green ash	9	3.8	29		33	58
		American elm	8	6.4	29		60	55
		Quaking aspen	3	5.8	27		20	13
		Beaked hazel				80	7	3
		Box elder				10	13	3
					Part =	10		
9	North of Pembina River, close to edge	American elm	5	13.2	66		60	55
		Box elder	5	5.1	23		73	64
		Bur oak	6	5.9	29		40	52
		Nettles				85	20	3
		Wolfberry				10	27	29
		Grass				5	20	36

Table 5 - Tree and shrub quadrat results (cont.)

Quadrat	Location and description	Elevation	Species	Number	Average diameter (inches)	Average height (feet)	Cover (Percent)	Fidelity (Percent)	Constancy (Percent)
13	South of Pembina River on floodplain		Box elder	8	7.8	30		73	64
			Juneberry				20	33	29
			Grass				80	20	36
16	Near to and south of Pembina River		Box elder	18	7.8	40		73	64
			American elm	2	11.5	60		60	55
			Willow, beach leaved	1	15.0	48		7	3
			Herbs, mostly annuals				90	27	29
			Juneberry				10	33	29
17	Near to and north of Pembina River		Box elder	2	4.1	20		73	64
			Bur oak	2	13.0	32		40	32
			Chokecherry				80	33	36
			Juneberry				20	33	29
19	About 30 yards north of Pembina River on floodplain		American elm	1	23.4	53		60	55
			Nettles				50	20	3
			Virginia creeper				20	7	3
			Red osier dogwood				15	27	16
			Chokecherry				20	33	36
20	Near to and south of Pembina River on floodplain		Box elder	4	6.7	22		73	65
			Red osier dogwood				50	27	16
			Hazel				15	27	36
			Willow				10	7	3
			Snowberry				10	13	6
			Other				10	27	29
21	South of Pembina River, near to and west of Little Pembina River on floodplain		Box elder	14	6.4	27		73	65
			Green ash	3	5.3	31		53	58
			American elm	1	9.1	32		60	55
			Grasses				50	20	36
			Herbs (annuals)				50	27	29

Point	Location and description	Species	Number	Average diameter (inches)	Average height (feet)	Percent	Fidelity (Percent)	Constancy (Percent)
23	South of Pembina River, west to and west of Little Pembina River on floodplain	Box elder	4	6.0	25		73	65
		Bur oak	4	7.2	31		40	52
		Balsam poplar	1	8.2	33		7	13
		Juneberry				90	33	29
		Hazel				5	27	36
		Chokecherry				5	33	36
28	Near to and south of Pembina River, north exposure on grassland except plot center	Quaking aspen	4	6.7	24		20	13
		Bur oak	1	14.5	21		40	52
		Green ash	1	11.2	18		53	58
		Hazel				90	27	36
		Wolfberry				10	27	29
30	River bottom, floodplain, large area of box elder, post size	Box elder	40	6.2	20		73	64
		Green ash	1	6.6	30		53	58
		Box elder				75	13	3
		Red osier dogwood				25	27	16
34	Near to and north of Pembina River in floodplain flat area on creek bank	Green ash	6	6.9	29		53	58
		Box elder	5	9.6	26		73	65
		American elm	2	23.0	54		60	55
		Wolfberry				90	27	29
		Raspberry				10	7	3
32	Near to and north of Pembina River on bank and in floodplain	American elm	4	10.6	26		60	55
		Box elder	1	4.4	18		73	65
		Green ash	1	6.1	20		53	58
		Chokecherry				40	33	33.5
		Juneberry				30	33	29
		Green ash				20	53	58
		Open sand				10	13	16

EXHIBIT 5

Table 1 - Trees and shrub quadrat results (Cont.)

Quadrat	Location and description	Elevation	Species	Number	Average diameter (inches)	Average height (feet)	Cover (Percent)	Fidelity (Percent)	Constancy (Percent)
Moist slopes - upland mixed hardwoods forest									
3	South of Pembina River, above the floodplain		Green ash	9	4.9	36		73	58
			American elm	4	13.2	56		64	55
			Basswood	3	10.4	48		18	13
			Box elder	6	4.8	36		64	65
			Bur oak	2	10.4	46		55	52
			Hazel				30	46	36
			Ironwood				20	9	3
			Wolfberry				10	27	29
			Grasses				40	46	36
4	South of Pembina River	About 1080	Green ash	9	5.6	31		73	58
			American elm	6	6.5	47		64	55
			Box elder	3	5.5	23		64	65
			Currant or gooseberry				20	9	3
			Young box elder				30	9	10
							Bare 50%	18	16
6	South of Pembina River	About 1080	American elm	1	3.2	20		64	55
			Box elder	5	6.8	27		64	65
			Green ash	3	10.2	59		73	58
			Nettles				100	18	16
10	About 50 miles south of Pembina River	About 1080	American elm	9	8.8	29		64	55
			Basswood	12	8.7	29		18	13
			Chokecherry				20	27	36
			Hazel				50	46	36
			Unknown				30	18	6
14	South of Pembina River	About 1080	Box elder	4	8.4	41		64	65
			Green ash	1	4.4	24		73	58
			American elm	1	5.0	26		64	55
			Chokecherry				50	27	36
			Wolfberry				10	27	36
			Honeysuckle				20	18	6
							Bare 20%	18	16

EXHIBIT 5

Table 1 - Trees and shrub quadrat results (Cont.)

Quadrat	Location and description	Elevation	Species	Number	Average diameter (inches)	Average height (feet)	Cover (Percent)	Fidelity (Percent)	Constancy (Percent
15	About 120 feet south of Pembina River, above the floodplain		Box elder	3	6.0	26		64	65
			Green ash	2	3.3	22		73	58
			Bur oak	4	5.4	26		55	52
			Paper birch	3	10.7	68		18	10
			Chokecherry				20	27	36
			Hazel				20	46	36
			Honeysuckle				25	18	6
			Grass				35	46	36
22	South of Pembina River and 120 yards west of Little Pembina River		Green ash	7	4.1	25		73	58
			American elm	3	10.6	39		64	55
			Balsam poplar	1	11.8	40		18	13
			Bur oak	1	4.0	25		55	52
			Juneberry				30	18	29
			Hazel				10	46	36
			Chokecherry				20	27	36
			Grass				20	46	36
			Unknown				20	18	6
29	50 yards south of Pembina River, above the floodplain		Box elder	16	6.3	12		64	64
			Bur oak	1	4.0	34		55	52
			Box elder				80	9	10
			Wild sarsaparilla				15	9	3
			Herbs				5	36	29
31	South of Pembina River	Near 1080	Bur oak	6	5.6	24		55	52
			Paper birch	5	7.0	23		18	10
			Grass				70	46	36
			Juneberry				25	18	29
			Herbs				5	36	29

EXHIBIT 5

Table 1 - Trees and shrub quadrat results (Cont.)

Quadrat	Location and description	Elevation	Species	Number	Average diameter (inches)	Average height (feet)	Cover (Percent)	Fidelity (Percent)	Constancy (Percent)
32	South of Pembina River, above the floodplain, side hill, eastern exposure		Green ash	5	4.9	18		73	58
			Quaking aspen	3	6.4	20		9	13
			Bur oak	3	7.1	21		55	52
			Hazel				75	46	36
			Rose				10	9	13
			Green ash				10	9	3
			Herbs				5	36	29
33	Near to and south of Pembina River on a bench, northwest exposure		Green ash	10	7.2	28		73	58
			Box elder	3	8.9	29		64	64
			American elm	2	11.5	38		64	55
			Balsam poplar	1	11.1	34		18	13
			Wolfberry				50	27	29
			Nettles				25	18	16
			Grass				20	46	36
			Forbs				5	36	29
Dry slope habitat - upland oak savanna woodland community									
2	Near to and north of Pembina River but above the floodplain		Bur oak	3	9.8	29		80	52
			Green ash	3	4.9	20		40	58
			Smooth sumac				80		
			Young bur oak				10		
			Poison ivy				5		
							Bare 5		
12	260 yards north of Pembina River, high on valley wall	About 1080	Bur oak	13	9.5	2		80	52
			Grass				60	60	36
			Wolfberry				40	20	29

EXHIBIT 5

Table 1 - Trees and shrub quadrat results (cont.)

Quadrat	Location and description	Date	Species	Number	Average diameter (inches)	Average height (feet)	Cover (Percent)	Fidelity (Percent)	Constancy (Percent)
18	About 30 yards west of Pembina River		[illegible]	[illegible]	[illegible]	15		80	52
			[illegible]	1	[illegible]	20		[illegible]	58
			[illegible]	3	[illegible]	17		[illegible]	58
			[illegible]	1	[illegible]	26		[illegible]	13
			[illegible]				[illegible]	[illegible]	29
			[illegible]				[illegible]	[illegible]	36
			[illegible]				[illegible]	[illegible]	36
			[illegible]				[illegible]	[illegible]	13
			[illegible]				[illegible]	[illegible]	36
24	South of Pembina River	About 1080	[illegible]	1	8.3	28		[illegible]	65
			[illegible]					[illegible]	46
26	270 yards north of Pembina River, scoured coulee, history of burning, unstable	About 1070	[illegible]	[illegible]	8.0	25		[illegible]	52
			Balsam poplar	1	10.2	26		[illegible]	13
			[illegible]	1	[illegible]	20		[illegible]	65
			Hazel				[illegible]	[illegible]	36
			[illegible]				[illegible]	[illegible]	29
			Rose				[illegible]	[illegible]	13
			Bur oak				[illegible]	[illegible]	52
			Forbs and grasses				[illegible]	[illegible]	29
Nonforested quadrats									
5	300 feet north of Pembina River, land cleared, ground cover 100 percent grain								
11	About 50 miles north of Pembina River, level, cleared of trees	About 1080	Chokecherry				85	100	36
			Wolfberry				10	50	29
			Thistle				5	50	3

EXHIBIT 5

Table 1 - Trees and shrub quadrat results (Cont.)

Quadrat	Location and description	Elevation	Species	Number	Average diameter (inches)	Average height (feet)	Cover (Percent)	Fidelity (Percent)	Constancy (Percent)
25	Near to and south of Pembina River. Was probably a bottomland hardwood forest but now has been cleared		Red osier dogwood				65	50	16.1
			Chokecherry				20	100	36
			Snowberry				10	50	6
			Rose				5	50	13
27	North of Pembina River. Washed out, now in river								

(1) Applies to an earlier project proposal. Some of the quadrats may be in the flood pool instead of the permanent pool, or they may be downstream of the damsite ultimately selected.

EXHIBIT 6

Table 1 - Timber volume within conservation pool area of proposed Pembilier Dam[1]

Species	Scribner board feet[2] (8-inch top diameter inside bark)		Cubic feet of entire stem, peeled		Cords (variable top to 3-inch diameter inside bark)	
	Live	Dead	Live	Dead	Live	Dead
Ash	37,975	-	37,277	922	344	8
Aspen	30,135	-	10,033	-	117	-
Basswood	65,905	-	22,136	123	226	-
Birch	16,170	2,318	8,685	1,103	90	10
Box elder	84,035	-	64,656	2,499	617	26
Elm	365,908	14,945	111,181	6,431	1,226	70
Oak	91,875	-	38,955	1,188	379	9
Poplar	12,127	-	4,079	-	41	-
Willow	16,783	-	3,161	-	35	-
Total	720,913	17,763	300,163	12,336	3,075	123
Average volume per acre	1,897.1	46.7	789.9	3.3	8.1	0.3

(1) Applies to an earlier proposal damsite with different water levels than the current proposal.

(2) Estimation of board feet based on size of uncut tree or log.

EXHIBIT 7

Table 1 - Ground cover within conservation pool area of proposed Pembilier Dam(1)

Type	Total sample area (1/10 acres)	Percent of total
Annuals	1.40	4.52
Ash	0.30	0.97
Bare ground	0.90	2.90
Box elder	1.95	6.29
Buck brush	2.10	6.77
Chokecherry	2.95	9.52
Dogwood	1.35	4.35
Grass	4.75	15.32
Hazel	4.95	15.96
Herbs	0.35	1.13
Honeysuckle	0.55	1.77
Ironwood	0.20	0.65
Juneberry	2.65	8.55
Nettles	3.40	10.97
Oak	0.20	0.65
Poison ivy	0.05	0.16
Raspberry	0.10	0.32
Ribes	0.20	0.65
Rose	0.45	1.45
Sarsaparilla	0.15	0.48
Snowberry	0.10	0.32
Sumac	0.80	2.58
Unknown	0.65	2.10
Virginia creeper	0.20	0.65
Willow	0.10	0.32
Wolfberry	0.20	0.65
	31.00 or 3.1 acres	100.00

(1) Applies to an earlier proposed damsite with different water levels than the current proposal.

EXHIBIT 3

Table 1 - Ground cover to be inundated(1)

Vegetation	Percent	Acres
Trees		
Box elder	6.29	
Ash	3.97	
Oak	0.65	
Ironwood	0.65	
Willow	0.32	
Total trees	8.88	33.7
Herbs		
Grasses	15.32	
Nettles	10.97	
Other forbs (Nongrass herbs)	1.11	
Annuals	4.52	
Total herbs	31.94	129.4
Unknowns	2.10	
Bare ground	2.90	11.0
Shrubs		
Hazel	15.96	
Chokecherry	9.52	
Juneberry	8.55	
Wolfberry	7.42	
Red osier dogwood	4.35	
Sumac	2.58	
Honeysuckle	1.77	
Rose	1.45	
Pines sp.	0.65	
Virginia creeper	0.65	
Wild sarsaparilla	0.48	
Raspberry	0.32	
Snowberry	0.32	
Poison ivy	0.16	
Total shrubs	54.18	205.9
Total	100.00	372.0

(1) Thirty-two, one-tenth acre, randomly selected sampled plots. Applies to an earlier proposed damsite with different water levels than the current proposal.

Segment	Name	Location	Date	Description	Fish species	Common name
1	South Pembina River (Little Pembina River)	1.1 1/2 miles south of Cooperstown, N. Dak., T 145 N., R 59 W., sec. 2 and 11, Griggs County	14 June 66	Gravel and pebble shoal with sand and silt, undercut banks and overhanging vegetation, depth 0.2 to 2 feet, width 2 to 15 feet, bottom gravel, boulders, mud and silt, moderate current	Notropis cornutus Notropis dorsalis Pimephales promelas Rhinichthys atratulus Semotilus atromaculatus Catostomus commersoni Luxilus zonatus Ictiobus niger	Common shiner Bigmouth shiner Fathead minnow Blacknose dace Creek chub Common white sucker Brook stickleback Johnny darter
2	Little South Pembina River	3 miles east of Walhalla, T 161 N., R 57 W., sec. 14, Pembina County	14 June 66	Pool and gravel shoal with sand and boulders, undercut banks and overhang, depth 0.2 to 2 feet, width 2 to 15 feet, bottom sandy, gravel and silt, no vegetation	Notropis cornutus Notropis stramineus Rhinichthys cataractae Semotilus atromaculatus	Common shiner Sand shiner Longnose dace Creek chub
3	Pembina River	1 1/2 miles west of Walhalla, T 161 N., R 57 W., sec. 23 and 30, Pembina County	14 June 66	Gravel and pebble shoal with sand and boulders, undercut banks, depth 0.2 to 2 feet, width 10 to 30 feet, bottom sand, silt, and boulders, no vegetation	Esox lucius Notropis cornutus Notropis stramineus Pimephales promelas Rhinichthys atratulus Rhinichthys cataractae Semotilus atromaculatus Catostomus commersoni Percopsis omiscomaycus Ictiobus niger Percina maculata	Northern pike Common shiner Sand shiner Fathead minnow Blacknose dace Longnose dace Creek chub Common white sucker Trout-perch Johnny darter Blackside darter
4	Pembina River	Walhalla Park, Walhalla, T 161 N., R 57 W., sec. 13, Pembina County	14 June 66	Gravel and pebble shoal with sand and boulders, undercut banks and overhang, depth 0.2 to 2 feet, width 10 to 30 feet, bottom sand, silt, and gravel, no vegetation	Esox lucius Notropis cornutus Notropis dorsalis Notropis stramineus Rhinichthys atratulus Semotilus atromaculatus Catostomus commersoni Ictalurus melas Percopsis omiscomaycus Ictiobus niger Percina maculata Etheostoma nigrum Lepomis cyanellus Lepomis gibbosus	Northern pike Common shiner Bigmouth shiner Sand shiner Fathead minnow Blacknose dace Creek chub Common white sucker Trout-perch Black bullhead Johnny darter Log perch Blackside darter Orange-spotted sunfish Bluegill

TABLE 1 - Physical characteristics of stations sampled (cont.)

Station	River	Location	Date	Description	Scientific name	Common name
7	Longmire River	2 miles north of Elbow, T 19S, R 25E, Section 4	11 Jun 74	Extensive flooded area, water slightly turbid, sediment silty; depth to 3 feet, width to 2 feet, no vegetation	None	None
8	Longmire River	4 miles northwest of Nowata, T 25N, R 16E, Section 24 and 25, Washington County	10 Jun 74	Eddie in gravel area of water slightly turbid, sediment muddy and fairly stable, depth 1 to 3 feet, width 2 to 12 feet, bottom material gravel and silt, no vegetation	Notropis cornutus Fundulus zebrinus Rhinichthys atratulus Semotilus atromaculatus Catostomus commersoni Percina caprodes Etheostoma nigrum	common shiner plains killifish longnose dace creek chub common white sucker logperch johnny darter
9	Longmire River	Gowd's Reservoir, 1.5 miles west of Nowata, T 25N, R 15E, Sec. 12, Washington Co.	10 Jun 74	Marsh and lake formed by Gowd's Dam	Salmo gairdneri Salmo trutta Micropterus salmoides Notropis cornutus Fundulus zebrinus Semotilus atromaculatus Catostomus commersoni Lepomis humilis Etheostoma nigrum	rainbow trout brown trout largemouth bass common shiner plains killifish creek chub common white sucker orangespotted sunfish johnny darter
10	Longmire River	1.5 miles east of Nowata, T 26N, R 16E, Section 31, Washington Co.	10 Jun 74	Deep pool area below dam; water turbid as rising, effort moderate to strong, depth 6 ft., width 15 to 40 ft.; bottom sand, boulders, and silt; no vegetation	Salmo gairdneri Salmo trutta Micropterus salmoides Notropis cornutus Fundulus zebrinus Rhinichthys atratulus Semotilus atromaculatus Catostomus commersoni Etheostoma nigrum Percina maculata	rainbow trout brown trout largemouth bass common shiner plains killifish longnose dace creek chub common white sucker johnny darter blackside darter

EXHIBIT 9 - Environmental description of Pembina River (cont.)

Station	River	Location	Date	Description	Fish species	Common name
11	Tongue River	4 miles southwest of Bathgate, T. 162 N, R. 53 W, sec. 18, Pembina Co.	24 July 64	Pool area: water turbid; current slight; depth to 2.5 ft; width 15 to 30 ft.; bottom sand and silt; vegetation sparse	Notropis cornutus Notropis stramineus Pimphales promelas Semotelus atromaculatus Catostomus commersoni Eucalia inconstans Etheostoma nigrum	Common shiner Sand shiner Fathead minnow Creek chub Common white sucker Brook stickleback Johnny darter
12	Tongue River	4.5 miles southwest of Pembina, T. 163 N, R. 52 W, sec. 23 and 26, Pembina Co.	24 July 64	Pool and riffle area: water 76° F. and highly turbid; current slight to moderate; depth to 4 ft.; width 10 to 15 ft.; bottom clay and gravel; no vegetation.	Esox lucius Notropis stramineus Pimphales promelas Rhinichthyes cataractae Catostomus commersoni Ictalurus melas Percopsis omiscomaycus Etheostoma nigrum Percina maculata	Northern pike Sand shiner Fathead minnow Longnose dace Common white sucker Black bullhead Trout-perch Johnny darter Blackside darter

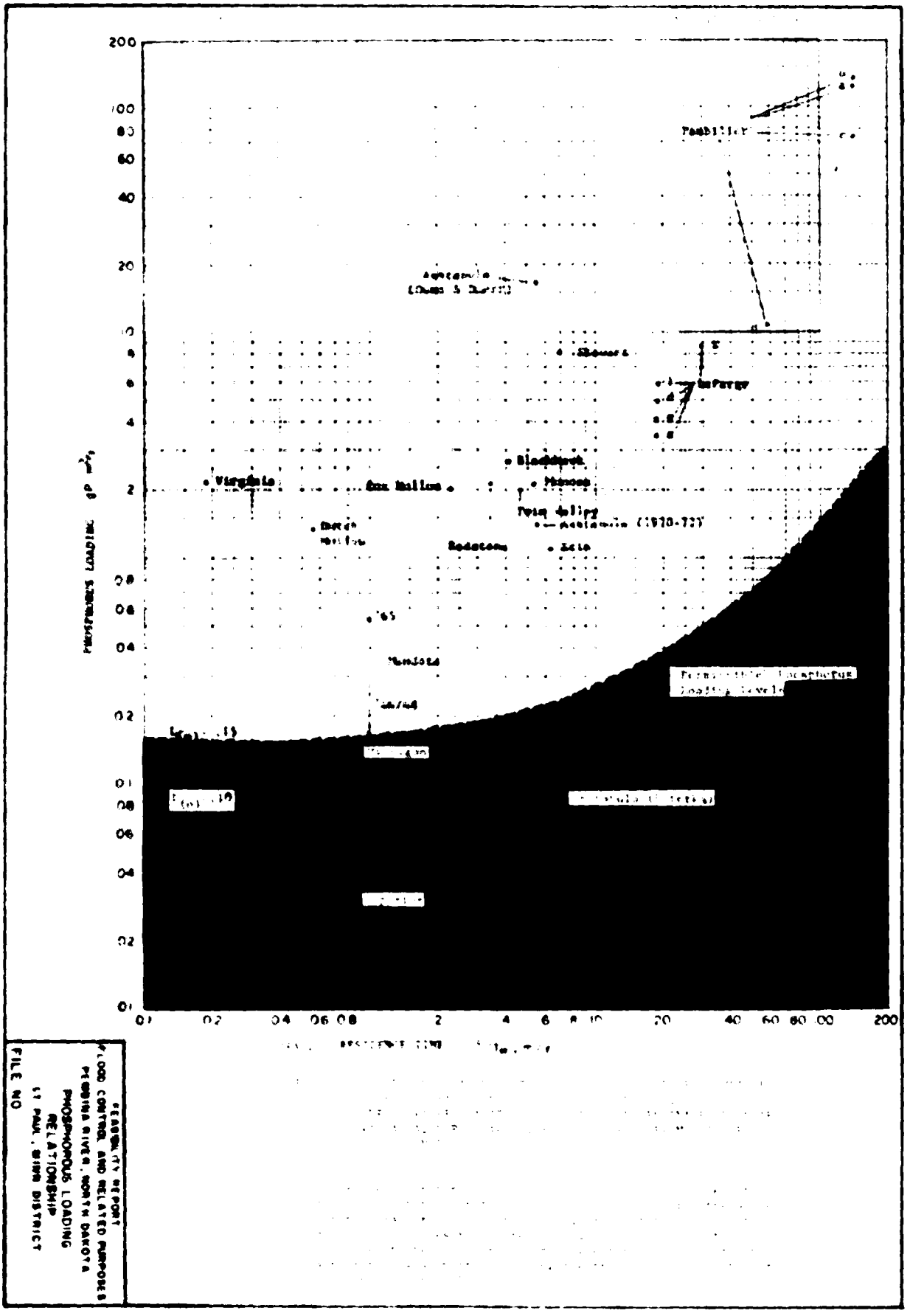
Source: Copes, F.A. and R.A. Tubb. 1966. Fishes of the Red River tributaries in North Dakota. Contributions of the Instute for Ecological Studies. The Univ. of North Dakota. No 1. 26 pp.

EXHIBIT 10 - Mussel (Unionidae) species of the Pembina and Tongue Rivers, 1969-70.*

Station No.	Location	Predominate Bottom	Species present (alive)**
113	Tongue River, NW edge, Akra, N.D.	Gravelly(pebbly) sand	Lampsilis siliquoidea
114	Tongue R., 5 3/4 miles E. Bathgate	Clayey mud	Lasmigona complanata Anodonta grandis Anodontoides ferussacianus
115	Pembina R., 6 1/2 mile W. Walhalla	Sandy,(pebbly)gravel	Lasmigona compressa Anodonta grandis Anodontoides ferussacianus Lampsilis siliquoidea Anodontoides ferussacianus
116	Pembina R., 1 1/4 mile SSW Walhalla	Sandy,(pebbly)gravel	Anodonta grandis Strophitus rugosus Lampsilis siliquoidea
117	Pembina R., 1/2 mile N. Leroy	Gravelly(pebbly)sand	Lampsilis siliquoidea
118	Pembina R., 2 1/2 mile E. Neche	Sand	Anodonta grandis Anodontoides ferussacianus Lampsilis siliquoidea
119	Pembina R., 2 3/4 miles SW Pembina	Muddy sand	Lasmigona complanata Anodonta grandis Lampsilis siliquoidea

* Source: Cvancara, Alan M. 1970. Mussels (Unionidae) of the Red River Valley in North Dakota and Minnesota, U.S.A. Malacologia. 10(1): 57-92.

** Collected at the rate of about 25 per hour by hand-picking without regard to species.



FLOOD CONTROL AND RELATED PURPOSES
PEMBINA RIVER, NORTH DAKOTA
PHOSPHOROUS LOADING
RELATIONSHIP
ST PAUL, BIWR DISTRICT

FILE NO

EXHIBIT 12: METHODOLOGY FOR PHOSPHORUS LOADING ESTIMATES

Method A

Procedure for calculation of concentrations:
Individual samples are flow weighted within each month for each year. Monthly flow-weighted averages are then summed and divided by the number of months represented to arrive at a time weighted average for each month for the period from October, 1968 until November, 1972. The product of the average monthly flows, for the same four-year period, and the average monthly concentrations are summed over all months to yield the total grams of dissolved phosphorus passing the sampling station during a year.

Average monthly weights of dissolved phosphorus

Product of average monthly concentrations and total monthly flows.
Sample calculation:

October: $4{,}750 \frac{ft^3}{sec} \times 28.32 \frac{liters}{ft^3} \times 0.07 \frac{mg}{liter} \times 86{,}400 \frac{sec}{day} \times 10^{-3} \frac{grams}{mg}$
= 813,577 g.

November:	2,646 cfs	.06 mg/l	= 388,462 g
December:	924 cfs	.07 mg/l	= 158,262 g
January:	592 cfs	.11 mg/l	= 159,339 g
February:	377 cfs	.06 mg/l	= 55,348 g
March:	3,216 cfs	.40 mg/l	= 3,147,625 g
April:	72,378 cfs	1.75 mg/l	= 309,921,420 g
May:	49,657 cfs	.53 mg/l	= 64,396,657 g
June:	22,099 cfs	.24 mg/l	= 12,977,494 g
July:	12,960 cfs	.25 mg/l	= 7,927,788 g
August:	6,714 cfs	.17 mg/l	= 2,792,783 g
September:	3,761 cfs	.12 mg/l	= 1,104,311 g

ΣP = 403,843,066 g/yr.

Area of conservation pool: $800 \text{ ac} \times 4047 \frac{m^2}{ac} = 3{,}237{,}600 \text{ m}^2$

T_w = residence time = V/Q = 0.043 yr. ($\sim$16 days)

V= volume of pool = $15{,}500 \text{ ac-ft.} \times 43{,}560 \frac{ft^3}{ac} \times 28.32 \frac{l}{ft^3} \times 10^{-3} \frac{m^3}{l}$
= 19,121,097 m^3

Q= annual flow - $180{,}074 \text{ cfs-day} \times 28.32 \frac{l}{ft^3} \times 10^{-3} \frac{m^3}{l} \times 86{,}400 \frac{sec}{day}$
= 440,613,690 m^3/yr.

$\bar{Z}$= mean depth $\sim$ 6 m

$\bar{Z}/T_w$ = 140 m/yr.

$gP/m^2/yr$ = 125

EXHIBIT 12: METHODOLOGY FOR PHOSPHORUS LOADING ESTIMATES (Cont.)

Method B

Procedure for calculation of concentrations:

Individual samples are flow-weighted within each month for each year. Individual monthly flow-weighted average concentrations and average sample flows are then assumed to be the average concentration and flow for that month. The product of these values are summed for each month and divided by the sum of the average sample flows for that month yielding a flow-weighted concentration for that month for the years from October, 1968 until September, 1972.

Example: October

Year	1968-69	1969-70	1970-71	1971-72
Sample flow/conc.	-	69/.05;60 .06	105/.01	86/.14
Flow-weighted conc.	-	.05	.01	.14
Avg. flow	-	64	105	86

Avg. conc. for period = $\frac{(.05 \times 64) + (.01 \times 105) + (.14 \times 86)}{64 + 105 + 86}$ = 0.06 mg/l

Average monthly weights of dissolved phosphorus = product of average monthly concentrations and total monthly flows.

October:	4,750 cfs	.06 mg/l	=	697,352 g
November:	2,646 cfs	.06 mg/l	=	388,462 g
December:	924 cfs	.06 mg/l	=	135,653 g
January:	592 cfs	.12 mg/l	=	173,824 g
February:	377 cfs	.06 mg/l	=	55,348 g
March:	3,216 cfs	1.01 mg/l	=	7,947,754 g
April:	72,378 cfs	1.98 mg/l	=	350,653,960 g
May:	49,657 cfs	.46 mg/l	=	55,891,440 g
June:	22,099 cfs	.23 mg/l	=	12,436,765 g
July:	12,960 cfs	.26 mg/l	=	8,244,899 g
August:	6,714 cfs	.18 mg/l	=	2,957,065 g
Sept:	3,761 cfs	.12 mg/l	=	1,104,311 g

ΣP = 440,686,743 g/yr.
Q = 440,613,690 m^3/yr.

$\bar{z}/T_w$ = 140 m/yr.

$gP/m^2/yr$ = 136

EXHIBIT 12: METHODOLOGY FOR PHOSPHORUS LOADING ESTIMATES (Cont.)

Method C

All samples for a given month were combined to give a flow-weighted concentration for that month for the period.

Ex: October 1968-71

$$\frac{(.05x69) + (.06x60) + (.01x105) + (.14x86)}{69+60+105+86} = \frac{19.99}{320} = 0.06$$

Average monthly weights of dissolved phosphorus = product of average monthly concentrations and total monthly flows.

Oct.	4,750 cfs	.06 mg/l	697,352 g
Nov.	2,646 cfs	.06 mg/l	388,902 g
Dec.	924 cfs	.06 mg/l	135,653 g
Jan.	592 cfs	.12 mg/l	173,824 g
Feb.	377 cfs	.06 mg/l	55,348 g
Mar.	3,216 cfs	1.02 mg/l	8,026,444 g
Apr.	72,378 cfs	.85 mg/l	150,533,250 g
May	49,657 cfs	.46 mg/l	55,891,434 g
Jun.	22,099 cfs	.23 mg/l	12,436,761 g
Jul.	12,960 cfs	.26 mg/l	8,244,899 g
Aug.	6,714 cfs	.18 mg/4	2,957,065 g
Sept.	3,761 cfs	.12 mg/4	1,104,311 g

ΣP = 239,947,891 g/yr.

$gP/m^2/yr.$ = 74

$Z/\overline{Tw}$ = 140m/yr.

EXHIBIT 12: METHODOLOGY FOR PHOSPHORUS LOADING ESTIMATES (Cont.)

Method D

Average monthly concentrations (Method B) and average sample flows for each month for the period were plotted on log paper and a regression curve for the data was fitted by eye.

A long-term average flow of 205 cfs was selected to determine an average concentration of dissolved phosphorus. From the graph (figure), the concentration corresponding to 205 cfs is 0.19 mg/l.

Therefore, the average annual weight of dissolved phosphorus was calculated as:

$$205 \frac{ft^3}{sec} \times 28.32 \frac{l}{ft^3} \times 86{,}400 \frac{sec}{day} \times 365 \frac{day}{yr} \times 0.19 \frac{mg}{l} \times 10^{-3} \frac{g}{mg}$$

$$= 34{,}786{,}226 \text{ g P/yr.}$$

$$Q = 205 \text{ cfs} \times 28.32 \frac{l}{ft^3} \times 10^{-3} \frac{m^3}{l} \times 86{,}400 \frac{sec}{day} \times 365 \frac{day}{yr}$$

$$= 19{,}121{,}097 \text{ m}^3$$

$Tw = 0.104$ yr. ($\simeq$ 38 days)

$\bar{Z}/Tw = 58$ m/yr.

$gP/m^2/yr. = 10.7$

EXHIBIT 13: PHOSPHORUS LOADING ESTIMATES FOR LAKE ASHTABULA BASED ON INTERPRETATION OF U.S. GEOLOGICAL SURVEY WATER QUALITY RECORDS FOR THE SHEYENNE RIVER NEAR COOPERSTOWN, NORTH DAKOTA, FOR THE PERIOD FROM OCTOBER 1970 TO SEPTEMBER 1972. TWO ADDITIONAL ESTIMATES INCLUDED BASED ON PREVIOUS STUDIES OF THE RESERVOIR.

Effective drainage area - 1,988 mi^2
Surface area of permanent pool = 5,430 Ac. = 21,975,210 m^2

Volume = 70,700 Ac-ft. = 87,216,877 m^3

$\bar{Z}$ = mean depth = 4m

Q = average flow (1970-72)= 119,333,511 m^3/yr.

Tw = 0.73 yr. ($\triangleq$ 267 days)

Employing similar procedures as in exhibit 12, Method B:

P = 30,791,964 g P/yr.

$gP/m^2/yr$ = 1.4

$\bar{Z}/Tw$ = 5.5

Additional estimates of phosphorus loading to Lake Ashtabula

Owen, J.B., and F.G. Duerr. 1974. Nutrient sources and lake Nutrient dynamics as affected by commercial and sport fishery harvest in Lake Ashtabula, North Dakota. North Dakota Game and Fish Dept., Div. of Fisheries, Rept. No. 1322-89 pp.

Estimated maximum amount of phosphorus that could accumulate during some years in the reservoir.

1,250 tons PO^4 x .326 = 407.5 ton P

x 2,000 $\frac{lb}{ton}$ x 453.6 $\frac{g}{lb}$ = 369,684,000 g P/yr.

g $P/m^2/yr.$ = 16.8

Peterka, J.J. 1970. Productivity of phytoplankton and quantities of zooplankton and bottom fauna in relation to watre quality of Lake Ashtabula Reservoir, North Dakota. Research Project Technical Completion Report WI-221-008-70 FCST: VFG.

Estimate of the amount of orthorphosphate retained in the reservoir from June 1967 to June 1968.

5.8 metric tons PO^4 x .326 x 2,205 $\frac{lb}{ton}$ x 453.6 $\frac{g}{lb}$ = 1,891,155 Pp/yr.

$gP/m^2/yr.$ = 0.086

EXHIBIT 14: ARCHAEOLOGICAL COORDINATION

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL MINNESOTA 55101

IN REPLY REFER TO
NCSED-PC

3 July 1975

Mr. Lynn H. Thompson
Director, Rocky Mountain Region
National Park Service, CRUO
Post Office Box 25287
Denver, Colorado 80225

Dear Mr. Thompson:

We are now in the process of preparing a draft environmental impact statement for the construction of Pembilier Reservoir on the Pembina River in North Dakota.

In general, the statement will discuss the environmental effects of the Corps of Engineers actions necessary to impound the Pembina River near Walhalla, North Dakota. The proposed project provides for construction of an earthen dam, multiple-level outlet structure, emergency spillway, road modifications, recreation facilities, and wildlife mitigation areas. The resulting impoundment would satisfy to varying degrees the Pembina River basin demands of flood control, water supply, recreation, and lake-type fisheries. The area of influence of the proposed reservoir is shown on the inclosed map.

In compliance with section 106 of the National Historic Preservation Act of 1966 and Executive Order 11593, we are requesting your comments concerning the existence of any historical, archaeological and paleontological resources which may exist in the vicinity of the proposed project, and which may be affected by the proposed action. These include: 1) the existence of any sites or properties listed in the National Register of Historic Places which may be affected by the proposed project, 2) the existence of any sites which may be potential nominees to the National Register of Historic Places and 3) the existence of any archaeological or historical surveys of the area which have been conducted and the dates and findings of these surveys.

A limited reconnaissance of the proposed project area was recently conducted by a professional archaeologist under contract with the Corps of Engineers. A report describing the findings of the field reconnaissance will be available about mid-July and a copy will be furnished you at that time. Nineteen lithic sites were recorded by that investigation, all of which would be inundated by the proposed reservoir. Further determination concerning salvage actions would be made during post-authorization studies.

EXHIBIT 14: ARCHAEOLOGICAL COORDINATION (Cont.)

NCSED-ER 3 July 1975

Mr. Lynn H. Thompson

The draft environmental impact statement is scheduled for completion in July and you will be furnished a copy for review and comment.

If you have any questions, please do not hesitate to contact this office.

Sincerely yours,

2 Incls
1. Project map
2. List of coordination

MAX W. NOAH
Colonel, Corps of Engineers
District Engineer

EXHIBIT 14: ARCHAEOLOGICAL COORDINATION (Cont.)

List of coordination:

Mr. Nick Franke
Research Archaeologist
State Historical Society of North Dakota
Liberty Memorial Building
Bismarck, North Dakota 58501

Mr. James E. Sperry
State Historic Preservation Officer
State Historical Society of North Dakota
Liberty Memorial Building
Bismarck, North Dakota 58501

Mr. Lynn H. Thompson
Director, Rocky Mountain Region
National Park Service, USDI
Post Office Box 25287
Denver, Colorado 80225

Incl 2

EXHIBIT 15: U.S. FISH AND WILDLIFE LETTER OF 25 JUNE 1975

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Area Office - North Dakota
1500 Capitol Avenue
P. O. Box 1897
Bismarck, North Dakota 58501

JUN 25 1975

Colonel Max W. Noah, District Engineer
St. Paul District Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

We are providing this letter to coordinate the fish and wildlife planning for flood control alternatives being considered for the Pembina River near Walhalla, North Dakota. Specifically this letter enumerates 11 fish and wildlife considerations that need to be addressed in detail in the process of planning for a reservoir alternative. These considerations will be developed and presented to the District Engineer as a part of the Fish and Wildlife Service report on the project. Our report will explain fish and wildlife compensation planning that is being developed through cooperative field work and meetings with State biologists, local project sponsors and your staff in the Environmental Resources and Planning Branches.

The project related fish and wildlife considerations are as follows:

1. All land necessary for carrying out the various purposes of the project be acquired in accordance with the provisions of the joint policy signed by the Departments of the Interior and Army.

2. Wildlife compensation acreage is to be acquired at project cost to compensate specifically for direct wildlife losses caused by dam construction and flooding, as well as losses induced by the project and manifested in changed land use practices in the Pembina River watershed. All said lands above Vang Bridge are to be turned over to the North Dakota Game and Fish Department for administration and management under the terms of a General Plan in accordance with Section 3 of the Fish and Wildlife Coordination Act and in cooperation with the Pembina River Flood Control Association.

3. Compensatory lands are to be surveyed and fenced at project cost.

4. An annual O&M budget will be made available to North Dakota Game and Fish Department to cover recurring costs for habitat management.

5. [illegible]

6. [illegible]

7. [illegible] water quality standards.

8. Channel clearing and snagging will be deleted from project planning and corrective action will be limited to clear[illegible] of watercourse debris.

9. No use permits or leases will be issued on any project lands by the Corps of Engineers.

10. Game Management Area land owned by the North Dakota Game and Fish Department within the project line will be coordinated for.

11. A program will be designed in cooperation with the Pembina River Flood Control Association and appropriate State and Federal agencies to protect wetlands in the Pembina River watershed that may be lost through project-induced drainage.

The content of these considerations is essentially the same as expressed in the Fish and Wildlife Service report of August 7, 1973 given by Mr. Madden to which Mr. Gallon of your staff responded. There has been considerable effort between our agencies to resolve these issues and there remaining work to be done. Your staff is aware of certain details relative to the acreage of conservation lands, the O&M budget to the North Dakota Game and Fish Department, and the protection of wetlands in the watershed that remain to be worked out. Information concerning these matters will be discussed with your staff as part of our continuing coordination. The specifics on all 11 considerations will be treated in our detailed report as formal recommendations.

You will receive our detailed report within 45 days of our receipt of the Draft Feasibility Report and Environmental Impact Statement.

Sincerely yours,

[signature]

James C. Sritzan
Area Manager

EXHIBIT 16: STANDARDS OF SURFACE WATER QUALITY-STATE OF NORTH DAKOTA

I. Declaration of Policy

It is declared to be the public policy of the State of North Dakota to maintain reasonable standards of quality and purity of the waters of the State, and to be essentially in compliance with Section 101(a) of the 1972 Federal Water Pollution Control Act. These standards are promulgated to be consistent with the public health and public enjoyment of such waters, for the propagation and protection of fish and wildlife, and the economic, industrial, and social development of the State. The waters of the State shall include those waters within the State as defined in Chapter 61-01, Section 61-01-01 of the North Dakota Century Code and those rivers, streams, and lakes forming boundaries between North Dakota and other states or Canada. All known and reasonable methods to control and prevent pollution of the waters of North Dakota shall be required.

The portion of the "Statement of Policy," Chapter 61-28, Section 61-28-01, of the North Dakota Century Code which reads as follows, shall become a part of these Standards:

> "It is hereby declared to be the policy of the State of North Dakota to act in the public interest to protect, maintain and improve the quality of the waters in the State for continued use as public and private water supplies, propagation of wildlife, fish and aquatic life, and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses, to require necessary and reasonable treatment of sewage, industrial, or other wastes."

It is the purpose of these Standards to maintain and improve the quality of waters in the State. The "quality of the waters" shall be the quality of record existing at the time the first standards were established in 1967, or later records if these indicate an improved quality in certain waters. However, there are parameters of quality included herein which are more stringent than those in previous standards and new paramters of quality will be attained by July 1, 1977.

VI. Specific Standards of Quality for Designated Classes of Waters of the State

It is recognized that some waters may, during certain periods of the year and in some stretches of the stream, contain certain natural, physical, chemical, and biological characteristics or properties equaling or exceeding the limits set forth in these Standards. Where waters of the State contain certain natural

characteristics or properties exceeding the limits set forth in these Standards, the Department may use the natural background level as the standard for that particular parameter(s) as a basis for controlling the addition of wastes from controllable discharges.

The following standards are prescribed as specific water quality for designated classes of waters to protect beneficial water uses as set forth in the following water use descriptions and classifications.

Class I

The quality of waters in this class shall be such as to permit the propagation and life of fish species native to the stream under natural conditions and shall be suitable for boating, swimming, and other water recreation. The quality shall be such that after treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the treated water shall meet the bacteriological, physical, and chemical requirements of the State Health Department. The quality of water shall be such as to permit its use for irrigation, stock watering and wildlife use without injurious effects.

The requirements of this class of waters is as follows:

Substance or Characteristics	Limit or Range
Ammonia	1.0 milligrams per liter
Arsenic	0.05 mg/1
Barium	1.0 mg/1
Boron	0.5 mg/1
Cadmium	0.01 mg/1
Chlorides	100. mg/1
Chromium (Travalent or Hexavalent)	0.05 mg/1
Copper	0.05 mg/1
Cyanides	0.01 mg/1
Lead	0.05 mg/1
Nitrates	4.0 mg/1
Phenols	0.01 mg/1
Phosphates (as "P")	0.1 mg/1
Selenium	.01 mg/1
T.D.S.(1)	500. mg/1
Zinc	0.5 mg/1
Sodium	50% of total cations as milliequivalents per liter

EXHIBIT 16 (Cont.)

Fecal Coli	Shall not exceed a geometric mean of 200 fecal coliforms per 100 ml based on a minimum of not less than five samples obtained during separate 24-hour periods for any 30-day period, nor shall 10 percent of total samples exceed 400 fecal coliforms per 100 ml.
Coliform	The geometric mean of total coliforms should not exceed 1000 coliforms per 100 ml, based on a minimum of not less than five samples obtained during separate 24-hour periods for any 30-day period, nor shall 20 percent of the samples exceed 2000 during any 30-day period.
Turbidity(2)	10 Jackson Units
Color(2)	15
pH	7 - 8.5
Dissolved Oxygen	Not less than 5.0 mg/l
Temperature	85° F. The maximum increase shall not be greater than 5° F. above natural background conditions. Natural background conditions are those that exist before the addition of any controllable heat source.

Radiological Criteria

1. The average dissolved concentrations (including the naturally-occurring or "background" contribution) of iodine-131, radium-226, strontium-89, strontium-90, and tritium shall not exceed the following concentration limits:

Iodine	5 pCi/L
Radium-226	1 pCi/L
Strontium-89	100 pCi/L
Strontium-90	10 pCi/L
Tritium	3000 pCi/L

For all other radionuclides, the average dissolved concentration limits shall be 1/150 of the corresponding maximum permissible concentration in water for continuous occupational exposure as recommended by the National Committee on Radiation Protection (Natural Bureau of Standards Handbook 69 or subsequent revisions).

EXHIBIT 16 (Cont.)

2. For the case of a mixture of radionuclides, the following relationship shall be satisfied:

$$\frac{C_1}{L_1} + \frac{C_2}{L_2} + \ldots + \frac{C_n}{L_n} \leq 1.00$$

Where C denotes the average concentration of the respective radionuclide and L denotes its concentration limit (Item 1).

3. In cases where alpha emitters, strontium-90, radium-228, iodine-129, iodine-130, and lead-210 are known to be absent, routine analyses for dissolved gross beta radioactivity (excluding potassium-40 contribution) may be employed to monitor and show compliance with this criteria (except for tritium) so long as the gross concentration does not exceed 100 pCi/L. When these conditions are not met, routine quantitative analyses of individual radionuclides shall be performed to show compliance. Except in cases where tritium from other than natural sources is known to be absent, routine tritium analyses shall be performed to show compliance. (Note: Absence is taken to mean a negligible small fraction of the specific concentration limit, where the limit for unidentified alpha emitters is taken as the limit for radium-226.)

4. For radionuclides associated with suspended material in transport, the average concentration limits shall be 1/150 of the corresponding maximum permissible concentration in water (insoluble form) for continuous occupational exposure as recommended by the National Committee on Radiation Protection. Moreover, instream sedimentation of these materials shall not produce solids beds such that there is noncompliance with the provisions of Items 1 and 2 (because of leaching) and/or excessive accumulation in native flora and fauna.

5. "Average" concentrations shall be computed from monitoring data acquired during the previous twelve months; however, maximum concentrations shall not exceed three (3) times the average concentration limits specified herein.

6. Variances from concentration limits specified herein shall be permitted only if (a) the contributing source(s) is a noncontrollable, natural source, (b) best available treatment is provided for manmade discharges, and (c) the exposure received by affected population groups is within established dose limits.

Class IA

The quality of this class of waters shall be such that its uses shall be the same as those identified for Class I, except that treatment for municipal use may also require softening to meet the chemical requirements of the North Dakota State Department of Health. The physical and chemical criteria shall be those for Class I, with the following exceptions:

Substance or Characteristics	Limitation
Chlorides	175 milligrams per liter
T.D.S.(1)	1000 mg/l
Sodium	60% of total cations as milliequivalents per liter

(1) TDS limits, due to natural conditions, may exceed the specified amounts during periods of low flows.

(2) Turbidity and color limits, as specified, may be exceeded during periods of runoff from heavy rains or during spring snow thaw periods.

EXHIBIT 17: MITIGATION STUDIES FOR THE PROPOSED RESERVOIR

The mitigation acreage of 16,000 acres recommended by the U.S. Fish and Wildlife Service (FWS) was arrived at through the use of non-monetary habitat evaluation criteria essentially as presented in the January 1974 draft of the Ecological Planning and Evaluation Procedures (EPEP).

The EPEP were developed by the National Coordinating Committee for Fish and Wildlife Conservation in Federal Water Development Programs and were presented in a preliminary draft in January 1974. The Committee was composed of members representing Federal, State, and private wildlife organizations. The EPEP were developed in an effort to identify, in a non-monetary manner, the fish and wildlife resources in a given area and to evaluate probable impacts on them that would result from developments. A quantification of those impacts is required under the Principles and Standards for Planning Water and Related Land Resource Projects developed by the Water Resources Council. A non-monetary method was used because the value of most wildlife cannot be completely quantified in terms of hunter and fishermen-days, the traditional approach to assessing benefits and losses resulting from a proposed project.

A brief description of the EPEP contained in the January 1974 draft follows. This description is limited to the terrestrial evaluation methodologies since the key issue seems to be habitat losses and since losses primarily occur to the terrestrial component with water resources projects.

1. A team of wildlife biologists is formed. Team members represent the construction agency, the FWS, and the State game and fish agency. Team members should have a good familiarily with the project area's ecological characteristics.

2. Working from large-scale aerial photographs, the project area is divided into areas of more-or-less discrete habitat types (upland hardwoods, grasslands, croplands, etc.).

3. Team members develop a list of wildlife species that are representative of the project area. They also develop sets of criteria for each species which will be used to evaluate the ability of existing habitat types to fulfill living requirements (food and cover) of the representative species.

4. The team conducts a field evaluation to determine the existing value of each habitat type for each of the representative species. An average habitat unit value per acre is then calculated for each habitat type based on the field evaluations.

5. The total number of habitat units in the project area is calculated by multiplying the average habitat unit value per acre for each habitat type by the total acreage of that habitat type.

EXHIBIT 17: (Cont.)

6. Future conditions representing "with" and "without" project conditions are evaluated in terms of habitat units. The difference in habitat units between these two futures represents the benefits that accrue because of the project or the losses that require compensation or mitigation.

7. The amount of land required to replace the number of habitat units lost is determined by dividing the number of habitat units lost by the mitigation potential of the replacement/mitigation lands. The mitigative potential is the difference between the existing habitat unit value per acre (1 to 10) and the value that could be obtained through intensive habitat management (assumed to be 10 for the present study).

8. For the proposed project, the average annual habitat units lost were calculated by the USFWS to be 17,904. The mitigative potential on the replacement/mitigation lands was 1.3 (the difference between the existing value of 8.7 and a maximum value of 10). The mitigation acreage required was calculated as 13,772 acres, i.e. 17,904 divided by 1.3. This value was increased by 25 percent, to cover certain contingencies that are discussed below, and resulted in a value of 17,215 acres. However, based on previous recommendations and after consulting the North Dakota Game and Fish Department, the USFWS recommended a mitigation value of 16,000 acres. Essentially, this value includes a contingency factor of about 16 percent.

The acreage recommended to mitigate wildlife losses that would occur because of the proposed project is considered a planning estimate and is consistent with the level of precision required of other project details during the current study phase.

The present mitigation study was, by necessity, an abbreviated implementation of the EPEP. Areal photography of the area was very limited and was of minor significance in deliniating habitat types. Downstream effects of the project were not assessed because of time, monies and manpower limitations and because of uncertainties with reservoir operating procedures. Effects of recreation developments were not evaluated because of late stage changes in the magnitude of these developments. In addition, the EPEP were new and the evaluation team experienced some problems in interpreting the procedures.

If the proposed project is authorized and funded for additional study, a more detailed evaluation of the effects on fish and wildlife resources of the area will be initiated. This study would consist of

EXHIBIT 17: (Cont.)

large scale aerial photographs and habitat type maps, more extensive field evaluations, considerations of recreation, a more detailed evaluation of the operating plan, and a more realistic determination of the mitigation potential of proposed mitigation/replacement lands. This restudy would significantly increase the level of precision for the mitigation requirements. However, the concensus of the St. Paul District is that the 16,000 acres is justified based on the information presently available.

END

FILMED

1-83

DTIC