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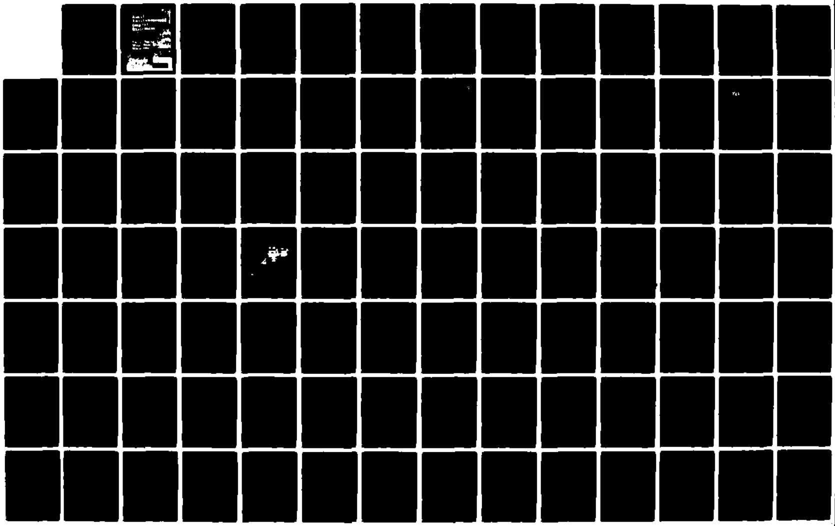

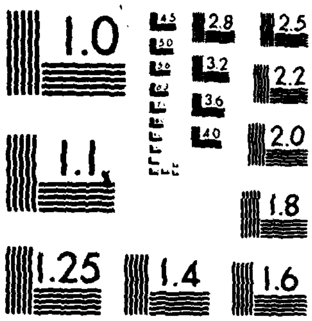
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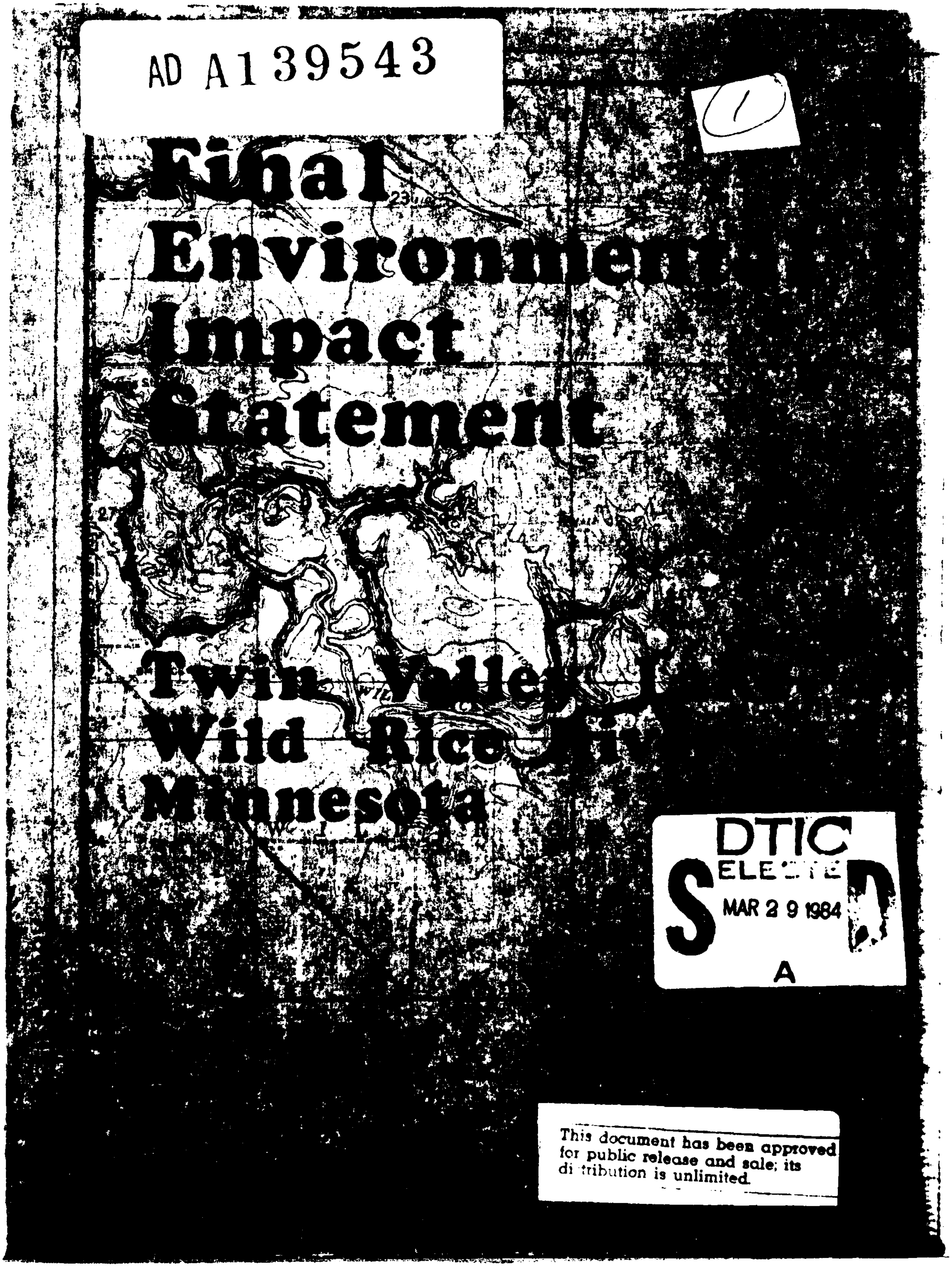

Final Environmental Impact Statement

Twin Valley
Wild Rice River
Minnesota

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REPORT DOCUMENTATION PAGE

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18. SUPPLEMENTARY NOTES

Includes addendum, dated May 1976.

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

ENVIRONMENTAL IMPACT STATEMENTS
EARTH DAMS
MINNESOTA

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

The proposed project provides for construction of an earthen dam on the Wild Rice River near Twin Valley, Minnesota. The location of the damsite discussed in this EIS is an alternative site than the one authorized in House Document no. 366, 90th Congress, 2nd session. Besides the earthen dam, the project also provides for the construction of a low flow outlet works, emergency spillway, road relocations, and overlook and recreation facilities. Project purposes include flood control, recreation, and fish and wildlife development.

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The project would reduce flood damages along the Wild Rice River downstream of Twin Valley, along the Marsh River, and also along the Red River of the North downstream of the confluence of the Wild Rice River.

TWIN VALLEY LAKE

FINAL ENVIRONMENTAL IMPACT STATEMENT

MAY 1976 ADDENDUM

INTRODUCTION

This final environmental impact statement (FEIS) on the proposed Twin Valley Lake project was essentially complete in February 1975. At that time, however, several unresolved issues existed between the Corps of Engineers and the U.S. Fish and Wildlife Service (FWS), the U.S. Environmental Protection Agency (EPA), the Minnesota Department of Natural Resources (DNR) and the Minnesota Pollution Control Agency (MPCA). Further processing of this FEIS was, therefore, deferred and additional coordination undertaken to attempt to achieve agreement between the Corps and these agencies regarding further study of the proposed project.

This addendum is intended to inform the reader of the issues involved, coordination which has occurred, and agreements which have been reached during the period February 1975 to May 1976. In addition, a schedule of the continued study on the proposed project has been included. The text of the EIS has not been changed; all new information is contained in this addendum.

ISSUES

FISH AND WILDLIFE MITIGATION AND/OR ENHANCEMENT

The letter of comment on the draft EIS received from the U.S. Department of the Interior, dated 27 January 1975 (pages 146-155, FEIS), reaffirmed the position taken by the FWS and stated opposition to the Twin Valley Lake project with a recommendation that alternatives to the proposed project be studied. This opposition occurred due to the lack of adequate compensation for the fish and wildlife losses which would occur with implementation of the proposed project. The DNR indicated in their letter of comment (pages 161-164, FEIS) that adverse environmental impacts would occur with the implementation of the proposed project, and they made several recommendations for compensation measures to be incorporated in the project to mitigate the fish and wildlife losses.

WATER QUALITY

The EPA stated in their letter of comment, dated 27 February 1975 (pages

137-142, FEIS), that they had environmental reservations regarding the project and that information provided in the draft EIS was not sufficient to fully assess the environmental impacts of the project. Their primary concerns related to the proposed project's effects on water quality, natural land resources and wetlands. The EPA recommended that the Corps study other alternatives to the proposed project. Meetings held with MPCA indicated that their concerns over the proposed project centered on the project's effects on water quality and recreation. A letter stating their concerns was received after preparation of the FEIS and is appended to this addendum (see exhibit A-1).

SUMMARY OF ISSUES

Both the FWS and the EPA recommended that the Corps investigate other alternatives to the proposed Twin Valley Lake project. However, the Corps stated that all practical and implementable nonstructural and structural alternatives for flood damage reduction were considered in the Phase I studies and that Twin Valley Lake was found to be the only alternative which was economically feasible.

COORDINATION EFFORTS (February 1975-May 1976)

As indicated in Section 9 of the FEIS, coordination with known interested parties was attempted during the Phase I GDM and EIS studies. This effort has continued in recent months in the case of the major issues outlined above. A summary of the results of the coordination efforts by major issue follows:

FISH AND WILDLIFE

In a letter dated 26 February 1976 the FWS modified their earlier position and indicated they would work with the DNR and Corps to determine needed mitigation measures. Also, since the final EIS was prepared, meetings have been held between the Corps, FWS and DNR. As a result of this coordination, agreement on further study needs has been reached with these agencies. Pertinent letters are appended to this addendum (see exhibits A-2, A-3, A-4 and A-5). A summary of the proposed plan of action follows.

Discussion centered on fish and wildlife issues of a project formulation scope. The conclusion reached was that a study defining a conceptual mitigation, compensation and/or enhancement plan ("mitigation plan") would be conducted according to the schedule in exhibit A-6. Initially, certain ecological baseline data will be obtained, including:

1. Summary and analysis of pertinent fish and wildlife data in agency files.

2. Aquatic field sampling, which is aimed at characterizing selected reaches of stream as to the probable value to the fishery. Studies will be based essentially on statistically designed sampling of one, or possibly several, fish species, with extrapolations made for other species, other reaches of stream, other seasons and periods significant to stream biota, and other years.

3. Terrestrial studies will mainly involve habitat typing and land use information from aerial imagery, with ground truthing.

After the usual ecologic numerical analysis and interpretation, the data will be subjected to a hurried analysis following the Ecological Planning and Evaluation Procedures. After "mitigation" requirements are thus estimated, the planning team (Corps, FWS, DNR) will decide upon the appropriate contingency factor to account for the lack of definition in ultimate construction plans, unrefined remote imagery usage, deficiencies in field data, lack of certain basic knowledge on probable water quality conditions in the reservoir and downstream of the dam, uncertainty as to the reservoir regulation plan, and a factor of safety. The team will then use professional judgments to arrive at a tentative, justifiable "mitigation plan" which seeks to replace losses in kind, or which arrives at an acceptable substitute. A report will be drafted which outlines the conceptual "mitigation" plan along with estimated cost allocation and cost sharing and supporting data in the form of basic resource replacement needs plus information on key environmental concerns, such as wildlife wintering areas. Enhancements will also be identified. If additional lands need to be purchases specifically for fish and wildlife mitigation, compensation and/or enhancement, a letter report supporting the need for these lands will be drafted for presentation to Congress for authorization. The study is scheduled for initiation in April 1976 and completion in October 1976.

WATER QUALITY

There was reason to believe as early as 1972 that the reservoir would be eutrophic. This judgment was strengthened during Phase I GDM studies using limited available water quality data and models developed for natural lakes. Reviewers of the draft Phase I reports, expecially the EPA and MPCA, expressed concern about projected water quality. As a result, additional coordination was exacted with those agencies (see exhibits A-8 and A-9), and the schedule for preparation of a Water Quality Design Memorandum (exhibit A-7) was proposed to them. The EPA and MPCA were initially unfamiliar with Corps reservoir water quality models, but they agreed that the study should be conducted. They made several recommendations which should strengthen the study, and they offered assistance through review in the scheduled preparation of a Water Quality Design Memorandum by December 1977. The scheduled studies will provide estimators to aid in determining whether the proposed project will meet water quality standards, and if not, whether standards can be met by design and operational modifications. The study and corresponding coordination should also result in better understanding and concurrence as to the applicable constraints, e.g., what water quality standards will be applied to what aspect or reach of the project. The water quality studies will be continued after Water Quality Design Memorandum preparation and will involve interpretation in biological terms which will be used to adjust the recreational plans and "mitigation plan" to be set forth in the Recreation Master Plan and Fish and Wildlife Facilities Design Memorandum, respectively.

OTHER ACTIVITIES

Results of the fish and wildlife and water quality studies will be coordinated with other known local, State and Federal interests. If minimum standards are met, enhancements will be scaled at various levels in order to achieve the optimal trade off possible under current guidelines between economic, social and environmental factors.

A letter report setting forth estimated land acquisition requirements for fish and wildlife mitigation, compensation and enhancement is scheduled for submission to higher Corps offices in December 1976.

Revisions or supplements to the EIS will be scheduled as changes to the project, or knowledge as to its effects, require.

A revised project schedule has been developed to incorporate the studies covered in this addendum, to adjust other activities, and to start construction while the project is still economically feasible under current guidelines (exhibit A-10). Construction is currently scheduled to start in 1979.

EXHIBITS

EXHIBIT A-1

Minnesota Pollution Control Agency

June 27, 1975

Colonel Max Noah
District Engineer
U. S. Army Corps of Engineers
1134 U. S. Post Office & Customs
St. Paul, Minnesota 55101

Re: Draft EIS
Twin Valley Lake Project
MPCA 408

Dear Colonel Noah:

We have reviewed the draft environmental impact statement for the Twin Valley Lake Project and have the following comments to make:

1) Preliminary calculations of phosphorus loading to the reservoir based on average yearly flow, the proposed volume, and an arbitrary total phosphorus concentration of 0.1 mg/l, show that the loading will be 61 lbs/acre or 6.8 g/M^2. Based on Vollenweider's input/output models, as shown in the EPA's National Eutrophication Survey, working paper No. 23, the lake will be eutrophic.

2) It is understood that the Corps of Engineers presently has a water quality monitoring program in progress, and that the results of this program will allow more accurate prediction of water quality and recreation potential for the reservoir.

3) The benefit cost ratio for the proposed alternative includes increased recreation benefits at Twin Valley Lake. These benefits are substantially dependent on water quality, and may or may not be realized.

4) Paragraph 4183 discusses usage of the Wild Rice River by canoeists. The adverse effect of the reservoir on canoeists cannot be over-emphasized.

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Fast-water/white-water canoeing is becoming an increasingly important recreational activity in Minnesota. Although the Wild Rive River is not a designated canoeing river, this resource still exists. Canoeing opportunities on the proposed reservoir is essentially no substitute for river canoeing. The potential canoeing recreation on the river should be more closely examined, and its loss should be subtracted from the recreation benefits of the proposed reservoir.

5) Further consideration should be given to alternatives which are less cost effective, but will have less effect on the environment.

Yours very truly,

LYLE H. SMITH
Chief Engineer
612/296-7306

LHS:jac

EXHIBIT A-2

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
LWR

FEB 26 1976

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

Dear Colonel Gay:

This is in response to your February 17 letter concerning the "plan of action" for attaining adequate fish and wildlife mitigation for the proposed Twin Valley Lake project, Minnesota.

The U.S. Fish and Wildlife Service position is that we will conduct a study in coordination with the Minnesota Department of Natural Resources and the St. Paul District Corps of Engineers to determine mitigation measures necessary as a result of the construction of the proposed Twin Valley Lake.

This study would begin in late May 1976 and be concluded with a report of recommendations by October 1976.

The U.S. Fish and Wildlife Service will need $6500 in additional transfer funds from the Corps of Engineers to participate in the study.

The U.S. Fish and Wildlife Service Ecological Planning and Evaluation Procedures will be used to determine the necessary mitigation.

We understand that the cost of mitigation measures will be included in the total project costs, that the benefit to cost ratio will reflect the cost of necessary mitigation, and that this aspect of the proposal will become an integral part of the development and completion of this flood control project.

It is further understood that Congressman Bergland, Senator Humphrey, and Senator Mondale will support adequate appropriations from Congress to implement the necessary mitigation measures in the reauthorization

AMERICAN REVOLUTION BICENTENNIAL 1776-1976 of the project. A copy of Senator Mondale's letter is attached for your information.

Sincerely yours,

Jack E. Hemphill

Regional Director

Attachment

cc: Minnesota Department of Natural Resources

EXHIBIT A-3

United States Senate

COMMITTEE ON THE BUDGET
WASHINGTON, D.C. 20510

February 6, 1976

Mr. Jack Hemphill
Regional Director
U.S. Fish & Wildlife Service
Room 6307 - Fort Snelling
Federal Building
Twin Cities, Minnesota 55111

Dear Jack:

I understand my staff assistant, Mike Sullivan, has been working with you, Commissioner Bob Herbst and Colonel Ted Gay on the Twin Valley Dam project. As you know, I have had a long term interest in this flood control project. The floods and millions of dollars of damage to agricultural and highway properties throughout the Red River Valley this last summer only heightened my interest and reinforced my belief that something must be done to control and direct the flow of water in the Twin Valley area.

I have been keenly aware of the many environmental concerns you and the Department of Natural Resources have shared on this project. I also share those interests and want to commend you and the DNR for your very thorough review on these matters. Mike informs me that you assured him in a phone conversation earlier this week that, with adequate compensation measures, you found the present Dam proposal acceptable and you were in a position to begin working with the DNR to select suitable sites for this compensation.

I am delighted by this progress and shared this information and your other concerns with Colonel Gay. He assured me that the cost estimates for these compensation properties would be included in the total project costs, that the benefit to cost ratio will reflect the purchase and any necessary enhancement of these properties and that this aspect of the proposal will become an integral part of the development and completion of this flood control project.

I know there are times when the Corps submits project and budget requests that become derailed at the White House or in the Congress. I have discussed this with Congressman Bergland

and Senator Humphrey and we want to reassure you that we will do everything we can to see that adequate appropriations will be approved by the Congress to complete the entire flood control and environmental protection phases of this project as agreed to by you, the Department of Natural Resources and the Army Corps of Engineers.

Again, thank you for your special cooperation on this project and I want you to know that I have a continuing interest and am available to do whatever I can to see this project through to its earliest possible completion.

With warmest personal regards.

Sincerely,

Walter F. Mondale

cc: Commissioner Bob Herbst
Colonel Ted Gay
Senator Hubert Humphrey
Congressman Bob Bergland
Don Ogaard

EXHIBIT A-4

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
(LWR)

MAR 26 1976

Colonel Forrest T. Gay
District Engineer
U.S. Army Engineer District
St. Paul
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

This is in reference to your March 19, 1976 letter concerning scheduling and funding requirements for our participation in the fish and wildlife mitigation study for the proposed Twin Valley Dam and Lake Project, Wild Rice River, Minnesota.

For planning and programming purposes, our funding requirements remain as indicated in your letter. As we informed you previously, we have $4,000 available for work on this project for the remainder of fiscal year 1976. Since we have no funds programmed for the Twin Valley Project during the 1976 transition quarter, we understand that we will receive $4,500 through an interagency transfer of additional funds for that period. Also, $2,000 of the amount programmed for this project in fiscal year 1977 will be applied to the study.

We concur with the funding outline and study schedule enclosed with your March 19 letter. Realistically, however, we all must accept the concept that this schedule may be interrupted by any one of a number of problems including bad weather, equipment failure, and personnel matters. Although we shall proceed with the study as expeditiously as possible, the schedule should remain flexible to tolerate minor setbacks.

We look forward to initiation of this cooperative study in the near future.

Sincerely yours,

Jack E. Hemphill

Regional Director

cc: Minnesota DNR

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STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING • ST. PAUL, MINNESOTA • 55155

EXHIBIT A-5

March 30, 1976

Colonel Forrest T. Gay, III
District Engineer
St. Paul District
Corps of Engineers
St. Paul, Minnesota 55101

Dear Colonel Gay:

The Department of Natural Resources (DNR) has received your letter of March 19, 1976, advising that funds have been secured for the required electro-fishing surveys and participation in subsequent data analysis and report preparation phases on the Twin Valley Dam and Lake project.

The Department of Natural Resources is in full agreement with the study and funding schedule noted in your March 19 letter. This program will insure that DNR will be able to fully participate in the study designed to document the necessary fish and wildlife mitigation measures for the Twin Valley project.

We sincerely appreciate the efforts you and your staff extended in coordinating this project among the various federal and state agencies. With the support of our Congressional delegation and continued inter-agency coordination I am confident we can design a project to satisfy all concerns.

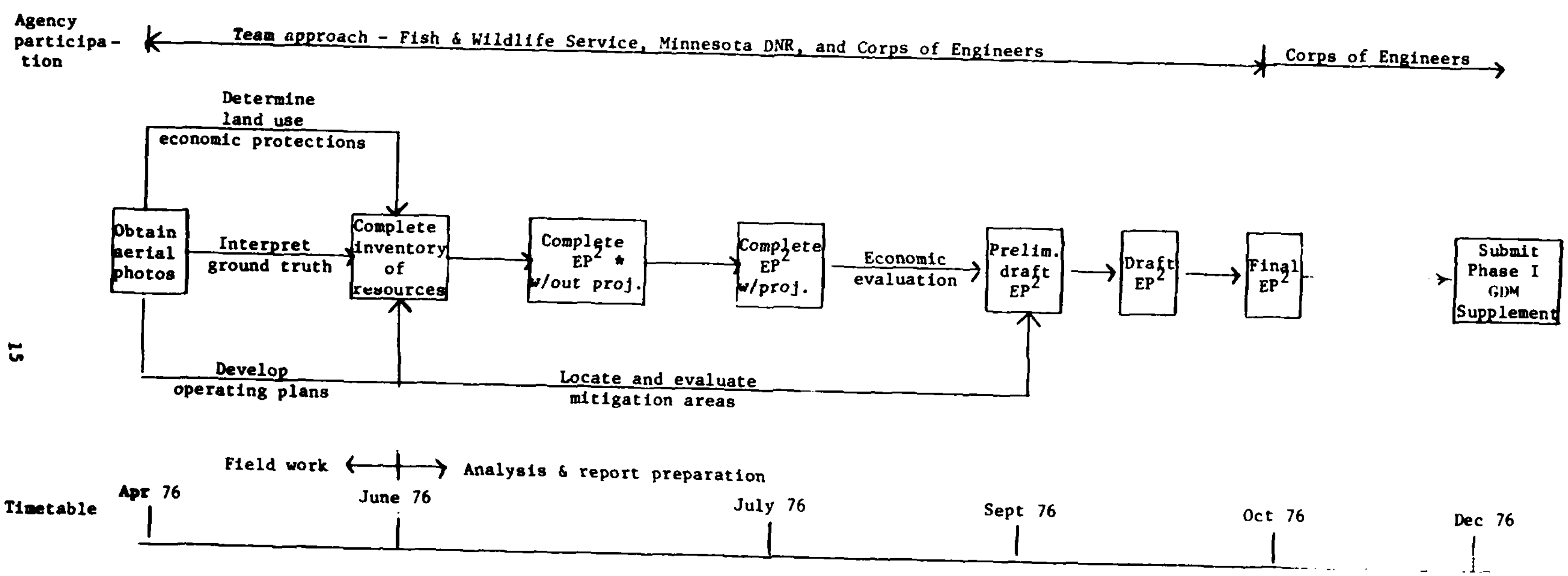
Sincerely,

Robert L. Herbst
Commissioner

cc: Governor Wendell R. Anderson
Representative Robert Bergland
Senator Roger Moe
Representative Willis Eken
Minnesota Congressional Delegation
Merlyn Wesloh
Division of Waters
Division of Fish and Game

EXHIBIT A-6

SCHEDULE FOR DEVELOPMENT OF A FISH AND WILDLIFE
COMPENSATION PLAN FOR THE TWIN VALLEY LAKE RESERVOIR PROJECT



* Refers to Ecological Planning and Evaluation Procedure.

SCHEDULE FOR WATER QUALITY STUDY
TWIN VALLEY LAKE RESERVOIR PROJECT

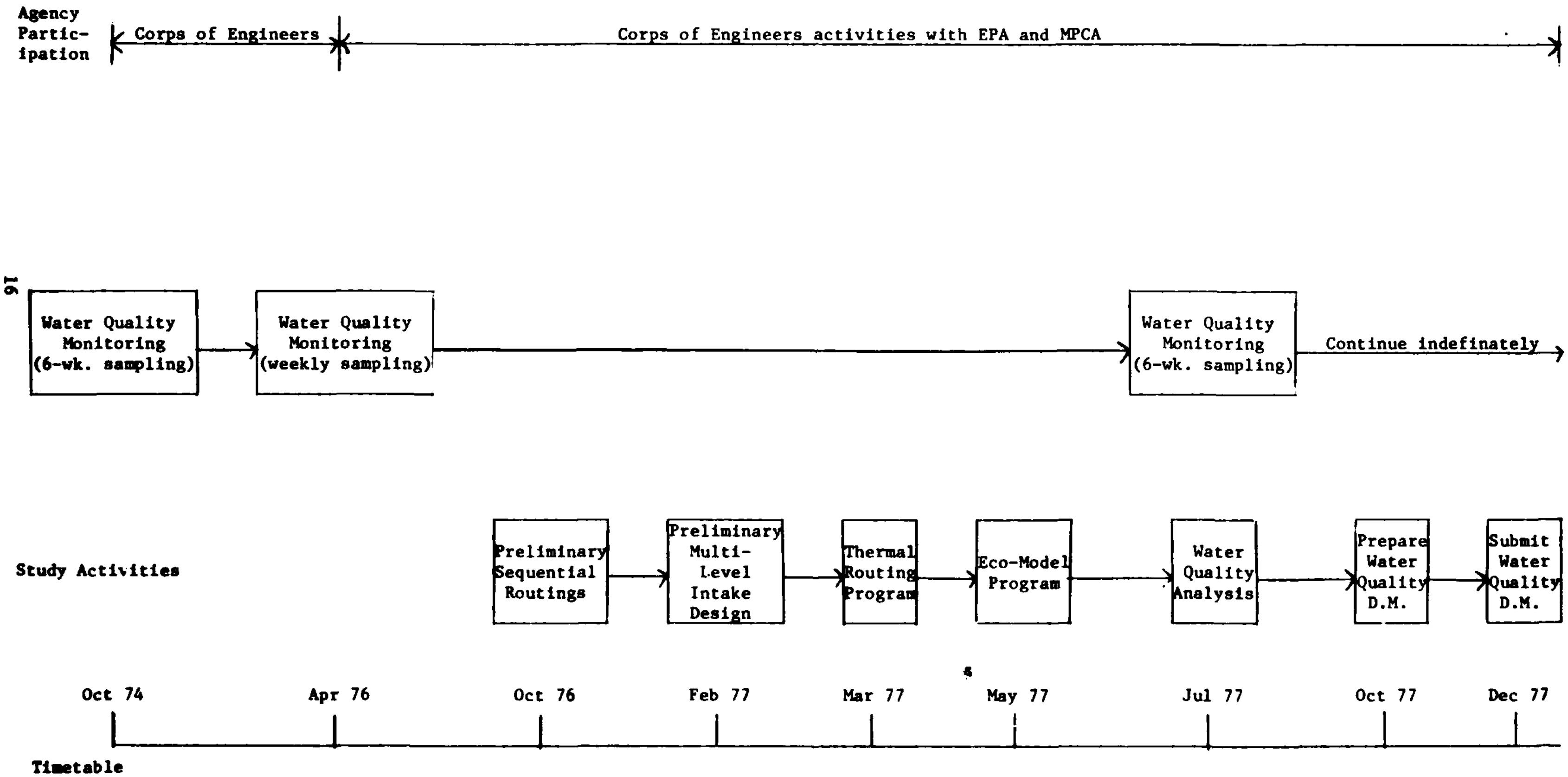


EXHIBIT A-7

EXHIBIT A-8

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST
CHICAGO, ILLINOIS 60604

APR 15 1976

Colonel Forrest T. Gay, III
District Engineer
U. S. Army Engineer District, St. Paul
1135 U.S. Post Office & Customhouse
St. Paul, Minnesota 55101

Dear Colonel Gay:

Reference is made to your February 27, 1976 letter requesting our recommendations on the proposed Twin Valley Lake water quality monitoring program, the proposed thermal simulation and ecological models to be used and the proposed schedule for preparing a water quality report. As explained in several telephone conversations with your staff, we have no objections at this time to the conceptual use of the thermal simulation and ecological models that were discussed at the February 24, 1976 interagency cooperative meeting. However, this general concurrence is based upon the following conditions:

1. the proposed models will be able to "accurately" predict reservoir water quality over a period of time.

2. the proposed models will be able to "accurately" predict downstream water quality effects of the reservoir discharge and take into account downstream tributary inputs.

3. the water quality data to be generated from the water quality monitoring program will provide adequate input to the model such that the model can output high confidence ("accurate") predictions of water quality changes in the reservoir and downstream reach of the Wild Rice River.

4. the monitoring data base would be extended if it were determined that the period from April 1976 - April 1977 was <u>not</u> a typical year in terms of meteorology.

5. that the period from April 1977 to July 1977 will be used for model verification and sensitivity analysis provided the period from April 1976 to April 1977 is considered a typical year.

In general, the proposed Corps of Engineers monitoring program for simulation and projection of water quality behavior in the future Twin Valley Reservoir appears to be fairly adequate. Analysis of present loads flowing past the proposed dam site will provide an estimate of total loads carried to the reservoir by all its tributaries. As recommended by the State of Minnesota, the additional station at (or just north of) Hendrum should also be monitored. At Hendrum the main effect of the reservoir would be on flow; thus, continuous flow measurements should be made there, but other parameter coverage may be somewhat limited.

We do, however, recommend that an additional water quality station be located at approximately River Mile 77. The incorporation of this station into the monitoring program would be useful for isolating mainstem loads from other tributary loads. Since the reservoir model allows concentration variations in the vertical direction only, the additional information could not be used to predict water quality conditions in any specific part of the reservoir. It can only be used to give the general area where pollution source controls could be applied if the reservoir is built.

None of the proposed monitoring will estimate additional sediment and nutrient inputs caused by erosion of the land occupied by the flood control capacity (that is, the land between the maximum and minimum pool elevations). In addition, it should be kept in mind that the proposed monitoring gives only information on input loads to the reservoir. It will not supply values for calibration of model parameters such as algal potential growth rates, BOD decay rates, nutrient uptake rates, etc. The values to be used should be well documented and representative of the area. Also, an explanation should be provided on their derivation and their appropriateness for use in the model.

With regard to the parameters to be monitored in the sampling program, we find that the proposed list of parameters is more than adequate and in fact some of the parameters may be deleted as they are either not necessary or applicable to the river being sampled. The parameters to be studied should include (1) all those for which water quality standards (with a 2B classification) exist and (2) those input parameters required for the proposed models.

We note that many of the tested parameters have values that can be calculated from a single basic parameter. Since there are quite a number of these in the list and some of them are not necessary, they could be deleted if there is a cost affixed to them. "Dissolved" tests should be scrutinized very carefully as many of the tests are not that reliable. These are documented in the literature. For this reason, greater emphasis should be given to tests for "totals" rather than "dissolveds". Other parameters that might be deleted include:

Fluoride, Dissolved
Aluminum, Total
Beryllium, Total
Cyanide
Lithium, Total
Molybdenum, Total
Silver, Total
Vanadium, Total

We note that pesticide analysis will include both the bed material and the water at a two samplings per year frequency. Tests for herbicides should be taken in the spring or taken at such times that would be consistent with the application of herbicides. For additional information, please contact Mr. Billy Fairless of our Central Regional Laboratory at 312-353-8370.

In general, we believe the proposed scheduling for the water quality sampling program (April 1976 to July 1977) is satisfactory. We do, however, have some concern as to whether the proposed weekly sampling scheme would give an accurate portrayal of spring runoff and storm events. Because these events are critical in water quality management planning and can contain as much as 90% of the year's nutrient loadings, suspended solids, etc., the sampling scheme should be designed such that it could be flexible enough to sample at a greater frequency in the spring, and to possibly pick up samples during significant storm events.

Specific items that should be included in the water quality report are:

1. A detailed description of the site characteristics, vegetation, soils, topography, hydrology, meteorology.

2. Inclusion of water quality data, flow data, sediment loads.

3. A discussion of the design and operational characteristics of the project and anticipated modification of natural flows.

4. A detailed water quality impact assessment for the reservoir, areas within the reservoir and the river downstream to the Red River. Areas within the reservoir might include the area to be stratified, the recreational areas and the upstream end of the reservoir. The models to be used in this assessment should be explained in terms of how they are used, what is being inputed and how these inputs are derived. Time will be be an important factor of consideration. It might be desirable to predict water quality at completion of the project, 5 years after completion and for the project's design life.

5. A comparison of predicted water quality (particularly during low flow conditions) with applicable water quality standards. The predicted quality of both hypolimnetic and epilemnetic waters should be assessed and compared to standards. While standards don't exist for some nutrients, a discussion should be included detailing short-term and long-term effects of nutrient loading and concentrations upon reservoir water quality.

6. Conclusions of the water quality study results. These should explain how the project will affect water quality standards and whether predicted water quality problems can be resolved. Recommendations should be made on whether the project in terms of water quality should be constructed and if problems can be resolved, mitigated or eliminated with an alteration in the design.

For guidelines on what is expected in the water quality report, we suggest using An Assessment Methodology for the Environmental Impact of Water Resource Projects, EPA-600/S74-016 July, 1974; Guidelines for EPA Review of Environmental Impact Statements on Projects Involving Impoundments, Contract No. 68-01-2924, June 1975; and the Environmental Analysis of the Kickapoo River Impoundment prepared by the Institute for Environmental Studies, University of Wisconsin-Madison.

Another item that should be addressed in the water quality report is the project's secondary effects. From our discussions at the February 24, 1976 meeting, we note that no monitoring will be performed to determine whether secondary effects of reservoir construction will have a significant adverse impact on water quality in the Wild Rice River between the dam and the Red River of the North. A potential secondary effect could be a decrease in the groundwater inflow to the downstream portion of the Wild Rice River such that pollutants become more concentrated and their impacts more pronounced. Another potential secondary effect could be an increase in the use of downstream land uses such that point and non-point sources of pollutants are increased. This could increase pollutant concentrations and problems in the Wild Rice and/or Red River. A third potential secondary effect could be the additional upstream drainage of wetlands and lowlands increasing the pollutant loading in the reservoir and downstream waters. If these secondary effects are not at least considered in the water quality analysis, the long-term water quality impacts of the reservoir project could be underestimated.

We trust the above satisfactorily clarifies our position with regard to the items raised in your letter.

Sincerely yours,

Christopher Timm
Director
Surveillance & Analysis Division

cc: David Rockwell, TSB, EPA
Billy Fairless, CRL, EPA
Gary Schenzel, Water Div, EPA
Charlie Delos, Planning, EPA
Michael Sullivan, Planning, EPA
Harlan Hirt, Planning, EPA
John Helvig/Keith Beseke, MWDO, EPA
Douglas Hall, MPCA
Chris Potos, WQS, EPA

EXHIBIT A-9

Minnesota Pollution Control Agency
(612) 296-7256

April 6, 1976

Colonel Forest T. Gay, III
District Engineer
U.S. Army Corps of Engineers
1135 U.S. Post Office & Customs House
St. Paul, Minnesota 55101

Dear Colonel Gay:

This letter will provide your office with necessary follow-up to a meeting held on February 24, 1976, between members of your staff, the Minnesota Pollution Control Agency and the U.S. Environmental Protection Agency. Discussions at that time related specifically to the influence of the proposed Twin Valley Dam and Lake project on the water quality of the Wild Rice River. The following paragraphs address certain points on which more information or clarification was desired by your agency from the MPCA.

1. Water quality standards for recreational waters classified 2B are not required to be met in hypolimnetic regions of a lake or reservoir. The Agency recognizes that the depletion of oxygen or the build-up of ammonia in the hypolimnion is a natural phenomenon in a large number of Minnesota lakes and reservoirs of sufficient depth and fertility. However, we do strongly recommend that overflow structures at a dam be designed and operated such that violations of downstream water quality standards in the Wild Rice River will not be caused by the release of hypolimnetic waters which may be oxygen deficient, high in oxygen demand, or which may contain potentially harmful levels of toxic substances such as ammonia or hydrogen sulfide. Water quality standards would apply to all non-hypolimnetic regions of the reservoir.

2. With regard to water quality changes which may occur in the future, the classification of the water body, and hence the standards, will be based on the type of biological community or recreational uses which it can support. For example, as the reservoir fills up the biological makeup of the reservoir could change from primarily that of a fishery to a waterfowl area. Under these circumstances, the classification of the waters would also be subject to change based on a determination as to the actual use of the waters. Such changes in classification and standards resulting from natural conditions do not involve variance procedures.

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EXHIBIT A-9

Colonel Forest Gay
Page 2

3. Pollution Control Agency Regulation WPC 14, Section (a)(7) provides an interpretation of water quality standards which may be violated under natural conditions. If the water quality standards are exceeded by the background levels, the background levels control the compliance of a stream segment. If the character of the reservoir were to change as a result of flood control activities, new background levels for the water body would have to be established in order to determine compliance. These new background levels would then become the standards if they exceed the limits specified in the regulations.

4. Upon review of the proposed water quality monitoring program in this area, it is the staff's feeling that parametric coverage and sampling frequency as proposed is ample. The recommendation has been made and verbal agreement obtained from your staff to add an additional station near the mouth of the Wild Rice River at Hendrum to provide more adequate background water quality data. Sampling at this station was to take place at the same frequency as that at the dam site but for limited parametric coverage.

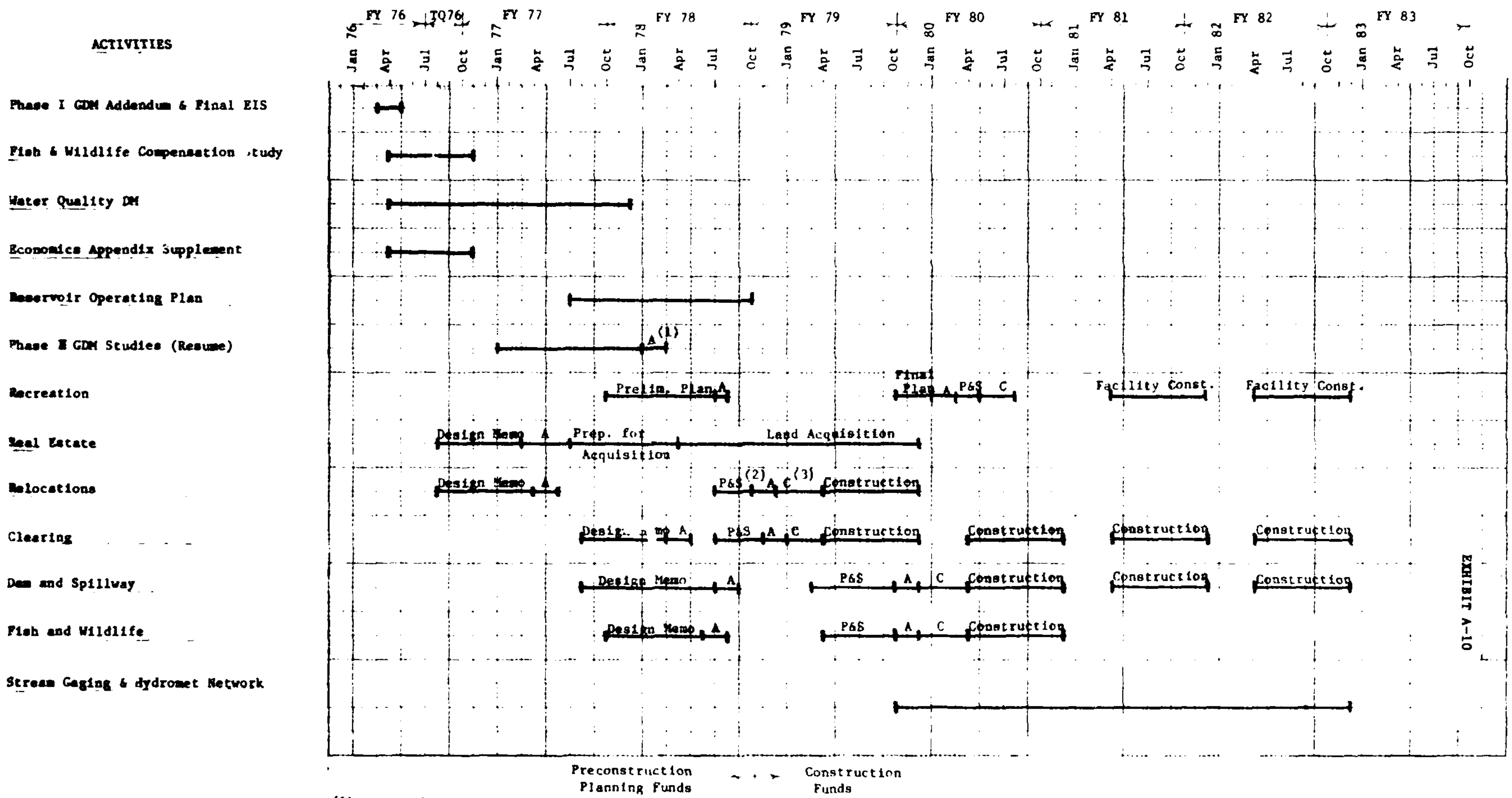
5. Our staff has reviewed the Thermal Routing and Ecological Models proposed for use in predicting the water quality of the reservoir and finds them acceptable.

If any of the above responses fail to adequately answer your questions or if you have any additional questions, please do not hesitate to contact us for further information.

Sincerely,

Peter L. Gove
Executive Director

SCHEDULE OF ACTIVITIES THROUGH CONSTRUCTION -
TWIN VALLEY LAKE PROJECT, WILD RICE RIVER, MINNESOTA



(1) Approval
(2) Plans & Specs
(3) Advertise & Award Contract

FINAL

ENVIRONMENTAL IMPACT STATEMENT

TWIN VALLEY LAKE

WILD RICE RIVER, MINNESOTA

U.S. ARMY ENGINEER DISTRICT, ST. PAUL
St. Paul, Minnesota
February 1975

SUMMARY

TWIN VALLEY LAKE

WILD RICE RIVER, MINNESOTA

( ) Draft Environmental Statement (X) Final Environmental 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. Description of Action: The project would include a rolled earth-fill dam across the Wild Rice River upstream from Twin Valley, Minnesota. A recreation and silt storage pool of 7,500 acre-feet would be created. An additional 44,700 acre-feet would be allocated for flood storage capacity.

3. a. Environmental Impacts: Flood control storage would result in a 66 percent reduction of agricultural, urban and rural flood damages in the Wild Rice River Basin. Recreational benefits are expected due to the 7,500-acre-foot pool being reserved for recreation, as well as for conservation and silt retention.

b. Adverse Environmental Effects: The project would modify or destroy existing ecosystems of floodplain forest, agricultural land, and stream bed. Reduction and changes in habitat and disruption of ecological balances would affect vegetation and wildlife well beyond the limits of the design flood pool. Recreational enjoyment of upland hunting and river canoeing would be adversely affected.

4. Alternatives to the Proposed Action: The nonstructural alternatives to the proposed action include: no action; flood warning and emergency protection; permanent floodplain evacuation; flood proofing; flood insurance; floodplain regulation; and a combination of permanent floodplain evacuation, flood proofing and floodplain regulations. Structural alternatives include: channel modifications on the Wild Rice River; channel modifications on the Marsh River; levee-floodway system; 18-mile diversion channel; Twin Valley Lake; a series of eight small tributary reservoirs; Twin Valley Lake plus eight small tributary reservoirs; Twin Valley Lake plus channel modifications; and Twin Valley "dry" dam.

5. <u>Comments Requested</u>: For a list of those Federal, State and local agencies, citizen groups, and individuals from whom comments have been requested, refer to page 98.

6. DRAFT STATEMENT NOTED IN FEDERAL REGISTER: 9 January 1975.

FINAL STATEMENT TO CEQ:

FINAL

ENVIRONMENTAL STATEMENT

TWIN VALLEY LAKE

WILD RICE RIVER, MINNESOTA

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FINAL

ENVIRONMENTAL STATEMENT
TWIN VALLEY LAKE
WILD RICE RIVER, MINNESOTA

1. PROJECT DESCRIPTION

1.01 The proposed project provides for construction of an earthen dam and associated features on the Wild Rice River near Twin Valley, Minnesota (figure 1). The dam could be located at either the damsite as described in the authorizing document (House Document No. 366, 90th Congress, 2nd session) or at an alternate damsite located about one mile upstream of the authorized site. The location of the damsite for the proposed project as discussed in this environmental impact statement (EIS) is at the alternate site. However, since the economic, social, and environmental impacts resulting from implementation of the proposed project at either site are similar, the information presented in this EIS is also applicable to the project at the authorized site except that some specific degrees of impacts and effects would be slightly different. These differences are described in the phase I general design memorandum and noted under plan 11 in the Alternatives section of this EIS.

1.02 The proposed project at the alternate site provides for construction of an earthen dam, low flow outlet works, emergency spillway, road relocations, and overlook and recreation facilities. The current schedule has construction starting about 1980, and completion scheduled for about 1983.

Dam

1.03 The dam would be a rolled earth-fill structure 84 feet high with a crest length of 7,700 feet, including the spillway. The top of the dam elevation would be 1116.0.* The embankment would have a top width of 20 feet and side slopes of 1 vertical on 3 horizontal on the downstream face and 1 vertical on 4.5 horizontal on the upstream face. The embankment would include a central impervious core with random fill sections upstream and downstream. The upstream embankment slope would be riprapped down to about elevation 1059.0, 4 feet below the permanent pool surface, and the downstream slope would be seeded.

Spillway and Outlet Works

1.04 The low flow outlet works would consist of a gated circular conduit through the south abutment of the earthen embankment section. The conduit would be 11 feet in diameter and have an invert elevation of

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* All elevations are feet above mean sea level.

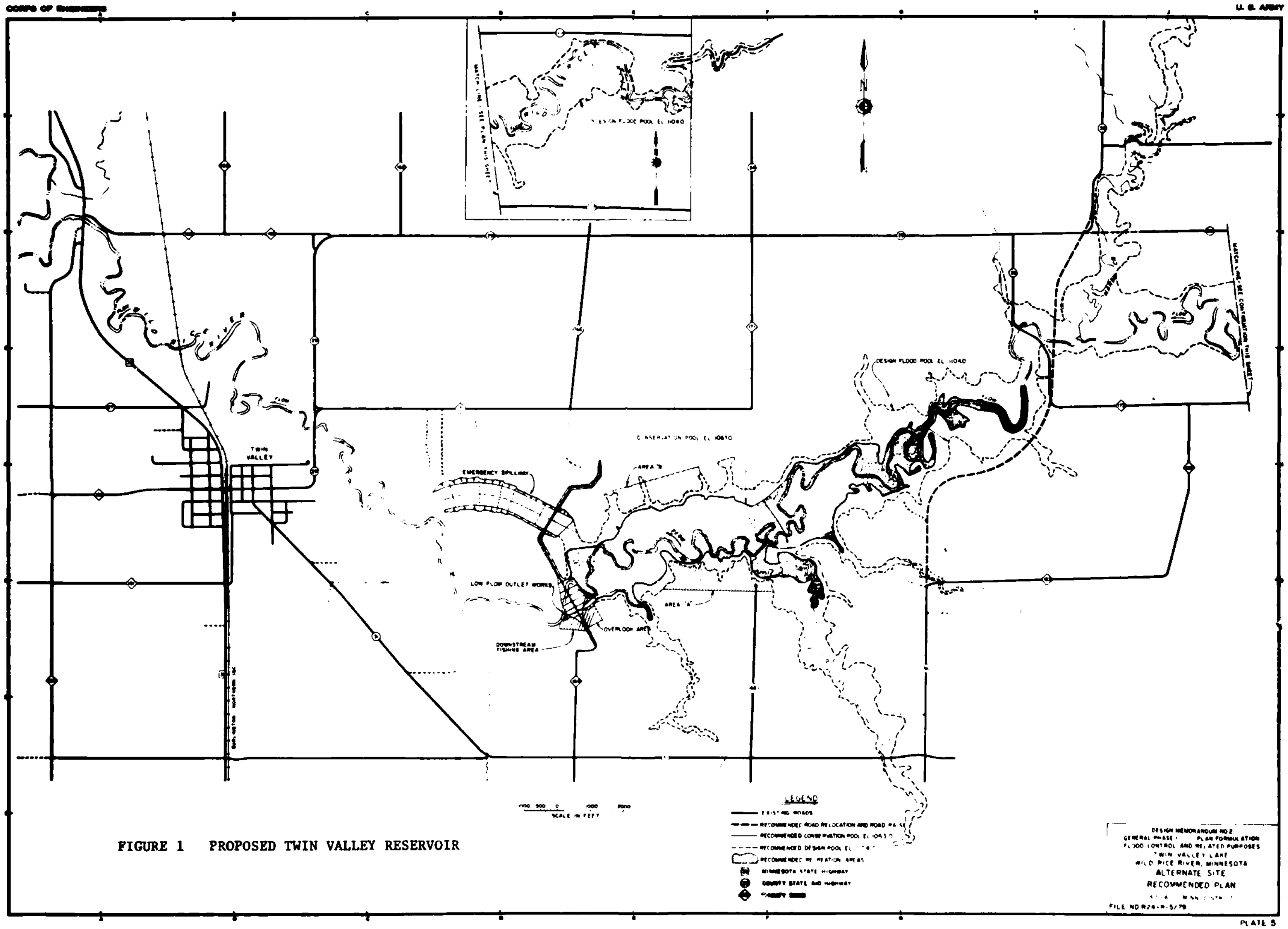

FIGURE 1 PROPOSED TWIN VALLEY RESERVOIR

1040.0. There would be a gated inlet tower at the upstream end of the conduit to control the discharges. The discharge capacity of the conduit at the conservation pool would be about 2,000 cubic feet per second (cfs), although only 1700 cfs of the planned capacity would be utilized. The low flow conduit would handle all discharges from the reservoir up to the design flood. When floods in excess of the design flood are experienced, the emergency spillway would be utilized to pass flows in excess of those being discharged through the low flow conduit.

1.05 The emergency spillway would consist of a fixed crest concrete spillway section with a grass-lined outlet channel. The spillway crest would be at elevation 1104.0 and would be 680 feet long. The outlet channel would have a slope of about 2.5 percent and a length of about 2200 feet. For floods which would utilize the spillway outlet channel for long durations and have water flowing at high velocities, portions of the spillway outlet channel could erode. There would be sheet pile cutoffs placed along the outlet channel to check this erosion and keep it to a minimum. The factors influencing this potential erosion would be investigated in more detail during phase II general design memorandum studies.

Reservoir

1.06 The reservoir impounded by the dam would provide 52,200 acre-feet of controlled storage. Of this amount, 7,500 acre-feet below elevation 1063.0 would be reserved for recreation and sedimentation, and 44,700 acre-feet between elevation 1063.0 and 1104.0 would be reserved for flood control. Surcharge storage between elevations 1104.0 and 1111.0 would be used for passage of flood flows in excess of the project design flood. The permanent pool would provide storage for silt deposition over a 100-year period and a surface area of 540 acres for fish, wildlife, and recreation purposes. About 405 acres of woodland would be cleared in the permanent pool area which would include lands up to 3 feet vertically or 300 feet horizontally from the permanent pool edge, whichever is less.

Land Use

1.07 Total project lands would encompass about 3,500 acres of which currently about 2,800 acres have native vegetation and about 700 acres of which are agricultural. Of this total amount, about 110 acres would be utilized for project structures, about 100 acres would be utilized for recreation and fishing access development, about 540 acres would be water surface area, and about 2,750 acres would be available for wildlife management or other suitable and compatible uses as appropriate, possibly including grazing or agriculture. The Minnesota Department of Natural Resources has expressed an interest in managing these potential wildlife management lands. A land use plan would be developed by the Corps of Engineers in conjunction with preparation of a master plan for resource management in later studies. The master plan would take into account any potential land use conflicts and would be developed to minimize any such conflicts to the maximum extent practicable.

Utilities

1.08 Construction of the dam and reservoir would require raising County Highways 29 and 36 at reservoir crossings to elevation 1109.0, 5 feet above the reservoir design flood pool level. This raise would include probable construction of a bridge at the County Highway 36 river crossing. Also, rerouting of County Highway 36 for a total distance of 14,050 feet would be involved; however, only the 6,350-foot length of the proposed route between County Highway 173 and County Highway 39 would be chargeable to the project, as the remainder would be a highway improvement not necessitated by reservoir development. The design traffic capacity of the highway modifications would be for estimated traffic loadings 20 years into the future.

Recreation

1.09 To accommodate anticipated recreation visitation, public use facilities are planned at the dam and downstream and upstream of the dam. As an integral part of the project and at Federal expense, a downstream fishing access with a parking area would be provided just downstream of the dam and developed in conjunction with the downstream segment of the low flow outlet works. An overlook facility would be provided at the dam on the south abutment to facilitate sight-seeing activities associated with the dam and lake. Two recreation areas would be provided in conjunction with the lake. Development of these two areas would be contingent on non-Federal participation in sharing specific costs associated with these developments. One area would be located on each side of the lake, with the area on the south planned as a day-use area for activities such as swimming, picnicking, and boating. The area on the north would be planned as an overnight facility to accommodate activities such as camping. Both upstream areas would provide boat-launching ramps.

1.10 The two recreation areas located on the lake would be developed as recreation demand and desires of the non-Federal sponsor dictate. Sufficient initial basic facilities would be provided to accommodate present demand, and future expansion of facilities would be undertaken as necessary. Development of a 2-mile long recreation trail system downstream of the dam to reach the Highway 29 crossing would be a desirable adjunct to the project. This feature is justified and could be incorporated subject to the views of the non-Federal sponsors and other agencies responsible for review of project plans and features. Additional, more detailed information on recreation features and aspects of the project are discussed in appendix C, Recreation, of the phase I general design memorandum.

Fish and Wildlife

1.11 Fish and wildlife aspects of the project include the 540-acre reservoir-type lake which should provide a good fishery over the initial years of the project. The fishery would decline over the life of the project; however, with active fishery management and appropriate reservoir management, a good lake fishery could be maintained for a longer period. The Minnesota Department of Natural Resources would have primary responsibility for fishery management and has tentatively indicated limited interest in such an undertaking. The fishery downstream of the dam should be good in the area of turbulent water near the low flow outlet works. Fishing access and boat launching ramps would be included in the recreation plans to allow maximum utilization of the fishery resource.

1.12 Under the preliminary land use plans, all project lands would be used for project purposes which include fish and wildlife management. Those lands which are suitable would be available for wildlife management, contingent on the interests of the State of Minnesota. Heavy grazing would be prohibited on project lands unless such lands would be deemed of no value for project purposes. Elimination of heavy grazing would provide a better opportunity for wildlife to utilize project lands whether or not specific management measures would be undertaken. Light grazing is recognized as potentially beneficial to wildlife management and will be considered during phase II studies.

Operation and Maintenance

1.13 Operation and maintenance of the project would be a Federal responsibility, except for management and operation of recreation facilities and fish and wildlife features which would be a non-Federal responsibility. The project would be operated primarily for flood control, with the operating plan enhancing other reservoir uses insofar as practicable. The maximum controlled discharge of 1,700 cfs would be released from the dam for up to and including the design flood. The design flood would have a 1.9 percent chance frequency of recurrence (about once every 53 years) with a maximum inflow discharge of about 7,000 cfs and maximum outflow discharge of 1,700 cfs. For the design flood, the water level in the flood pool would reach an elevation of 1104.0, and floodwaters would be stored above the permanent pool level for a period of about 45 days. Inflowing floodwaters would be stored in the reservoir only when discharges were greater than 1,700 cfs. The permanent pool would tentatively be maintained at a constant level year-round to the maximum extent practicable, although this, and other aspects of the management plan, will be reviewed during further studies.

Summary and Economic Analysis

1.14 The project purposes include flood control, recreation, and fish and wildlife development. Water quality control and water supply are not included as project purposes. The project would reduce flood damages along the Wild Rice River downstream of Twin Valley, along the Marsh River, and also along the Red River of the North downstream of the confluence of the Wild Rice River.

1.15 A summary of project benefits is contained in table 1. The estimated first cost of the project is $13,271,000, and the average annual cost is estimated at $911,500, which includes about $55,500 for annual operation and maintenance. The estimated non-Federal participation includes about $152,000 of the first cost and about $10,500 in annual operation and maintenance costs.

Table 1 - Project Benefits[(1)]

Type of Benefit	Average Annual Amount ($)	
Flood Control		
Urban		391,600
Wild Rice River Basin	211,500	
Red River of the North	180,000	
Agricultural		522,700
Wild Rice River Basin	471,800	
Red River of the North	50,900	
Transportation		18,900
Total Flood Control		933,200
Recreation and Fish and Wildlife		99,200
Area Redevelopment		84,200
Total average annual benefits		1,116,600

(1) Based on January 1974 price levels, a 5 7/8 percent interest rate, and a 100-year period of analysis.

1.16 The benefit-cost ratio of the project is estimated at 1.23.

1.17 A thorough discussion of hydrology and hydraulic analysis for Twin Valley Lake is on file in the St. Paul District Office in Design Memorandum No. 1: Hydrology and Hydraulic Analysis. Further details on plan formulation are also on file in Design Memorandum No. 2: Phase I-General-Plan Formulation.

2. ENVIRONMENTAL SETTING WITHOUT THE PROJECT

Introduction

2.01 The watershed of the Wild Rice River (which also includes the South Branch Wild Rice River, Marsh River, and Felton Ditch) encompasses about 1,980 square miles in northwestern Minnesota (figure 2). Most of Norman and Mahnomen Counties and portions of Clearwater, Becker and Clay Counties are included. The community of Twin Valley, Minnesota, is just west of center in the basin while the proposed project site lies approximately in the center of the watershed. The environmental setting in the area and the impacts of project alternatives were studied by Hibbard (1973). Much of the following discussion includes his work.

2.02 The geology, topography, groundwater, soils, and hence the economic climate of the basin, have been heavily influenced by the legacy of past glaciers and glacial Lake Agassiz which covered much of the region during the Pleistocene Epoch.

Geology

2.03 Sims and Morey (1972) and Schwartz and Thiel (1963) are excellent references on the geology of the Wild Rice River Basin. Allison (1932) discusses the geology of northwestern Minnesota in detail. He states that prior to the invasion of the glaciers, the land consisted of a Precambrian crystalline rock surface mantled by a thick residue of weathered rock and scattered remnants of Cretaceous shales and sandstones. On this surface, the glaciers deposited 200 to 500 feet of glacial drift consisting of tills, outwash sands and gravels, lake clays and sandy shoreline deposits. The western or Red River lowland section of the watershed lies within the basin of glacial Lake Agassiz. The huge glacial lake was formed as a result of meltwater ponding behind the glacier front which blocked the northern outlet to Hudson Bay during the last ice age. The lake at one time covered approximately 110,000 square miles. Sediments of clay and silt from rivers emptying into Lake Agassiz were deposited to depths of 20 to 1,000 feet (SRRRB, G-31, 1972). As the ice dam melted and the lake water receded, sandy shorelines were established at various levels around the lake. The shorelines are evident today as low, sandy ridges. The sequence of materials under the lake bed of the extreme western portion of the watershed is approximately 80 feet of lake silt and clay underlain by 200 to 250 feet of glacial till. These materials rest on a nearly continuous bed of Cretaceous sediments approximately 50 feet thick which is underlain by Precambrian crystalline rocks. The silts and clays thin eastward and end in the shoreline deposits which form a band 3 to 8 miles wide, 20 to 30 miles east of the Red River of the North. Throughout the rest of the area, glacial deposits consisting primarily of till, 250 to 500 feet thick, underlain by Precambrian crystalline rock, comprise the geologic column. Deposits are high in lime and most contain sufficient minerals needed for plant growth (WRCC, 1969). The till is an unsorted mixture of silt and clay with lesser amounts of sand, gravel and boulders. Lenses and beds of sand and gravel ranging from a few inches to several feet in thickness occur in many places throughout the till.

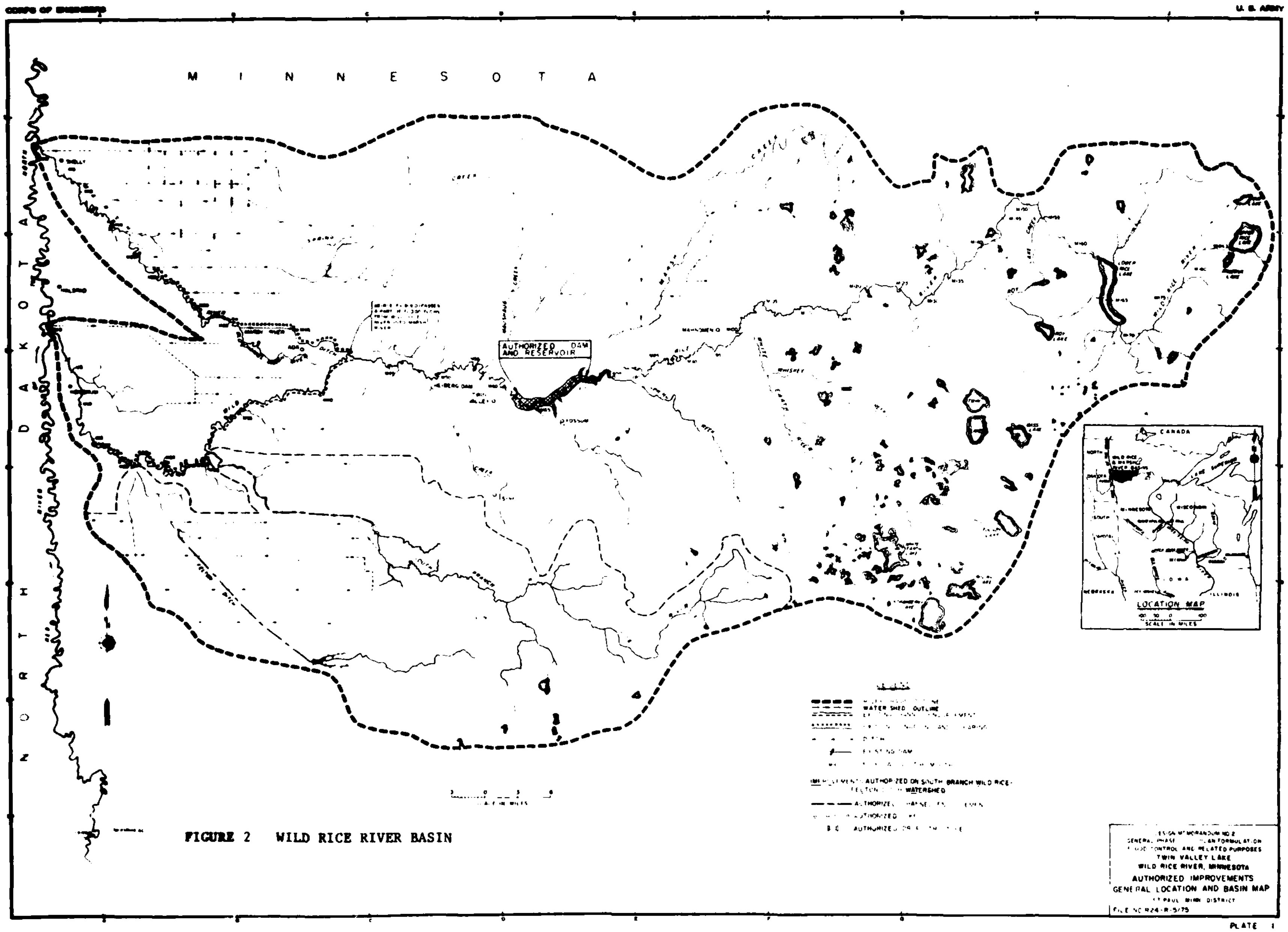

FIGURE 2 WILD RICE RIVER BASIN

2.05 The area is structurally stable and without tectonic disturbances of regional or local magnitude. The Seismic Risk Map developed by St. Algermissen (U.S. Coast and Geodetic Surveys, 1969) shows the area to lie in zone I or a non-critical area that could expect only minor damage from any probable earthquake. Local sloughing of banks along the larger rivers in the Red River lowland is common, but mass movement is not a prominent feature east of the Lake Agassiz Basin.

2.06 Economic mineral deposits in the Wild Rice River watershed are restricted to deposits of sand and gravel located in the shoreline area of the Red River lowland and in the glacial moraine area. These deposits are most abundant in the shoreline area where they occur between elevations 975 and 1050 feet. Potential mineral resources under the project site are suggested by a pronounced northeast-trending aeromagnetic anomaly that traverses the region just east of Twin Valley. Also, the State geological map (Sims, 1970) shows the presence of undivided metavolcanic rocks including, perhaps, iron-formations and greenstones, host rocks for metallic deposits elsewhere in Minnesota. Although economic deposits may be present, there is some question whether they would be developed since mining regulations may not allow mining in the narrow valley itself and since the competing agricultural use of surrounding lands is quite intensive. However, this matter will be further investigated during future studies.

2.07 Natural problems relating to the geology of the watershed are nonexistent. The potential for geologic related problems caused by the works of man does, however, exist. The thick deposits of silts and soft clays present throughout the Red River lowland are notoriously unstable in excavations or as foundations for earth fills, bridges or large structures. The possibility of contaminating surface or groundwater should always be considered in the locating of disposal sites for liquid or solid wastes.

2.08 The entire watershed area is composed of geologic features that could be considered unique on a continental scale. On the basin scale, however, there are major land forms for which the term geologic feature is misleading. Although it is possible that some persons or groups may consider a particular exposure or glacial deposit unusual or rare, no feature in the basin is known to be generally accepted as unique.

Topography

2.09 The continental glacier which covered the entire Red River of the North Basin eroded the rough topography, thus producing the rolling surface now characteristic of portions of the basin (SRRRB, G-31, 1972).

2.10 Three distinct regional landforms characterize the watershed areas (figure 3). These features were formed during the Pleistocene epoch and have remained essentially unaltered by erosion since the glaciers

MAJOR PHYSIOGRAPHIC AREAS

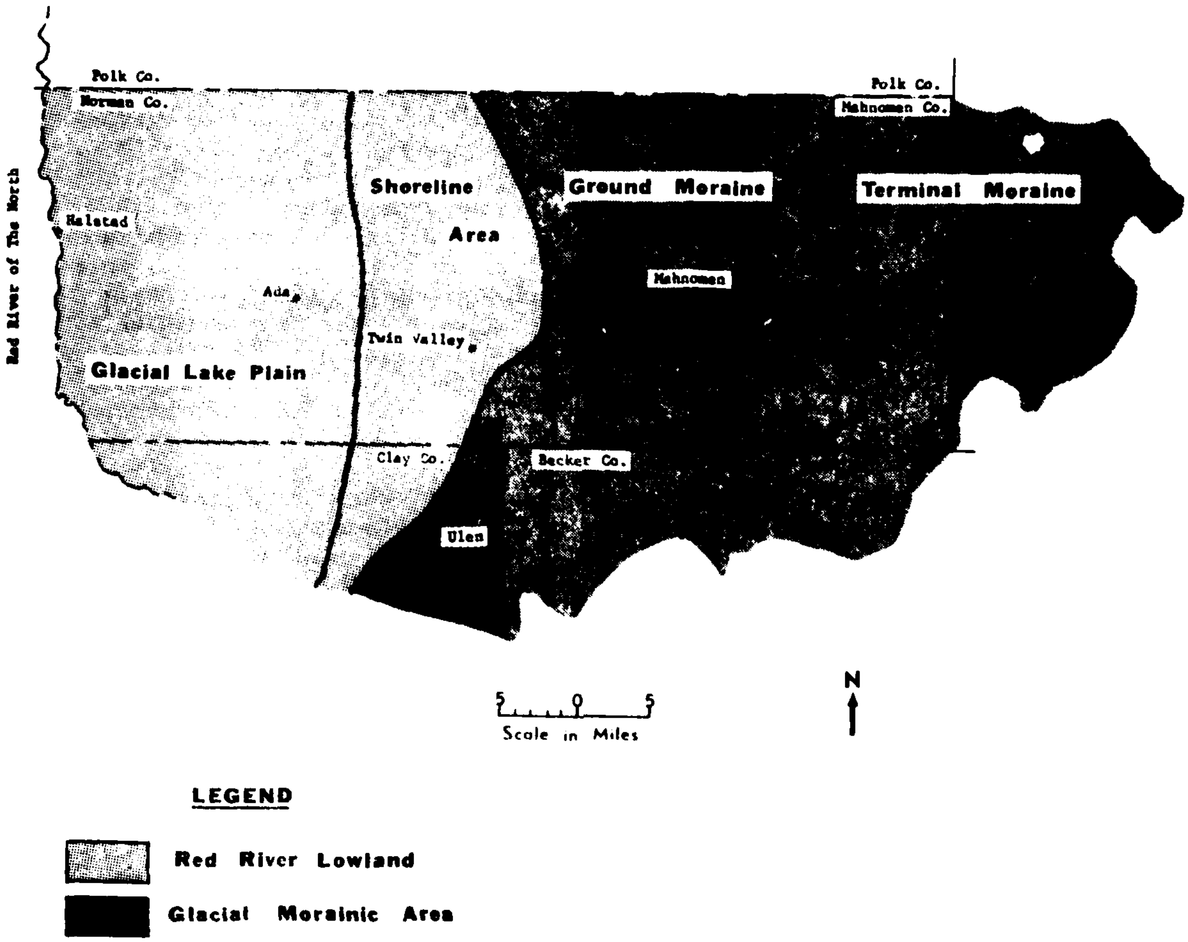

FIGURE 3

retreated from the area. The western one-half of the area lies in the Red River lowland which was the basin of glacial Lake Agassiz. The lake basin is represented in the watershed by a broad, featureless plain to the west bordered on the east by a sloping shoreline area marked by occasional low sand and gravel beach ridges (WRRC, 1969). A glacial moraine area borders the Red River lowland on the east. The moraine area has a nearly level to hummocky, poorly drained surface at an average elevation of 1200 feet. Local relief in the area averages less than 20 feet although the river is incised below the plane surface.

2.11 The eastern third of the watershed consists of terminal moraine material approximately 20 miles in width. The headwaters of the Wild Rice River, Lower and Upper Rice Lakes, are located in this region.

Soils

2.12 Some of the more common area soils include members of the Fargo, Bearden, Ulen, and Barnes soil groups. These are the soil divisions which are of prime importance to the agriculturally oriented Wild Rice River Basin (Soil Survey, 1939).

2.13 The Fargo group is composed of soils of a clay nature. Fargo clay and Fargo silty clay loam are two of the most extensive soils of the basin. Both soils are dark gray to black and occupy great expanses of land that was originally prairie. Both types retain moisture resulting in a sticky, slow drying soil. A number of legal drains in the area has resulted in a more efficiently drained landscape, thus benefiting agriculture on these soil types. The members of the Fargo soil group are intensively cultivated in the Wild Rice River Basin and are generally very productive.

2.14 Members of the Bearden soil group are generally dark gray to black and range from 8 inches to 2 feet in thickness. Bearden loam and silt loam are easily tillable under a wide range of conditions and are usually adequately drained. The ditching (figure 2) which is common throughout the Agassiz lake bed region has improved drainage for this soil type in marginal areas. Members of the Bearden group are generally silt loam, rich in lime, provide a good seed bed, and do not clod. As is the case with the Fargo soils, the Bearden members are intensively cultivated.

2.15 Ulen loamy sand is dark gray to black soil with a consistency which grades into light brown or yellowish brown sand. Sandy loam is generally very dark gray and ranges from loamy sand to silt loam. These two soils comprise the less common Ulen group. Both soil types have a low moisture holding capacity and dry rapidly. Wind erosion, where these soils are cultivated, can be of considerable concern after fall plowing.

2.16 The final major soil group in this area is the Barnes group. Barnes loam and Barnes silt loam are not common in the area. Both soils are very dark grayish brown to black. The loam fraction of this division is more common than the silt loam and tends to compact in the virgin condition.

Characteristics common to the members of this division include a high lime content, rapid drying, and adequate surface drainage. Cultivation of both soil types is intensive.

Climate

2.17 Weather Bureau observations are made at three sites within the basin: Ada, Mahnomen and Twin Valley. Precipitation and temperature records are available from the Ada area for as far back as 1892, with exceptions.

2.18 The climate of the region combines typical features of the continental climate of the central United States. It is characterized by long winters and relatively hot summers. About 78 percent of the annual precipitation occurs during the growing season from April through September.

2.19 Temperature extremes in Norman County range from a low of -53°F at Ada on 15 February 1936 to 111°F at Ada on 6 July 1936, resulting in a temperature range of 164°F. January is normally the coldest month with an average temperature of 7°F while July is normally the warmest month recording an average temperature of 71°F. The average annual temperature for the basin is about 41°F.

2.20 The snowfall during the winter totals about 31 inches on the average. Nearly every winter has one to four severe blizzards, in which the snowfall is accompanied by strong winds and often by very low temperatures. Much of the snow does drift due to the exposed nature of the flat and open country, and some of the snow settles in ditches, other low places, or wooded areas. The spring break of the cold period commonly occurs during the latter half of March or the beginning of April. The snow cover melts rapidly and the land thaws and dries sufficiently to allow the beginning of agricultural operations as early as the middle or latter part of April. However, ground frost may be encountered at considerable depth in some places as late as the end of May.

2.21 Because of their undulating or rolling relief, which provides for runoff of the spring rains, the fields in the open part of the upland section dry considerably faster than those in the lake bottom plain. Generally, the soils of this section are ready for spring field work and are sufficiently warmed for germination of seed earlier than the soils of the plain. The spring runoff from the flats in the lake bottom section is slow. The deep drainage ditches are often filled with ice and snow which does not thaw in time to render the ditches most serviceable. This results in a slow opening of the ditches which delays the runoff and causes the submergence of large areas of land, sometimes for several weeks.

2.22 The last killing spring frost generally occurs during the latter part of May throughout most of the area. However, the last frost may occur during the early part of June. The earliest autumn frost generally comes in the latter part of September. The length of the frost-free season in the basin has ranged from 110 to 143 days.

2.23 The average annual number of sunny days is about 90. Approximately 110 days are recorded as partly cloudy, and about 165 days are usually cloudy every year. Measurable precipitation occurs approximately 100 days per year.

2.24 The mean annual rainfall is about 20 inches for the area. About 16 inches fall during the months from April to September. More than 9 inches of rain occurs from May to July, while the winter months, December, January, and February, total less than 2 inches of precipitation.

2.25 The data for the driest and the wettest years show great variations, although the deviation from the normal rainfall is not so extreme as to be completely unfavorable for agriculture. The recorded maximum precipitation of 33.39 inches occurred in 1941, and the recorded minimum precipitation of 10.07 inches occurred in 1910 at Ada, Minnesota.

2.26 Crop injury from excess moisture is more common in the western part of the area adjoining the Red River. This can be attributed to the heavy texture of the surface and subsurface soils as well as the flat relief of the country. This results in reduced drainage activity both on the surface and through the soil. Crop injury by drought more frequently occurs on the sandy soils which occupy the central and eastern parts of the lake bottom plain.

2.27 Both the lake bottom and the upland sections have practically the same amount of precipitation per unit of surface. However, due to the difference in relief, the soils of the lake bottom section are able to retain a far greater proportion of the rain water than are the soils of the upland region. Thus, during dry summer years, the soils of the plain more greatly benefit from the precipitation. These soils are not as susceptible to erosion as the slopes of the rolling country, whose uplands are marked by many "baldplates" resulting from the wasting away of the dark colored surface soils and the exposure of the light colored subsoils.

2.28 The flat prairie land of the Red River Valley is exposed to all wind movements, and, although the wind velocity usually is not excessive, strong winds may occur in all seasons. Two especially windy periods usually occur during the year, each of about 1 or 2 weeks duration, one in late spring, usually in the second half of May, and the other in the fall, usually in October.

Groundwater

2.29 The primary sources of groundwater in the Wild Rice River Basin are the glacial drift aquifers. Several aquifers with moderate to large potential are known, but the majority are smaller, yielding localized deposits. The shallowest and most prolific aquifers are the beach and shoreline deposits of glacial Lake Agassiz and the river channel deposits (SRRRB, G-35, 1972). Other bodies of buried sand and gravel yield moderate amounts. Except in the extreme western part of the basin, water for domestic and farm supplies can usually be obtained from wells less than 150 feet deep (USGS, 1970).

2.30 Water resources are richer on the Minnesota side of the Red River than on the Dakota side. Streamflows are greater and more dependable and, in general, surface and groundwater is lower in total dissolved solids (SRRRB, 1972).

2.31 The basin may be separated into two general areas with respect to groundwater movement. The eastern half of the basin is a groundwater recharge area. Due to the poor drainage of this area, precipitation collects in low areas where some of it seeps to the subsurface. Groundwater movement is generally down and westward. The western half of the basin is a groundwater discharge area. Groundwater movement in this area is upward. This phenomenon accounts for a zone trending northward through the western area in which flowing wells may be developed.

2.32 The groundwater may be classified by quality into four major groups: calcium magnesium bicarbonate, calcium magnesium sulfate, sodium bicarbonate, and sodium chloride. The calcium magnesium bicarbonate and calcium magnesium sulfate waters occur in the eastern, or recharge, area and at shallow depths in the western area. The sodium bicarbonate water occurs in the western, or discharge, area. The sodium chloride water is found in the extreme western edge of the basin where it occurs in the Cretaceous sediments and adjacent glacial drift. Water in the recharge area contains 300 to 500 milligrams per liter (mg/l) dissolved solids. The dissolved solids in the discharge area range from 500 to 1200 mg/l. The presently applicable water quality standards, the 1962 U.S. Public Health Service standards for groundwater to be used for domestic consumption, allow no more than 500 mg/l total dissolved solids.

2.33 Groundwater contribution to streamflow is most significant from the outwash sand and gravel of the moraine area and the beach ridges and sand hills in the shoreline area of the Red River lowland. Little or no contribution to streamflow is made in the glacial lake plain.

Flood History

2.34 The major area of flooding is the Red River lowland. As the Wild Rice River and other streams emerge from the glacial lake beach ridges, stream slopes become more mild and channel capacities are exceeded, causing flows to escape the channel and move overland. The typical flood season in the watershed extends from April through June; however, mid-summer flooding due to heavy rains is not uncommon. Widespread and damaging floods have been noted since 1882. Particularly damaging floods have taken place in April and May of 1950, 1965, and 1969. At the present, seven major floods are on record. More than half of the flood damage is agricultural while additional damage occurs in the urban areas and at bridge crossings, etc. The maximum flood of record (July 1909) inundated the entire community of Ada as well as nearly 100,000 acres of cropland.

2.35 In 1965, several inches of rainfall along with the snowmelt produced wide-spread damaging floods. About 42,000 acres of land along the Wild Rice and Marsh Rivers and several thousand acres along the South Branch Wild Rice and Felton Ditch were inundated. The most recent flood to cause considerable damage to the area's economy was in 1969.

Flood Damage

2.36 Recurrent flooding causes serious damage along the Wild Rice and Marsh Rivers from the point of diversion of the Marsh River ditch (figure 2) downstream to near Hendrum and Shelly, Minnesota. High flows on these streams also aggravate downstream flooding on the Red River of the North. Under present conditions, Wild Rice and Marsh River flows in excess of bankfull capacity cause damages to agricultural, residential, commercial and publicly-owned properties. Damages to commercial establishments include damages to stock, equipment, buildings, land and private roads and losses of wages and business profits. Residential flood damages consist of physical damages to dwellings and personal property. Public properties that sustain damages are highways, streets, bridges, parks, sewers, schools and water supply systems. Highway and bridge damage in the area is relatively small due to the flat gradient of the channels and the low stream velocities.

2.37 The extent of agricultural losses resulting from a particular flood is dependent upon the season of its occurrence and on the amount and timing of precipitation following the flood. A spring flood immediately preceding or occurring during the soil preparation and planting period could result in reduced yields and poor crop quality on acreages which could still be planted following subsidence of the flood. A summer flood could destroy a large percentage of the growing crop, and a flood occurring during harvest season could destroy the unharvested portion of the crop. Other agricultural damages include damages to farmsteads, barns, stored crops, machinery, and fences.

2.38 The standard project flood for the Wild Rice River would inundate the entire city of Ada and flood a rural area of about 170,000 acres. About 660 homes, 115 businesses, 7 churches, and 2 schools would sustain flood damages.

Regional Economics

2.39 The Upper Midwest is geographically coincident with the Ninth Federal Reserve District and includes Minnesota, North Dakota, South Dakota, Montana, Northwestern Wisconsin and Upper Michigan. This region has been the subject of intensive economic analysis begun in 1960 and conducted jointly by the University of Minnesota and the Upper Midwest Research and Development Council. Since 1960 many technical papers and reports have been published by the Upper Midwest Economics Study and have been summarized in published form (Henderson and Krueger, 1965). Some of the important findings and conclusions are as follows:

a. The Upper Midwest economy developed initially because of the abundance of the region's natural resources, i.e., agriculturally productive land, minerals and timber. From this base, support activities such as railroads, the processing of natural resources, construction and services contributed to the expanding economy. Today, the dependence upon natural resources is declining in importance, but the region as a whole still relies upon them and has specialized in activities relating to them.

b. There is a distinct difference in the economy of urban and rural areas in the region. Urban areas have more rapid employment growth, population increases, and more economic and employment specialities.

c. While the Upper Midwest is undergoing an economic transition with increased diversification and less reliance on natural resources, many of the people employed in agriculture and similar occupations are being displaced by technological changes and a declining demand for natural resources. The greatest problem and challenge in the immediate future will be the provision of employment opportunities in new fields.

d. The labor force may grow more rapidly than the total population in the next ten years and this expanding labor force will be required to have more education, more skills and more specialized knowledge than job seekers of the previous decade.

e. In summation, the Upper Midwest is in transition, becoming more urban, more diversified in its economic base with greater numbers of the population entering a labor market which will demand greater skills and increased specialization in education. Trends indicate that the region will become more like the nation as a whole in terms of its economy, urban-rural balance and dependence upon natural resources.

Watershed Economics

2.40 Norman County is used to describe the social and economic environment of the project area because it is typical of the problem areas in the watersheds. Clay County census data is influenced by the large Fargo-Moorhead urban area whereas Norman County is rural with no population centers in excess of 2,500 people. Becker County is situated in the morainic hills region of western Minnesota, is not in the bed of glacial Lake Agassiz, and is not considered representative of the agricultural economy of the Lake Agassiz area, nor does it have the sheet water flooding problem characteristic of the lake bed area.

2.41 Ada, with a 1970 population of 2,076 people, is the county seat of Norman County, population 10,008 (1970 census). Some nine trade nodes have been classified within Norman County ranging from a partial shopping center to a hamlet to serve local trade needs. The entire county is located within the Fargo-Moorhead trade area with Fargo-Moorhead being about 45 miles southwest of Ada. Farming is the primary economic activity in the county, followed by retail trade which supports the agricultural base.

2.42 Agriculture, the primary industry in Norman County, accounted for the use of over 93 percent of all land in 1969. Farm production in Norman County is summarized in table 2 in terms of the value of agricultural products sold. The value of agricultural products sold in the county has risen at a steady rate to an 89 percent increase between 1949 and 1969. The value of crops produced has increased at a faster rate than that of other products sold. A gain of 135 percent between 1949 and 1969 has been recorded. Livestock and dairy products have also increased substantially, 64 and 62 percent, respectively, during the period 1949 to 1969 while poultry declined by 86 percent during the same period. Table 3 provides Norman County data on crops grown, and production and value of each crop. Wheat, oats and barley are the principal crops both in average production and in value, accounting for about 70 percent of each. Hay, sugar beets and soybeans accounted for about 22 percent of the crop sales in 1969. During the same period, government farm programs were active on 717 commercial class farms which resulted in payments of $1,787,744 to the farmers.

2.43 The national trend toward larger farms is evident in Norman County where the average farm size changed from 287 acres in 1959 to 496 acres in 1969, an increase of 73 percent. During the same period the number of farms decreased by 43 percent (table 4). Consolidation of farms into large units is indicated by the increase in the number of farms with 500 or more acres. Farms over 1,000 acres in size have increased by 256 percent between 1959 and 1969. This trend is doubtless continuing at the present time due to economies of scale.

2.44 Table 5 provides information on the trends in agricultural land values for the period 1954 to 1969. Agricultural land values in Norman County have shown a steady increase throughout the period. The increase in farmland values is partially accounted for by the bidding up of prices by farmers seeking more economically efficient farm units.

2.45 Table 6 provides past population trends for Norman County during the period 1940 to 1970. A steady decline in total county population has occurred during the period. Most of the villages and unincorporated townships have undergone a general downward trend in population. Ada,

Table 2 - Trends in agricultural sales - Norman County, Minnesota - Value of agricultural products sold (in dollars).

	Norman County					Percent change 1949-1969
	1949	1954	1959	1964	1969	Norman County
All Products	$ 10,079,940	$ 10,380,217	$ 12,787,445	$ 14,661,029	$ 19,118,816	89%
Average/Farm	5,693	5,105	9,069	11,065	18,019	216
All Crops	5,612,149	6,572,434	8,055,133	8,604,515	13,204,648	135
Livestock (excluding poultry & dairy)	2,397,506	1,734,562	2,873,430	4,113,470	3,931,152	64
Poultry	923,319	865,996	471,417	205,820	126,115	-86
Dairy Products	1,145,497	1,204,814	1,387,465	1,736,023	1,856,901	62

SOURCE: U.S. Bureau of the Census, Census of Agriculture, Statistics for the State and Counties, Minnesota, U.S. Government Printing Office, Washington, D.C., 1954, 1964 and 1969.

Table 3 - Crop production - Norman County, Minnesota

	Acres harvested	Percent of total acres	Total farm production	Farm value[a]	Percent of total dollars
Corn	15,700	4.1%	392,000 bu.	$ 403,760	2.6%
Wheat	75,500	19.9	3,151,700 bu.	4,223,278	27.2
Oats	105,700	27.8	6,342,000 bu.	3,488,100	22.4
Barley	76,300	20.1	3,815,000 bu.	3,128,300	20.2
Flax	6,400	1.7	64,000 bu.	182,400	1.2
Soybeans	20,800	5.5	353,600 bu.	866,320	5.6
All Hay	38,900	10.3	69,900 tons	1,363,050	8.8
Alfalfa	29,000	7.6	58,000 tons	159,500	1.0
Potatoes	2,700	0.7	337,500 cwt.	506,250	3.3
Sugar Beets	7,300	1.9	81,600 tons	1,183,200	7.6
Rye	1,500	0.4	33,000 bu.	30,360	0.2
TOTAL	379,300	100.0%		15,534,513	100.0%

SOURCE: Minnesota Agricultural Statistics, 1969, Crop and Livestock Reporting Service, U.S. Department of Agriculture, Minnesota Department of Agriculture, St. Paul, Minnesota, March 1969.

[a] Calculated from annual average price index.

Table 4 - Agricultural statistics - Norman County, Minnesota

	1950	1954	1959	1964	1969	Percent Change 1950-1969 Norman County
Number of Farms	1,862	1,711	1,469	1,325	1,061	-43
Acres in Farms	534,467	536,741	502,739	522,367	527,140	-1
Average Size of Farms	237	313	342	394	496	73
Number of Farms by Size						
Less than 10 acres	32	36	27	31	22	-31
10-49 acres	102	33	77	66	26	-74
50-99 acres	114	94	79	63	50	-56
100-259 acres	756	619	481	361	266	-63
260-499 acres	656	636	525	470	330	-49
500-999 acres	172	205	232	261	260	51
1,000 acres or more	30	38	48	73	107	256

SOURCE: U.S. Bureau of the Census, Census of Agriculture, Minnesota, U.S. Government Printing Office, Washington, D.C., 1952-1969.

Table 5 - Trends in agricultural land values, Norman County, Minnesota

	1954	1959	1964	1969
Dollars per acre, Norman County	$63.00	$93.00	$118.00	$161.00
Dollars per acre, Minnesota	105.00	154.00	166.00	225.00

SOURCE: U.S. Census of Agriculture, U.S. Department of Commerce, Bureau of the Census, 1964, U.S. Government Printing Office, Washington, D.C.

Table 6 - Past population trends - Norman County, Minnesota

	Percent change	1940	Percent change	1950	Percent change	1960	Percent change	1970
United States		132,165,000	7.2%	151,326,000	14.5%	179,323,000	19.0%	
Minnesota	11.5	2,792,300	8.9	2,982,482	6.8	3,413,864	14.5	3,804,971
Norman County	11.1	14,746	4.9	12,909	-12.5	11,253	-12.8	10,008
Ada	0.6	1,938	50.8	2,121	9.4	2,064	-2.7	2,076
Borup	-11.7	NA		NA		145	a	128
Gary	1.1	300	-2.6	278	-7.3	262	-5.8	265
Halstad	-6.4	570	6.5	635	11.4	634	0.6	598
Hendrum	2.0	341	4.6	352	3.2	305	-13.5	311
Perley	-9.7	246	6.5	204	-17.1	165	-19.1	149
Shelly	16.1	344	11.7	329	-4.4	310	-5.8	260
Twin Valley	3.2	844	28.5	899	6.5	841	-6.5	868
Rural Unincorporated	-17.9	10,163	-2.4	8,091	-20.4	6,522	-19.4	5,353

SOURCE: U.S. Bureau of the Census, U.S. Census of Population, Minnesota, Number of Inhabitants, U.S. Government Printing Office, Washington, D.C., 1920-1960.

NA - Not Applicable.

[a] - Cannot be calculated because of the incorporation of Borup in 1951.

Gary, Hendrum and Twin Valley are marginal exceptions. On the other hand, the State as a whole has experienced a steady increase in population. Clay County, which contains the city of Moorhead (part of the regional trade center of Fargo-Moorhead), has experienced a solid population increase while the population in the remainder of the economic area has remained the same or decreased.

2.46 Employment distribution by industrial groups is illustrated in table 7. Agriculture remains the dominant employment group, although it decreased significantly during the 1960 to 1970 period. Professional services, manufacturing, wholesale trade, transportation, communications and utilities have experienced growth during the 1960 to 1970 period. Agriculture, mining, construction, retail trade, business and repair services, and recreational services have declined during the same period.

Transportation

2.47 Norman County is situated approximately 255 miles northwest of the metropolitan Minneapolis-St. Paul area. The county is served by three north-south highways and two east-west highways. The major highway in Norman County is U.S. Highway 75 which roughly parallels the Red River through northwestern Minnesota. As Interstate 29 is developed in North Dakota, certain amounts of traffic from Highway 75 will undoubtedly be served by the Interstate, thus reducing the relative importance of Highway 75. Other north-south routes in the county are State Highways 9 and 32.

2.48 State Highway 9 travels through the center of the county in a north-south direction and serves no major communities south of Norman County, but it does serve the communities of Red Lake Falls and Thief River Falls to the north. East-west traffic through the county is handled primarily by State Highway 31. This highway runs from Mahnomen in the east through the community of Ada, on to Halstad, and then joins North Dakota State Highway 7 south which connects with U.S. 81 in Hillsborough, North Dakota. State Highway 113 in the east-southeastern portion of the county extends from Syre on State Highway 32 approximately 8 miles south of Twin Valley in an easterly direction through Waubon in Mahnomen County and terminates at U.S. Highway 7 on the south edge of Itasca State Park.

2.49 The Burlington Northern railroad maintains lines through the Wild Rice River watershed. Burlington Northern has three sets of tracks in the area: one follows the Red River of the North, handling mostly sugar beets from local stops at Perley, Hendrum, Halstad, and Shelly; another traverses through Ada and Borup; and the third line runs further to the east through Twin Valley and Gary. It should be noted that many of the older settlements in the county are located on the rail lines, with each settlement having had at one time use for the railroad passenger or cargo service.

Table 7 - Employment by industrial groups - Norman County, Minnesota

	1960	1970	Percent of total
Agriculture	1,864	1,136	35.6%
Mining	8	5	.2
Construction	174	169	5.3
Manufacturing	125	242	7.6
Transportation, Communications & Utilities	130	161	5.0
Retail Trade	444	385	7.3
Wholesale Trade	134	233	12.1
Finance, Insurance & Real Estate	80	95	3.0
Business & Repair Services	98	64	2.0
Personal Services	145	113	3.5
Recreational Services	7	0	0.0
Professional Services	315	429	13.4
Public Administration	116	132	4.2
Industry Not Reported	38	27	0.8
TOTAL	3,678	3,191	100.0%

SOURCE: U.S. Bureau of the Census, U.S. Census of Population, General Social and Economic Characteristics, Minnesota. U.S. Government Printing Office, Washington, D.C., 1952 and 1961.

2.50 At the present time, Norman County has two public airports located within its boundaries, one located at Ada and the other at Twin Valley. However, neither airport facility is used by passenger airlines. Both Norman County airports are classified as basic utility airports that can accommodate 95 percent of the existing general aviation type planes. Anyone wishing airline passenger service would normally use the Fargo, North Dakota, airport which is located some 45 miles south of Ada.

2.51 Other than the air facilities at Fargo-Moorhead, only one other limited service airport exists at Dilworth, Minnesota.

2.52 Clay County is crossed by a major network of State and Interstate highways. The Fargo-Moorhead area is served by Interstate 94 and U.S. 29 which run in an approximate east-west direction across the county. State Highways 9 and 32 traverse the county in a north-south direction. These main throughfares are connected to an extensive system of county roads.

2.53 Rail facilities in Clay County are again provided by Burlington Northern. Two separate tracks enter Moorhead, one from Hawley and the second from Bonnesville. Other Burlington Northern lines run between Felton and Barnsville, and Ulen to Hawley.

Recreation

2.54 Recreation facilities in the area are generally quite limited. A 9-hole golf course of 63 acres exists near Ada. The city of Ada has three municipal parks with facilities for picnicking and swimming. Halstad has the 20-acre Halstad Riverside Municipal Park adjacent to the Red River of the North. Community parks also exist in most of the other small communities in the county. Wayside rest areas located along the major highways in Norman County account for 23 acres of passive recreational space. Federal and State wildlife refuges comprise the bulk of the recreational space in the county with 3,326 acres in public ownership (state wildlife management areas) and 1,303 acres in private ownership.

2.55 Local rod and gun clubs provide skeet and trap shooting opportunities to county residents. Some fishing opportunities for northern pike and walleye exist on the Red, Wild Rice and South Branch Wild Rice Rivers. Canoeing and swimming opportunities exist on the Red and Wild Rice Rivers, but overall recreational use is low due to insufficient summer flows in both rivers and inadequate access points which mainly consist of limited bridge crossings.

2.56 Norman County has no national forests, national wildlife refuges, State parks, or State forests. It also has no established horseback or snowmobile trails, or marinas. Buffalo River State Park and the Barnsville Wildlife Area are located in Clay County.

Scientific Areas

2.57 The Minnesota Chapter of the Nature Conservancy owns two natural areas in Norman County, Frenchman's Bluff and Agassiz Dunes Natural Area. Frenchman's Bluff is a 42-acre tract of shortgrass prairie on an elevated, gravelly moraine. It is dry grassland typical of the Great Plains much farther to the west. The tract is located about 5 miles southeast of Twin Valley. The Agassiz Dunes Natural Area is located about 2 miles southwest of Fertile, Minnesota. Within the boundaries of the tract lie sand dunes and blowouts of marked scenic beauty formed 4,000 to 9,000 years ago. The area lies on the prairie-forest border and possesses characteristics of both biomes. There are also three potential natural landmarks in the morainal uplands of the basin. One of these, Hellickson Prairie, located west of Ogema in Becker County, contains scattered prairie wetlands and unbroken prairie sod, one of the very few such sites left in Minnesota. The area is top quality waterfowl production habitat, and it is used by prairie chickens. Another significant area is the Waubun Prairie, located southwest of Waubun in Mahnomen County. It is a typical low wet prairie with highly productive prairie potholes utilized by a great diversity of waterfowl, and it is used as an ecological study area by students from the Itasca Biological Station. Marshall Bog, located west of Zerkel in Clearwater County, is a sphagnum bog with a small pond at the center, and it has also been heavily used for ecological studies.

Historical and Archaeological

2.58 The Minnesota Historical Society has indicated that there is one site having historical significance within the Wild Rice River Basin. The Faith Mill and Dam is on the Wild Rice River east of the village of Faith. This is the last of three such flour mills located in Norman County and is reported to be operational. The damsite is used by local residents for swimming and picnicking. A second site, the Heiberg Dam, has some local significance. It is on the Wild Rice River just downstream of Twin Valley. The dam would need to be restored, and the area around the site could be developed as a recreation area.

2.59 An archaeological survey conducted by the Office of the Minnesota State Archaeologist determined that there are no prehistoric sites within the project area. However, there are three prehistoric sites recorded within the Wild Rice River Basin. All three sites are outside the project area and should not be affected. However, care must be taken to avoid these and any unrecorded sites that might be on the gravel beach ridge (Campbell beach) when borrow areas are chosen. An archaeologist should be present when such borrow sites are chosen, as well as when new road routes are selected. Should the contractors uncover archaeological material during consturction, an archaeologist should be called in immediately since it is not always possible to locate deeply buried archaeological sites on survey.

2.60 The National Register of Historic Places has been consulted and no sites within the Wild Rice River Basin are on the Register.

Stream Resources

Physical Aspects

2.61 The Wild Rice River has its origin in the headwaters and tributaries of an area of about 1,980 square miles. Lakes, marshes, springs, and ditches all contribute their runoff from adjacent woodlands, grassland, croplands, and marshes. As the main channel flows westward, a rather significant gradient is maintained as it courses through glacial moraines and beach ridges of glacial Lake Agassiz, until it reaches the former lake bottom, the Red River Valley. At this point the current drops and the stream becomes comparatively sluggish.

2.62 The site of the proposed Twin Valley Lake is located in the upland plain of glacial till east of the beach ridges. In this area the stream is rather swift and aggressive. The degree of meandering is indicated by the ratio of stream distance to straight-line distance, which is 2.36 to 1 in the river reach proposed as the reservoir site.

2.63 Leopold and Langbein (1966) assess the meandering configuration to be a result of a certain conservation of energy in the overall flow. In the Wild Rice River, the gradient, meanders, and substrate have interacted to form a stream with the conventional pattern of alternating riffles and pools. The pools were divisible into two subcategories: deep pools (pools) and shallow pools (sand flats). This classification seems to be descriptive of the physical divisions of this stream.

2.64 Rapids, or riffles, generally exist as short segments of 20 yards or less; however, a few extend for at least 100 yards. Water depth is shallow (less than 1-1/2 feet deep). Associated with the riffles are boulders, cobbles, and, to a much lesser extent, pebbles and gravel. Although the stream velocity decreases shoreward, mid-stream riffles are characterized by rather high velocities of 1.5 to 4.0 feet per second. During the year these velocities fluctuate considerably with the water levels.

2.65 Pools represent the deeper, slower waters which generally have a soft substrate. They are commonly associated with the outer arc of a meander, a large boulder, a beaver dam or an obstacle anchored in the bank, such as a log or brush pile. As a result, they often occupy only a portion of the stream width. The current is generally slow (less that 0.8 feet/second), and the substrate is often composed of gravel, sand, or silt, generally in combination. Seldom does the depth reach 5 to 6 feet. The maximum depth is about 8 feet.

2.66 The shallow pools, or sand flats are stretches showing great uniformity in depth, substrate, and basic characteristics. These pools sometimes extend for hundreds of yards and seem to be associated with the straighter portions of the river, thus agreeing with the hypothesis of Leopold and Langbein (1966). The substrate, composed principally of fine gravel and sand but sometimes dotted with boulders, is constantly shifting to produce a highly unstable habitat. Water depth and velocity are generally intermediate between rapids and deeper pools.

2.67 Table 8 presents an estimation of the composition of a representative river section in the proposed reservoir area according to the classification system of Cummins (1962). The acreages presented in table 8 are those which would be expected in the reservoir area and are based on a planimeter study of 60 acres of river bed.

Table 8 - Estimated bottom composition, Wild Rice River, Minnesota

		Bottom Composition					
	Size	Riffles, Rapids		Non-Riffles, Pools		Overall	
Item	(mm)	Acres	Percent	Acres	Percent	Acres	Percent
Boulder	(>256)	3.8	31	3.8	8	7.6	13
Cobble	(64-256)	6.0	50	7.2	15	13.2	22
Pebble	(16-64)	2.0	17	5.8	12	7.8	13
Gravel	(2-16)	0.2	2	14.4	30	14.6	24
Sand	(.13-2)	--	--	15.8	33	15.8	26
Mud-Silt	(<.13)	--	--	1.0	2	1.0	2
Total		12.0	100	48.0	100	60.0	100

2.68 Flows in the Wild Rice River at Twin Valley have not reached zero discharge during the period of record 1911-1962, although a one-day mean discharge of 1.1 cfs was reached in 1935. About 99 percent of the time the flow is above 3 cfs, about 98 percent of the time it is above 5 cfs, and about 83 percent of the time it is above 20 cfs. The 7-day low flow for the Wild Rice River at Twin Valley for a non-exceedance frequency of 10 percent is 5 cfs. The median flow for the same point on the stream is 60 cfs, and the average seasonal flows are as follows:

Season	Months	Average Flow (cfs)
Winter	Dec.-Feb.	47
Spring	Mar.-May	370
Summer	June-Aug.	195
Fall	Sept.-Nov.	60

Chemical Aspects

2.69 The Minnesota Pollution Control Agency (MPCA) has established a water quality monitoring station on the Wild Rice River at the U.S. Highway 75 Bridge near Hendrum, Minnesota. Data available from this source should generally reflect overall basin water quality since the monitoring station is near the confluence of the Wild Rice and Red River of the North. However, the drainage area above the sampling station has a relatively higher percentage of agricultural land use than the drainage area above Twin Valley. As a result, the MPCA station should reflect higher nutrient concentrations, and the MPCA data could be used as a "worst condition" to be expected for the Twin Valley Lake drainage area. Point sources of pollution in the basin have been identified in the Interim Water Quality Management Plan (anon., 1971). Table 9 is a list of the communities which in 1971 discharged sewage effluents into the Wild Rice or its tributaries. Other sources of pollutants are agricultural runoff and commercial establishments.

Table 9

Township and County	Population	Treatment	Receiving water
Waubon-Mahnomen	345	Secondary (Stabilization pond)	Spring Creek WRR
Ulen-Clay	486	"	SBWRR
Twin Valley-Norman	868	"	WRR
Mahnomen-Mahn	1,312	"	WRR
Felton-Clay	232	"	Felton D. WRR
Borup-Norman	128	"	Ditch SBWRR
Begou-Mahnomen	157	None	Marsh WRR
Gary-Norman	265	None	Ditch WRR
Ogema-Becker	236	None	Ditch WRR

2.70 Various water quality data are given in appendix A, tables A-1, A-2, and A-3. Coded locations are referenced in figures A-1 and A-2 of appendix A.

2.71 In summary, the temperatures of the Wild Rice River and its tributaries rather closely approximate those of the aerial environment. The shallowness of these waters, combined with the heat exchange that occurs in the rapids and riffles, probably account for this correlation.

2.72 Oxygen values are generally at saturation or slightly above, a condition that possibly reflects some supersaturation as a result of the photosynthetic release of oxygen by algae. It could also be due to the supersaturation created by the warming of oxygen-saturated water.

2.73 The stream water would be classified as hard, and it falls into the category established by Moyle (1956) for rivers characteristic of the northwestern Minnesota region. The alkalinity values agree favorably with those of Cvancara (1967) for streams in the vicinity, as well as the analysis (table A-3) made by the Minnesota Pollution Control Agency in sampling near the mouth of the river (Hendrum, Minnesota) from August 1971 to May 1972.

2.74 Phosphates and nitrates, two of the important nutrients to protoplasm in general, do not exist in unusual amounts. From the limited data available, phosphate concentrations would not be considered limiting to plant production and could probably support a large algal population in a more physically favorable environment, i.e., a reservoir. Nitrate concentrations, however, could be considered in limiting supply during the period sampled. MPCA samples, however, indicate higher nitrate concentrations during the spring and winter, periods of low biological activity. It is probable that in a reservoir these concentrations of nitrates could limit primary production for some period of time until biological nitrogen fixation, nitrification, and mineralization of accumulated organic matter could increase the levels of dissolved inorganic nitrogen in the water.

2.75 The sediment load, according to Hibbard (1973), seems to average in the slightly turbid category. The findings, cited above, of other workers seem to substantiate this characteristic.

2.76 The tributaries and headwaters were generally similar to the waters of the main channel. Some of the smaller, more sluggish creeks are higher in bicarbonates, which is partly due to a concentration effect caused by the low water and basic differences in solute load. The differences in phosphates can generally be explained by the concentrating action of low water and by the field and pasture runoff entering the river.

Biotic Communities and Species Diversity

2.77 Most of the river can readily be divided into two or three biotic community types, which are, in turn, reflections of the form of substrate and the velocity of water movement. Thus, the most natural categorization is into riffles and pools, the latter being divisible into two types, deep pools and shallow pools ("sand flats"). Appendix B lists the families of organisms in relation to stream velocity (table B-1), while tables B-2, B-3 and B-4 give the genera and species arranged according to sampling site (figures A-1 and A-2).

2.78 The most consistent and homogeneous community is that of the riffles and rapids. In each instance the larger rocks are festooned with several species of green algae (mainly *Cladophora*), some of which show a microscopic coating of diatoms (periphyton). Less frequently an aquatic moss is a primary producer. Utilizing these fixers of energy are the primary and secondary consumers, which include several genera of larvae of caddisflies, snipe flies, stone flies, mayflies, and midges. These immature insects are generally dependent physiologically and ecologically on well-aerated, fast-moving water.

2.79 The shallow, sandy pool "runs" or "flats" are almost devoid of producer forms except for several species of diatomaceous and green algae at the water-substrate interface. Fish populations are low. Low densities of several species of fingernail clams and mussels are characteristic.

2.80 The deeper pools or pockets as previously mentioned generally occur at the outer arc of the meanders or as a result of current deflection.

2.81 In deeper pools the bottom is occupied by a few algae, mostly diatoms, and several species of fingernail and unionid clams. In this habitat the thinner-shelled mussles make their appearance. Fish are commonly found to be inhabiting these pools.

2.82 Non-quantative plankton data from the Wild Rice River are presented in table 10. Producers include some green filamentous algae, desmids and diatoms, most of which are of the same genera as those which compose the periphyton on the green algae filaments characteristic of the riffles. Consumers include several species of testate amoeba and diatom-eating rotifers. Copepods are the largest in size of the consumers.

Table 10 - Analysis of plankton from site D, gaging station, Wild Rice River - 25 August 1972 (#25 net, 20 liters of water)

Item	
Algae	
Chlorophycease (Green Algae)	
<u>Pediastrum</u>	
<u>Oedogonium</u>	
Conjugateophyceae	
<u>Closterium</u>	
Bacillariophycease (Diatoms)	
<u>Diatoma</u>	
<u>Navicula</u>	
<u>Fragilaria</u>	
<u>Cocconeis</u>	
<u>Gomphonema</u>	
<u>Nitzchia</u>	
<u>Melosira</u>	
Protozoa	
<u>Difflugia</u>	
<u>Arcella</u>	
<u>Centrophyxis</u>	
Rotifera (Rotifers)	
<u>Cephalobdella</u>	
<u>Euchlanis</u>	
<u>Monostyla</u>	
Copepoda (Copepods)	

2.83 In the Wild Rice River and its tributaries, aquatic flowering plants are uncommon except in some small upstream tributaries where they occur irregularly. Algae, particularly the diatomaceous forms, are fairly well represented as to genera.

2.84 The animal populations are more diverse. Thirty-one species of fish were caught during one survey (Hibbard, 1973) although Tubb, Copes, and Johnston (1965) recorded 43 species for the neighboring Sheyenne River of North Dakota. Their value is probably fairly representative for the Red River and would naturally include large-river species. Hubbs and Lagler (1958) list about 55 species that occur in the Red River drainage and Underhill (1957), Nordlie, Underhill, and Eddy (1961), Eddy and Underhill (1959) record in the literature or by specimen, 25 species of native minnows (Cyprinidae) and six species of darters (Etheostrominae) in the Red River drainage. Hibbard (1973) recorded only three species of darters and 13 species of minnows. However, he collected (in class field trips) black bullhead, pumpkinseed, and brassy minnow from the pool below Heiberg Dam so it is possible that the downstream portions are richer faunistically and that the dam presents a barrier to dispersion. Also of interest is the observation that many of the fish below the Heiberg Dam were infected with a parasite (presumably a fluke) that produces a large flesh-colored swelling under the skin. Very few of these parasites were encountered in upstream areas.

2.85 Similarly the diversity of clam (Unionidae) species is representative of the area. Cvancara (1967) reported 11 species of mussels from the Wild Rice River. These were substantiated by Hibbard (1973). Transport of the clams in the drainage is accomplished through their larval stages which parasitize various species of fish. Specific fish hosts are, in many cases, unknown (Parmalee, 1967). Table 11 lists other bivalves common to the area.

Table 11 - Molluscan valves present in a raccoon food-pile on Wild Rice River

Item	Amount
Fusconaia flava	18 valves = 9 mussels
Lampsilis siliquoidea	48 valves = 24 mussels
Legumia recta	1 valves = .5 mussel
Lampsilis ventricosa	4 valves = 2 mussels
Strophitus rugosus	6 valves = 3 mussels
Lasmigona compressa	1 valves = .5 mussel

2.86 Certain species are much rarer than the habitat would suggest. For instance, very few leeches are present, a fact which perhaps attests to the relative scarcity of certain other organisms such as painted and snapping turtles. No carp were collected by Hibbard (1973).

2.87 Sites along the headwaters and tributaries of the Wild Rice River generally reflect the existing biota of the river proper. However, the current, degree of shading, adjacent land use, aquatic flora, and amount of siltation differ enormously and therefore create variations from site to site. For example, the White Earth River is a rapidly flowing stream, whereas Coon Creek and Whiskey Creek represent very minor and local drainages that are almost stagnant. Although a few species of pondweed occur in the main channel, aquatic plants seem to be more characteristic and dominant in some of tributary areas. Some species of fish, namely red belly dace, Johnny darter, brook stickleback and white sucker, common in certain upstream sites, are very rare in the main river. Certain clams, such as the cylindrical paper shell and the floater, show a similar propensity for the upstream portions. In general, the invertebrates, algae and aquatic flowering plants range in diversity and numbers from extremely dilute populations to very rich ones.

2.88 Northern pike was the only game fish species common to all sites. Generally, the number and size were small. Fishing at these sites occurs on a seasonal basis, if at all.

2.89 No rare or endangered species are evident in the area. Although Miller (1972) lists the trout-perch as an endangered species for North Dakota, the situation is not comparable in Minnesota waters where this fish is locally common. Concern is also appearing (Imlay, 1972) for the protection of mussels, but no detailed list is apparently available at the present.

2.90 By definition, productivity is the rate of fixation of energy as biomass. Since it is a rate, it must be studied over a sufficiently long interval to adequately minimize sampling variation and produce reliable values. Hynes (1972) and others have discussed the particular difficulties met in measuring the productivity of streams. Waters (1962) and others have successfully used stream drift as an index. Only the suggestion of production rate as indicated by standing crop can be attempted, and then only in the most gross manner, i.e., as the counts or organisms allow. In general the suggestion is that the productivity of the Wild Rice River proper is not high; at least that is the interpretation most warranted from the amount of biomass collected by Hibbard (1973). The most productive sites are the (1) rapids community composed principally of green algae, insect larvae, and several species of fish and (2) the detritus microcommunity inhabited by burrowing mayflies, sphaeriid clams, amnicolid snails, and chironomid larvae that depend heavily upon allochthonous material and associated bacteria as their energy sources.

2.91 In the absence of any direct study to elucidate the limiting factors operative in the river, only speculation can be given. It is believed that the main restriction on productivity is that imposed by the transient character of the stream bed and its preponderant sandy substrate. Evidence for this conclusion comes from the extreme paucity of organisms in the sandy stretches ("flats"). Luxuriant algae growths, in contrast, occur on the rocks in the riffles, and the pools contain much more biomass than the "flats". The quality of the water does not appear to be the main limitation of productivity, rather the mobility of the sand substrate is probably the major factor in the overall composition of the riverbed. In trout streams, Bell (1968, 1969), Needham (1938) and Smith and Moyle (1944) suggest that rubble, gravel, bedrock and sand are the most productive, in that order. Hynes (1972) says, "...it is possible to conclude that, in general, sand is the poorest habitat, that bedrock, gravel, and rubble on the one hand and clay and mud on the other, especially when mixed with sand, support increasing biomass."

Recreational Uses

2.92 At the present time the river serves only a token function as a fishery. Local residents do engage in some angling, particularly in the spring when there is increased water depth and "runs" of more desirable fish. Reports of good walleye and northern pike fishing in the pools of the Beaulieu area are not uncommon, and the lower part of the Wild Rice River near Hendrum and Highway 75 is a favorite locale for catching walleye and channel catfish, particularly in the fall. According to the townspeople, channel catfish do not frequent the upper reaches beyond Ada as do walleye and northern pike. Felton Ditch is locally important to a small but loyal group of fishermen who seek the brook trout that are annually stocked by the State of Minnesota.

2.93 During the late summer months or in low water periods, the only water that will provide adequate cover and depth is that in the deep pools. These pockets probably represent less than 5 percent of the stream bottom. Desirable-sized walleyes, northern pike, rock bass, and channel catfish do occur in the deeper pools, and it appears that the river as it now exists could support heavier fishing pressure except for the problem of limited access. However, on a sustained basis, it is believed that the river would soon deplete its supply of fish, at least until the season for natural replenishment from upstream and downstream could occur. The fisheries of the river as a whole are severely limited because of a low basic productivity and of a restricted amount of habitat favorable to game and commercial species. The low productivity of the river is due in part to the earlier flood damage reduction projects to be described later.

2.94 The upstream reaches and tributaries probably attract even less fishing attention, although many one pound fish, mainly northern pike, were caught and seen at several locations by Hibbard (1973). The largest fish, a 10-pound-plus pike, was netted in the South Branch Wild Rice River. These areas perhaps are fished heavily in the spring. Indications are that the stream fishery resources are under-utilized, probably because of the proximity of the excellent lake fishing of west central Minnesota.

2.95 The only other form of water-associated recreation for which the Wild Rice River provides a base is that of canoeing. This form of recreation would probably enjoy greater popularity were it not seasonally dependent on higher water and were the bridges somewhat closer together so that a run of reasonable length could be made with easy ingress and egress of the river.

Plant Resources

2.96 A number of studies have been conducted in vegetation types which have some features in common with those in the area of the proposed reservoir. In North Dakota recent work has been done on the floodplain forests of the Missouri River by Johnson (1971) and Keammerer (1972). Nelson (1964) studied the forest communities of the lower Sheyenne River valley, Wikum (1972) investigated the vegetation-environmental relationships along a portion of the Forest River in the northeastern part of the State, and Wanek (1967) described the gallery forests along the Red River of the North from its origin to the Canadian border. In northcentral Minnesota the floodplain forests of the Upper Mississippi River near Bemidji were recently studied by Lago (1971). A comprehensive description of forest and bog vegetation from northwestern Minnesota published a few years ago by Janssen (1967) covers numerous forest types, some of which are similar to those in the proposed reservoir area. In fact, several of Janssen's western floodplain stands were located on the floodplain of the Wild Rice River in eastern Mahnomen County. Other pertinent studies include those of Bergman and Stallard (1916), Braun (1950), Buell and Buell (1959), Buell and Cantlon (1951), Christensen et al (1959), Curtis (1959), Curtis and McIntosh (1951), Dansereau (1959), Daubenmire (1956), Hosner (1958, 1960), Kittredge (1938), Stallard (1929), and Yeager (1949). Plant nomenclature for this environmental statement follows Gleason and Cronquist (1965).

2.97 In the 28 stands surveyed by Hibbard (1973), a total of 234 species of vascular plants representing 69 families were recorded (appendixes C and D). This number is approximately twice that recorded by Wikum (1972) for the Forest River gallery forest in northeastern North Dakota. It is also considerably more than the number encountered by Lago (1971) along the Upper Mississippi River, although his study was restricted to the floodplain proper. The number is only slightly less than the total recorded by Wanek (1967) for 200 miles of gallery forest along the Red River of the North from its origin to the Canadian border. Floristically, then, the proposed reservoir area is relatively rich.

2.98 In general, the natural vegetation of the Wild Rice River Basin is composed of a mixed grass prairie, oak-savanna, deciduous forest and coniferous forest on a gradient from west to east. The natural vegetation of the western portion of the watershed is bluestem prairie dominated by big bluestem, little bluestem, switchgrass, and Indian grass. The prairie vegetation now exists only in small patches because most areas have been converted to agricultural uses.

2.99 Within the prairie, other vegetational systems once occurred as a result of watercourses and topographic features. Thus natural forest vegetation extended into the prairie along streams and was dominated by cottonwood, American elm, willow, box elder, basswood, and green ash. Marshes were interspersed in the prairie in potholes and sloughs. These systems were dominated by cattails and bulrush and were fringed by wet prairie species such as reed-canary grass, phragmites and sloughgrass. A portion of the Felton Ditch area was a large marsh and wet prairie area until drainage ditches effectively drained the area in the 1900-1910 era. A similar situation existed where the South Branch Wild Rice River flowed onto the flat Lake Agassiz plain. There are still many wetlands in the upland areas of the watershed, but their number and areal extent have been reduced.

2.100 The oak-savanna region extends from the beach ridges of ancient Lake Agassiz a few miles eastward and gives way rather abruptly to the maple-basswood deciduous forest region. The oak-savanna is dominated by bur oak as the overstory along with a mixture of grasses and forbs as the understory. Well drained, sandy soils are characteristic of the oak-savanna type. Interspersed in the region are marshes and wet prairies which occur in the potholes and wetlands. Natural forest types occur along the streams and in the valleys that are carved by stream flow through the beach ridges. Fire was necessary to maintain the prairie and oak-savanna types. Bur oak, because of its thick bark, was able to withstand the prairie fires and in part serves as a fire break between the prairie to the west and deciduous forest to the east. Other factors such as drainage, soil type, and precipitation serve to create the impressive diversity of ecosystems present in the watershed. The area is ecologically unique in that a person can pass through tall grass prairie, oak-savanna, maple-basswood forest, and coniferous forest (pines, balsam fir, spruce and tamarack) in less than an hour's drive.

2.101 A narrow fringe of riparian vegetation occurs along the natural streams composed of American elm, basswood, cottonwood, box elder, willow and green ash as the overstory. Shrubs such as dogwood, buckbrush, currant, rose, juneberry and plum occur along this thin riparian fringe in varying densities, usually as the influences of man dictate. Herbaceous cover along the streams in this area display a considerable amount of variation due to factors such as presence or absence of overstory vegetation and disturbance factors such as bank slumping or channel clearing.

2.102 Appendix C presents the text and data of Hibbard (1973) relating detailed descriptions of plant community types within the Wild Rice River Basin. Appendix D presents a list of woody plants found in the Wild Rice watershed.

Animal Resources (Terrestrial)

2.103 Beidleman (1948) was one of the first to study the vertebrate ecology of a floodplain. His work, however, was conducted in Colorado, a geographically dissimilar area. Goff (1952) and Wetzell (1958) studied vertebrates of Midwestern floodplains. The latter author specifically studied mammalian succession, as did Hibbard (1972), who also studied avian succession in a North Dakota floodplain forest. Uvardy (1957) has summarized breeding bird population studies of various communities, including floodplain forests. Hibbard (1972) has a more recent summary of the breeding bird populations of Midwestern and Western floodplain forests and also discusses the effects of inundation by Garrison Dam in North Dakota on avian and mammalian populations. Yeager (1949) has described the effects of flooding upon an Illinois bottomland. He discusses both woody vegetation and the more common vertebrates. New (1972) has made one of the few comparisons available of bird populations in channeled and unchanneled forest stream habitats.

2.104 Only a few major animal ecology studies have been undertaken within the local area around the proposed Twin Valley Lake. These have been primarily concerned with prairie or prairie-forest ecotone habitats, however, rather than riparian forest communities. Tester has studied vertebrates of the Waubun prairie in Mahnomen County. One of his studies concerned toads, and another, bird and mammal populations (Tester, 1961). Iverson (1963, 1967) has investigated small mammals in the prairie-forest ecotone of the Wild Rice watershed.

2.105 In the interests of brevity, many uncommon species are not mentioned in the text. A summary of their status can be obtained by examining appendixes E, F and G. While reliable information on the populations per unit area is not available (as is the case for most of the vertebrate species listed) an indication of the relative abundance is given, using a scale ranging from one to three. The nomenclature for birds follow American Ornithologists Union (1957), for mammals, Hall and Kelson (1959), and Breckenridge (1944) for the amphibians and reptiles.

Mammals

Game and Fur Species

2.106 The most important mammalian game species in the Wild Rice watershed is the white-tailed deer. Little information is presently available as to the population of this species within the watershed. An aerial census of the Wild Rice gallery forest under ideal winter snow conditions would be helpful in this regard. Unfortunately, there is no such data for Minnesota as "pellet counts" have been the census method used in this State since 1970 (Karns, 1972). In the absence of available population data on live animals, information on the hunter kill within the area and the number of recreational days furnished by this species is presented here. The sampling techniques probably lead to an underestimate of the size of the herd. This conclusion is consistent with the literature on wildlife management and very likely also applies to other species for which population data are given.

2.107 The Minnesota Department of Conservation collected information on the hunter kill in this area during the November 1972, deer season. All successful hunters were asked to report the locality of their kill at checking stations established throughout the State. Each deer taken was then assigned to a particular "block" or management area. During the month-long 1972 season, 694 deer were taken within the block of land containing that portion of Norman County lying east of Highway 32 (slightly more than 1/4 of the county) and most of Mahnomen County. At least 120 of these animals were probably taken "locally" for they were checked at the Twin Valley checking station. The rest may have been taken anywhere in the two county region. This rather heavy hunting pressure and kill figure compares to kill figures of approximately 150-250 animals for similar-sized adjacent blocks to the west, southwest and south of this Norman-Mahnomen County unit. Probably the heaviest kill was in the patchwork of aspen upland timber scattered throughout this portion of Norman County and the more heavily forested region of eastern Mahnomen County. A fairly large number of these deer, however, were taken on or adjacent to the Wild Rice River or its tributaries. In the first and third days of the November deer season in the proposed reservoir area at least two deer and possibly more were killed on the bottomlands in the reservoir site. There were also a number of deer hunters in the area who had seen animals but were unsuccessful. Hunting during this period represented at least 28 man-days of hunting. Deer hunting was reported to have been more intensive in the area on the first and second weekend but dropped somewhat after that. If a proportional number of man-days were spent hunting in the remainder of the season, the reservoir area would have supported 280 man-days of hunting. This figure is probably too high, although it appears likely that at least 150-200 man-days of hunting were supported by the area.

2.108 Considering the amount of tracks seen and the number of deer observed, Hibbard (1973) assumes that a population of at least 25 deer utilize the proposed reservoir site. (This includes the proposed 540-acre conservation pool plus additional land affected to the extent of a total of approximately 1,000 acres.) This is only an estimate based upon the amount of deer-related signs seen and a general concensus of opinion that normal deer ranges in the Lake States can adequately sustain an average of 15-20 deer per square mile without undue pressure on the range. At a recent symposium on the white-tailed deer in Minnesota, Mooty (1971) states that this figure might range from 25-35 deer per square mile for young aspen stands to 10-15 per square mile for older stands. Since much of the bottomland and slope overstory vegetation is in a climax or near-climax state (as discussed in the section on vegetation), it is expected that this type of habitat would support deer at a level near the lower population figure indicated, depending on whether they use the area for food and cover or primarily for cover. However, the interspersion of woodland and agricultural land in the project area suggests that the deer would commonly feed upon crops, which would allow the carrying capacity of the range to be higher than otherwise expected.

2.109 The only other big game species occurring at present in the watershed are the black bear and the moose. Bear are undoubtedly rare, for their main range lies to the east although sightings have been reported.

2.110 Moose were reported to have been present south of the reservoir site in the summer of 1972 near Syre and just upstream from the reservoir along the Wild Rice River near Faith (James Goltz, conservation officer at Mahnomen, personal communication). Elk and bison were formerly abundant in the region. An indication of the former presence of the latter species within the reservoir site was a nearly perfect skull that Hibbard found while canoeing the river.

2.111 Within most of the recommended reservoir site, cottontail rabbits are rare, for the forest is quite mature and offers little of the brushland habitat required by this species. This species is common only in brushy former pastureland such as described in vegetational type I-F, (appendix C). It also appears to be fairly common in areas near Ada. Gray squirrels also occur there, but at the present time are low in population. Fox squirrels are known to occur within the county but are near the northern limit of their range and are very scarce. The two remaining game species occurring in the watershed are the snowshoe hare and jackrabbit. The jackrabbit is absent or unimportant in the wooded valley of the watershed. The snowshoe hare was not observed by Hibbard (1973). It becomes more abundant in the upper reaches of the watershed in Mahnomen and Clearwater Counties, but it is rare in Norman County. However, during the years of peak abundance, it reportedly occurs in aspen thickets along the beach line of Lake Agassiz and may even be abundant.

2.112 Other economically important mammalian species are fur-bearing or predatory species. Mink, raccoon, red fox and beaver are common in the area. Beaver "drag-trails" and fresh cuttings are abundant. At least one and probably two colonies of beaver lived within the reservoir site in 1972. One of these colonies dammed the river near the proposed location of the Twin Valley dam.

2.113 One trapper who trapped the Wild Rice River west of Mahnomen, at least as far as the vicinity of Faith, had already taken 50-60 fox by early January of 1973 (Hibbard, 1973). One or two of these were gray fox, a relatively rare animal in western Minnesota and largely confined to the gallery forest in prairie areas. Several other members of the canid and weasel families also occur, but are rare.

Small Mammals and Non-Economic Species

2.114 Information on small mammal populations in the area is available from Hibbard (1973) and Iverson (1963, 1967), who trapped the Wild Rice watershed to determine the distribution of small mammal species across the prairie-forest ecotone in Norman and Mahnomen Counties.

2.115 Iverson's stations were close to the Wild Rice River, but none lay within the proposed reservoir site. In August of 1973, a North Dakota State University graduate student, Mr. C. Alan Miller, live-trapped a number of the trapping stations established by Iverson in 1962, making further information available.

2.116 Information on the species in some groups is rather scant. For instance, only one bat is listed for the area. Several other species were known to occur, for they were observed in flight by Hibbard (1973), but no verification of their presence could be made. It is believed that one or two species each of the insectivore and rodent groups also occur but were not listed.

2.117 The species of small mammals that are most abundant in the floodplain forest near Twin Valley were also those species listed by Iverson (1967) as most characteristic of upland deciduous forests in the area: the white-footed mouse, red-backed mouse, the short-tailed shrew and the eastern chipmunk. These are all common mammals for this region. No boreal or coniferous forest species, such as the southern bog lemming and the woodland deer mouse, which Iverson listed as occurring rarely in the upper watershed of the Wild Rice River, were noted by Hibbard (1973).

2.118 The only rare or unusual mammals found in the area are the black bear and moose, previously mentioned, one specimen of the grasshopper mouse (taken by Miller in grassland habitat near the South Branch Wild Rice River) and reports or specimens taken of the arctic shrew, woodchuck, Richardson's ground squirrel, gray fox and the least weasel. All of these mammals except the least weasel are species which may be common or even abundant within their chief natural range, but are rare in this ecotone or transition region between the grasslands and the deciduous and boreal forests. The presence of the grasshopper mouse and Richardson's ground squirrel represent an extension of range for grassland species which are quite common further west. These two species were not found by

Hibbard (1973) on the wooded floodplain of the Wild Rice River. The rest of the group are boreal or deciduous forest species which are on or near the edge of their main range which lies to the east or north.

2.119 Appendix E summarizes information available on the status of various mammal species within the watershed.

Birds

Game Species

2.120 The chief upland game birds in the Wild Rice watershed at the present time are the Hungarian partridge and the ruffed grouse. Several Hungarian partridge broods and coveys were noted by Hibbard (1973) near Twin Valley. They do not occur, however, within the wooded reservoir site. Within the watershed they are probably most common in the Red River Valley and on the adjacent Lake Agassiz beach lines.

2.121 The ruffed grouse is quite common in the Twin Valley reservoir site. No valid population estimate can be given, but judging from the half dozen or more broods observed in 1972, there must have been at least two or three coveys within the 540-acre permanent pool area and another eight or ten coveys within the design flood pool area. This species furnished only incidental hunting for area residents, but is still important, for one local hunter is known to have taken seven grouse prior to 1 November 1972.

2.122 No other upland game birds are presently abundant enough to be hunted in the area. Prior to about 1964, the ring-necked pheasant, although near the northern limit of its range in Minnesota, was common enough to be hunted.

2.123 A socially very significant animal found in the Wild Rice watershed is the greater prairie chicken (*Tympanuchus cupido*). This once abundant prairie dwelling bird is presently making its last stand in Minnesota, primarily on the remnant prairie areas of the ancient Lake Agassiz beach ridges. When the U.S. Department of the Interior officially develops a list of threatened species pursuant to the requirements in the Endangered Species Act of 1973 (Public Law 93-205), there is a strong possibility that this bird will be on the list.

2.124 Morris Patterson of the Minnesota Department of Natural Resources has made censuses of booming grounds found in Mahnomen, Becker and Norman Counties the past several years. Table 12 summarizes this data on the birds which remain in the region.

Table 12 - Prairie chicken booming grounds found in three Western Minnesota Counties

County	Year	No. of grounds	No. of birds on ground or adjacent to it
Becker	1971	5	75
Mahnomen	1971	7	110
Norman	1972	8	152

2.125 Note that the largest number of booming grounds and birds are found in Norman County. Several grounds are located south and west of Twin Valley, but none are found near the Twin Valley reservoir site, for this species does not utilize heavily forested areas to any great extent.

2.126 The other game birds that utilize the watershed are migratory. Species such as the woodcock and the sandhill crane were observed only rarely and are only of incidental importance. Many species of ducks utilize the watershed for breeding and migration, and the upper watershed contains important waterfowl breeding habitat.

2.127 Sandpipers and wood ducks can be observed along the stream. The wood duck utilizes abandoned oxbows of the river to a large extent. Hibbard (1973) noted several broods.

2.128 Kingfishers and bank swallows utilize the banks for nest burrows, and mallards breed in surrounding upland habitats and probably use oxbows occasionally.

Non-game Species

2.129 Little information is obtainable on breeding populations of woodland birds in the project area. Population estimates can be made, however, from breeding bird censuses made in similar habitats elsewhere. Uvardy (1957) reviewed 130 breeding pair censuses conducted in deciduous forests in various parts of eastern North America. He found that the density of breeding pairs varied from a low of 100 breeding pairs per 100 acres to over 750 pairs per 100 acres. The highest density of birds occurred in mixed bottomland and floodplain forests on the most productive soil. Figures of 300 to 500 pairs per 100 acres were considered average or normal for these habitats. For the later stages of succession (which is typical of much of the Wild Rice River gallery forest), a figure of 300 pairs per 100 acres would probably be a conservative estimate of the number of breeding pairs that could be expected.

2.130 This density compares to breeding pair figures ranging from 235 to 510 and averaging 330 pairs per 100 acres for ten censuses of intermediate-aged or older floodplain forests on the Missouri River in North Dakota (Hibbard, 1972). Stands of intermediate age had the highest density (510 pairs per 100 acres) with the older stands (which were green ash-American elm forests resembling gallery forests of the Wild Rice River) producing breeding pair densities closer to the 300 pair per 100-acre figure suggested above.

2.131 The breeding bird fauna would consist of at least 20 to 25 species. Common species typical of this type of habitat and found in the area are listed in table 13. Population estimates for the various species are listed in their probable relative order of abundance. Estimates are based on knowledge of bird populations in this and similar floodplain habitats and published breeding pair censuses (Hibbard, 1972; Breckenridge, 1955; Cink, 1969 and Kendeigh, 1948). Appendix F lists the scientific names of the birds mentioned and gives additional information on the status of birds not included in table 13.

2.132 None of the woodland birds could be considered rare although three are at the edge of their range (woodcock, pileated woodpecker, barred owl) and should be considered western-most extensions of the deciduous avifauna. The bird species considered to be rare for the area are chiefly grassland types (marbled godwit, Sprague's pipit, Baird's sparrow) and are not found in the wooded floodplain. Two other species, the goshawk and the magpie, are observed only in the winter. Both are uncommon for this locality.

2.133 One important aspect of the prairie-woodland-stream ecotone is the number and diversity of species of both plants and animals associated with it. The rather abrupt transition from prairie to woodland to stream tends to create an area that supports a community with characteristics additional to those which adjoin the ecotone. In other words species can be found in the ecotone that would not exist in any of the separate communities. This translates in terms of bird populations into some rather impressive breeding pair populations in the gallery forests along the prairie streams. The ecotone created by the stream, gallery forest, and agricultural field interface is important, first, because it is an ecotone and second, because it represents some high quality wildlife habitat in the midst of an intensely cultivated area. Practices such as fall plowing and annual fall burning of roadsides and drainage ditches effectively limit the quantity and quality of habitat in the Red River Valley. Hence, the value of the stream side vegetation is immeasureable in regard to wildlife populations and species diversity.

Table 13 - Breeding birds of the Twin Valley Reservoir area and estimate of their population within the reservoir unit

Species	Breeding pair
Woodland Species	(Population/100 acres) *
Red-eyed Vireo	60
Ovenbird	30
Redstart	30
Rose-breasted Grosbeak	20
Black-capped Chickadee	15
White-breasted Nuthatch	15
Crested Flycatcher	12
House Wren	12
Brown-headed Cowbird	12
Blue Jay	10
Least Flycatcher	10
Hairy Woodpecker	5
Veery	5
Flicker	5
Warbling Vireo	5
Yellow-throated Vireo	5
Downy Woodpecker	5
Baltimore Oriole	5
Warbling Vireo	2
Scarlet Tanager	2
Mourning Dove	2
Cooper's Hawk	1
Broad-winged Hawk	0.8
Great Horned Owl	0.4
Barred Owl	0.3
Miscellaneous woodland species	5
Stream-side Species	
Bank Swallow	40**
Yellow Warbler	5
Wood Duck	1
Great Blue Heron	0.5
Kingfisher	1
Spotted Sandpiper	1

* The tabulation in Hibbard (1973) was for population/1,000 acres. The units of estimate were changed to make them consistent with those of the text, and are not intended to imply a greater level of accuracy than in Hibbard's report.

** There were at least three colonies of this species on the face of eroded banks 50 to 60 feet in height. One colony contained at least 150 pairs.

Other Vertebrates and Terrestrial Insects

2.134 A list is given in appendix G of amphibian and reptile species in the basin together with an indication of their abundance. None of the species are unusual or rare. Probably the most common of the amphibians within the forested floodplain are the chorus frog and the wood frog. Several of the other species listed are only found in the grasslands, and while they were found in adjacent uplands, they do not frequent the forested floodplain.

2.135 The methods used by Hibbard (1973) to obtain insects were sweep netting and Berlese funnel samples of soil and litter. Table 14 presents information on the numbers of invertebrate organisms obtained from the Berlese funnel samples. Sweep net results indicate that the largest numbers, both in individuals and number of species, are in open or brushy areas rather than the deep woods. Berlese funnel results make it apparent that the largest number of organisms are in the leaf litter of weeds where it is quite damp.

Other Water Resource Projects in the Watershed

2.136 Near Ada the Marsh River diversion ditch together with a low concrete weir at the head of the ditch was constructed for flood control in 1895 by the Red River Drainage Commission to divert part of the high flows from the Wild Rice River into the Marsh River. The ditch extends a total distance of about 9.8 miles above its junction with the Marsh River at mile 35. In 1906 the Minnesota State Drainage Commission dredged a series of cutoffs on the Wild Rice River between miles 35 and 40 in the interest of flood damage reduction. In the past, municipalities and private interests have built small dams along the Wild Rice River for water supply and power, two of which remain at miles 3.6 and 57.4.

2.137 In 1954, the Corps completed 38.9 miles of channel modification for flood damage reduction which consisted of enlarging, straightening, and cleaning 14.9 miles of the Wild Rice River above mile 27.3 and cleaning of the Marsh River and Marsh River ditch for 24.0 miles above mile 20.8, except between river miles 31.7 and 34.8 where the channel was also enlarged and straightened. The modified channels were designed to handle flows corresponding to a discharge of 3,130 cfs just above the diversion to the Marsh River ditch. Below the diversion weir, the enlarged Marsh River ditch conveys 940 cfs and the Wild Rice River channel carries the remaining 2,190 cfs. The project included construction of a dike and gated culvert on the right bank of the Wild Rice River at mile 41.7 to permit diversion of limited flows through an old channel of the Marsh River for water quality control at Ada.

TABLE 14. BERLESE FUNNEL COUNTS OF INVERTEBRATE FAUNA BY DATE AND SITE (2-3 pound samples of soil,grass and/or litter)

	Invertebrate Fauna Count									
	August 8, 1972			August 15, 1972				August 17, 1972		
Item	Upland Grass	Wooded Slope	Wooded Upland	Wooded Bottom 1	Grassy Bottom	River Edge	Wooded Bottom 2	Wooded Slope	Wooded Upland	Grass Brush
Insecta										
Orders										
Tysanura										
Campodeidae	0	4	12	4	0	0	0	8	2	0
Psocoptera	4	2	-			6	4	19	-	-
(trogiomorpha)			8	-	-	-	-			
Collembola										
Sminthuridae	0	0	16	0	3	0	0	4	0	0
Poduridae	23	8	19	8	2	8	9	18	36	0
Entomobryidae	82	94	364	82	46	39	53	111	108	11
Coleoptera										
Larvae	10	6	30	29	2	4	4	4	8	6
Staphylinidae	14	0	9	6	6	2	4	21	4	2
Lepidoptera larvae	0	0	0	0	0	0	1	0	0	0
Diptera	0	0	26	4	0	0	0	0	0	0
Larvae	0	0	4	0	0	0	0	0	0	0
Psychodidae	0	0	0	4	5	0	0	3	0	0
Hymenoptera										
Formicidae	30	12	3	18	32	3	26	16	0	1
Chilopoda		3	13	9	1	0	6	2	2	0
Diplopoda	1	2	2		-	1	3	3	0	0
Arachnida										
Orders										
Chelonethida	10	14	81	0	0	0	0	35	19	0
Acarina	245	163	580	146	61	20	49	418	203	22
Araneida	101	38	62	31	18	14	12	119	30	4
Annelida	0	0	4	4	2	0	6	3	0	6

2.138 In 1964, snagging and clearing of a 12-mile reach of the Wild Rice River between miles 15.2 and 27.2 for flood damage reduction was completed by the Corps.

2.139 The District Engineer has also recommended a project for flood damage reduction on the Wild Rice River - South Branch, and Felton Ditch, Minnesota. The project on the South Branch Wild Rice River would tentatively consist of debris removal from its mouth to mile 1.4, and one-side channel excavation where possible from mile 1.4 to mile 8.1 and from mile 14.2 to 16.0. Excavation of both sides of the channel would be necessary between mile 8.1 and 14.2.

2.140 One-side excavation on Felton Ditch would be done where possible from mile 4.8 to mile 6.0 and mile 8.1 to 8.4. The excavation of both river channel banks would be required on river miles 1.6 to 4.8, mile 6.0 to 8.1, and mile 8.4 to mile 17.1. Clearing of debris only would be conducted from mile 0 to mile 1.6. No channelization work would be accomplished upstream of mile 17.1. Between mile 17.1 and 19.9 the existing channel would be inclosed by flanking levees.

2.141 A total of 32.9 miles of stream and ditch would be directly affected by the recommended flood damage reduction project. Of this total, 6.6 miles represent previously unattended channel that would be adversely affected by debris removal and/or channel bank modification. The project would provide protection against the 6 percent frequency flood. This channel modification project and the Twin Valley Lake project would both provide for reduction of flood damages to limited areas at the confluence of the Wild Rice River and the South Branch Wild Rice River and Felton Ditch. Appropriate distribution of flood damage reductions in this area have been made to each project.

2.142 The South Branch Wild Rice and Felton Ditch project was authorized by the Flood Control Act approved 13 August 1968 (Public Law 90-482), and project formulation has been reexamined in the phase I general design memorandum (GDM) subject to approval by higher authority. An environmental impact statement was prepared for concurrent review with the GDM. Phase II design has also been initiated.

2.143 Corps of Engineers projects in the Wild Rice River Basin were evaluated by A. D. Little, Inc. (1973) in a submittal to the Council on Environmental Quality. The report dealt mainly with the projects completed in 1954 and 1964 and only briefly with the Twin Valley and Wild Rice River - South Branch and Felton Ditch projects.

2.144 The Wild Rice Watershed Board is studying the feasibility of constructing small dams for flood damage reduction in the upper reaches of Felton Ditch and the South Branch Wild Rice River. More generally, since 1970 there has been a joint effort by the East Agassiz Soil and Water Conservation District, Norman County Wild Rice Watershed District, and the Norman County Agricultural Stabilization and Conservation Service to place the highest priority of planning and financial support toward the development of flood water control projects. Since then, ten small impoundments have been built, nine having drainage areas of less than 2,500 acres each and one having a drainage area of over 13,000 acres. Along with the impoundment program, proper management of soil and water is stressed, and it is estimated that about half of Norman County's farmers are District Cooperators in the programs of the East Agassiz Soil and Water Conservation District.

3. THE RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS

3.01 Six major land use categories have been described for Norman County's 566,400 acres. Agriculture is the dominant land use category which in 1969 accounted for 93 percent of the total land surface. Rights-of-way for Federal, State, county, township and village roads, railroad and transmission lines is the second largest land use category. Residential development, public land, commercial and industrial categories account for the remaining land use in the county. Commercial and industrial development is restricted mainly to established communities in the county. The majority of the industrial development is located along the major rail lines and is devoted to agriculturally related industries: grain processing and storage, feed milling and storage, bulk fertilizer and specialized farm produce handling and storage. Public land is devoted to schools, churches and county property such as gravel pits and cemeteries. Wildlife management areas account for the largest use of public land in Norman County. The Marschner vegetation map, which was compiled from the notes of the original land surveyors, was used as a basis for the original vegetation types in the county (Orning and Maki, 1972). According to the map, Norman County has had a 99-percent reduction in 40-acre parcels (forties) predominantly marsh, a 64-percent reduction in forties predominantly forested, and a 94-percent reduction in forties predominantly grassland. Data were not readily available for Clay County. Mahnomen County has had less wetland drainage.

3.02 The lucrative nature of the agricultural economy is such that land use in the watershed of the Wild Rice River is not expected to change significantly in the future. No Federal, State or local land use plans have been formulated to modify the present agricultural status of the area.

3.03 The project as proposed is expected to enhance the present agricultural uses of the land by reducing flood damages. However, the project would commit 3,500 acres of woodlands, cropland pasture and river bottom to the construction of the dam and reservoir and any mitigation measures. Any croplands or pasture areas involved in such land use changes would be taken out of agriculturally productive use and converted to flood control and related purposes (e.g., recreation) for the life of the project. The project would therefore generally enhance present land uses in most areas but be in conflict in others.

4. ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

Introduction

4.01 The environment includes the physical, chemical, and biotic elements which interact as an integrated unit or ecosystem. A change in the environment, even of small magnitude, results in some minor adjustments in the system, whereas in a major alteration the modification necessitates a new reintegration of the physical, chemical, and biotic components. During further study the necessity of instituting an environmental monitoring program would be determined. The intent of the program would be to gather data which could be useful in minimizing adverse effects during project operation and which would serve as documentation of the changes induced by the reservoir. The nucleus of the present environmental statement is the impact associated with the changes from a primarily shallow-water, lotic (running water) environment to a moderately deep, lentic (standing water) one. This is a major change and one that is irreversible for practical purposes.

Economic and Social Impacts

4.02 The proposed plan has a benefit-cost ratio of 1.23 to 1. It would reduce flood damages in the Wild Rice River Basin by containing a flood with a peak inflow of 7,000 cfs and expected frequency of occurrence of once in about 53 years. Large flood flows would pass over the spillway. The social consequences of the project's not being able to provide complete flood protection are recognized. It is for this reason that the local sponsor will be required to "at least annually inform affected interests that the project will not provide complete flood protection."

4.03 The estimated average annual benefits of Twin Valley Lake total $1,116,600. Flood control benefits total $933,200, or by category of damage: agricultural - $522,700, transportation - $18,900, and urban - $391,600. Other project benefits include recreation and fish and wildlife - $99,200, and area redevelopment - $84,200.

4.04 The estimated average annual costs of project implementation would total $911,500.

4.05 The persons who live in protected areas would experience less rural community disruption and threats to public health and safety during flood periods. Human misery would also be reduced, although these social effects would hold only for the more frequent floods since large floods would still inundate the area. Those individuals owning a total of about 3,500 acres of land would have to sell property necessary for the project. Acquiring of real property would be guided to the greatest extent practicable by the land acquisition policy in Public Law 91-646, the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. Estimates would be based on estimated fair market value. In any event, the loss of land by individuals owning property adjacent to the stream is an adverse social effect of the project. Four rural families would be displaced by the project as now conceived, and relocation may be a hardship for those individuals.

4.06 In general, Public Law 91-646 provides for moving and related expenses for displaced persons, supplemental housing payments for homeowners, supplemental housing payments for tenants and certain others, and costs of conveying property to the local government, and requires a uniform acquisition policy. An adverse social impact would necessarily occur as some sectors of the public would be required to bear substantial social costs in the reduction of flood damages for a larger sector of the public.

4.07 The primary benefits of this plan are economic advantages to the agricultural lands in the flood prone area. By providing for reduced flooding, earlier planting dates are available during some flood years and crop losses are cut by the reduction in frequency and severity of summer floods. Other economic benefits are expected to accrue from the project through reduced flood damages for public roads and bridges. The direct economic beneficiaries are landowners in the flood prone area. Secondarily, the county taxpayers benefit from decreased road and bridge maintenance costs. The relocation of existing utilities is not expected to cause any long-term inconvenience or disruption of service.

4.08 Making farming in the floodplain more profitable could well influence land use and agriculture. That is, if the farmer has more money available for capital improvements and if more intensive use of some of his property would become profitable because of reduced flood frequency, the project may induce changes in the intensity or type of agriculture in the basin. If this were to occur, secondary unidentified economic, social and biological impacts would occur. These possible effects would apply to any of the alternatives which are economically advantageous to the farmer.

4.09 The proposed project would, at a given point downstream and to a lesser degree farther downstream, reduce river levels at a given discharge and thereby redefine, for example, the one percent floodplain. As noted in the following section on alternatives, the one percent floodplain is used as the standard for floodplain regulations which are designed to prevent damage to structures (and contents) within this particular floodplain. Restricting the area of the one percent floodplain with the proposed project would therefore allow development of a greater area unrestricted by the encumbrances of floodplain regulations, i.e., it would induce development relative to the without-project condition. At the same time it is true that as floods become increasingly larger, a project such as Twin Valley Lake becomes less effective in attenuating flood levels. The proposed project would therefore reduce the average flood damages while it would increase the damages from any one very large flood. Although the project would therefore create the anomalous situation of contradictory social goals (as measured by present economic criteria versus long-term social welfare), it is also true that past experience has indicated that changing social values and measures may alter the situation before the project-induced greater disaster potential is realized.

4.10 The water table at the valley floor is at river level. Other than dewatering operations for the construction of the proposed underseepage prevention, no difficulties with groundwater are anticipated during the construction. However, the possibility of contaminating surface or groundwater should always be considered in the locating of disposal sites for liquid or solid wastes.

4.11 The permanent pool would probably cause a change in the groundwater table adjacent to the reservoir and may cause a rise in the groundwater table to the west and downstream of the proposed damsite. These possible effects will be studied at a later date. Intermittent floodwater storage is not expected to significantly affect groundwater levels adjacent to the reservoir because the time required for water table readjustment would be greater than the duration of floodwater storage. Changes in the groundwater table could, in turn, impact on the upland vegetation as discussed under Plant Resources.

4.12 Historic and Archaeological - The Wild Rice River Basin does contain significant archaeological/historical resources but none which would be affected by the proposed project. Construction of the project, however, could affect surrounding sites if fill or borrow material were taken from unsurveyed areas. An archaeologist should be present when borrow areas and road routes are chosen. An archaeologist should be called in if materials of a historical nature are uncovered during construction.

Stream Resources

4.13 All impoundment studies point to the significance of the changes in going from a running water condition to a standing water one. Accompanying the current reduction, water depth increase, and dropping of the suspended load, significant changes in the temperature relationships, light transmission, gas chemistry, and solute equilibria would occur. All affect the biota. The aquatic environment thus broadens and deepens with the impoundment pool; communities become more stratified and more complex. Additionally, as a lake is interjected into the center of a well-developed flowage, both the upstream and downstream proximities of the river would feel its effects. Superimposed on this picture are the changes which would be utilized to fulfill the flood control aspect of the project. For instance, depending upon the final reservoir operating plan, the periodic lowering (fall) and filling (spring) would further complicate the stability of the biotic communities that develop.

Physical and Chemical Aspects

4.14 Damming of the Wild Rice River to form Twin Valley Lake would immediately reduce the current and, therefore, produce a sediment "trap". For Twin Valley Lake, 7,500-acre-feet (the volume of the permanent pool) is the estimated volume of sediment to be trapped during the 100-year period of economic analysis. It is obvious that the sediment accumulation would adversely affect the lake's value to society. However, the sediment would accumulate in the upstream portions of the pool, and even after 100 years there should be a deep pool near the dam embankment. The rate of sedimentation is naturally dependent on completeness of erosion control in the watershed. As a result of the trapping effect, the reservoir would be expected to be clear for the first several years except perhaps after periods of heavy runoff. Because some of the sediments, particularly in the larger particle sizes, would be trapped behind the dam, downstream reaches of the Wild Rice River would have a reduced sediment load. The reduced load would give the river greater capacity for scour during low-flow periods. Erosion of the river bank and bed at downstream locations would then be greater under low-flow conditions and lesser during floods.

4.15 A question of considerable interest is whether the lake would thermally stratify. The likelihood of stratification depends upon several variables including the lake's fetch, form, size, area/volume relationships, and flushing rate; surrounding topography; and the lake's orientation to the prevailing wind.

4.16 The permanent pool would total about 540 acres and be elongate in form, with the long axis of the pool running east-northeast-west-southwest. The lake would be about three miles long and would be about one-third mile wide along much of its length. It would be incised into a fairly steeply walled valley with the surrounding, fairly flat uplands lying about 40 to 60 feet above the water surface.

4.17 The volume of the permanent pool would be about 7,500 acre-feet, and based on a median flow in the Wild Rice River of 60 cfs, the reservoir flushing time would be about two months. Inspection of the surface area-capacity curves for the reservoir gives the following data on permanent pool area-depth relationships:

Elevation (Feet)	Depth (Feet)	Horizontal Area Cross-Sectional at Depth	Percent of Total
1063	0	540	100
1058	5	420	78
1053	10	320	59
1048	15	220	41
1043	20	140	26
1038	25	70	13
1033	30	30	6

4.18 The method of R.A. Ragotskie (personal communication) was used to determine whether the lake would thermally stratify. It is recognized that the lake's location on the edge of the prairie would theoretically expose it to more wind action than was true for the lakes in Ragotskie's study in forested areas; however, the pool's rather small size, its entrenchment within the river valley, and the wooded nature of the uplands immediately to the north were judged to counteract the effect of geographic location. Ragotskie's method was therefore judged to be applicable, and his studies suggest that the lake would stratify in late spring and that the thermocline would be found at increasing depths during the course of the summer, being found at nearly 30 feet in August. The extent of lake-bottom below that depth would be somewhat less than 10 percent of the total permanent pool surface area.

4.19 Further studies will consider an alternate operating plan which would include holding the summer pool level up to (possibly) 5 feet above the currently designated permanent pool elevation of 1063.0. The purpose of this raise would be to increase the summer water surface area, and thereby increase the project's recreation benefits (although it is recognized that there are other advantages as well as disadvantages). During the fall, the pool would be drawn down to the 1063-foot elevation in order to provide the designated flood control storage before the spring snow melt. If the summer pool were held 5 feet higher, the area and volume of water below the thermocline would significantly increase.

4.20 Thermal stratification is important because it would result in an anaerobic hypolimnion due to substantial biochemical oxygen demand and essentially no oxygen additions from the epilimnion or the river. Release of anaerobic hypolimnetic waters with high nutrient content would degrade downstream water quality. Accordingly, further studies will consider the advisability of constructing a multiple-level outlet structure which would allow mixing of reservoir outflows and thereby minimize degradation of downstream water quality.

4.21 Further studies will also aim at verifying that the lake would stratify. If it is determined during further studies that the reservoir would probably not stratify, consideration will still be given to including a multiple-level outlet structure for use in the event that the lake stratifies in the future under a revised reservoir operating plan. Although a substantial revision in the operating plan cannot be foreseen, past experience indicates that project purposes and operating plans do on occasion change significantly within the lifetime of the project due to changes in the needs or desires of society or to technological advances. Also, as sedimentation advances in the upper end of the pool, the likelihood of stratification and the relative volume of water below the thermocline would increase. Such changes which occur during the lifetime of the project make it highly desirable to periodically review the project and make structural or operational modification as practicable. In any case, there is a growing realization that provision for a multiple-level outlet structure should be considered a standard engineering practice whenever a reservoir will stratify or there is a reasonable expectation of its doing so.

4.22 Given the above and considering the more complex ecological situation associated with a stratified reservoir, the ensuing discussion assumes a stratified condition unless otherwise indicated.

4.23 Some factors may cause Twin Valley Lake to diverge from the typical manner in which stratification forms in the natural lakes in the area. Periodic receipts of large quantities of runoff is to be expected. The density of this water is dependent on a number of characteristics, such as temperature and the concentrations of dissolved and suspended materials. During average flow periods, temperatures in the stream are essentially externally induced because of its numerous rapids and the general shallowness. Therefore, the larger volume of the reservoir would cause water temperatures to lag behind those of the inflowing water. Neel (1966) says, "In general, reservoirs delay river temperature rise in the spring and decline in the autumn..." and they "also postpone ice formation and spring breakup". After stabilization of the water level in the spring, inflow of lower density water could advance stratification to some undetermined degree. The greater the density differential between inflow and reservoir water, the greater the effect. To what extent this overflow phenomenon would affect the ultimate stratification depth would depend upon numerous factors such as the amount of insolation to the reservoir surface, initial temperature (density) differential of inflow and reservoir waters, and discharge pattern. It is assumed that any differences would be minimal by the time the fall cooling period began. In the fall a reverse condition would exist with inflow waters underflowing the epilimnetic waters. Again, any effects due to this phenomenon should be minimal.

4.24 Stratification in the much deeper flood pool would be infrequent and of little consequence because its floodwater storage would usually be coincident with the colder seasons of the year when the water is almost isothermic and because floodwater storage would be of short duration, about 45 days for the design flood, and greater or lesser durations for other floods of lesser or greater frequency of recurrence, respectively. Some winter temperature stratification could occur but the consequences probably would be minimal.

4.25 Both rain and wave-action would contribute to the erosion of the shoreline zone, particularly in the areas cut into the steep hills. The valley walls in the lake area would suffer some erosion, and an occasional unstable area should be expected along the shoreline of the lake. In addition to the contribution to the siltation of the pool, the leaching of these denuded areas would be expected to contribute small amounts to the total solutes carried in the water.

4.26 Many factors operate to modify the chemistry of the stream water once it is dammed. The biological and chronological age of the stratification and retention of the water, the magnitude and frequency of drawdowns, the design of the discharge apparatus, and the level of the outflow are some of the more important factors. As has been seen (tables A-1 and A-2), the Wild Rice River is well oxygenated, "hard", with an appreciable concentration of sulfates, moderate phosphate concentrations, and low nitrate concentrations.

4.27 Algae and plankton, heretofore poorly developed and lost due to the straining action of the rapids of the stream, would be encouraged by a prolonged development period and the species-enriching capacity of the reservoir. With biological aging and enrichment (eutrophication), some considerable changes in the water chemistry could be expected. Oxygen would vary from super-saturated (algal produced) in the lighted zone near the surface to low amounts or none near the bottom if stratification develops. Nitrogen fixation by blue-green algae and bacteria would increase the supply of this essential nutrient to plants. If the oxygen depletion were severe in the hypolimnion, reduced substances such as hydrogen sulfide, soluble iron compounds and phosphates would appear in the hypolimnion. Many of these substances, which are primarily the byproducts of organic decomposition from the "rain" of dead and dying organisms, would alternately go into solution when the conditions were anaerobic and be precipitated when oxygen was available. In this manner, the deep layers and sediments perform as a nutrient "trap". Marl would be expected to form in the shallower areas where high rates of photosynthesis cause a shift in the carbon dioxide-carbonate equilibrium. Marl lake bottoms are generally considered to be relatively unproductive of fish.

Stream Communities and Diversity

4.29 After several years of aging, the biotic communities typical of the lakes of the region would probably begin to appear as recognizable association of plants and animals in the reservoir. There would be three main communities, namely, (1) limnetic (open-water), (2) benthic (bottom), and (3) littoral (shoreward).

4.30 The limnetic community is characterized by wind-moved warm water and high to moderate levels of oxygen and light. Planktonic blue-green and green algae and diatoms are principal producers. Feeding on them would be rotifers, copepods, cladocera, plus a few protozoa which act as consumers. Many species of each of these groups would be found in the reservoir. After death these microscopic forms slowly "rain" downward and contribute to the deep-water sediments and to the forage base below the thermocline.

4.31 In a stratified situation the benthic environment would be dark, stagnant, cool to cold in temperature, with seasonally low to seasonally high oxygen values alternating with reduced substances. In the sediments a few detritus feeders, namely chironomid and chaeroborid (Diptera) insects, sphaeriids, and a few protozoans could exist. Midge larvae sometimes exist in unusually high densities (Underhill and Cole, 1967).

4.32 Peterka (1972) found the benthos of generally unstratified 20-year old Lake Ashtabula to be composed of mainly snails, leeches, dipterous larvae, fingernail clams, and mayflies. Because of its rather shallow average depth (four meters) and oxygen circulation throughout, it represented a transition between the strictly littoral life forms and those of the deep benthos.

4.33 The littoral zone is characterized by rooted vegetation, much of which is emergent. Pondweeds, water lilies, cattails, and bulrushes protrude through the water while other species such as coontail, elodea, stoneworts, and mud plantain vegetate the bottom. These plants as well as the substrate are covered with a thick growth of microscopic algae and animals. This community abounds in mayfly, dragonfly, damselfly larvae, and water bugs in addition to several species of snails, mussels, leeches, crayfish, fish, reptiles, and amphibians. It is a complex community involving high densities of individuals and diversity of species, which reflects generally the successional status and layered aspect of the association. Aquatic weeds would be expected to reasonably predominate much of the shallow water areas after several years. In the sheltered bays and inlets, their activity would lead to a series of plant populations that would ultimately produce a marsh. The species of plants involved might well be somewhat atypical of succession for the area because of the selective effect of the water level fluctuations, which would be greater than those of most natural bodies of water in the area, with or without the afore-mentioned 5-foot summer increase in pool depth. As a result of this, only those species which seem to be capable of surviving alternate submergence and emergence with some desiccation would succeed. (Further studies would consider the applicability of warm-season drawdown techniques to manage this vegetation. Disadvantages, such as that to recreation in the year of drawdown, would also be considered.) However, the retention of water would generally occur in the early spring of the year at which time active growth is still scanty, so the overall effect on aquatic vegetation might be small. In a waterfowl marsh, Kadlec (1962) found that the alternation did not affect many species but did encourage bulrushes and cattails where wet, and sedges where dry. Aquatic invertebrate populations were reduced. Bennett (1971) states that most aquatic plants are not affected by a drawdown and in the North this is not an effective way of plant control. In certain instances Bennett cites the increased growth of aquatic plants due to changes in water level; crawling invertebrates are generally adversely affected. In a Connecticut river, the level of which fluctuated below a hydroelectric dam, Fisher and LaVoy (1972) found that oligochaetes predominated on the most exposed sites and molluscs were least prevalent. Amnicolid snails and sphaeriids were able to endure the exposure however. High populations of carp, should they occur, would greatly reduce the diverse biomass in the littoral zone.

4.34 After a period of time the impoundment would become decidedly richer in aquatic biomass and diversity. Stream species would by-and-large disappear from the confines of the impoundment. For instance, few of the fish species (mostly minnows) presently in the stream are lake-tolerant species while species such as bluegills, northern pike, and white sucker, should do well in the reservoir. Similarly, few species of freshwater mussels would be expected to survive in the impoundment proper out of the 11 species now known to inhabit the river. However, some species are relatively ubiquitous and could exist in a microhabitat in the lake similar to that in the stream.

4.35 It would be expected that the portions of the river upstream and downstream from the reservoir would also be affected. Fish movements, both up-and-downstream, would be limited by the dam. It might be expected that fish from the reservoir would forage upstream and probably enhance the fishing value of certain stream pools.

4.36 Creation of the reservoir would have profound, and to date largely unpredictable, effects on the downstream lotic ecosystems. It is obvious that the permanent pool would intercept the normal stream "drift" components (mainly immature aquatic insects and amphipods). Stream "drift" is very important in providing a forage base for stream fisheries and would be lost to a reach of the Wild Rice River below the dam. However, the lake would also produce arthropods, but of generally different species. These organisms could be swept through the outlet works and contribute to downstream "drift". However, it is unknown whether the arthropods in the lake would behave in such a manner and occur in such numbers that a lentic source of "drift" would be significant or could replace the normal stream "drift". It is also unknown whether the arrangement of arthropod production areas and the outlet works would allow entrainment of significant arthropod biomass in the lake's outflow. It is recognized that the amount of suspended plankton in the Wild Rice River below the damsite would be significantly increased with the reservoir in place through entrainment of the larger (as compared with present stream conditions) plankton standing crops in the reservoir. It is likely, however, that the species composition would differ. Alteration of the plankton populations below the damsite could be important because many of the early life stages of the arthropods important in stream food webs obtain much of their food by trapping planktonic forms. The larger amounts of plankton below the dam could encourage greater arthropod production unless the proportion of blue-green algae, which is usually considered to be a poor forage base, is high. To compound the problems caused by lack of knowledge about the effects on the downstream area, the length of stream which would be affected is unknown. It is conceivable that the streambed immediately below the dam could be sufficiently productive to replace the normal "drift" from upstream reaches.

Productivity

4.37 Productivity of the land would be adversely affected through the foregoing of part of the periodic enrichment created by the siltladen floodwaters. However, this conclusion does not consider the (generally controllable) erosion losses during flooding. The distinction must be 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.

4.38 It is thought, as mentioned earlier, that productivity of the river is primarily limited by the lack of a stable substrate. The rather spectacular growths of green algae in the riffles attests to the general nutrient quality of the water. With the impoundment, this limitation would be removed and the productivity would increase. After the initial filling, much of the biomass would probably be in the planktonic forms and related food chains, but as eutrophication, aging, and succession progressed, littoral production would become more important. Peterka and Reid (1972) found the rather shallow (four meters average depth) Lake Ashtabula to be highly productive and eutrophic. Since the region from which the Wild Rice River drains is biologically very productive and the lakes are hardwater, eutrophic bodies of water (Moyle, 1956; Eddy, 1966), there is little reason to believe that the impoundment would not b eutrophic with time. Blue-green algae blooms and associated limnological events would be expected.

Plant Resources

4.39 In evaluating the significance of project-induced changes in the vegetation, one must consider not only the plants and plant communities present now, but the potential for the site under present climatic conditions. Potential vegetation, as defined by Kuchler (1964), is that which would be present today if unaltered by the white man. Since large areas have been drastically altered by man, present-day vegetation close to its potential on sites relatively free of man's influences is ecologically unique, valuable, and worthy of preservation.

4.40 The potential vegetation for most of the Red River Valley is bluestem prairie dominated by big bluestem, little bluestem, switchgrass, and Indian grass. Within the region of bluestem or tall grass prairie, natural forest is present only along the rivers and streams. This northern floodplain or gallery forest is dominated by cottonwood, willow, American elm, box elder and green ash. This potential mosaic of prairie and gallery forest extends eastward approximately to the area projected for the reservoir. Fifteen or twenty miles east of Twin Valley, the potential vegetation is more typical of northeastern and east-central Minnesota. Oak savanna, with scattered individuals of bur oak as the overstory and a mixture of grasses as the understory, soon gives way to the maple-basswood forest. Then, approximately 20 miles east of Twin Valley, coniferous forest species appear, containing balsam fir, white spruce, and tamarack. In brief, one might best describe the proposed reservoir area as lying on the ecotone or ecological boundary between the prairie to the west and the forest to the east. Many species, if not already present, might reach their eastern or western limits here should the area remain sufficiently undisturbed long enough for its potential to be realized.

4.41 Under the influence of man, the actual vegetation present in much of the region today is considerably different from the potential. Much of the original prairie has been plowed and converted to intensive agricultural use or is heavily grazed. It has been estimated that approximately one quarter of Minnesota's total land area of 84,068 square miles was once covered by prairie. A generous estimate of the amount of reasonably good prairie remaining in all types of ownership is about twenty square miles or one-tenth of one percent of what once prevailed (Lawrence, 1972, mimeograph). Much of the oak savanna has also been converted to intensive agriculture or is heavily grazed. The floodplain forests and the maple-basswood forests of today more closely approach their potential than does the prairie or the savanna. Although often disturbed by man as a result of grazing and lumbering, many stands are relatively undisturbed. Associated with the tree species in these forest communities are many of the shrub and herb species which would also be present under pristine conditions.

4.42 One of the most obvious effects of the proposed reservoir on the present environment of the area would be the direct loss of 540 acres of bottomland community types. These communities lie below the 1,063.0-foot contour interval and would be permanently inundated by the conservation pool. Although the total acreage of bottomland vegetation is relatively small, the bottomland forests are ecologically important because they are the only forest types close to maturity in the study area. Additionally, this is one community type which has not been significantly affected by man's activities and is therefore ecologically valuable. It has also been pointed out that floristically the bottomland forests and other bottomland types are markedly different from those occurring on the slopes or level upland. A number of species occur on the bottomlands which were found nowhere else in the area. None of these, however, are on Morley's (1972) list of rare or endangered plant species in Minnesota.

4.43 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.

4.44 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 on 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)."

4.45 Lago (1971) studied vegetation in north-central Minnesota in an area similar in many respects to the proposed reservoir site. In his study of floodplain vegetation along the Upper Mississippi, Lago compared stands located above a power dam constructed in 1909 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 does not reach the Twin Valley site, was significantly affected by the construction of the reservoir. This species was almost entirely restricted to upstream stands. Box elder, a less important species in his study area but found in Twin Valley bottomland forests, responded in a similar fashion.

4.46 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 the species exhibits a positive growth response following a flood, an observation confirmed by Lago (table 15).

Table 15 - A comparison of rate of growth (diameter in mm/year) for the major tree species above and below Lake Bemidji

Species	Above Lake Bemidji (mm per year)	Below Lake Bemidji (mm per year)
Silver Maple	5.08	5.00[a]
Paper Birch	3.50	3.74
Green Ash	4.76	2.56
Balsam Poplar	5.96[b]	5.26
Bur Oak	3.36	2.48
Basswood	5.94	4.74
American Elm	3.26	3.22

SOURCE: Lago, 1971.
[a] Rate of growth based on one core.
[b] Rate of growth based on two cores.

4.48 Germination, seedling establishment, and early development are also affected by flooding (or the lack of it) and the period of inundation. Hosner and Minckler (1960) found that box elder seedlings tolerate flooding quite well with green ash 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 occur in the study area. Table 16 is a comparison of sapling density and presence percentages above and below a dam (Lago, 1971). Green ash shows the highest absolute density both above and below the dam, but its relative density is significantly less in the downstream stands. A similar pattern exists for box elder. Not all the differences shown in table 16 can be ascribed to the direct effects of the flooding regime, however, since some of the species, notably balsam poplar and trembling aspen, respond tremendously to disturbance of the forest canopy. Disturbance of the canopy could be a direct effect of an altered flooding regime, however.

Table 16 - Comparison of presence and average density values for sapling species above and below Lake Bemidji

Species	Presence: Above Lake Bemidji (percent)	Presence: Below Lake Bemidji (percent)	Average density: Above Lake Bemidji (No./acre)	Average density: Below Lake Bemidji (No./acre)
Balsam Fir	10	90	2.1	9.7
Box Elder	70	20	30.9	2.4
Red Maple	10	40	10.1	46.9
Silver Maple	80	--	119.0	--
Paper Birch	10	80	4.0	5.2
Green Ash	100	100	885.4	868.2
White Spruce	20	--	6.5	--
Balsam Poplar	40	100	14.1	192.5
Trembling Aspen	10	90	4.0	104.0
Red Oak	10	--	2.5	--
Bur Oak	90	100	32.0	175.4
Basswood	60	30	12.2	19.6
American Elm	100	100	149.5	163.9
TOTAL			1,272.7	1,587.8

SOURCE: Lago, 1971.

4.49 A definite difference was also observed by Lago in the shrubby species. The lack of a well developed shrub layer in vegetation which is 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 a higher density in the downstream stands.

4.50 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 an increase in numbers of more mesic deciduous forest herbs and a decline of those more typical of wet bottomlands.

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

4.52 Disruption in vegetation patterns similar to those described above can be predicted for the proposed Twin Valley dam and 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.

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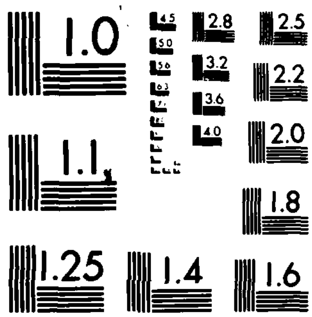

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

A significant decrease in the density of these species in downstream locations can be expected as the drier environment allows upland species of balsam poplar, aspen, bur oak and paper birch to dominate the old floodplain.

4.53 Over a time span of approximately 15 years, as the floodplain species of timber would die out and be replaced, a dense downstream shrub layer would establish itself below the dam. Two of the exceptions substantiated by Lago's work are the black haw and gooseberry, both common to the Twin Valley area. These species would probably experience a decline in downstream locales. The increase in most of the shrubby species below the dam would be the result of reduced flooding and the absence of prolonged periods of inundation.

4.54 Forest herbaceous species can also be expected to parallel the results of Lago (1971). The composition of the bottomlands in the upstream stands would remain unchanged and typical of wet bottomland types, or may show an increase in wet-adapted species. Below the damsite the hydric (wet-adapted) species would die off and be replaced by the mesic (moderate moisture-adapted) species.

4.55 The dam would probably affect vegetation downstream until major tributaries, such as the South Branch of the Wild Rice River, are reached. The 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.

4.56 While it is primarily the bottomland types which would be permanently inundated by the conservation pool, the design pool would occasionally inundate vegetation above the 1,100-foot contour interval, the approximate upper limit of the slope types. This means that communities not subject to periodic flooding would be occasionally flooded if the reservoir were constructed. Presently, slope elevation, direction, and angle seem to be the factors responsible for the characteristics of the slope stands. 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 shrub species below the upper limit of the design pool.

4.57 By comparing the density, dominance, and frequency tables for each community (appendix C) it can be seen that with the exception of some willows and cottonwoods which occur only in type I-A and black ash which is found only in types I-C and I-D, no tree species is restricted to a particular community type or topographic position. There are quantitative differences in a species from one type to another, but all the trees except for those mentioned can be found on the uplands and slopes as well as the bottomlands. Presumably this means that even if the design pool fluctuates, there would be a well-developed overstory of trees above contour levels that are rarely or only temporarily flooded. The nature of the understory is, however, in doubt.

4.58 Since the reservoir, even during periods of spring flooding, would exceed the 1,100 foot contour interval by only a few feet, most of the vegetation on the level uplands would be less noticeably affected than that of the bottomlands and slopes. Some quantitative changes in the tree species on the uplands adjacent to the reservoir might occur as a result of modification of groundwater levels. Very slight changes in depth of groundwater have been shown to have a significant effect on the abundance of several of the tree species which occur in the group III (upland) community types (Lindmeier *et al.*, 1961). Even if these changes do occur, the basic assemblages of species on the level uplands should not be significantly altered by the presence of the reservoir.

Animal Resources

4.59 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 may gradually be eliminated as the reservoir fills, other species may become more abundant and take their place. They would not be rapidly eliminated as would many of the terrestrial species.

4.60 Several authors have reported on the effect of permanent flooding upon wildlife and vegetation. Yeager (1949) has studied the effects of impoundment on an area 20 miles upstream from 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 correlated with the effects of Twin Valley Lake, 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.

4.61 In assessing the impact of a large dam (Garrison Dam in North Dakota) in an earlier paper Hibbard (1972) stated, "The obvious statement concerning the effect of inundation upon vertebrates is that it has augmented populations of fishes and other aquatic species and eliminated those vertebrates that require a terrestrial habitat."

4.62 A report written at the time of the initial filling of Garrison Reservoir (Hibbard, 1954) may best describe this impact. "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 large mammals, such as mink and raccoon, had apparently already vacated the area, for none were evident.

4.63 Large numbers of terrestrial birds were also eliminated by 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.

4.64 In contrast, populations of a number of species were increased by the formation of the reservoir. Chief among this group were the waterfowl. Use of the unimpounded Missouri River by these species was negligible except for minor use by late-season mallards and geese. By 1963, ten years after the closing of the dam, waterfowl use on the reservoir had reached a high of an estimated 460,000 birds (Enyeart, 1964). Several other bird species dependent upon fish or 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. Construction of reservoirs along the Missouri River has also concentrated wintering eagles, which may or may not be to the detriment of the species. Twin Valley Lake 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.

4.65 Effects upon terrestrial vertebrates resulting from smaller impoundments on the Red River of the North have been less spectacular, but similar to those discussed above. Two examples are Homme Dam on the Park River (North Dakota) and Orwell Dam on the Ottertail River in the vicinity of Fergus Falls, Minnesota. The operation and maintenance of these facilities are presently being evaluated from an environmental viewpoint, and while it is apparent that there are significant environmental problems, application of those study findings to the Twin Valley project must await the final environmental analysis of the Homme and Orwell projects.

4.66 A question frequently raised in connection with flood damage reduction projects is whether the project would induce upstream wetland drainage. In the case of reservoirs, it is the feeling of some individuals that this would occur, the rationale being that the upstream landowners are relieved of the responsibility to retain water on the land. Although few studies quantitatively dealing with this question have been made, it is felt that wetland drainage is controlled by various economic, legal, and social factors unrelated to the existence of downstream flood damage reduction works. That is, the social factors surrounding any increased downstream flooding do not weigh heavily upon consideration of drainage, and drainage is considered by landowners whether or not there are downstream protective works. The St. Paul District is presently conducting baseline studies for several proposed reservoirs, and post-project changes should be identifiable if the reservoirs are built. However, even if quantitative data on land use changes on the watershed become available, it will be difficult, it not impossible, to document the causitive agent(s). However, this matter is receiving continuing study.

4.67 Woodland species of birds would be one of the major groups of animals affected should the valley above Twin Valley be inundated. Based on a conservative population estimate of 300 breeding pairs per 100 acres, the habitat of about 1,620 pairs of breeding birds would be eliminated by the proposed 540-acre conservation pool. It is probable that 500 additional acres, or a total of more than 1,000 acres, would be sufficiently disturbed to eliminate the breeding of typical terrestrial woodland species. Thus, the reservoir might be expected to eliminate about 3,000 pairs of breeding birds. Additional pairs would be eliminated from upland sites due to dam building operations and parking site construction. This loss would be counterbalanced somewhat by the addition or redistribution of water-oriented species which are now infrequent in the area.

4.68 A review of the information given for terrestrial animals would indicate that the groups of birds and animals listed in table 17 would be chiefly affected.

4.69 Note that 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 counteracted by the addition of new species. As occurred 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.

4.70 Increased use of the reservoir area by migrant waterfowl may counteract to some extent the loss of wood duck habitat. Possibly this species may even increase at the upper end of the reservoir as was noted in the Illinois study (Yeager, 1949). Since the reservoir is largely surrounded by woodland, it is doubtful that a significant increase in other breeding waterfowl would occur, as flooded timber or the surrounding forest lands do not generally provide good waterfowl nesting habitat. The reservoir may be an asset to waterfowl by providing temporary habitat for migrating ducks, especially those of the diver group. This would not necessarily cause an increase in population levels, however. Rather, the waterfowl populations would be redistributed with the Twin Valley birds coming from other migration stop-over areas. It is for this reason that table 17 indicates a population loss for waterfowl (although it is recognized that there are many other pertinent factors in waterfowl management, and hence this approach is somewhat simplified).

Table 17 - Effect of the proposed Twin Valley Reservoir on resident bird and mammal species within the reservoir site [1]

	Population on reservoir site	Potential hunting per year		Population loss within reservoir site
	(No./1,000 acre)	(man-days/yr)	(1972 dollars)	(percent)
White-tailed deer	25	150-200	$900-1200*	100
Ruffed grouse	100-150	100	$300*	100
Wood ducks and other species	50	50	$225	50
Beaver	20	-	$200**	100
Fox	5	-	$125**	100
Mink, raccoon, etc.		-	$700**	0-50
Woodland birds[2]	3,000 pairs	-	-	90
Stream-side birds[2]	500 pairs	-	-	50

* Hunter recreational value only.
** Pelt value only.

(1) Adapted from Hibbard (1973). The population and recreational value of several game species which are rare or only of incidental importance in the study area have not been estimated. Examples are tree squirrels, rabbits, and Hungarian partridge.
(2) See table 13.

4.71 Although most of the true woodland bird species mentioned in table 13 would be eliminated, some species which frequent forest-edge or water-edge habitats should increase. Examples are kingbirds, several species of sparrows such as the song sparrow, and several of the warblers. Some "streamside" species such as the kingfisher, bank swallow and rough-winged swallow, which make nest burrows in high banks (such as are created by erosion in the occasional area where the river meets the edge of the bluffs) may be partially or entirely eliminated, although wave action on the lake would create other vertical soil banks. (The relative amounts of suitable habitat cannot be presently assessed, however.) This special type of nesting requirement is unique and scarce in flat or rolling grassland areas. The bank swallow would likely be replaced by a close relative, such as the tree swallow, which thrives in the habitat the reservoir would create.

4.72 While the pheasant, Hungarian partridge and prairie chicken occur in the area, the chief upland game bird affected would be the ruffed grouse.

4.73 The ruffed grouse has a huntable population both within the reservoir site and within the surrounding aspen-oak uplands. While this species might be especially prized in this area where it is at the western edge of its range in Minnesota, it is relatively common in the (mainly) deciduous forests of the upper Wild Rice watershed to the east. Its range in the Twin Valley area has been shrinking fast because of recent elimination of much of its former habitat of upland aspen forest. Hence, any loss of habitat in the area becomes significant for this bird.

4.74 The most important mammalian game species in the Wild Rice River watershed and the one that would be most affected by rising reservoir waters if the dam were built is the white-tailed deer.

4.75 This deer, although it is highly adaptable, requires brushlands or young or open forest for its best population growth. Even without the loss of forest lands within the proposed reservoir, this species faces a deteriorating habitat due to the increase in land clearing. Its position in relation to forest habitat is similar to that of the ruffed grouse. The "prairie deer" of western Minnesota and the Dakota's typically spread out from the larger areas of woody cover in spring. Many individuals move into the cultivated uplands at this time where they may remain throughout the summer and early fall. By late fall the cover afforded by natural herbaceous vegetation and row crops such as corn and sunflowers becomes scarce. At this time, deer move into any available woody or brushy cover, including floodplain forests. Thus, any loss of woody cover is especially critical to deer since it depletes their winter range. Availability of winter food and cover is usually considered the limiting factor for deer in this area. Loss of deer habitat is important since the deer population is very closely harvested (in fact, and also relative to the grouse population) and since deer license fees support a substantial part of the wildlife management effort in Minnesota. The loss to be occasioned by the deer herd because of Twin Valley Lake could be dismissed as insignificant on a State-wide basis, but it is worthy of thoughtful consideration within the context of assessing the cumulative effects of many small projects and within the context of the various Federal mandates concerning the overall public interest and requiring consideration of fish and wildlife values.

4.76 The effects of the reservoir upon the remaining groups of terrestrial animals would be similar to that just discussed. Larger vertebrate animals would simply move out, 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 high levels within the pool area and be eliminated. To the extent that the habitat of these various species becomes 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 flood storage pool area 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 would be replaced by aquatic representatives of those groups.

Endangered and Rare Species

4.77 Using Morley's (1972) list of rare plants in Minnesota as a criterion, the project, if implemented, would not be a significant threat to any rare or endangered plant species in the State. Of the 234 plant species recorded for the study area, only one, the yellow lady-slipper, (Cypripedium calceolus) is on Morley's list. This species has a broad distribution, but is not really common anywhere within its range. It should be pointed out that the reservoir area does lie in a region where a number of species reach (or might potentially reach) either their eastern or western limits. None of these species, however, are currently considered endangered.

4.78 The prairie chicken could be one socially significant "threatened" terrestrial vertebrate encountered. No project alternative evaluated in this statement would directly affect this species. However, if drainage of lands with high water tables along the old Agassiz beach line were encouraged, this could be detrimental to the species. Drainage tends to bring more lowland native prairie under cultivation. This is extremely harmful to prairie chickens. This bird is, as of this date, at least holding its own in what is its "last stronghold" in Minnesota. All possible precautions should be taken to preserve it. Such precautions cannot be seen as applicable to the proposed project at this time, however.

4.79 Several species of invertebrates and fishes were considered to be very uncommon for the area. Among these are the trout-perch and the pearl dace which are very restricted in their local distributions. For the neighboring State of North Dakota, Miller (1972) lists the trout-perch as an endangered species; in Minnesota it is not, however, threatened at present. In addition, the watershed does constitute suitable habitat for a rather high diversity of unionid clams for this region. Populations of these animals are adversely affected by the adulteration of the habitat through siltation and pollution which are affecting many of the nation's waters.

Recreational Impacts

Fishing

4.80 Utilization of the area for fishing as well as success in fishing could improve. Just as the deeper pools of the river held northern pike, walleye and rockbass, it would be expected that the fishery would be dominated by these species plus bullheads, and various sunfishes which are characteristic of productive warm water lakes. Carp could become a problem. For most of the species, spawning sites would be available, particularly at the inflow area of the impoundment. However, successful reproduction may be jeopardized for some species, such as the shallow-water spawners, if the retention of water for flood control followed by a quick drawdown coincides with egg-hatching and the early developmental stages of young fish. Further studies would attempt to achieve optimum balance between conflicting factors, such as the desire for good fish reproductive success by maintaining high spring water levels versus the corresponding undesirable effects of such a program on terrestrial biota. Basically, the existing stream fishery would be replaced by a lake fishery and, through active fishery management, could be much more productive assuming that certain parameters, such as water quality, allow effective management.

4.81 Winterkill would probably not be of significance because of the large water volume and the aerated water being introduced at the upstream end of the reservoir. If summer stratification would occur in the conservation pool, lower levels would suffer from inadequate oxygen, particularly as the reservoir progressed in eutrophication. Therefore, some attention would be given to the level from which water would be exhausted in order to preserve as large a volume of aerated water as possible.

4.82 Several scenic and recreational topics not directly associated with fishing have been briefly mentioned previously. These will now be discussed in more detail. Most of these sports are stream related.

Canoeing

4.83 Canoeing is a rapidly growing sport in Minnesota. Wild, fast-flowing rivers are especially desirable for canoeists, and the Wild Rice River fits several of the conditions necessary for this sport. It has a fairly steep gradient, providing just enough of the element of danger to make an interesting trip but not enough to be actually dangerous. It is quite wild and well forested throughout the region of the reservoir site with only one visible sign of habitation between the Peterson Bridge and the

Twin Valley Bridge. On the adverse side are the numerous rocks and boulders which are found throughout much of this stretch of the river. Also during low water periods there are short stretches of the river which are of insufficient depth to float a heavily loaded canoe. Despite these inconveniences, this stretch of the river is desirable and increasingly used for canoeing. Several people reported taking trips in 1972, especially during time of high river flow. With 100,000 people in the Fargo-Moorhead area about 50 miles away there is an increasing need for this type of recreation. The State of Minnesota has not designated the river as a canoe route nor have any intentions been made known of including it in the State scenic and wild rivers system. Creation of a lake could discourage the use of this section of the river by river canoeing enthusiasts, as the scenic meanders of the river would be replaced by an open expanse of water. The reservoir would be used for lake canoeing, and the overall capacity of the basin to support canoeing would be increased. Because of the differing natures of lake and river canoeing, the with versus without project comparison then involves both quantitative and qualitative comparisons. The presence of outboard motors incident with the use of the lake by fishermen or the power boating public would be detrimental to the use of the lake by canoeists. However, there will be consideration given to maintaining the lake as a non-motor area. Furthermore, there are numerous lakes in the upper watershed and the region which are presently available for motor-oriented water sports, while free-flowing rivers providing a semi-wilderness setting are becoming scarce. The portion of the river under consideration as a reservoir site, with its deep gorge cutting through the Agassiz beach line, is one of the most scenic portions of the river. The effect of the reservoir in altering the aesthetic qualities of the valley would be a matter of personal taste with some individuals feeling there would be a positive effect and other concluding the contrary.

Snowmobiling

4.84 This sport has undergone a rapid growth in Minnesota in recent years, especially in the region under question. The importance of this industry to the region is indicated by the numerous dealerships located in the area towns and the presence of several manufacturers in northwestern Minnesota. During the winter of 1972-73 there was a heavy use of the Wild Rice River floodplain and particularly of the stream itself by these vehicles. This use was noted all along the river in the Ada, Twin Valley and Mahnomen area.

4.85 The sport has its controversial aspects due to noise and abuse by the vehicle with respect to wintering wildlife. The frozen surface of a lake would provide a large, open area that would be very desirable to snowmobilers who are not generally welcome on private land. The presence of such a "course" may reduce the environmental impacts on the terrain, vegetation and wildlife of the floodplain forest. However, damage to the surrounding terrain could still occur through irresponsible use of the vehicle. Restricting access points and use of the snowmobile to the reservoir proper could reduce this harm, assuming that restrictions are effective. Present plans call for control of access points and no snowmobiling on project lands.

Motorcycling

4.86 There is a motorcycle "hill-climbing" site on the south side of the river midway along the reservoir site. If the sport is to continue, the participants would have to find a new site.

Hiking, Camping and Scenery-Viewing

4.87 Although there are choice areas for camping and hiking within the reservoir area, the region remains quite rural and is too near the fine lake region to the south, east, and north to receive much use from non-local recreationists. There are some excellent views, however, of the gorge of the Wild Rice River from several vantage points on the south rim. In any case, the local region is deficient in several categories of recreational facilities which the project could provide. These and other recreational aspects of the project are discussed in appendix C of the phase I general design memorandum.

Impacts of Construction

4.88 Temporary, but unavoidable, air, noise and water pollution would be expected during the construction phase of this project. Contractors would be required to comply with existing Federal, State, and local regulations governing air, noise and water pollution. Noise pollution would affect both humans and wildlife during actual project construction, even with noise pollution control devices such as mufflers on construction equipment. Air pollution would be caused by internal combustion engines and also by machinery movement creating dust, even with such appropriate measures as sprinkling. Burning of trees, debris, brush and snags removed from the reservoir area during clearing operations would also cause air pollution. Neither the air nor noise pollution is expected to cause the death of any large organisms, but significant irritation to both human and wildlife populations in the project area could result. The Corps would observe the work of the Contractor in an effort to reduce impacts, but would not specifically monitor the project as regards water quality effects of the construction activity.

4.89 Construction of the project would also generate impacts which cannot as yet be closely identified. For example, the procurement of fill material would impact upon the environmental setting in the borrow areas, but the identification of such impacts must await the final identification of sources of material. Also, some impacts, such as the amount of turbidity and sedimentation caused by construction, depend upon unpredictable factors such as streamflow and rainfall during time of construction. Although suspension of sediments in the water is temporary, the resultant siltation on downstream areas is permanent for practical purposes. However, as noted earlier, the lake would also trap sediments which would otherwise go to downstream reaches.

5. ANY PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

5.01 Temporary and unavoidable adverse impacts include dust and siltation of the river as well as noise and unsightliness generated by construction of the project.

5.02 Productivity would be lost on agricultural lands within the proposed project areas including those acquired in fee title or easement for possible tree planting or other habitat creation for the purpose of mitigation.

5.03 Specific long-term adverse impacts relate to the elimination of floodplain forest, a lesser amount of cropland or hayland and associated wildlife, and alteration of 14 miles of stream bed by the creation of the reservoir with attendant effects on aquatic ecological characteristics detailed previously and below. Certain adverse impacts, if not permanent, can be considered to be prolonged for the physical 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.

Aquatic Resources

5.04 The major modification in the stream environment would be directly associated with the change from a running water condition to that of a standing water condition. In this regard, physical and chemical parameters of the stream such as depth and temperature would increase while light penetration and dissolved oxygen would decrease, all to the detriment of the present stream ecosystems.

5.05 Eutrophication of the reservoir pool would result as runoff from the watershed and pool fluctuations increase algae and plankton production which is, at present, low. Organic decomposition would further augment productivity. This situation could also lead to the establishment of rough fish populations which usually are successful in outcompeting game fish in a degraded body of water.

5.06 Erosion of bank soils from runoff and pool fluctuations would increase the suspended soils load and add materially to the siltation of the reservoir, covering and destroying stream bottom species.

5.07 Any reduction of dissolved oxygen and smothering by siltation would reduce diversity and abundance of aquatic organisms. This would deplete the lower trophic levels of the food chain, and the corresponding reductions in secondary production up through the food chain would be unavoidable. Siltation could destroy the productivity of spawning areas, and the success of species spawning in shallow water could be low to nonexistent due to pool level fluctuations.

5.08 Fish could be effectively trapped in the reservoir and prevented from reaching downstream fishing areas. Also, they would be blocked from passing through the reservoir area to upstream reaches.

Vegetation

5.09 Approximately 540 acres of ecologically unique bottomland vegetation would be initially flooded and destroyed by the permanent pool. 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.

5.10 Communities not generally subject to flooding would be periodically submerged within the design flood pool up to an elevation of approximately 1,104 feet. The adverse impacts associated with periodic inundation would be proportional to the 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 changes in the groundwater levels. As downstream areas are deprived of periodic inundation, productivity and numbers of wet-adapted plant species would decrease as they are replaced by those that are dry adapted.

Animals

5.11 Here again, adverse impacts would extend to disruptions of current community stability through the elimination of animal species requiring a terrestrial habitat or bottomlands for food and shelter from the elements or predators. Population losses within the pool area would range from 50-100 percent of the existing populations of such animals as white-tailed deer, grouse, wood duck, beaver and mink. Of more significance is the fact that the losses are occasioned by losses of habitat, and hence are permanent for practical purposes. The habitat for more than 3,000 pairs of breeding woodland birds would be lost through construction of the reservoir and associated recreation sites. The losses would occur within the conservation pool area and some of the adjacent area within the design flood pool.

Recreation

5.12 Elimination of a particularly desirable section of a winding, free flowing river would represent an adverse impact to the sport of river canoeing. However, present use is low and there is a surplus of canoeing streams in the region, given accepted criteria.

5.13 The quality of the upland game hunting experience would be adversely affected as reservoir encroachment onto wildlife habitat and use of the recreational facilities would discourage wildlife utilization of the area.

5.14 If snowmobiles were allowed on project lands and the frozen pool, adverse impacts would be expected. As noted earlier, this would be considered in a supplementary environmental assessment covering the recreational plans for the project.

Social Effects

5.15 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.

5.16 Various protective, remedial and mitigative measures could be developed to minimize adverse effects or compensate for losses. Studies necessary to justify and formulate such measures would receive emphasis during the next phase of project development.

6. ALTERNATIVES TO THE PROPOSED ACTION

6.01 Alternatives to the proposed plan have been studied in various combinations during the formulation of the project plan. A number of nonstructural and structural measures have been considered. Since Federal and State laws and regulations pertaining to nonstructural measures are based upon the intermediate regional flood, this flood frequency is used in discussing nonstructural alternatives. The non-structural alternatives provide for reductions in flood damages primarily to urban types of flood problems. 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, 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 slightly different. These plans impact upon different sectors of the public in different ways and to differing degrees with social and economic consequences. The economic analysis for all alternatives subjected to benefit-cost analysis used a 100-year period of analysis, a 5 7/8 percent interest rate, and January 1974 price levels.

Nonstructural Alternatives

No Action

6.02 One alternative would be to do nothing in terms of a federally financed flood damage reduction program. This would transfer the major burden of flood damage problems to the various communities involved irrespective of disaster relief and flood insurance subsidy funds available. It is extremely doubtful that the local units of government could secure the funds to construct a major flood damage reduction project of the magnitude proposed without assistance from the State of Minnesota or the Federal Government. The financial liability then, would probably preclude any large structural project on the local level. Under an alternative of strictly no action, flood damages amounting to an average annual loss to the national and regional economy of $1,082,000 would remain.

6.03 "No action" in a strict sense of the term is not possible, however, because under the Flood Disaster Protection Act of 1973 (Public Law 93-234) local government agencies are very strongly encouraged to adopt floodplain regulations and qualify for the flood insurance program. Environmental impacts of this alternative would therefore be those applicable to the floodplain regulation and flood insurance alternatives to be discussed later in this section. The "no action" alternative was in effect eliminated by Public Law 93-234.

6.04 "No action" can also be construed to mean no action by the Corps of Engineers. This would not preclude action by the local people or by another agency. For example, more than half the damages in the watershed are agricultural damages, and they could be reduced by altering farming methods or kinds of crops. This would require action primarily by the local people and by the U.S. Department of Agriculture and would have secondary impacts on the human environment.

Flood Warning and Emergency Protection (Plan 1)

6.05 Flood warning consists of predicting the timing and magnitude of floods to allow for evacuation of flood-prone areas or erection of emergency flood protective measures. The National Weather Service currently provides area officials and local news media with flood forecasts and warnings. 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. 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.

6.06 Flood warnings with subsequent emergency actions could alleviate about 5 percent of the total flood damages in the Wild Rice and Marsh River watersheds. Over $1,025,000 average annual flood damages would remain. Because of the uncertain nature of the costs for providing flood warnings and emergency protective actions, the net benefits of this plan cannot be estimated and it is not known whether such a plan would be truly beneficial. Accuracy of the flood warnings and adequacy of the emergency actions taken would play a large role in determining actual costs and benefits of such a plan.

6.07 Use of this alternative alone would mean continued anxiety for the residents during flood seasons and community disruptions during actual floods. Damages would remain very 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 of river stages and flood damages would vary among the plans.

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

6.09 The environmental impacts of this alternative are essentially the same as for "no action", flood insurance, and floodplain regulation.

Permanent Floodplain Evacuation (Plan 2)

6.10 Permanent evacuation of the floodplain would involve removal and relocation of all buildings from the floodplain and permanent conversion of lands to uses less susceptible to flood damage. Evacuation would eliminate nearly all damages to structures to the frequency of protection desired and would constitute a very hazard-free solution to the problem to the degree desired. Cultural features which would have to be relocated include the entire community of Ada and rural farmstead structures. About 140 businesses, 695 residences, and 10 public buildings at Ada; about 380 rural farmsteads, which include residences, other buildings, and stored crops; and about 20 other rural residences would be affected. Evacuation of Ada and the rural floodplain community to a flood-free area would require moving the structures and population about 10 miles eastward into the escarpment area. One of the more suitable locations for such a relocation might be in the vicinity of the city of Twin Valley, about 12 miles east of Ada. Land which would be freed for other uses could be available for cropland after all structures had been removed. However, lands required at the relocation site would most likely be taken out of crop production.

6.11 Probably no significant net changes in land use would occur, although up to about 760 acres of windbreaks at the rural farmsteads might be cleared to provide additional acreage for crop production, since the primary purpose of a windbreak would no longer exist if the farmsteads were removed. Moving farmsteads to the east might also tend to concentrate the relocated populations in a city rather than spreading them through the rural area since advantages of living on the acreage being cultivated would no longer be applicable. First costs of floodplain evacuation are estimated to be about $57 million. Due to the large costs and the limited economic benefits, the benefit-cost ratio is only about 0.1 to 1.

6.12 The plan would alleviate about 38 percent of total flood damages in the Wild Rice and Marsh River watersheds. However, agricultural crop damage would not be reduced, and an estimated $672,000 average annual flood damages would remain in the floodplain area. Existing community patterns and farm-to-market relationships would be substantially changed. Added economic burdens would be placed on farming operations due to the commuting distance required. This plan does not have the acceptance of the local people and would impose many social disadvantages compared to those advantages gained by removing developments from the floodplain. The exact relocation sites would have to be determined to fully assess the environmental effects; however, they would probably be relatively minor.

Flood Proofing (Plan 3)

6.13 Flood proofing may be successfully applied as a combination of structural changes in and adjacent to existing flood prone properties as well as in the design of new buildings and facilities for the purpose of flood damage reduction. 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. Several days duration of flooding and appreciable flood depths would cause seepage through the walls of most structures even with effective sealing of doorway and window openings, however.

6.14 The use of this alternative alone would result in elimination of only 22 percent of annual flood damages, and continued development of floodplain land, although more expensive, would result. The benefit-cost ratio is 0.3 to 1.

6.15 Considerable but short-term social disruption would result during structural modifications. Social effects of flooding during severe floods, such as disruption of transportation; isolation of residents from their homes, businesses, and farming operations; and well contamination would remain. Implementation of this plan would have no net beneficial effects to agriculture which is basic to the livelihood of area farmers and indirectly affects most urban residents in the area.

6.16 Environmental impacts would be mild, however, as no disturbances of river corridor vegetation or aquatic organisms would be necessary.

Flood Insurance (Plan 4)

6.17 The National Flood Insurance Program was created to curb the continually increasing annual losses from flood damage and was intended to be an alternative to structural programs and to be a method of reducing direct Federal disaster relief. For structures already existing in the floodplain, a high percentage of the 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.

6.18 Flood insurance is available within a community when an application for community eligibility has been approved by the Federal Insurance Administration. As of the date the Federal Insurance Administration approves the application, which must include land-use control measures, flood insurance is available on all existing and new construction within that community. Federally subsidized flood insurance is currently available to residents of Ada and of rural areas in the flood-prone portions of the lower Wild Rice River Basin. 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.

6.19 Although it does not prevent flood damages from occurring in the short term, flood insurance would assist property owners in recovering from flood damages. One of the major problems with this alternative is a general unwillingness of property owners to participate in the program, and in the project area only a few residents are taking advantage of the available insurance program. The lack of acceptance is due 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, and thus plan 5 must be a part of this plan. 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).

6.20 Based on current actuarial rates and Federal subsidized limitations, the total cost for complete flood insurance coverage (including crop insurance) would approximate $1,750,000 annually, of which Federal and non-Federal annual costs would be about $1,125,000 and $625,000, respectively. The total cost of flood insurance coverage for damages to structures caused by floods having a one percent frequency or greater chance of occurrence during any single year would approximate $300,000 annually. Federal and non-Federal annual costs of this coverage would be about $100,000 and $200,000, respectively. Average annual damages of $1,082,000 would remain during the period of analysis.

6.21 The economic and social impacts for residents of the floodplain would probably be great under this plan since it would internalize the costs of floodplain development more than any other plan. The public not residing in the floodplain would corresponding 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. The impacts of this alternative on floodplain ecosystems would be non-existent unless or until floodplain land use changed. Because the recommended plan would not provide protection against the one percent flood, this alternative would be applicable regardless of project construction, although the area of applicability would be somewhat reduced.

Floodplain Regulation (Plan 5)

6.22 Floodplain regulations are designed to modify land use and development in order to lessen the future effects of floods. Such measures require adoption and use of legal tools by local governmental units to control the extent and type of development permitted on the floodplain. This approach is in general agreement with the goals expressed by the Federal Flood Insurance Program, the Water Resources Council report, and the courts (Kusler and Lee 1972). Included in these goals are minimizing public expenditures, protecting life, and preventing or reducing flood damage to property. Restricted land use in flood-prone areas can be a major factor in reducing the economic impact of flooding.

6.23 Norman County has adopted a floodplain management plan based on the sparse available information. As more data accumulate, the regulations will be adjusted accordingly. As noted earlier, 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 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 (A floodway would not be designated, 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.

6.24 Floodplain regulation measures include zoning regulations, subdivision regulations, building codes and bridge construction regulations. However, damages to crop production and existing developments rather than potential increased damages to future structures and facilities constitute the major flood problem under study. Although this plan has a favorable benefit-cost ratio of 1.8 to 1, floodplain regulations would alleviate only about 8 percent of the total estimated annual damages. With floodplain regulations in effect, remaining average annual damages to crop production and existing development would approximate $992,000 during the period of analysis.

6.25 Strict floodplain regulations do have some adverse effects also. 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 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 is nearly impossible for the owner of that property to sell it at an acceptable price, and this in turn can result in large financial losses to some individuals, particularly at a time when they may be forced to relocate elsewhere for personal reasons. Some floodplain regulations forbid maintenance activities on flood-prone property to increase the rate at which it will deteriorate and depreciate in value in an attempt to speed up the rate of removing undesirable developments from the floodplain. Such very restrictive regulations would have adverse effects upon community appearance and pride.

6.26 The initial effects of an effective floodplain zoning program would generally be adverse to those people owning flood-prone property. In addition to the financial hardships, the floodplain regulations would have social and aesthetic effects in those areas where extensive developments were allowed to deteriorate to a point of uselessness before being torn down and the residents relocated. On the other hand this alternative would primarily affect those individuals that have developed in the floodplain and would not create extensive effects on the human or natural environment at some distance removed from the problem area.

6.27 Because the recommended plan would not provide protection against the one percent flood, under State law floodplain regulations would remain in effect regardless of project construction (although the area of applicability would be somewhat reduced).

6.28 Biological impacts of this alternative would be positive, particularly in the long term and to the extent that adverse effects of other alternatives are foregone.

Combination of Floodplain Evacuation, Flood Proofing, and Floodplain Regulation (Plan 6)

6.29 This plan would consist primarily of the salient features of plans 2, 3, and 5. Those residences which are subject to greater than a 2-foot depth of flooding on the first floor, with occurrence of a one percent chance flood, were considered to be most reasonable to relocate by floodplain evacuation. Businesses and those residences subject to less than a 2-foot depth of first-floor flooding were considered most reasonable to flood proof. Floodplain regulations would be used to assure that future floodplain developments would be constructed so that floods up to and including the one percent flood would not cause damage. There would be about 40 homes to be relocated, and the rest of the homes and businesses in the floodplain area would be flood proofed. The community of Ada would remain in place, although the residences and businesses would have to be modified.

6.30 There would be about a 32 percent reduction in total flood damages along the Wild Rice and Marsh River watersheds, with the greatest reduction in damages being a 71 percent reduction of the urban flood damages at Ada. The agricultural crop damages would not be reduced by this plan and as such would constitute the majority of the remaining average annual damages of $737,000. The benefit-cost ratio is 0.4 to 1.

6.31 Social inconveniences of implementing this plan have been considered separately under headings for each component of this compound alternative. Under this combined plan, however, considerably fewer residences would require relocation and, thus, any hardships of relocation would be reduced.

6.32 There would be biological benefits because evacuated areas would be ecologically enhanced as these floodplain areas were returned to a more natural condition.

Structural Alternatives

Channel Modifications on the Wild Rice River (Plan 7)

6.33 With this alternative (see figure 4 for the location and extent of plans 7 through 14) the Wild Rice River main stem would be enlarged and straightened from near Hendrum (mile 7.25) to the Marsh River diversion structure (mile 42.8) in order to contain the 15-year and more frequent flood. Flow to the Marsh River diversion would be restricted to its existing capacity during the design flood. Between mile 7.25 and mile 27.3 the river would be enlarged and straightened by means of oxbow cutoffs. From mile 27.3 to mile 42.8 (Marsh River Diversion Structure) the river would be enlarged only. The surface width of the channel would vary from 120 feet to 200 feet and the depth would vary from 10 feet to 21 feet. About 20 miles of the stream which would be altered under this alternative is "natural", not having been channelized in the past.

6.34 This plan would require 1,380 acres of land including 90 acres of cropland, 595 acres of lowland woods, 95 acres of unchannelized river low-flow water surface area, 50 acres of channelized river low-flow water surface area, 60 acres of unchannelized river secondary channel and bank area and 490 acres of channelized river secondary channel and bank area. Of the above, 650 acres are under Federal ownership and were acquired during a channelization project completed in 1954. The 650 acres are composed of 120 acres of lowland woods, 480 acres of channelized river secondary channel and bank area, and 50 acres of channelized low-flow water surface area.

6.35 The benefit-cost ratio is 0.8 to 1 with about 50 percent reduction of flood damages.

6.36 The typical stream pattern of intermittent pools and riffles, such as occurs on the Wild Rice River and as discussed in detail in the Environmental Setting section on stream resources, would be almost completely eliminated by channeling. (The detrimental effect of channeling on wildlife, particularly aquatic life and fisheries, has been well-documented in the literature (Emerson, 1971; Harnik, 1972; Hansen and Muncy, 1971; Reed, 1971).

6.37 A brief review, however, would be beneficial. Reed (1971) described the reduction of fish populations due to channelization projects in two States. On a 350-foot section of a Montana creek, trout production was reduced from 20 pounds to one and one-half pounds following dredging. In North Carolina, game fish production was reduced by 90 percent because of another channeling project. Henegar and Harmon (1971) have discussed additional detrimental effects of channeling. These include downstream flooding, sediment damage, lack of groundwater recharge, and fishery and wildlife losses.)

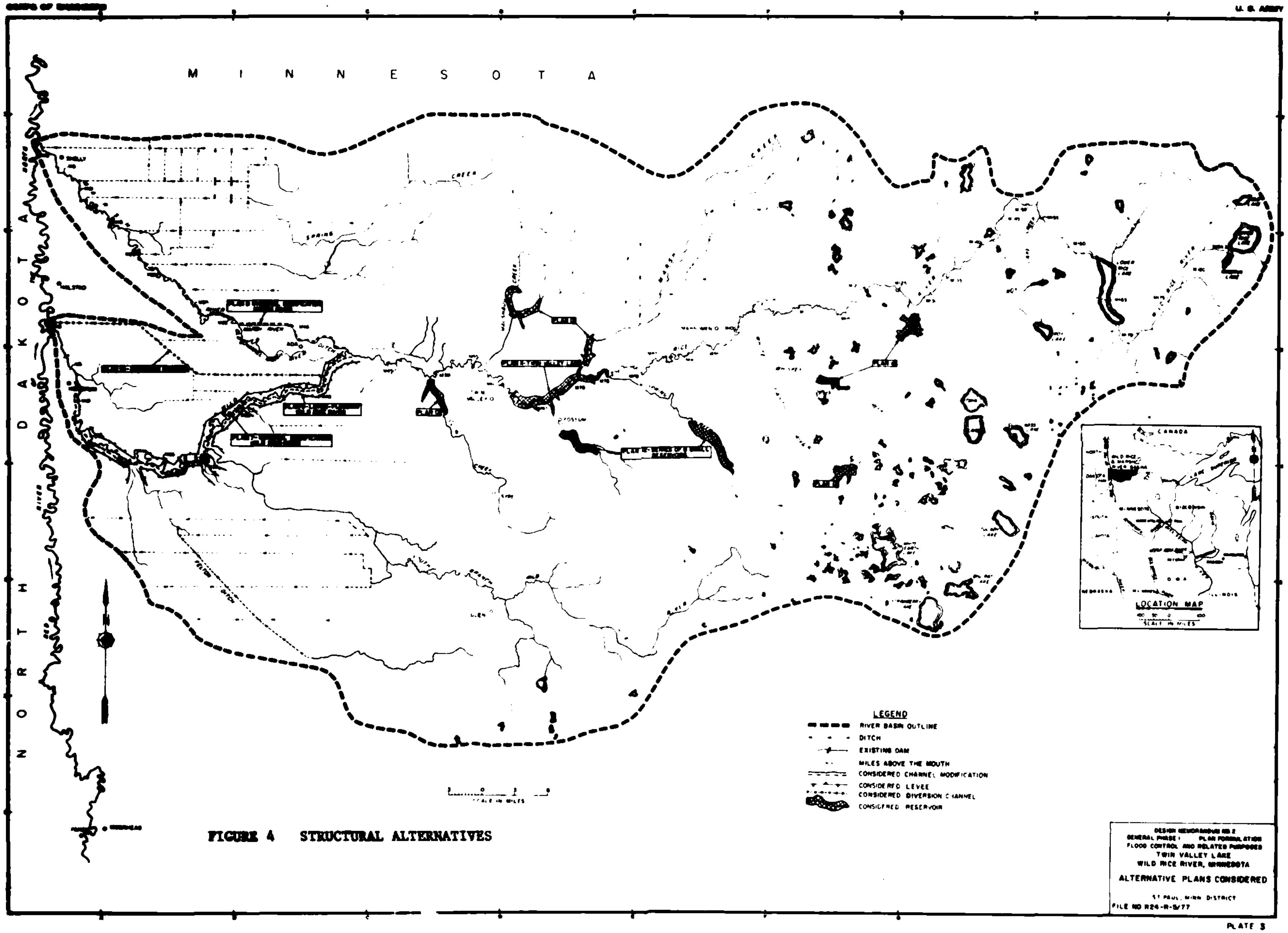

FIGURE 4 STRUCTURAL ALTERNATIVES

6.38 Emerson (1971) has given additional detail on erosion and sediment damage. In a study carried out in Missouri on the Blackwater River, he found that channelization has increased its width from about 28 feet to as much as 219 feet over a 60-year period due to erosion. At one point on the river, progressively longer bridges were constructed in 1930, 1942, and 1947 and each collapsed because of erosion. Basing his work on county records, Emerson states, "Erosion since channelization has averaged 1 m (meter) in width and 0.16 m in depth per year." Therefore, the straight "runs" and the uniform depths and widths that are artifically produced by channelization create features that contradict the physics of a river and its natural meandering (Leopold and Langbein, 1966).

6.39 In summary, the stream channelization alternative usually has very severe biological impacts. If the work were to be accomplished in the manner of the past, the expected destruction of stream bank plant and animal communities attendant with excavation of the Wild Rice River could be considered nearly total.

6.40 The vegetation along the main stem of the Wild Rice River considered for channelization is essentially the same as that found in the reservoir site, although below the ancient Lake Agassiz beach line the gallery forest becomes a narrow fringe of riparian growth. From qualitative observations made by Hibbard (1973) on river reaches previously excavated, channeling appears to have the same effects on forests on floodplains no longer flooded as were described downstream from dams. These effects have been previously discussed along with the interpretations made by Lago (1971), Johnson (1971), Hibbard (1972) and Lindmeier, et al (1961). Briefly, these authors found that floodplain forests which are no longer subject to regular flooding undergo a "drying out" which reduces the growth rates of some plant species and produces increases in species which cannot tolerate flooding. There were concomitant decreases in species which can tolerate considerable flooding.

6.41 The changes in vegetation toward a drier habitat has a distinctive effect on the resident animals. In the Ada area, animals adapted to the early stages of succession, such as the cottontail, are more common than in the near-climax type forest found on the reservoir site. There appears to be little information in the literature as to the effect of channeling upon terrestrial organisms. One recent study by New (1972) involved three streams in Indiana that had: (1) undergone channeling 20 years previously, (2) were channeled in 1971 or (3) were natural (never channeled). His studies indicated that channeling had little effect upon the total number of species using the area but that the total number of birds was reduced. Fifteen avian indicator species showed substantial declines due to channeling. Two species of warblers, which are most typical of riparian and early successional undergrowth, were substantially reduced by channelization. These two species (plus the Veery) showed a marked reduction in populations on a study area below Garrison Dam in North Dakota between 1959 and 1968 (Hibbard, 1972). This effect was also due to "drying out" of the habitat because of a lack of flooding following the closure of Garrison Dam.

6.42 From one-third to one-half of the "cut-off" loops of the Wild Rice River caused by the 1954 channelization still contain water. (For information on environmental impacts of the 1954 project, see the 1973 report by A.D. Little, Inc.) There has been sufficient time for sediment to fill in these abandoned sections (This is a process that also happens to oxbows found under natural river conditions.) A considerable mileage of stream is lost by this type of project. The portions of abandoned river that do remain are normally of lesser value to wildlife, although they may have some value for wood ducks and shorebirds.

6.43 With this alternative, channel excavation and oxbow cutoffs can be expected to have a definite effect on terrestrial animals, particularly the avian populations using the area.

Channel Modifications on the Marsh River (Plan 8)

6.44 This plan would involve enlargement of the Marsh River channel from mile 20 to the junction between the Old Marsh River channel and the Marsh River Ditch (mile 35.2). The Marsh River Ditch would be enlarged from its junction with the old Marsh River channel to its junction with the Wild Rice River (mile 45.15). A 15-year frequency flood on the Wild Rice River above the diversion structure would be controlled to limit flows continuing down the Wild Rice River to existing capacity. The surface width of the channel would vary between 100 and 150 feet and the depth would vary from 6 to 15 feet.

6.45 This plan would require 815 acres of lands including 135 acres of cropland, 320 acres of lowland woods, 50 acres of unchannelized river low-flow water surface area, 70 acres of unchannelized river secondary channel and bank area, and 240 acres of water surface and bank area along previously channelized stream reaches. Of this area, 170 acres are under Federal ownership acquired for a previous channelization effort. The 170 acres includes 8 acres of channelized river secondary channel and bank area and 74 acres of diversion ditch secondary channel and bank area. The benefit-cost ratio for this plan is 0.7 to 1.

6.46 Environmental impacts for this alternative could be expected to parallel those previously described for plan 7 insofar as channel modifications through excavation is concerned. Less detrimental results can possibly be predicted for the Marsh River Ditch portion of the modifications (mile 35.2 to 45.15).

Levee and Floodway System (Plan 9)

6.47 With this plan flanking levees would be built along the Wild Rice River from 14 miles upstream of its mouth to the Marsh River

Diversion (mile 42.8). The floodway would contain a 15-year flood, with flow to the Marsh River diversion restricted to its existing capacity during the 15-year frequency flood. The floodway width between levees would vary from 1,200 to 1,500 feet, and the height of the levee, from 2 to 6 feet.

6.48 This alternative would cover (by levees) or inclose (riverward of the levees) 4,630 acres of land, including 1,810 acres of cropland, 20 acres of pasture, 1,930 acres of lowland woods, and 870 acres of miscellaneous lands, including farmsteads and 650 acres of Federal lands previously mentioned under plan 7.

6.49 With this plan, 255 acres would be covered by the proposed levees. This includes 155 acres of cropland and 100 acres of lowland woods. The remaining 1,655 acres of cropland required for the project and lying riverward of the levees could continue to be farmed. Some additional area riverward of the levees could also become available for alternate uses such as agriculture because about 30 farmsteads and 5 other residences would have to be moved.

6.50 This plan has a benefit-cost ratio of 0.5 to 1 with flood damage reduction of 43 percent.

6.51 In terms of environmental impacts on stream resources and adjacent plant and animal communities, a floodway of levees is less damaging than the other structural alternatives considered. Floodways are outside the main channel and are less damaging ecologically because while trees and shrubs are removed little streambank excavation is required. Wildlife and fishery values are not decimated by the removal of stream side vegetation and natural pools and riffles.

6.52 About 100 acres of lowland woods would be lost through construction of the levees. However, the grassed levee slopes could provide attractive habitat for wildlife species such as upland game birds.

6.53 This alternative would allow the river to periodically reclaim part of its floodplain and in so doing, preserve its biological associations.

6.54 The floodways and levee system would be built on about 155 acres of land presently utilized for agricultural purposes, and continued cultivation of at least some of the land inside the levees would be possible so that agricultural production on these acres would not be totally lost.

18-Mile Diversion Channel (Plan 10)

6.55 This plan consists of an 18-mile diversion channel between river mile 1 and mile 40.6 of the Wild Rice River. The Wild Rice River channel would be enlarged from mile 40.6 to the Marsh River diversion at mile 42.8. A diversion structure on the Wild Rice River at mile 40.6 would, during a flood of 15-year frequency, divert flows in excess of the natural channel capacity to the diversion channel. The proposed diversion channel would follow the path described by County Ditches 1 and 24. The surface width of the channel would vary from 130 to 200 feet, and the depth would vary from 6 to 12 feet.

6.56 This alternative would require 720 acres of lands consisting of 615 acres for the diversion channel and 105 acres for channel modifications in the Wild Rice River. The diversion channel requirement of 615 acres consists of 80 acres of existing drainage ditch channel area plus 535 acres of adjacent cropland. The channel modification requirement of 107 acres includes 5 acres of cropland, 20 acres of lowland woods, 9 acres of channelized low flow water surface area (federally owned), and 71 acres of channelized river secondary channel and bank area (federally owned).

6.57 This plan would provide for a 33 percent reduction of damages in the Wild Rice and Marsh River watersheds with a benefit-cost ratio of 0.5 to 1.

6.58 The physical nature of the county ditch system is such that relatively slight permanent ecological harm would occur through implementation of this alternative. However, the reach between mile 40.6 and 42.8 is a "natural" stretch of river that would undergo enlargement through excavation. Environmental impacts associated with this stretch of the river would be identical for those described for plans 7 and 8.

Twin Valley Lake (Plan 11)

6.59 Twin Valley Lake is the proposed plan for flood damage reduction in the Wild Rice River Basin and is discussed elsewhere in this report. As noted in section 1, the proposed embankment location is about one mile upstream from the location as set forth in the authorizing document. For pertinent data on the project at the authorized damsite see appendix L. For a comparison of the projects at the two sites see appendix M.

6.60 The changes in the project in going from the authorized site to the alternate site include slightly higher elevations for project features (although the storage capacities would be the same); a higher benefit to cost ratio (1.23 as compared with 1.14); an increase in required lands of 35 acres of upland forest, 25 acres of lowland, 35 acres of cropland, 385 acres of natural habitat, 10 acres of other lands; one more bridge modification; and an increase of 0.12 percent in loss in tax base for Norman County. Parameters which decrease in going from the authorized site to the alternate site include a lower Federal first cost by $1.8 million (with a corresponding decrease in area redevelopment benefits), 5 fewer acres of meadow required, a 15-acre decrease in the size of the permanent pool as well as 10 fewer acres of pasture required. Social impacts would then be similar for the project at either the authorized or alternate damsite while the alternate site would involve more positive economic impacts and more negative biological effects.

Series of Eight Small Reservoirs on Upstream Tributaries (Plan 12)

6.61 This alternative would involve eight small reservoirs on tributaries of the Wild Rice River upstream of Ada, Minnesota. The reservoirs would be located on Twin Lake Creek, White Earth River, Spring Creek, Marsh Creek, Fossum Creek, Maushaug Creek, Coon Creek, and Whiskey Creek. The total surface area of the permanent pools would be 790 acres and the total surface area of the design flood pools would be about 2,690 acres. The flood control storage of these reservoirs would total 26,700 acre-feet.

6.62 This alternative would require 3,320 acres of land, including 1,225 acres of cropland, 240 acres of pasture, 56 acres of farmsteads, 390 acres of lowland woods, 10 acres of conifer bog, 120 acres of marsh or meadow, 10 acres of farm windbreak, 30 acres of marginal lakes, and 20 acres of natural unchannelized low-flow water surface area.

6.63 The acreages cited include the total required in fee or under easement. About 790 acres would be permanently inundated while most of the remaining 2,530 acres would be temporarily inundated during floodwater storage. A small amount of the acreage would be required to round out ownership parcels.

6.64 This plan has a benefit-cost ratio of 0.5 to 1 with a 28 percent reduction in damages.

6.65 The accompanying table from Hibbard (1973) summarizes information and his recommendations concerning alternate damsites for small reservoirs in the Wild Rice River drainage. The criteria Hibbard used in making recommendations included assessing the value of the site as agricultural land, determining the amount of gallery forest, and predicting fishery or waterfowl potential.

TABLE 18. SUMMARY OF ALTERNATE DAM SITES WITH RECOMMENDATIONS AND COMMENTS, WILD RICE RIVER BASIN, MINNESOTA

No.	Stream	Location	County	Recommendations and Comments
1	Coon Creek	SW24 T144 R45	Norman	Some loss of shrubby woodland and deer habitat, little loss of cropland. An undisturbed prairie could be preserved. Recommended.

TABLE 18. SUMMARY OF ALTERNATE DAM SITES WITH RECOMMENDATIONS AND COMMENTS, WILD RICE RIVER BASIN, MINNESOTA (Cont.)

No.	Stream	Location	County	Recommendations and Comments
2	Maushaug Creek	SE34 T145 R44	Norman	Contains excellent gallery forest similar to the Twin Valley Reservoir site. Deer and ruffed grouse are common. Not recommended.
3	Fossom	SE6 T143 R43	Norman	This site is a good storage area but has some well wooded portions. Not recommended or with reservations.
4	Marsh Creek	SW9 T144 R43	Norman	Mainly pastured forestland with steep, erodable banks. Not recommended because of loss of woodland.
5	Spring Creek	SE4 T143 R42	Mahnomen	Flat, lowland prairie. Tree growth is minimal. Heavily drained areas upstream from site contribute to flooding. Excellent waterfowl potential. Highly recommended.
6	White Earth	SW13 T143 R41	Mahnomen	Water storage capacity is good, but some gallery forest would be lost. Not recommended unless water storage is vitally needed.
7	Whiskey Creek	W23 T144 R41	Mahnomen	Chiefly pasture and hayland. Some cropland would be lost if used. Has good waterfowl potential. Recommended.
8	Twin Lakes	SW35 T145 R40	Mahnomen	Site would be largely on lowland prairie. Area surrounding it is mainly pasture and hay land with some small grains. Excellent prairie relics occur. Excellent waterfowl potential. Highly recommended.

Table 18 (Continued)

No.	Stream	Location	County	Recommendations and Comments
9	Upper Maushaug	Sec. 28, 29, 32 T146 R43, Sec. 5 T145 R43	Norman	Presently a shallow marshland area. Additional water would produce excellent waterfowl habitat. Highly recommended.
10	Upper Marsh	Several possible sites	Norman	This area is upstream from site no. 4 but not so heavily wooded. The area has been largely drained and there are several possible sites for water retention which would do little damage to agricultural land. Needs further investigation.

6.66 The Spring Creek and Twin Lakes Creek sites (No. 5 and No. 8) have excellent waterfowl potential and would restore water in a region that has been heavily drained. Both are in nonagricultural use at present except for some pasturing on the Spring Creek site. The Twin Lakes Creek site would have the added advantage of having several islands and a great amount of shoreline useful for breeding pairs of ducks. Some adjacent waterfowl habitat is already present, but less is available than is indicated on maps because recent drainage has been prevalent.

6.67 The Coon Creek and Whiskey Creek sites (No. 1 and No. 7) both show potential for waterfowl with little or no loss of forest. Most of the land utilized at these sites would be noncropland. The Whiskey Creek site is largely pasture and hayland while the Coon Creek site has the added advantage of containing some excellent native prairie (big bluestem, little bluestem, Indian grass, etc.) that could be saved without taking additional land. Most of the prairie area would be above the possible water storage area. There would be some loss of deer habitat at Coon Creek.

6.68 Alternate sites No. 2, 3, 4 and 6 were not recommended by (Hibbard) or only with reservations because of the large amount of woodland present. Tree species occurring are the same as those found on the Twin Valley Lake site except that one additional species, black cherry, was found at Maushaug Creek.

6.69 Most of these 10 sites are in an earlier stage of succession than the Twin Valley site, and thus furnish better habitat for game. The small linear areas of woodland are vital for the ecological balance of the area and should be saved. Portions of the Marsh Creek and Fossum Creek sites, while less valuable as forest land than the Twin Valley site, still contain some excellent wildlife habitat. The White Earth River area was not sufficiently studied (except at site 6) to give detailed information on vegetation and wildlife.

6.70 Four of the tributary damsites (Coon Creek, Spring Creek, Whiskey Creek, and Twin Lakes Creek) could be potentially beneficial to the wildlife of the watershed by providing wetland acres and habitat for nesting, feeding and protection. Unfortunately, the four alone would not provide the flood protection desired. In this regard, additional alternate damsites could be sought such as those mentioned at the end of table 18 that would provide for flood damage reduction without the habitat destruction that would accompany construction at sites 2, 3, 4 and 6.

6.71 Chemical, physical and biological changes (e.g. lake aging) similar to those predicted for the proposed reservoir would occur, but on a much reduced scale, in the alternate impoundments if they were constructed. The smaller impoundments would definitely not stratify, however, and the effects attributable only to stratification earlier in this report would not occur. The smaller size, shallower bowls, inadequacy of "flushing", and, in certain instances, high nutrient levels, would probably lead to a faster rate of eutrophication and succession so that the final results would not be biologically unlike the large ponds and potholes of the region.

Twin Valley Reservoir and a Series of Small Reservoirs (Plan 13)

6.72 This plan consists of the combination of plan 11 (Twin Valley Lake) and plan 12 (Series of Eight Small Reservoirs) as previously described. This plan was developed in an effort to provide a greater degree of protection for flood damage prone areas. The benefit-cost ratio is 0.6 to 1.

6.73 The average annual flood damages in the Wild Rice and Marsh River flood prone areas would be reduced by about 66 percent with the greatest reductions occurring at Ada and in the agricultural areas where flood damages would be reduced by about 86 percent and 60 percent, respectively. Flood damages would be reduced along the Red River of the North by this plan, as is also true for plans 11, 12, 14 and 15. There would be 13 farmsteads and 5 other residences relocated. About 6,400 acres of land would be required for this plan, including about 1,590 acres of cropland, 450 acres of pasture, and 4,220 acres of "natural habitat." There would be the permanent conversion of about 1,345 acres of various tracts of cropland, wildlife habitat, and free-flowing stream into nine permanent bodies of water, the largest being over 500 acres in size and the remainder being on the order of 100 acres each.

6.74 The environmental impacts of this plan amount to a summation of the impacts detailed for each of the two plans considered separately. The additional acreage converted to a standing water condition would provide for increased recreational opportunities; however, it would come at the expense of a considerable number of ecological associations.

Twin Valley Reservoir and Channel Modifications on the Wild Rice River (Plan 14)

6.75 This plan would consist of the main stem Twin Valley Lake as described earlier in addition to channel modifications along the Wild Rice River quite similar to those described in plan 7. The increased channel capacity downstream would allow greater discharges from the reservoir without causing flood damages and would allow for greater control of floods.

6.76 The benefit-cost ratio is 0.7 to 1. This plan would provide for reduction of average annual flood damages in the Wild Rice and Marsh River watersheds by about 89 percent, with substantial reductions of flood damages in all categories. There would be some reductions of flood damages along the Red River of the North, although perhaps somewhat less than for plan 11 because of the higher reservoir release rate with this combination plan. There would still be about $110,000 of remaining average annual flood damages in the Wild Rice and Marsh River watersheds.

6.77 There would be four farmsteads relocated with this plan, and about 4,460 acres of land would be required, including 455 acres of cropland, 210 acres of pasture and 3,725 acres of "natural habitat".

6.78 There would be about 1,220 acres of woodland and 40 acres of wetland directly affected by this plan, either by permanent inundation or clearing. About 49 miles of stream would be affected, 34 miles of which have not been previously channelized or affected by other major construction projects.

6.79 The environmental effects of this plan would result from a major change from terrestrial habitat to aquatic habitat in the reservoir area and a loss of streambed and bank habitat through channel modifications, as previous detailed under the consideration of each alternative separately.

Twin Valley "Dry" Dam (Plan 15)

6.80 This plan would consist of a large earth-fill dam similar in location, features, and construction as that described in plan 11, Twin Valley Lake, except that no permanent recreation pool would be maintained upstream of the structure. There would be limited recreation facilities planned in conjunction with this alternative. The flood control effectiveness of this plan is comparable to that of plan 11.

6.81 The first cost of this plan would be about $14.8 million. The average annual costs and benefits are estimated at $992,000 and $875,000 respectively, providing a marginal benefit-cost ratio of about 0.9. The general social and economic effects of the plan are quite similar to plan 11, with the same number of homes, businesses, and agricultural acreage receiving flood protection and the same degree of flood damage reduction provided to the flood-prone areas. The lands to be acquired for plan 15 would be about 3,000 acres including about 535 acres of pasture and cropland, about 2,395 acres of natural habitat, and about 70 acres of other lands. Of these lands, about 1,700 acres along about 14 miles of stream would be subject to periodic inundation due to the intermittent and temporary storage of floodwaters upstream of the structure. About three farmsteads would need to be relocated, one bridge would require modification, and about 3 miles of highways and utilities would need relocation.

6.82 For any given flood, a slightly smaller acreage would be inundated by the "dry" dam (as compared with the "wet" dam) during the early years of the project. The "dry" dam would impact upon a smaller area initially, but it would affect an incrementally greater area during floodwater storage.

6.83 The "dry" dam would have a somewhat lower overall trap efficiency with more sediments passing downstream of the dam. The uncaptured sediments would primarily be of smaller particle size, with the coarser sediments tending to be deposited at lower elevations within the pool nearer the old river channel, and at the upper end of the pool. The finer materials would more generally blanket the pool bottom. During time of high flows but no storage, the river would be able to pick up some of the previously deposited materials and sweep them to downstream reaches. A lesser ability to trap and hold sediments would make the "dry" dam less desirable in this regard.

6.84 After drawdown, the waterlogged sediments would be void of vegetation except for the woody materials protruding through the sediments, "trash" deposited on and intermixed with the sediments, and along a briefly-inundated band along the pool perimeter. Existing herbaceous vegetation in the deeper parts of the pool would be buried, and in the case of floods during the growing season, killed by the water plus sediment deposition. While not subject to burial, trees in the pool would be killed by changes in soil conditions, and trees around the perimeter would be weakened. In comparing the effects of the "dry" and "wet" dams upon intermittently flooded vegetation, the "dry" dam would have greater impact because the greater depth of sediment deposition would exacerbate the direct effects of submergency found with either dam alternative.

6.85 The pool area would then consist of a central area of sparse weedy growth ón a soft substratum, a surrounding band of relatively lush early successional growth and weakened and dead treas, and the existing vegetation above the pool's zone of influence. The economic or wildlife habitat value of the pool bottom would be low to nonexistent. However, management of surrounding project lands could be expected to increase wildlife populations on the uplands, although the net effect would still be negative. Stream fishery resources and canoeing opportunities would also be adversely affected. Because of the effects of a "dry" dam upon vegetation, it seems that most "dry" dams are converted to "wet" dams once they have been put into operation. Biologically, this would seem desirable, or of little consequence, since the biotic communities in the pool area would be preserved as long as possible. Subsequent conversion to a "wet" dam is less desirable, however, in the sense that exclusively "dry" dam features would represent sunk costs and since the structure may not permit optimal operation as a "wet" dam.

6.86 An alternative which could reduce adverse impacts in the pool area would be to increase downstream channel capacities. The required downstream channel enlargement would have environmental impacts as set forth in the section on channel modifications. Because the channel enlargement would have little effect in alleviating adverse impacts in the frequently-flooded, silt-laden pool bottom, the net environmental effect of a higher release rate with downstream channel modifications would be decidedly adverse.

6.87 The major difference between the "dry" and "wet" dam alternatives is the presence of a 540-acre permanent pool behind the "wet" dam. While the "dry" dam would not entail the biological costs associated with creation of the permanent pool, the biological benefits would also be lower. Foregone would be the advantages of creating a lake, although the merit of this factor depends upon the quality of the impoundment, which is questionable at present due to foreseeable problems with water quality, in-lake fishery management, and the shore zones. A second advantage foregone would be the ability to regulate aquatic conditions downstream, although the merit of this factor depends upon the quality of water which would be released from the impoundment and upon ultimate balancing of management goals for the lake and for the river downstream. These factors would receive attention during further studies.

6.88 Since the "dry" dam would not encourage water-based recreation, the majority of the recreational opportunities associated with Twin Valley Lake would be foregone with the "dry" dam alternative. The "dry" dam could encourage some recreation, however. For example, some lands would be in public ownership and therefore more available for land-based recreation than they were when in private ownership.

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

7.01 The implementation of the proposed project would result in a flood reduction program which is designed to protect the Wild Rice River Basin from flood flows of a once in 53-year frequency. This in itself is a short-term use of the environment that does not recognize the long-term productivity of the natural areas required for the project. Recreational opportunities created and freedom from anxiety from small floods on the part of the residents of the flood prone areas would be positive impacts resulting from the short-term use of the environment.

7.02 However, the short-term benefits accruing from the proposed project as a result of increased crop yields and reduced damages to structures within the protected area are not self-sustaining. A continued input of the resources are necessary to maintain alterations of the natural ecosystem. Also, productivity of the land would be adversely affected through the foregoing of part of the periodic enrichment created by the silt-laden floodwaters. The distinction is drawn here between reduced basic productivity and project-induced increased crop yields which the farmer would realize in his lifetime through reduced flood losses.

7.03 The natural ecosystem, now in existence, represents an integrated system in nature, sufficient unto itself. Natural life support communities such as the floodplain forests and wetlands of the Wild Rice River Basin are capable of storing energy. Disruption of this system would permanently alter its present capabilities.

8. ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

8.01 The human resources, construction materials and depreciation of equipment used to construct and maintain the project features comprise an irretrievable commitment of resources because the resources invested could not be practicably recovered. The use of energy to operate the equipment and the resources required to generate the energy would also be lost.

8.02 Crop production on the agricultural lands within the project area, including any acquired for mitigation, would be lost for the life of the project.

8.03 Beyond the irretrievability of construction efforts, the basic commitment of a natural river system, its associated habitats and floodplain forest below the 1,104-foot contour, would be essentially irreversible.

8.04 The fundamental characteristics of the river would be altered from a shallow, rapidly flowing waterway to essentially a standing water lake. A permanent loss of the present bottom and streamside habitats, ecosystems and most aquatic organisms would result.

8.05 Ecological balances in the river-woodland ecotone vegetation would be irreversibly altered or destroyed, and the maintenance procedures and pool fluctuations would probibit reversion to the natural regime for a period of time beyond the physical life of the project. This represents an irreversible commitment of valuable habitat for game species.

8.06 Animal populations currently inhabiting the impoundment area would undergo permanent alteration either through outright elimination by the rising water levels, siltation and water chemistry changes, or by migration from the area. In the case of the latter, elimination would ultimately follow.

8.07 Aesthetic resources changed by the project would also be irretrievably committed to project (and related) purposes.

8.08 In the final analysis, all resources committed to the perpetuation of the basic problem of floodplain development having damage potential would be irretrievably lost.

9. COORDINATION AND PUBLIC INVOLVEMENT

9.01 Coordination with Federal, State, and local interests was an important part of these post-authorization studies. Special coordination was maintained with the Citizens Advisory Committee of the Wild Rice River Watershed District. The committee was composed of a cross section of individuals from the Wild Rice River Basin representing civic and conservation groups, key figures in rural and urban communities, and a State Senator and State Representative. Interested Federal and State agencies served as technical advisors to the committee.

9.02 A total of 16 citizens advisory committee meetings were held throughout the investigation. The committee provided valuable assistance in keeping the public informed about the status and progress of reformulation studies and actively solicited from all concerned citizens their opinions and views regarding possible solutions. Further, the committee provided a definite contribution in assessment of impacts on the existing resources and evaluation of all alternate solutions including selection of the proposed plan. All committee meetings were open to the public, and pertinent information discussed at the meetings was disseminated through the news media. The meetings culminated in adoption of a position paper by the committee supporting the selected plan and covering proposals which should be taken into account during further studies.

9.03 All interested Federal and State agencies were informed of initiation of post-authorization studies and have been contacted during project reformulation and development on all phases that would affect their interests. An interagency governmental coordination meeting was held in the project area after distribution of the draft general design memorandum and draft environmental impact statement to further apprise interested agencies of the alternatives considered; the tentative selected plan; and the economic, biological, and social impacts of all plans considered. A field tour of the project area was made in conjunction with the meeting to give agency representatives a better background for evaluating the recommended plan.

9.04 A late stage public meeting was held on 8 January 1975, and a discussion of the meeting is included in the final general design memorandum.

9.05 Copies of the draft environmental impact statement were furnished to the following agencies and interest groups. Those who returned comments on the draft statement are noted with an asterisk and their letters are presented in the Letters of Comment section as noted below.

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Ada Development Corporation	
Citizens Advisory Board	
Clean Air, Clean Water Unlimited	
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Izaak Walton League	
Minnesota Conservation Federation	
Minnesota Environmental Control Citizens Association	
Minnesota Environmental Education and Research Association	
Minnesota Public Interest Research Group	
National Audubon Society	
Northern Environmental Council	
Sierra Club	
Soil Conservation Society of America	
Center for Environmental Studies, Bemidji State College	
Fresh Water Biological Institute, University of Minnesota	
Institute for Ecological Studies, University of North Dakota	
Water Resources Research Institute, North Dakota State University	
Tri-College University	
Mr. Ronald Thorsrud	
Mr. M. R. Durling	
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9.06 In addition, copies of the draft environmental impact statement were sent to the following libraries where they are available for public review:

Moorhead Public Library
Library, Ada, Minnesota
Environmental Library of Minnesota, Minneapolis
Library, Concordia College, Moorhead
Library, Moorhead State College
Library, North Dakota State University, Fargo
Library, University of Minnesota, Minneapolis
Library, University of North Dakota, Grand Forks

9.07 Discussion of Comments Received:

U.S. ENVIRONMENTAL PROTECTION AGENCY

1. Comment: We have environmental reservations regarding the project and believe that more consideration should be given to an alternative that would be more environmentally compatible in achieving the desired flood protection for the basin. Additional information should be provided in the EIS to fully assess the environmental impacts of the project. Our primary concerns relate to the project's effects upon water quality, natural land resources, and bottomland wetlands.

1. Response: Other alternatives which are more environmentally compatible can provide reasonable degrees of flood protection for the basin. These alternatives are discussed both in the alternatives section of the EIS and in the phase I general design memorandum. Although there are alternatives which are more environmentally compatible, they do not meet the requirements of economic efficiency or social well-being necessary to provide an overall acceptable project. Additional information and discussion on your areas of concern are contained in the responses to your more specific comments in the following paragraphs.

2. Comment: The EIS should indicate whether the loss of the 7,500 acre-feet reserved for recreation and sedimentation over the 100-year life of the project has been factored into the project's costs. Also, since benefits have been assumed for protection of transportation systems, it should be indicated whether road relocation and other transportation costs required by the project have also been computed as part of the project's costs.

2. Response: The benefits and costs are evaluated in the phase I general design memorandum. Appendix C of that document assumes the fishery value of the pool to decline over the 100-year period of economic analysis due to the loss of pool volume and area through sedimentation, as well as to the usual pattern of a high initial fishery value with a subsequent decline.

The recreation use projections take into account the decline in the fishery and the reduction in size and volume of the permanent pool. The economic analysis therefore takes sedimentation into account by reducing the benefits claimed as sediment accumulates.

Road relocation costs are included as a project cost. Project benefits claimed include reduced flood damages to roads and bridges.

3. Comment: We note that the proposed dam is designed to handle flows up to and including the 1.9% design flood. The benefits that this design will have on areas further downstream should be clarified as compared to the benefits of other alternatives. The EIS should indicate if this project assumes any flood protection benefits that the flood control project on the South Branch Wild Rice and Felton Ditch would provide.

3. Response: The alternatives evaluated were selected for their ability to reduce flood damages in areas subject to flooding from the Wild Rice and Marsh Rivers. Table K-1 in appendix K of the EIS indicates if flood control benefits are realized by the alternatives in the downstream areas along the Red River of the North. Only those alternatives which include reservoir storage provide reductions in flood damages along the Red River of the North. Table M-1 in appendix M of the EIS gives detailed information regarding the distribution of benefits for the selected plan between the Wild Rice and Marsh River reaches and the downstream reaches along the Red River of the North.

For infrequent floods, there are up to about 1,500 acres adjacent to the South Branch Wild Rice River and the Felton Ditch near their respective confluences with the Wild Rice River which are subject to flooding from both rivers. Appropriate distribution of the damages and benefits accruing to this acreage has been made between the Twin Valley Lake project and the South Branch Wild Rice River and Felton Ditch project. Sentences noting that both projects would reduce flood damages in the confluence area have been added to paragraph 2.141.

4. Comment: The EIS should include a soils map of the project because of the excessive erosion conditions in the area.

4. Response: Studies as detailed as the one suggested are undertaken during development of the phase II general design memorandum (GDM) and subsequent feature design memorandums. Studies at the feasibility and phase I GDM levels largely are reviews of existing information and are intended to establish (in this case) the feasibility of the reservoir concept. It is therefore assumed that problems such as the one cited would be feasible to control, and funding will be made available to cover the problems. Additional information concerning erosion problems is contained in comment/response 17.

5. Comment: A better description of the natural flow conditions on the Wild Rice River should be provided. Information regarding the 7-day once in 10-year low flow, average seasonal flows, and median flows should be included.

5. Response: The information has been added to paragraph 2.68.

6. Comment: We believe that the available existing water quality data is insufficient and should be supplemented with additional data. We are aware that a monitoring program has been set up in the watershed to provide more water quality information for the project area. We recommend that monitoring stations be located upstream and downstream of the proposed reservoir site. For your information, we have attached a copy of some STORET water quality data applicable to the subject project area.

6. Response: The inadequacy of existing water quality data is recognized, and it is correct that a water quality monitoring program has been initiated at the Twin Valley gauging station. Further studies will include estimation of loading factors for the proposed reservoir, and a monitoring station upstream of the reservoir site will be considered as a possible method to be used in the study. The STORET water quality data included only one sampling at Twin Valley (9 September 1966) while the majority of the data were from the U.S. Geological Survey gauging station at Hendrum. This latter information covers a 3-year period from 1971-74 and is presented as simple mean values for each parameter with no reference to flow or time of year. These results are of little predictive value in their present format. Maximum and minimum values could suggest areas for future investigations. Further studies will include a reanalysis of the STORET data in relation to flow weighted averages and seasonal trends.

7. Comment: The Wild Rice River is classified as Category 2B, fisheries and recreation, by the State Water Quality Standards. The quality of this designated class shall be such as to permit the propagation and maintenance of cold and warm water sport and commercial fishes and be suitable for aquatic recreation of all kinds, including full-body contact. A determination must be made within the EIS of the effect that this project will have on these water quality standards and the measures that will be utilized to minimize these effects.

7. Response: Water quality would be of concern both during construction and operation of the reservoir, and these matters will receive attention during further studies. During project design, consideration will be given to design modifications, if possible, which would minimize the effects of construction on water quality. Also, the contract specifications for construction will include specifications to protect water quality. The effects of project operation are treated in a following comment-response.

Data available would suggest that remaining sections of the river would still meet State criteria for 2B-type fisheries and recreation waters. However, future studies on the trophic status of the reservoir and effects of various operational plans will be examined in view of the above classification.

8. Comment: The EIS should determine the type of trophic conditions in the proposed reservoir that will exist due to the spring flush of agricultural lands containing macronutrients. The first step would be to collect water quality data needed to assess the nutrient budget. Using this data and mathematical models or studies like those undertaken by our National Eutrophication Research Center, an estimation of the expected trophic conditions for the proposed reservoir can be better defined, particularly with regard to the potential for the reservoir to become eutrophic.

8. Response: Existing water quality data of value has been summarized, and while limited, it has been used to draw the conclusion that the reservoir would become eutrophic with time. A contract has been negotiated with the U.S. Geological Survey for measurement of water quality parameters at Twin Valley. The measurements will continue for a period of at least 2 years, provided funds are available. Reservoir loading data will be collected during further studies. The data and appropriate available techniques will be used to predict the trophic condition of the reservoir. The practicability of implementing corrective measures will also be determined during these further studies.

9. Comment: While available water quality data are insufficient to make accurate predictions of expected water quality impacts, it is stated in paragraph 4.38 of the EIS that the impoundment would be strongly eutrophic with blue-green algae blooms.

9. Response: While we agree that the existing data are insufficient, the intent of the paragraph was to make the best prediction possible. Instead of the paragraph stating that the reservoir would be "strongly eutrophic", it now reads "eutrophic with time" because: (1) The words "strongly eutrophic" are not particularly more precise or better defined than "eutrophic"; (2) The limited data do not allow identification of the degree of eutrophication; and (3) The words "in time" were inserted to note that the effect would occur, but not immediately after pool filling.

10. Comment: According to Ragotskie's method which was judged in the EIS to be applicable to the project, it was stated that the proposed Twin Valley Lake would stratify. The effects that spring overflow and fall underflow would have upon Ragotskie's predictions should be addressed. Relative to the discussion on page 54 of the draft EIS of the expected effects of overflow and underflow upon stratification and the fact that flows during the summer are considerably reduced, a discussion of the maximum and average seasonal flushing periods that could occur should be presented.

10. Response: Paragraph 4.23 has been revised to more clearly set forth the expected effects of inflow into the reservoir. These effects and their ramifications will be considered during further studies.

11. Comment: The current levels of phosphates and nitrates indicated as being in the flowing stream may cause an accelerated rate of eutrophication to occur in the reservoir. This situation could be further affected by additional lands upstream being brought into agricultural production because of the improved price structure for agricultural commodities. Increased nutrients from these areas would be trapped in the proposed reservoir. Presently, forested areas that were once considered marginal are now being cleared for crop production throughout the Wild Rice River watershed. This practice is likely to continue into the future without abatement as long as a favorable price structure exists.

11. Response: The effects of changing land use practices on reservoir loading factors are recognized and will be considered during further studies.

12. Comment: The long-term secondary water quality effects of the proposed project should be addressed in detail.

12. Response: Concur; as such effects are identified, they will be presented in supplements or revisions to the EIS as appropriate.

13. Comment: Secondary effects might include project-induced development around the reservoir, increased drainage of remaining wetlands and lowlands for agricultural uses upstream and downstream of the project, and improvements of local transportation systems.

13. Response: Under the preliminary land use plans, all project lands would be used for project purposes which are flood control, recreation, and fish and wildlife. We encourage the State, county, and other local governmental units to implement, within their authorities, land use controls for lands adjacent to the project lands to assure that the land uses in the area are in the best interest of the public. It is recognized that other reservoir projects have induced considerable nearby development. This is not foreseen for Twin Valley Lake because of its relatively small size and remoteness from large population centers. Also, there are many other lakes in the general region which would possess more developable perimeters in terms of land use controls.

The possibility of induced upstream drainage is recognized in paragraph 4.66. In paragraphs 4.08 and 4.09 it is recognized that there would be developmental pressure on downstream wetlands and lowlands although the nature and extent cannot be identified. The economic analysis for the project does not claim economic benefits for intensification of land use.

The road relocations associated with construction would result in some betterment to roads in the area, and costs have correspondingly been apportioned to non-Federal interests. Other effects on local transportation systems would consist of reduced flood damages to highways and bridges in the flood prone areas. These are claimed as benefits of the project but are not seen as inducing other improvements in the local transportation systems.

14. Comment: The maintenance of a fishery in the proposed reservoir appears highly speculative considering the lack of shallow areas to support fish reproduction and the adverse effects of water level fluctuations. It should also be noted that water quality downstream of the reservoir would be affected by the reservoir design and operation. If the water discharged is of lower quality than existed prior to reservoir construction, then the effect is the same as that caused by a pollution source.

14. Response: The existing information on fisheries has been reexamined, and the comments of others have been incorporated. While these matters would require, and will receive, further study, the analysis still indicates that a good fishery is possible during the earlier years of the impoundment, assuming that other management goals for the project would allow the same.

One of the management goals would be to minimize reductions in downstream water quality. Further study will be required to determine the optimal balance among these, and other, management goals.

15. Comment: The total environmental, social and economic effects of this project on water quality should be determined and made an integral part of the agency's decision-making policies.

15. Response: Concur. The limited data available indicate that there would be water quality problems associated with the project. These problems and potential solutions will be studied in future, more detailed project designs and investigations.

16. Comment: We note that the alternate operating plan of Twin Valley Lake includes the holding of the summer pool level up to 5 feet above the currently designated permanent pool elevation of 1063.0. The effects of this plan due to the inundation of vegetation above elevation 1066.0 could adversely impact plant communities below elevation 1068.0. A better description of the operating time schedule of this plan's higher pool levels and its repercussions upon terrestrial habitats and flood levels in the event of summer storms should be detailed. We further note that uncleared plant communities above elevation 1068.0 would be periodically inundated up to elevation 1104.0 The EIS should include a discussion of the effects of different storm frequencies upon the affected plant communities, including an explanation of the extent and duration of inundation.

16. Response: The current plan includes a permanent pool elevation of 1063.0 and clearing of trees up to elevation 1066.0. If the 5-foot raise in the summer pool were included, clearing would be done up to elevation 1071.0. This was not discussed in paragraph 4.19 which mentions this option.

Under the optional plan the changes which would be expected include:

1. A lesser biomass of aquatic macrophytes would be found below elevation 1063 because the overlying waters would vary from 5 feet or more deep during the summer to 0 feet, or a little more, during the winter.

2. The cleared terrestrial zone between 1063 and 1066 under the present plan would be in the littoral zone during the summer and "dry" during the winter. The zone from 1066 to 1068 would also be cleared, would be in the littoral zone during the summer, and would be "dry" during the winter.

3. Clearing would be required between 1068 and 1071.

Storage of spring floods would not have significantly different effects on vegetation above elevation 1071 because storage would start at the same elevation under either operating plan. During summer floods however, the zone of impact on terrestrial ecosystems would be about 5 feet higher. The upper limit of the affected area would be similar under either optional plan.

Holding the summer pool at elevation 1068 would not significantly affect flood control capability because the major floods have historically been spring floods.

The next phase of study will better define the advantages and disadvantages of various project features within the concept of a multipurpose reservoir above Twin Valley. To the extent allowed by the data, the analysis will include the studies you have suggested.

17. Comment: Additional investigations should be made of the erosion potential of the reservoir site considering the extreme slopes on the reservoir margins and the effects of vegetation removal as a result of seasonal water level fluctuations. The effect that accelerated erosion due to wave action and drawdown procedures will have upon the 100-year 7,500 acre-foot sediment pool should be discussed in detail.

17. Response: The soil borings to be obtained during subsequent phases of study would be used in assessing the erosion potential. The vegetation analysis mentioned above would also be used in this regard. After the probable magnitude of the problem is determined, appropriate measures would be considered.

The 7,500 acre-foot allowance for sediment would indirectly allow for storage of sediments from reservoir bank sloughing since the projection was based on observations at Baldhill and Homme Reservoirs in North Dakota, both of which experience some bank sloughing. The principle area of concern as regards banks sloughing at Twin Valley, however, concerns the effects of shoreline erosion upon aesthetics, water quality, and fish and wildlife habitat because bank sloughing would probably contribute a relatively minor portion of the sediment volume input. By far the majority of sediments are expected to come from other than project lands. Because the drainage area above Twin Valley Lake has many lakes which appear adequate for trapping sediment, the area assumed to contribute sediments is 372 square miles of a total drainage area of about 888 square miles. Using that acreage, an estimated sediment production of about 0.22 acre-foot/square mile/year, and an estimated trap efficiency of about 90 percent, the 100-year sedimentation volume was estimated to be about 7,500 acre-feet.

18. Comment: We note that the proposed reservoir will remove 540 acres of bottomland community types. The bottomland forests were stated by Mr. Hibbard to be ecologically unique and valuable because they are the only forest types close to maturity in the study area and many of the species are found nowhere else in the area. Furthermore, as explained in paragraph 4.54 of the EIS, additional bottomlands would be altered. While not all bottomlands would be defined as wetlands under EPA's definition (swamps, bogs, and other low-lying areas, which during some period of the year will be covered in part by natural non-flood waters), it is reasonable to assume that a substantial portion of the existing floodplain forest, wet and lowland meadows, and other bottomlands are wetlands. Wetlands existing in the Wild Rice River basin represent a unique, irreplaceable water resource. It is our policy to give particular cognizance to any proposal that has the potential to damage wetlands, to recognize their value, and to preserve and protect them from damaging misuses.

The new Corps policy regarding the safeguard of wetlands as described in the April 3, 1974 Federal Register is highly desirable and consistent with our views (May 1973 Federal Register). Such policy could substantially discourage the unnecessary alteration and destruction of wetlands considered to be vital to the riverine flowage. Although Corps policy is directed primarily toward the evaluation of permit applications, we believe wetlands affected by Corps of Engineers projects may be as valuable as those being affected by permitted projects. Accordingly, the policy should be applied equally in both situations.

18. Response: As indicated in table M-1, appendix M, about 35 acres of wetlands would be permanently inundated by the permanent pool and affected by the structures. These wetlands would be the types which fit your definition.

Applicable portions of the above-referenced Corps policy (Engineer Regulation 1145-2-303, 3 April 1974) are:

"(1) Wetlands are those land and water areas subject to regular inundation by tidal, riverine, or lacustrine flowage. Generally included are inland and coastal shallows, marshes, mudflats, estuaries, swamps, and similar areas in coastal and inland navigable waters. Many such areas serve important purposes relating to fish and wildlife, recreation, and other elements of the general public interest. As environmentally vital areas, they constitute a productive and valuable public resource, the unnecessary alteration or destruction of which should be discouraged as contrary to the public interest.

"(2) Wetlands considered to perform functions important to the public interest include:

(a) Wetlands which serve important natural biological functions, including food chain production, general habitat, and nesting, spawning, rearing and resting sites for aquatic or land species;

(b) Wetlands set aside for study of the aquatic environment or as sanctuaries or refuges;

(c) Wetlands contiguous to areas listed in (a) and (b) above, the destruction or alteration of which would affect detrimentally the natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, current patterns, or other environmental characteristics of the above areas;

(d) Wetlands which are significant in shielding other areas from wave action, erosion, or storm damage. Such wetlands often include barrier beaches, islands, reefs and bars;

(e) Wetlands which serve as valuable storage areas for storm and flood waters; and

(f) Wetlands which are prime natural recharge areas. Prime recharge areas are locations where surface and ground water are directly interconnected.

"(3) Although a particular alteration of wetlands may constitute a minor change, the cumulative effect of numerous such piecemeal changes often results in a major impairment of the wetland resources. Thus, the particular wetland site for which an application is made will be evaluated with the recognition that it is part of a complete and interrelated wetland area.

"(4) Unless the public interest requires otherwise, no permit shall be granted for work in wetlands identified as important by subparagraph (2), above, unless the District Engineer concludes, on the basis of analysis..., that the benefits of the proposed alteration outweigh the damage to the wetlands resource and the proposed alteration is necessary to realize those benefits.

(a) In evaluating whether a particular alteration is necessary, the District Engineer shall primarily consider whether the proposed activity is dependent upon the wetland resources and environment and whether feasible alternative sites are available.

"(5) In accordance with the policy expressed in paragraph 7c, above, and with the Congressional policy expressed in the Estuary Protection Act, PL 90-454, state regulatory laws or programs for classification and protection of wetlands will be given great weight."

We concur that this policy should also be applicable to evaluation of Corps of Engineers project, and it is used as a guide in project evaluation and project management.

19. Comment: While we realize the need for flood protection in the watershed, we have reservations regarding the environmental impacts of the proposed Twin Valley project as described in the EIS and believe that a more environmentally compatible alternative is available. Consideration should be given to some combination of nonstructural and structural measures to achieve the desired flood protection.

19. Response: A problem that must be faced in choosing a nonstructural alternative for the Wild Rice River basin is that many of the flood damages are agricultural damages, while the nonstructural alternatives provide flood damage reductions principally to buildings and urban type damages. This is brought out in the response to the following comment and is mentioned at several places in the text of the EIS and in the phase I general design memorandum. Degree of flood damage reduction for each of the plans is set forth in appendix K.

It should be noted that there would be a residual floodplain associated with any of the plans. All of the structural plans redefine the 100-year floodplain to some extent, depending upon the area under consideration, and flood insurance and floodplain regulation would be applicable to the residual 100-year floodplain.

Discussion of the environmental compatibility of alternatives is also found in following comments and responses.

20. Comment: The EIS should discuss if the same degree of protection that was assumed for the proposed Twin Valley project was assumed for each of the alternative nonstructural and structural measures. If not, an explanation should be given on how the benefits and costs of each of the alternatives are comparable.

20. Response: The degree of protection for each alternative evaluated is not the same. Nonstructural alternatives were evaluated based on the intermediate regional flood levels, whereas structural alternatives were evaluated based on the degree of protection which would provide for the most feasible project design. The nonstructural alternatives provide flood damage reductions principally to buildings and urban type damages whereas the structural alternatives provide reduction of flood damages primarily to the agriculturally related flood problems.

The bénefits and costs of each alternative are comparable in that the level of development as discussed for each alternative is that level which would be most practical to develop. Paragraph 6.01 has been modified to reflect this concept.

21. Comment: With regard to nonstructural measures, consideration should be given to floodplain regulation (plan 5), partial evacuation of the most flood prone areas, and flood proofing those structures not requiring considerable expense. Raising of certain structures may be feasible.

21. Response: This combination alternative is essentially set forth as plan 6. While the relocation or purchase plus razing of structures having a greater than 2-foot depth of flooding on the first floor (as in plan 6) may be more costly than (as you suggest) raising the structures, any favorable difference in costs would at least partially be offset by the greater cost of providing public services to raised structures. The general conclusions expressed in the discussion of plan 6 would therefore hold for the suggested combination alternative.

22. Comment: Executive Order 11296, August 10, 1966, requires Federal agencies to provide leadership in encouraging broad and unified effort to prevent uneconomic uses and development of the Nation's floodplains and, in particular to lessen the risk of flood losses. Our mandated concern for water quality consequences of flood damage require us to take an active interest in floodplain encroachment. We believe a commitment should be required from local interests to regulate future development within the established 1 percent floodplain downstream in such a manner so that floods up to and including the 1 percent flood would not cause damage.

22. Response: The pertinent required local cooperation as set forth in the phase I general design memorandum is as follows:

a. Prevent encroachment which would reduce the flood-carrying capacities of the Wild Rice and Marsh River channels below the proposed reservoir;

b. At least annually inform affected interests that the project will not provide complete flood protection; and

c. Provide guidance and leadership in preventing unwise future development of the floodplain by use of appropriate floodplain management techniques to reduce flood losses.

These requirements of local cooperation within the guidelines of the State floodplain management and the Federal flood insurance programs (both relating to the 1 percent floodplain) would generally achieve the purpose you suggested. The exception is that the floodplain management programs are aimed at reducing damages to structures and contents, while other damages would remain. Damages to the other categories of agricultural lands and crops, roads, and utilities would be reduced to a lesser extent. The project document for the authorized plan did include a letter of intent from the Norman County Board of Commissioners to provide these necessary local cooperative requirements for the authorized plan. The current views of the County Board appear similar to those expressed in their earlier letter, and they have verbally expressed their intent to provide the necessary assurances of local cooperation for the proposed plan. The Wild Rice River Watershed District has also expressed the capability to provide the necessary assurances of local cooperation for the proposed plan relating to flood control.

Upon request, the Corps of Engineers floodplain management services program is also available to provide technical advice in sound floodplain management subject to constraints of time and funding.

23. Comment: With regard to the channel modifications on the Wild Rice River (plan 7), we believe this alternative has significant adverse channelization impacts on 20 miles of "natural" stream and therefore, is not environmentally compatible. Inspection of the channel modifications on the Marsh River (plan 8) reveals that while some adverse channelization impacts exist, they are less detrimental than those for plan 7. It appears that the old Marsh River channel and Marsh River Ditch from mile 20.8 to mile 44.8 has been subject to some previous channel modification (clearing from mile 20.8 to mile 44.8 and enlarging and straightening from mile 31.7 to mile 34.8), thus making it less sensitive environmentally. With regard to the levee and floodway system (plan 9) as described in the EIS, this alternative appears to have considerably less environmental impact than the other structural measures relative to water quality, stream resources and adjacent plant and animal communities. The 18-mile diversion channel (plan 10) involves 2.2 miles of channelization of the Wild Rice River from mile 40.6 to mile 42.8. Since mile 40.6 to mile 42.2 was previously channelized in 1954, only 0.6 miles of the "natural" Wild Rice River would require modification and is therefore less environmentally objectionable than plan 7, plan 11 and the proposed project.

23. Response: Concur. There are differences in the river miles cited in the EIS discussion of Alternatives (section 6) or Other Water Resource Projects (section 2); however, these differences have not been changed because they have no significant bearing on conclusions about the environmental compatibility of alternate plans.

24. Comment: Consideration should also be given in part to some combination of smaller reservoir sites that have been recommended by Dr. Hibbard.

24. Response: Small impoundments are being constructed in the basin as noted in the letter of comment from the East Agassiz Soil and Water Conservation District. The evaluation of small reservoirs including those recommended by Hibbard are summarized in the text under plan 12.

It should be clearly understood that for this type of study, the phase I GDM level of study is the one which establishes which of the overall alternatives (in this case a multipurpose reservoir above Twin Valley) will undergo further study and design.

25. Comment: While not discussed in the EIS, there is the possible alternative of a dry reservoir. This alternative should also be examined in the final EIS. While this alternative would result in foregoing of the long-term water quality impacts of impoundment and the recreational and fishery benefits of the reservoir, it would still adversely impact floodplain bottomlands.

25. Response: Concur; discussion of the "dry" dam has been added to the text as plan 15.

26. Comment: In summary, we believe a combination of nonstructural measures such as floodplain evacuation, flood proofing and floodplain regulation and structural measures such as channel modifications on Marsh River, levee and floodway system, 18-mile diversion channel and some combination of the small reservoir sites as those recommended by Dr. Hibbard would have less adverse environmental impact than the proposed Twin Valley project. Therefore, we request that consideration be given to a more environmentally compatible combination of structural and nonstructural measures to achieve the desired level of flood protection.

26. Response: Although this combination of alternatives has not been specifically evaluated and weighed against the proposed plan; the social and economic effects would essentially amount to a summing of those presented under the separate plans, minus duplicative and synergistic effects. A problem in such comparisons is that further studies are required before we can assess the optimal meld of water quality and other environmental quality parameters for Twin Valley Lake and affected reaches of the Wild Rice River.

Although the combination which you have suggested would probably have less environmental impact, based on the information contained in appendix K under evaluations of the individual alternatives, the social and economic aspects of this combination plan would be less desirable than that of plan 11. Sufficient information is available in both this document and the phase I GDM to consider the effects of combining several alternatives.

The consideration that was given to alternatives is documented in the texts of the project documents. Further consideration to additional alternative combinations was not given based on the overall unfavorable aspects of these alternatives considered singularly. An extremely large number of alternatives and combinations of alternatives can be considered; however, the majority of them would not be practical or feasible. We have discussed the environmental, social, and economic effects in both the

EIS and phase I GDM of what we feel are the most practicable alternatives. The next phase of study will involve engineering studies to implement the concept of a multipurpose reservoir above Twin Valley.

U.S. DEPARTMENT OF COMMERCE

28. Comment: The Department of Commerce feels that this draft environmental impact statement, on page 76, Flood Warning and Emergency Protection (plan 1) as described, is not effective nor descriptive of the river and flood forecasting services of the National Weather Service. It is suggested, therefore, that this statement be eliminated and substitution made of paragraphs 56 and 57 of the draft phase I general design memorandum.

28. Response: The material has been incorporated.

U.S. DEPARTMENT OF THE INTERIOR

The comments of the U.S. Department of the Interior as discussed below are only those which were addressed to the EIS in their letter of 27 January 1975. Discussion of the remainder of their comments is contained in the phase I GDM.

29. Comment: The fourth sentence of paragraph 1.07 notes that if no public agency expresses interest to manage available project lands for wildlife purposes, ". . . other uses could be made of the 2,750 acres." We wish to emphasize that a non-managed area retains its fish and wildlife values and should not be relegated to other uses simply because it is not managed. Management maximizes production of the species under consideration--its absence does not diminish any existing fish and wildlife values.

29. Response: Concur. The rest of the paragraph did indicate the Corps' interest in the wildlife capabilities of project lands, however. The Minnesota Department of Natural Resources in its letter of 24 February 1975 indicated an interest in managing the project lands, and the paragraph has been revised accordingly.

30. Comment: Paragraph 1.11 - Does the "active fishery management and appropriate reservoir management" alluded to in this paragraph include provisions for complete reservoir drawdown when conditions warrant it?

30. Response: The design of the outlet structure would allow complete drawdown. The embankment, however, is not currently designed for complete drawdown. The most costly item in such a design would be the probable required extension of riprap. The construction cost would rise roughly in proportion to the desired completeness and rapidity of drawdown.

Also of concern would be slope stability in the reservoir. At other reservoirs, drawdown rates of more than about 1/2-foot a day have caused some sloughing of the saturated soils below the permanent pool elevation. On the positive side, a drawdown would aid in ease, cost, and completeness of rough fish control with toxicants, for example. Further studies would attempt to determine the optimal trade-off among these considerations.

31. Comment: Paragraph 2.06 notes that sand and gravel comprise the only economic mineral deposits in the watershed, and tabulated data elsewhere in the statement indicates that neither the authorized dam and lake nor the several alternate proposals should affect mineral resources. The commitment, but not the source, of raw materials for construction is mentioned. The statement, however, does not describe mineral resources of the project area itself, does not discuss the significant potential for undiscovered resources that may underlie the site, nor does it indicate the quality of studies upon which conclusions about mineral resources are based.

So far as known mineral resources are concerned, our review, without benefit of field investigation, indicates that the project would have no significant adverse effect. Sand and gravel, the only mineral commodities produced in Norman County in recent years, are not produced within the project area, and any of such resources lost because of the project would be insignificant compared with abundant supplies available nearby. However, we are concerned about potential mineral resources that may be committed under the proposed reservoir.

According to maps prepared by the U.S. Geological Survey (e.g., GP-325, -471, -725), a pronounced northeast-trending linear aeromagnetic anomaly, similar to anomalies over known iron-formation in northeastern Minnesota, traverses the region just east of Twin Valley. The State geological map (Sims, P.K., 1970) shows that the project area is underlain by undivided metavolcanic rocks including, perhaps, iron-formations and greenstones, host rocks for vast deposits of iron and other metals elsewhere in Minnesota. Although the chance that major metallic deposits occur beneath the 3,500-acre site probably is not great, this possibility should not be ignored nor dismissed too lightly. We recognize that the project would affect but a small part of the anomalous region.

The Bureau of Mines has indicated low potential for metallic mineral resources in Precambrain rocks in the Red River Basin (Souris-Red-Rainy

River Basins Comprehensive Study, App. K - Minerals, 1972). Nevertheless, we believe that a survey to assess both known and potential mineral resources at the Twin Valley Lake site should be made by qualified personnel before the land is committed to uses that would preclude future development of mineral resources. For this project, a survey seems necessary at least to support the conclusion in the reports that mineral resources would not be affected; conceivably, such a survey might alter that conclusion. At any rate, the results of the mineral survey should be incorporated into the final environmental statement.

31. Response: It would be desirable if fill materials could be obtained from the site to be excavated for spillway construction (authorized site) or from borrow sites within the permanent pool area. Limited data suggest that this may be possible, but definite conclusions can be made only after more soil borings are available as other sources of materials are surveyed. Certain materials such as riprap would probably be procured from a source outside the immediate project area.

Your information on potential mineral resources has been incorporated into paragraph 2.06. During further studies, the Corps will consult with agencies such as the Bureau of Mines to determine whether further consideration of this problem is necessary. This information will not be incorporated into this final EIS because: (1) A useful study would require more time than is available; (2) The information would be less up-to-date than needed for purposes of pinning down the project location and operation; and (3) The likelihood of mining in the project area is questionable for reasons noted in paragraph 2.06. It should be noted that this phase of study is the one which establishes the concept, in this case, of a dam above Twin Valley; later phases of study will consist of refinements on this basic plan.

32. Comment: Figure 3 indicates that the lake would lie in the shoreline area of the Red River lowland where important sand and gravel deposits are most abundant (paragraph 2.06), but paragraph 2.62 says, "The site... is located in the upland plain of glacial till east of the beach ridges."

32. Response: Noticeable beach ridges (and sand and gravel operations) are located along the western edge of the "shoreline area" in figure 3.

33. Comment: Paragraph 2.59 indicates that an archaeological reconnaissance survey of the project area has been completed. In the event that this survey did not cover all of the 3,500 acres of project lands (including borrow areas, road and utility relocations, and recreational facilities), the State Archaeologist should again be contacted for recommendations relating to the need for further survey. The final environmental statement should present in a detailed form the results of this survey and present plans for any necessary salvage mitigation.

The final environmental statement also should reflect measures to be taken in the event that previously unknown cultural resources are encountered during construction.

33. Response: The sections on historical/archaeological resources have been revised. The locations of the three prehistoric sites recorded within the basin (21-NR-3, 21-NR-1, and 21-CY-2) are not specified for the sites protection. If additional sites are discovered during project design, a decision as to site avoidance or salvage will be made at that time.

34. Comment: No established or studied unit of the National Park Service or any National Landmark (natural or historic) would be adversely affected by the proposed action.

34. Response: Comment noted.

35. Comment: Paragraph 2.61 should describe drainage practices in the upper watershed which contribute runoff to the Wild Rice River, thereby aggravating flooding conditions in the lower reaches. An attempt should be made to quantify this increased runoff and its effect on flood stages. Wetland reclamation in the upper watershed may reduce flood crests of the Wild Rice River below Twin Valley and could, in combination with non-structural measures, provide a viable alternative to the environmentally destructive Twin Valley Reservoir. If wetland reclamation is combined with adequate land treatment measures in the upper watershed, the biological productivity of this stream could be considerably improved as a result of decreased sediment loading.

35. Response: It agreed that data on drainage practices in the upper watershed would be desirable to include. These data were not collected because wetland drainage has the most significant effect on the characteristics of the smaller, more frequent floods, while the project design is aimed at lessening damages due to the larger, less frequent floods. It is recognized that land treatment and wetland reclamation would have benefits in reducing flooding during the more frequent events, in decreased sediment loading of streams and lakes, in higher quality habitat, soil conservation, etc. The local people also recognize the desirability of these measures as shown in the letter from the East Agassiz Soil and Water Conservation District. Based on the information available, and recognizing that the runoff from the majority of the drainage area upstream of the project is regulated to some degree by the lakes in the area, it is unlikely that reclamation of the drained wetlands and nonstructural measures would be considered an acceptable or a viable alternative to the Twin Valley Lake project.

U.S. DEPARTMENT OF THE INTERIOR (Continued)

36. Comment: Three potential natural landmarks, which are located in the morainal uplands of the Wild Rice River basin, appear to be beyond the area of influence of the Twin Valley project. The presence of these significant natural areas, which have been identified in National Park Service theme studies for both Inland Wetlands and Northern Hardwoods, should be recognized in the description of the basin environment. They are:

1. Hellickson Prairie, located west of Ogema in Becker County.

2. Waubun Prairie, located southwest of Waubun in Mahnomen County.

3. Marshall Bog, located west of Zerkel in Clearwater County.

36. Response: Mention of these natural areas has been added to paragraph 2.57, "Scientific Areas."

37. Comments: We note that the analysis of structural alternatives does not include the concept of a "dry dam" to intercept flood flows. Although this alternative also could have environmental drawbacks, we believe that its feasibility should be investigated and compared with other structural measures. Of particular concern would be the expected duration and degree of floodplain inundation for various frequency floods and the attendant environmental effects. The disposition of trapped sediment in this type of structure also should be discussed.

37. Response: Discussion of the "dry" dam has been added as alternate plan 15. Elevation-duration-frequency of storage data are not included; however, the entries for these parameters change by a relatively small amount in going from the "wet" dam to the "dry" dam (due to the relatively small volume of the permanent pool at Twin Valley). The information on elevation-duration-frequency for the "wet" dam alternative can be considered generally applicable for the "dry" dam alternative.

U.S. DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION

38. Comment: The statement appears to adequately discuss effects on highways and highway improvements required as a result of construction of the proposed improvement. We therefore have no comments on the draft statement for the proposed project.

38. Response: Comment noted.

FEDERAL POWER COMMISSION

39. Comment: Our primary concern with developments affecting land and water resources is the possible effect of such developments on bulk electric facilities, including potential hydroelectric developments, and on natural gas pipeline facilities. Our review of the draft Environmental Impact Statement and the information available in this office indicates that the proposed project would not have significant adverse effects on such facilities.

39. Response: Comment noted.

MINNESOTA DEPARTMENT OF AGRICULTURE

40. Comment: With the exception of a few areas of concern, the Department supports the Twin Valley Lake project. The areas of concern include the possibilities of claiming economic benefits for cleared timber, calculation of recreation benefits, lack of discussion of the "dry" dam alternative, and land treatment in the watershed.

40. Response: The questions relating to benefits and costs are discussed in the phase I general design memorandum. Land treatment programs are noted in a following letter from the East Agassiz Soil and Water Conservation District. Discussion of the "dry" dam has been added to the alternatives section as plan 15.

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

41. Comment: The Department of Natural Resources continues to support the need for a flood control project at the Twin Valley site to provide for partial control of flood waters on the Wild Rice River and the Red River of the North.

41. Response: Comment noted.

42. Comment: However, legislation passed in the interim at both the Federal and the State level, namely the National Environmental Policy Act of 1969 and the Minnesota Environmental Policy Act of 1973, requires public agencies to weigh and document the environmental consequences of proposed actions before making a decision on how to proceed on a proposed project.

42. Response: Concur. Consideration of environmental consequences is required and is discussed in both the phase I general design memorandum and the environmental impact statement. Such requirements are not completely new, however, but rather a reaffirmation and/or extension of earlier legislation such as the Fish and Wildlife Coordination Act of 1958 (Public Law 85-624).

43. Comment: The project would destroy or adversely affect an appreciable amount of existing meandering free-flowing river which possesses unique aesthetic and environmental parameters for this area. The river and the valley provide fishing, hunting, canoeing, and various other opportunities such as environmental education.

43. Response: The project documents acknowledge and describe the direct and indirect effects of Twin Valley Lake on 7 miles of free-flowing stream to be inundated by the permanent pool and an additional 7 miles of free-flowing stream to be affected by temporary storage of floodwaters upstream of the permanent pool. Additional effects on downstream areas are also described. That the existing setting is scenic and valuable is acknowledged; however, "unique" may be a stronger term that might be applied by most observers.

44. Comment: The existing stream fishery would be replaced with a reservoir fishery. A man-made reservoir typically supports a good fishery for only about 15-20 years because eventually, erosion, siltation, turbidity, algal blooms and lack of shallow littoral zone create a habitat in which game fish cannot successfully compete with rough fish. Alternately, the existing stream fishery, left in its natural state, could be expected to last indefinitely.

44. Response: The decline of the fishery in the impoundment with time is recognized in the analysis, and further studies would refine the analysis and attempt to find ways to prolong desirable qualities, including those of the fishery.

45. Comment: The project would permanently interrupt an important biological corridor that brings a diverse woodland wildlife habitat into an intensively farmed area where such habitat resources are scarce and can ill afford to be lost. Approximately 555 acres of woodland would be consumed in the conservation pool while an additional 1,100 acres would be so adversely affected as to be considered as having minimal value for wildlife habitat.

45. Response: A resource management plan for project lands would be developed in further studies in conjunction and coordination with the Minnesota Department of Natural Resources and the Department of the Interior. The objective of the resource management plan would be to manage project lands in the best interest of the public, including amelioration of adverse effects caused by the project such as the recognized interruption of the biological corridor. The lands affected by temporary storage of floodwaters would have different, and generally lower, values as wildlife habitat than currently exist.

46. Comment: Implementation of the proposed plan would create a habitat of limited value for waterfowl. A minor amount of resting use by migrating waterfowl may occur but the lack of shallow littoral waters, in addition to siltation, turbidity, algal blooms and rough fish populations, would greatly reduce or eliminate aquatic plant growth. The plants are necessary for food production and protective cover for both waterfowl and game fish. Similarly, agricultural practices, such as Fall plowing, limit the food production capabilities on lands adjacent to the reservoir. In addition, the steep sides of the proposed reservoir would make the site unattractive for ingress and egress of waterfowl.

46. Response: Concur; however, studies of other reservoirs suggest that encouragement of aquatic flowering plants in the upper end of the permanent pool might be feasible with potential advantages as habitat and a silt and nutrient trap. The possibilities would be investigated during further studies.

47. Comment: Other environmentally related problems which could result from project implementation include:

1. increased bank erosion within the project area;

2. impetus for increased drainage in the watershed;

3. increased potential for upstream degradation caused by fluctuating water levels.

47. Response: Erosion problems are noted in the EIS in paragraphs 4.14, 4.25, 5.06, and 5.07; wetland drainage is treated in paragraph 4.66; and the effects of fluctuating water levels are discussed in a number of places in the EIS. Further studies would attempt to find ways to minimize these problems, except possibly for the upstream drainage problem which could not be corrected in this case by design modifications or land use controls by the Corps of Engineers. We are procuring information wherever available on the relationship between projects and upstream drainage, and we hope to develop design criteria which would avoid or minimize drainage where it is not in the public interest. This would probably be done in connection with a project which has high potential for design corrections, such as a channel modification project.

48. Comment: Some of the benefits attributed to this project appear to us to be of dubious value. For example, there are 3,279 lakes of 10 acres or greater within a 2-hour drive or an 80-mile radius of Twin Valley. The attempt to use the creation of a new lake as a justification for this project is obviously unwarranted. Furthermore, the recreational and fishery benefits would be relatively limited and of short duration, especially in light of the fact that there are so many excellent natural lakes nearby.

48. Response: The existence of the referenced lakes and their relationship to the project are discussed in appendix C of the phase I general design memorandum. Their existence does not, however, offset the benefits attributable to the project nor does it make the project less desirable. The Twin Valley Lake project would provide additional needed recreational opportunities for the project area. See also the responses to similar U.S. Department of the Interior comments.

49. Comment: The calculation of the benefit-cost ratio, with particular regard to the costs of negative environmental impacts, is another subject of great concern to us. While it appears that positive benefits accrued to the project were considered in the tabulation of the "benefit" value, it does not appear that the costs of the fish, wildlife and forest resources and aesthetic values which will be destroyed have been included in the "cost" value. Thus, we would anticipate that the true benefit-cost ratio will be presented prior to implementation.

49. Response: The economic evaluation of benefits and costs, including fish and wildlife gains and losses, is presented in the main report section of the phase I general design memorandum under "Economic Impacts." Additional discussion regarding other impacts of the project is contained in the phase I general design memorandum and the environmental impact statement. The economic costs of losses to fish and wildlife resources are estimated in table 12 of the phase I general design memorandum. The economic losses to other accounts such as forest resources and aesthetics are to some degree reflected in the purchase price of the land. These economic costs as estimated do not necessarily reflect all of the losses to environmental parameters, such as the fish, wildlife, aesthetics, etc. To truly reflect the losses to these accounts in the benefit-cost ratio, a method of placing economic values on these currently "unquantifiable" environmental losses would be desirable. Any assistance the Department of Natural Resources could provide in estimating these values more accurately would be appreciated. The fish and wildlife and recreation benefits are net benefits, and the costs have been subtracted.

50. Comment: To mitigate and compensate for the environmental losses and to attempt to enhance the environmental situation that will exist if the proposed plan is implemented, a number of recommendations are offered:

1. To increase the likelihood that the existing fisheries value can be maintained, or even enhanced, we recommend that the Corps develop an operational plan for discharge release when the reservoir stage increases by 5 feet or more during the spawning season. If feasible, these efforts should be made to protect spawning areas for approximately 50 days. Consideration should also be given to the construction of wing dams downstream from the main dam to provide resting places for fish.

MINNESOTA DEPARTMENT OF NATURAL RESOURCES (Continued)

50. Response: Maintenance and/or enhancement of the fishery resource in the permanent lake to be established in conjunction with the project and in the stream areas immediately adjacent to the project are identified as project purposes. Measures which are desirable, feasible, and justifiable to accomplish this objective will be incorporated into the project. Inclusion of specific features, such as construction of wing dams downstream of the Twin Valley dam, and modifications to the operational plan, will be evaluated in greater detail during phase II general design memorandum or subsequent feature design memorandum studies.

51. Comment:

2. Stipulation should be made that Norman County and the cities of Ada and Twin Valley use available data to adopt floodplain regulations concurrently with project approval. Furthermore, lands adjacent to the project should be zoned to prohibit any type of development which would be detrimental to either the project's effectiveness or habitat enhancement.

51. Response: Land-use zoning outside of project lands is not within the authority of the Corps of Engineers. However, one of the requirements of local cooperation is that the local sponsor of the project "provide guidance and leadership in preventing unwise future development of the floodplain by use of appropriate floodplain management techniques to reduce flood losses." Both Norman County and the Wild Rice River Watershed District have indicated their capability to provide the local cooperation requirements relating to this matter. Although the Corps of Engineers does not have the authority to require adoption and enforcement of floodplain regulations in Norman County and the cities of Ada and Twin Valley, we very strongly encourage these governmental units to adopt and enforce such regulations. Similarly, zoning of lands adjacent to the project lands does not fall within Corps of Engineers authority. We encourage the State, county, and other local governmental units to implement, within their authorities, regulations to assure that the project purposes are retained in the best interest of the public.

52. Comment:

3. In the final design of the structure, every effort should be made to blend with the natural landscape and thus, provide an aesthetically pleasing project, rather than a distortion on the landscape.

52. Response: Landscaping and aesthetics will be a consideration in project design, and blending the project into the natural landscape will be done to the maximum extent practicable.

53. Comment:

4. If the project is utilized as a local recreational resource we recommend that the size of the recreational sites be developed and if possible to be increased, to provide maximum recreational benefits; that a trail be established around the entire project area and that an adequate public access system be established. We believe that through these actions, the recreational values of the project can be enhanced.

53. Response: The recreational facilities to be developed in conjunction with the project, with the exception of an overlook area and a downstream fishing access at the dam, will be developed jointly with the local sponsor, and cost-sharing will be required of the non-Federal interests. The ultimate size and type of the recreation facilities developed will depend in large part on the desires and wishes of the non-Federal sponsor. The trail system and other features will be considered during preparation of the master recreation and resource management plan for the project.

54. Comment:

5. In an effort to enhance wildlife habitat and, in part, to compensate for the habitat that would be either lost or adversely affected by implementation of this project, we recommend that approximately 1,000 acres be acquired and added to the nearby DNR Faith Wildlife Management Area. Furthermore, we recommend that an additional 400 acres be acquired so that the area to be managed, including both the Faith Wildlife Management and the additional acreage to be acquired, is contiguous with the project area lands.

6. To provide for the development and management of good habitat in the project area, we recommend that a border of land at least 1/4 mile in depth and totally around the uppermost perimeter of the flood control reservoir be acquired in fee and turned over to the Department of Natural Resources to manage. We would like to express our interest in managing any lands which are made available, as discussed in the draft environmental impact statement on pp. 3-4.

7. Purchase in fee or by easement, a strip of land approximately 660 feet wide (1/8 mile) on both sides of the Wild Rice River (about 480 acres) from the proposed dam to the Village of Twin Valley, for angler access and other recreational uses.

Concerning our recommendations 5, 6, and 7, a further explanatory note could be helpful. We are recommending that these lands be acquired and monies be made available for development because we consider them to be very important and necessary to compensate for the loss of habitat, both wildlife and stream, and also, because they are key elements in making the project proposal acceptable and beneficial to the people of the State.

54. Response: Additional lands above the amount currently estimated to be acquired for the project can be acquired dependent upon satisfying several criteria. Additional lands for general recreation can be acquired as part of the recreation plan for the plan subject to the justification of the proposal, the concurrence of the non-Federal sponsor, and the indication of intent of the non-Federal sponsor to reimburse the Federal Government for 50 percent of the specific costs associated with the lands so acquired and subsequent recreation facility development.
Additional lands specifically for compensation of adverse effects to wildlife habitat can be acquired subject to justification of the amount of land to be acquired and authorization by Congress to acquire the lands. The lands acquired specifically as wildlife compensation would be wholly a Federal cost. Additional lands specifically for enhancement of wildlife habitat can be acquired subject to justification, an indication of intent of the non-Federal sponsor to reimburse the Federal Government for 25 percent of the costs of the lands so acquired, and authorization by Congress to acquire the lands. Justification is presented in the phase I general design memorandum for establishment of a recreational trail system downstream of the dam, including the acquisition of lands. This trail system would be evaluated in further detail during later studies. Acquisition of additional lands for wildlife habitat enhancement or as compensation for wildlife losses attributable to the project would require establishment of the justification and subsequent recommendation and approvals for purchase. The Corps of Engineers will work with the Department of Natural Resources to determine the appropriateness of such acquisitions and assist in developing the necessary information to establish the justification for such lands. The assistance of the U.S. Fish and Wildlife Service will also be requested in evaluating this recommendation for acquisition of additional lands. The interest of the Department of Natural Resources in managing these lands will be noted in the project documents. Studies to evaluate the feasibility and desirability of acquiring the recommended additional lands will be made during phase II general design memorandum and subsequent feature design memorandum studies.

55. Comment:

8. For the area that is acquired under recommendations 5, 6, and 7, the boundaries should be squared so as to provide for manageable tracts of land. Again, zoning and limited development of adjacent lands would be vital to maintain the integrity of these areas.

55. Response: The boundaries of any additional lands to be acquired based on recommendations of the Department of Natural Resources would be coordinated with that agency, and the management of the lands would be a key factor in the establishment of these boundaries. Zoning and development of adjacent lands would be desirable, but would not be within the authorities of the Corps of Engineers. See the response to your item 2.

56. Comment: In closing, we feel that our recommendations form the basis of a sound mitigation and enhancement plan. It is in this manner that the project can truly be in the best interests of the citizens of the State of Minnesota.

56. Response: The recommendations form a sound basis upon which a mitigation and enhancement plan can be formulated to assure that the best interests of the public are served through implementation of the Twin Valley Lake project. We will work with the Department of Natural Resources to assure that its recommendations can be incorporated to the maximum extent in the final plan.

MINNESOTA HIGHWAY DEPARTMENT

57. Comment - It does not appear that trunk highways will be materially affected by the proposed project. If anything, some benefits could be derived downstream from the proposed dam site, by the control of discharges during flood periods, and releasing the waters more uniformly over a longer period of time. Any benefits derived would be along T.H. 200 and T.H. 9 where the Marsh or Wild Rice Rivers cross these highways. It is doubtful if any areas on T.H. 75 that are subject to backup of the Red River would be significantly affected by this project.

On the other hand it appears that flood related damages on the secondary road systems (CSAH, CR and Twp. Road) will be considerably less if the proposed project were completed.

The two County State Aid Highways upstream of the dam site that would require reconstruction, namely CSAH 29 and CSAH 36 were viewed in the field. Local County officials have been working closely with the Corps in the design phase of this project, and are satisfied with the proposals for changing these routes as shown in the Corps plan.

We were asked to state our views to the Corps of Engineers whether it would be desirable and whether there is a need for a public highway across the dam. We are of the opinion that it is not desirable or necessary to have a public road across the dam. The area is served adequately by a road system that provides access to all those proposing to use the site without a road across the dam.

57. Response -Average annual flood damage reduction benefits to transportation of $18,900 are credited to the proposed Twin Valley Lake project. These benefits are derived principally from reduced flood damages to highways in the flood prone areas. The rest of the comment is noted.

MINNESOTA STATE ARCHAEOLOGIST

58. Comment - Though no significant archaeological sites were located in the project area surveyed, I strongly support the need for additional detailed survey when the borrow areas for the earth dam fill are located and if the site of the dam is altered because of public opinion or engineering changes.

58. Response - Concur; we will be scheduling detailed surveys as the features of the project are designed. Note that the paragraphs in the text which deal with historic/prehistoric resources have been revised.

EAST AGASSIZ SOIL AND WATER CONSERVATION DISTRICT

59. Comment - The Supervisors of the East Agassiz Soil and Water Conservation District wish to indicate their unanimous support toward the earliest possible construction of a flood control dam on the Wild Rice River east of Twin Valley. The dam and reservoir is needed to effectively control the discharge of the river. With a controlled flow, projects to stabilize the river banks and provide suitable road crossings and development of agricultural lands previously subject to flooding can be made with little hazard to their destruction.

59. Response - Information on erosion of the downstream river channel and banks has been added to this final EIS. Other points raised in the comment are covered in the text of the document. The position of the Supervisors is noted.

60. Comment - The East Agassiz Soil & Water Conservation District was organized in 1941 to provide technical assistance to landowners on management of soil and water problems. Approximately one-half of the farmers of Norman County are District Cooperators interested in the proper management of soil and water. There are undoubtedly many others that are following minimum conservation guidelines who have not requested assistance through the SWCD.

Since 1970 there has been a joint effort by East Agassiz SWCD, Norman County Wild Rice Watershed District and Norman County ASC Committee to place the highest priority of planning and financial support toward the development of flood water control projects. Since then 10 such dams have been built. Nine of these are with drainage areas of less than 2,500 acres each, one with a drainage area of over 13,000 acres. Landowner cooperation has been a very important item in the development of these projects.

We feel these small retention dams provide benefits to lands and roads below each structure and overall will compliment the benefits of the dam on the Wild Rice River.

While a vast system of small dams will provide local benefits to tributaries of the Wild Rice River, we do not feel there are enough sites nor would they be adequate to harness the flood flows of the Wild Rice River to provide the degree of protection desired in the flood plan.

60. Response - A series of small reservoirs is discussed in the text under alternate plans 12 and 13 although the Corps impoundments would usually be larger than the impoundments mentioned. The information provided on local soil and water conservation programs has been added to paragraph 2.144.

61. Comment - We therefore support the construction of the flood control dam on the Wild Rice River and will continue to work with local landowners and governmental agencies towards soil and water management practices on the land.

61. Response - Comment noted.

MR. HAROLD HABEDANK, CITIZENS ADVISORY COMMITTEE

62. Comment - Paragraphs 2.107 and 2.108. I have lived on the bank of the Wild Rice River all my life. I own land that would be flooded by either site of the proposed dam. It appears to me the number of deer living in the river bottomland of the area is vastly underestimated. Within the past 3 years I have personally seen herds of 20 or more at one time and have heard reports of sightings of as many as 140 at one time. I also have personal knowledge of at least 4 times the deer kill in hunting season (1 to 3 days, restricted firearms) that is listed in the report.

According to other parts of the report, this wildlife population would be virtually driven from the area entirely due to the fact of loss of cover and brush type growth. Not only in the lakebed itself but, according to the report, in most of the design flood pool area also due to periodic inundation. Reference also paragraphs 5.08, 5.09, 8.06.

62. Response - Paragraphs 2.106 through 2.108 present the best information available, but numerous sentences in those paragraphs suggest that the estimates may be too low. For lack of better data, the Fish and Wildlife Service has indicated that they would accept the figures of 150-200 man-days of hunting in 1972. The loss of the hunting opportunity due to the project was deducted from the fish and wildlife benefits in the economic analysis for the project.

There are some shortcomings with this approach in addition to the problem you have pointed out, that of accurately determining the number of animals or hunter-days. Future projections assume an increase in the numbers of hunters afield, yet the dollar value assigned to a hunter-day is the same unless hunters have a very much higher (or lower) quality hunting experience. Also, the economic analysis is based upon the number of animals or hunters in the area, or only indirectly on the capability of the area to support deer and deer hunting. Since the production of an area is difficult to define, in addition to its perhaps being quite different from the area's capability, the Corps is considering a policy of habitat replacement to mitigate wildlife losses. The past policy for mitigation was based on numbers of animals and hunters. Every method of estimating wildlife values of an area has its advantages and disadvantages. We attempt to use as realistic a method as possible, which can be supported by scientific evidence.

63. Comment - Page 5, Paragraph 1.13 and Page 27, Paragraph 2.68. There is a question in my mind as to the level of the permanent pool being maintained constant. With a body of water the size of the lake and the shoreline area it would encompass and knowing the flow of the river feeding into the proposed lake from having observed it over my lifetime, I seriously question whether there would be any water available for discharge during some periods in the summer. The periods of low flow on the river usually coincide with warm weather when the evaporation and seepage factors would almost always be greatest.

63. Response - The problem of losing water from the conservation pool due to evaporation and seepage during the 6-month period May to October was studied and found not to be a problem. It was found that an average release rate of 19 cfs could be maintained during the 6-month period even if the most critical conditions of record were combined in a single year, the most critical conditions being the lowest amount of rainfall over the basin combined with the lowest flows on the Wild Rice River at Twin Valley for this 6-month period. Seepage is expected to be minimal.

64. Comment - Paragraph 4.11. Knowing the area, this rise in groundwater would be detrimental in effect as far as agricultural considerations are concerned, but as is stated in this paragraph "these will require further study", and no further figures, damages of costs in regard to this were found in the statement.

64. Response - The paragraph has been changed to note that these possible effects will be studied at a later date. No data or damage and cost figures will be available until the studies are completed.

65. Comment - Paragraph 4.03 has the recreation, fish and wildlife benefit at $99,200. Is any value assigned to the present value of these that would be destroyed by the implementation of this project? Also just what is meant by "area redevelopment?"

65. Response - The value of $99,200 is a net benefit, and the losses have been subtracted from the gains. Other information on this topic is contained in appendix C of the phase I general design memorandum. "Area redevelopment benefits" are now being more descriptively termed "local employment benefits." They are an estimate of the utilization of unemployed or underemployed labor resources in the area which would be employed in construction, operation and maintenance of the project. These benefits are not used in choosing among alternatives nor in calculating cost allocation and cost sharing. They are included in the final presentation of the benefit-cost ratio.

66. Comment - Paragraph 4.05. I am one of those involved in the last part of this paragraph. If the way in which I have been approached on this project so far is any indication of the way in which these "hardships" and "adverse social effects" are going to be dealt with,

it would appear it is going to be pretty heavy handed as so far I have been neither contacted officially or unofficially regarding any of the property required for the project; yet what is going to be allowed for the acquisition and relocation is already decided in the cost estimates.

66. Response - Estimates of real estate costs are based on fair market value, but you as a landowner would be able to appeal the estimate if you felt it to be too low. The estimates of real estate costs at this stage are based on preliminary estimates of land values in the project and are not made on an individual property-owner basis. Specific discussions and property appraisals will be undertaken with each affected landowner at later stages closer to construction of the project, after the site selection has been made and a more definite real estate take line has been selected. The estimates at this time are liberal in the sense that they assume purchase of land in fee title, while the ultimate arrangement between landowner and government may be a less costly and disruptive flooding easement, for example.

67. Comment - Paragraph 4.09. "The proposed project would therefore reduce the average flood damages while it would increase the damages from any one very large flood." Has the increased damage from "a very large flood" been taken into account in the cost or benefit figures for the project? It appears not as far as I can determine.

67. Response - Induced damages are recognized in Corps benefit-cost analyses, and they are considered to result from a project's inducement of floodplain development. The economic analysis for this project does not claim benefits for induced development, however, and therefore costs of induced damages have properly not been included in the analysis.

68. Comment - Paragraph 4.12 refers to "action to avoid loss of archaeological resources." Has cost of any such action been included?

68. Response - Costs have not been included since at this time no need for salvage is foreseen. Note that the paragraphs on historic/prehistoric resources have been revised.

69. Comment - Paragraph 4.21. Has the cost of multiple level outlet structures been taken into account?

69. Response - Costs for this feature are not included in the current cost estimate. However, this feature would add only a relatively small amount to the project cost, and there is also some uncertainty as to the need at this time. As the definite need for this feature is determined, an estimate cost for this feature would be included.

70. Comment - Paragraph 4.15 and related paragraphs in this section. What is really meant by "thermally stratify?" Is this the same thing essentially that happened to the lakes in North Dakota this past summer which resulted in the death of so many fish?

Again by reading these paragraphs I gain the impression that the "cure" or thing to do to alleviate this situation is to discharge water from various levels and at various velocities, but again this period is associated with low flow into the lake and what would happen to the lake level? The reason I seem to be concerned with the lake level is that as far as I can see, the only real benefit to the people of the immediate area is that we will have a recreation lake facility closer by than at present.

70. Response - The term thermal stratification describes a common phenomenon in temperate zone lakes which results from heating of the upper water layers. Because water has a maximum density (heaviest) at about 39° F, water that is warmer or colder than this temperature will "float" on the denser water. In the spring, after the ice has melted and winds have mixed the entire lake, temperature is rather uniform throughout the entire body of water. Upon heating from solar radiation, the surface waters warm rapidly while heating of deeper waters is retarded because the short-waved solar radiation is absorbed in the first few feet of water. As the surface water is warmed it becomes less dense and "floats" on the denser cold water below it. As more and more heat is absorbed at the surface, the thermal-density discontinuity becomes more pronounced until the resistence to mixing between the two layers becomes greater than any mixing force executed by winds. A condition of thermal stratification would then exist with the lake divided into three essentially discrete vertical components: a well mixed (wind action), warm, upper layer - the epilimnion; a transition zone of rapid temperature change-the metalimnion or thermocline; and a cold, stagnant bottom layer-the hypolimnion. A series of similar but reverse processes occur during the fall where the surface water is cooled and stratification is broken down.

The significance of thermal stratification in lakes and reservoirs is that little or no exchange of dissolved gasses or solutes takes place through the thermocline. Because of this, oxygen can be "used up" in the hypolimnion which can result in distress and/or death to most of the aquatic biota present in this layer if oxygen concentrations approach zero (anaerobic conditions). This is the usual cause of "summer kill" in lakes of this area although fish occupying areas with dense growths of aquatic plants may also be exposed to periods of low dissolved oxygen due to night-time respiration of the plants. Thermal stratification may therefore have contributed to the cause of the North Dakota fish kills. Since other causes such as toxic substances are also possibilities, we cannot answer your question except with a "maybe".

The question of adequacy of low flow is addressed in a previous response.

The conclusion is correct that the people of the immediate area with benefit from having a lake closer than at present. Other benefits would accrue from the greater economic activity in the immediate area. The bulk of the benefits, those for flood control, would accrue to residents of the old Lake Agassiz lakebed, although some of these benefits would also affect non-floodplain residents through reduced maintenance costs for roads.

71. Comment - Paragraph 4.65 states that there are significant environmental problems with the Homme and Orwell dams that probably will occur if the Twin Valley Lake dam is built. What are the nature of some of these problems? I assume whenever there are problems that require solutions there is a cost involved.

71. Response - Operation and maintenance problems at Homme include bank erosion, higher than originally expected sedimentation rates and corresponding loss of reservoir capacity, eutrophic conditions in the reservoir, and unsatisfactory fish production. These topics as applied to Twin Valley Lake are discussed in other sections of this environmental statement. Further information on Homme and Orwell would be contained in the environmental impact statements for those projects, the draft statements being currently scheduled for circulation in June 1975. Copies of the documents would be available in libraries in the project areas.

It may or may not be correct to state that the problems at the other projects will occur at Twin Valley. Findings for other projects in the area are cited because they may apply to Twin Valley Lake and because a review of existing information is a necessary first step in a scientific evaluation. Limited data specific to the Wild Rice River (e.g. water quality data) have been applied to the present stage of environmental analysis. The scientific study necessary to predict with reasonable accuracy the quality of Twin Valley Lake will be undertaken as soon as funds become available. Some of the problems will be amenable to correction or amelioration, and further studies would attempt to identify the measures which could be taken and to estimate their effectiveness. The corrective measures would involve costs, but the magnitudes and bearers of the costs cannot be determined at this time. Further studies will set forth the costs of any needed corrective measures.

72. Comment - Most of the charts and studies state they are for the reservoir area, yet it states again and again in the report "some quantitative changes---on uplands adjacent to the reservoir will occur" (Paragraph 4.58).

It seems to me that in regard to the wildlife aspect, the actual design and operation of the dam structure and pool, and the cost estimates, not only of the whole project but hidden hinted at costs, we are not being given the whole picture. It seems from what has been referenced to in this letter that the benefits have been overrated and the adverse effects and costs have been treated as lightly as possible. In other words, on the basis of the report I cannot but come to the conclusion that I must oppose the project.

72. Response - The tabular data on the environmental effects of the project may be considered a summary of minimal effects only. The data were prepared principally on the permanent pool area. The specific effects on the wooded acres, etc., affected in the design flood pool or downstream of the dam have not been tabulated because the degree and location of effect is so difficult to identify. The difficulty of measurement becomes overwhelming when forecasting secondary effects, e.g., the effects of floodplain development or redevelopment induced by the project. These effects are described as accurately as possible based on the current information available.

Part of the problem in judging whether benefits and costs have been given appropriate weight lies in the imperfect nature of the system. For example, the area redevelopment benefit you questioned earlier has no corresponding cost figure to account for the increased demand upon community services: schools, sewerage, fire and police protection, etc. That would be one of the reasons it is not used in choosing among alternatives.

PASTOR PERCY J. SMEREK, CITIZENS ADVISORY COMMITTEE

73. Comment - There would be a general decrease in woodlands and in woodland flora and fauna. Especially hit would be old stands of such trees as bur oak and some birches along with amphibians and some woodland birds. Would they truthfully be destroyed or just moved up river? The trees cannot move, the rest can.

73. Response - Most wildlife species generally considered to have economic or aesthetic value, such as birds, defend territories, at least during the breeding season. This is commonly judged to be a behavioral adaptation which insures sufficient space, food, etc., for the individuals and which reduces competition or strife between individuals. These species cannot be "packed" into an area more closely than their behavior will allow. (Witness the strife among robins when several try to use the same area in your yard.) Numerous studies suggest that if a territory becomes vacant through death of the occupant, it will ultimately be taken over by those individuals which have previously not been able to successfully compete for a territory.

Other species are weakly territorial, or perhaps not at all under "normal" population densities. They will still be adversely affected by loss of habitat, however. In the case of deer, for example, an influx of displaced animals into a woodland would result in greater vulnerability to predators and hunting, reduced high quality forage supplies for individuals, easier transmission of diseases and parasites, and so forth.

While there are exceptions to the above, they are uncommon and it must be assumed that a habitat is populated by as many animals as it can comfortably support. New individuals coming into the area will cause an increase in the mortality rate. When habitat is destroyed, it must then be assumed that there will be a corresponding decrease in wildlife populations.

See also the U.S. Department of the Interior comment on this subject.

74. Comment - I wondered about the responsibility of a statement where on page D-2 poison ivy is listed as being the following things: a very common plant with importance as "wildlife cover" and more *interesting*, that it has "major value for cultural, aesthetic and scientific purposes." I am sure that whatever scientific purposes they might find for the plant can be carried on outside the lake project since there is an abundance of the stuff in many areas.

74. Response - Poison ivy is browsed by deer in many areas, including the Itasca area to the east of you, and it probably is used in the Twin Valley area. It has scientific value in that it frequently is an indicator of archaeological sites; it grows in disturbed areas and on rich human occupation sites. The entries for poison ivy have been changed to reflect these factors, and the species is now portrayed as having less value.

Letters of Comment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V
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FEB 27 1975

Colonel Max W. Noah
District Engineer
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St. Paul, Minnesota 55101

Dear Colonel Noah:

We have completed our review of the Draft Environmental Impact Statement (EIS) for Twin Valley Lake on the Wild Rice River in Minnesota as requested in your letter of November 26, 1974. We have classified our attached comments as Category ER-2. Specifically, this means that we have environmental reservations regarding the project and we believe that additional information should be provided in the EIS to fully assess the environmental impacts of the project. The classification and the date of our comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed Federal actions under Section 309 of the Clean Air Act.

Our primary concerns relate to the project's effects upon water quality, natural land resources and bottomland wetlands. We believe that more consideration should be given to an alternative that would be more environmentally compatible in achieving the desired flood protection for the basin.

The additional time granted and the opportunity to review this Draft EIS is appreciated. Also, we especially thank Mr. William Spychalla of your staff for his assistance to my staff on the December 12, 1974 field trip. Should you have any questions regarding our comments, please contact Mr. Gary A. Williams or me at 312-353-5756.

Sincerely yours,

Donald A. Wallgren
Chief,
Federal Activities Branch

Attachments
As Stated

EPA'S COMMENTS ON THE DRAFT EIS FOR TWIN VALLEY LAKE, MINNESOTA

PROJECT DESCRIPTION

The EIS should indicate whether the loss of the 7500 acre-feet reserved for recreation and sedimentation over the 100-year life of the project has been factored into the project's costs. Also, since benefits have been assumed for protection of transportation systems, it should be indicated whether road relocation and other transportation costs required by the project have also been computed as part of the project's costs.

We note that the proposed dam is designed to handle flows up to and including the 1.9% design flood. The benefits that this design will have on areas further downstream should be clarified as compared to the benefits of other alternatives. The EIS should indicate if this project assumes any flood protection benefits that the flood control project on the South Branch Wild Rice and Felton Ditch would provide.

ENVIRONMENTAL SETTING

The EIS should include a soils map of the project because of the excessive erosion conditions in the area. A better description of the natural flow conditions on the Wild Rice River should be provided. Information regarding the 7-day once in 10-year low flow, average seasonal flows and median flows should be included.

We believe that the available existing water quality data is insufficient and should be supplemented with additional data. We are aware that a monitoring program has been set up in the watershed to provide more water quality information of the project area. We recommend that monitoring stations be located upstream and downstream of the proposed reservoir site. For your information, we have attached a copy of some STORET water quality data applicable to the subject project area.

ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

The Wild Rice River is classified as Category 2B, fisheries and recreation, by the State Water Quality Standards. The quality of this designated class shall be such as to permit the propagation and maintenance of a cold and warm water sport and commercial fishes and be suitable for aquatic recreation of all kinds, including full-body contact. A determination must be made within the EIS of the affect that this project will have on these water quality standards and the measures that will be utilized to minimize these effects. The EIS should determine the type of trophic conditions in the proposed reservoir that will exist due to the spring flush of agricultural lands containing macronutrients. The first step would be to collect water quality data needed to assess the nutrient budget. Using this data and mathematical models or studies like those undertaken by our National Eutrophication Research Center, an estimation of the expected trophic conditions for the proposed reservoir can be better defined particularly with regard to the potential for the reservoir to become eutrophic.

While available water quality data is insufficient to make accurate predictions of expected water quality impacts, it is stated in Section 4.38 of the EIS that the impoundment would be strongly eutrophic with blue-green algae blooms. According to Ragotskie's method which was judged in the EIS to be applicable to the project, it was stated that the proposed Twin Valley Lake would stratify. The effects that spring overflow and fall underflow would have upon Ragotskie's predictions should be addressed. Relative to the discussion on page 54 of the EIS of the expected effects of overflow and underflow upon stratification and the fact that flows during the summer are considerably reduced, a discussion of the maximum and average seasonal flushing periods that could occur should be presented. The current levels of phosphates and nitrates indicated as being in the flowing stream may cause an accelerated rate of eutrophication to occur in the reservoir. This situation could be further affected by additional lands upstream being brought into agricultural production because of the improved price structure for agricultural commodities. Increased nutrients from these areas would be trapped in the proposed reservoir. Presently, forested areas that were once considered marginal are now being cleared for crop production throughout the Wild Rice River watershed. This practice is likely to continue into the future without abatement as long as a favorable price structure exists. The long-term secondary water quality effects of the proposed project should be addressed in detail. Secondary effects might include project-induced development around the reservoir, increased drainage of remaining wetlands and lowlands for agricultural uses upstream and downstream of the project, and improvements of local transportation systems.

The maintenance of a fishery in the proposed reservoir appears highly speculative considering the lack of shallow areas to support fish reproduction and the adverse effects of water level fluctuations. It should also be noted that water quality downstream of the reservoir will be affected by design and operation of that reservoir. If lower water quality is discharged than previously existed before the reservoir, then the effect is the same as that caused by a pollution source. In summary, the total environmental, social and economic affects of this project on water quality should be determined and made an integral part of the agency's decision-making policies.

We note that the alternate operating plan of Twin Valley Lake includes the holding of the summer pool level up to 5 feet above the currently designated permanent pool elevation of 1063.0. The effects of this plan from the inundation of vegetation above elevation 1066.0 could adversely impact plant communities below elevation 1068.0. A better description of the operating time schedule of this plan's higher pool levels and its repercussions upon terrestrial habitats and flood levels in the event of summer storms should be detailed. We further note that uncleared plant communities above elevation 1068.0 will be periodically inundated up to elevation 1104.0. The EIS should include a discussion of the effects upon affected plant communities from different storm frequencies, and with an explanation of the extent and time period of inundation.

Additional investigations should be made of the erosion potential of the reservoir site considering the extreme slopes on the reservoir margins and the effects of vegetation removal as a result of seasonal water level fluctuations. The effect that accelerated erosion due to wave action and drawdown procedures will have upon the 100-year 7500-acre foot sediment pool should be discussed in detail.

We note that the proposed reservoir will remove 540 acres of bottomland community types. The bottomland forests were stated by Dr. Hibbard to be ecologically unique and valuable because they are the only forest types close to maturity in the study area and many of the species are found nowhere else in the area. Furthermore, as explained in Section 4.54 of the EIS, additional bottomlands would be altered. While not all bottomlands would be defined as wetlands under EPA's definition (swamps, bogs, and other low-lying areas, which during some period of the year will be covered in part by natural nonflood waters), it is reasonable to assume that a substantial portion of the existing flood plain forest, wet and lowland meadows, and other bottomlands are wetlands. Wetlands existing in the Wild Rice River basin represent a unique, irreplaceable water resource. It is our policy to give particular cognizance to any proposal that has the potential to damage wetlands, to recognize their value and to preserve and protect them from damaging misuses.

The new Corps policy regarding the safeguard of wetlands as described in the April 3, 1974 Federal Register is highly desirable and consistent with our own views (May 2, 1973 Federal Register). Such policy could substantially discourage the unnecessary alteration and destruction of wetlands considered to be vital to the riverine flowage. Although this policy is directed primarily toward the evaluation of permit applications, we believe wetlands affected by Corps of Engineers projects may be as valuable as those being affected by permitted projects. Accordingly, the policy should be applied equally in both situations.

ALTERNATIVES TO THE PROPOSED ACTION

While we realize the need for flood protection in the watershed, we have reservations regarding the environmental impacts of the proposed Twin Valley project as described in the EIS and believe that a more environmentally compatible alternative is available. Consideration should be given to some combination of nonstructural and structural measures to achieve the desired flood protection. The EIS should discuss if the same degree of protection that was assumed for the proposed Twin Valley project was assumed for each of the alternative nonstructural and structural measures. If not, an explanation should be given on how the benefits and costs of each of the alternatives are comparable.

With regard to nonstructural measures, consideration should be given to flood plain regulation (Plan 5), partial evacuation of the most flood-prone areas, and flood-proofing those structures not requiring considerable expense. Raising of certain structures may be feasible. Executive Order 11296, August 10, 1966 requires Federal agencies to provide leadership in encouraging broad and unified effort to prevent uneconomic uses and development of the Nation's flood plains and, in particular to lessen the risk of flood losses. Our mandated concern for water quality consequences of flood damage require us to take an active interest in flood plain encroachment. We believe a committment should be required from local interest to regulate future development within the established 1% flood plain downstream in such a manner so that floods up to and including the 1% flood would not cause damage.

With regard to the channel modifications on the Wild Rice River (Plan 7), we believe this alternative has significant adverse channelization impacts on 20 miles of "natural" stream and therefore, is not environmentally compatible. Inspection of the channel modifications on the Marsh River (Plan 8) reveal that while some adverse channelization impacts exist, they are less detrimental than those for Plan 7. It appears that the Marsh River and ditch reach from mile 20.8 to mile 44.8 has been subject to some previous channel modification (clearing from mile 20.8 to mile 44.8 and enlarging and straightening from mile 31.7 to mile 34.8) and thus making it less sensitive environmentally. With regard to the levee and floodway system (Plan 9) as described in the EIS, this alternative appears to have considerably less environmental impact than other structural measures relative to water quality, stream resources and adjacent plant and animal communities. The 18-mile diversion channel (Plan 10) involves 2.2 miles of channelization of the Wild Rice River from mile 40.6 to mile 42.8. Since mile 40.6 to mile 42.2 was previously channelized in 1954, only .6 miles of the "natural" Wild Rice River would require modification and is therefore less environmentally objectionable than Plan 7, Plan 11 and the proposed project. Consideration should also be given in part to some combination of smaller reservoir sites that have been recommended by Dr. Hibbard. While not discussed in the EIS, there is the possible alternative of a dry reservoir. This alternative should also be examined in the Final EIS. While this alternative would eliminate the long-term water quality impacts of impoundment and the recreational and fishery benefits of the reservoir, it would still adversely impact flood plain bottomlands.

In summary, we believe a combination of nonstructural measures such as flood plain evacuation, flood proofing and flood plain regulation and structural measures such as channel modications on Marsh River, levee and floodway system, 18-mile diversion channel and some combination of the small reservoir sites such as those recommended by Dr. Hibbard would have less adverse environmental impact than the proposed Twin Valley project. Therefore, we request that consideration be given to a more environmentally compatible combination of structural and nonstructural measures to achieve the desired level of flood protection.

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

January 28, 1975

Major Norman C. Hintz
Acting District Engineer
St. Paul District Corps of Engineers
Department of the Army
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Major Hintz:

The draft environmental impact statement for Twin Valley Lake Wild Rice River, Minnesota, which accompanied your letter of November 26, 1974, has been received by the Department of Commerce for review and comment.

The statement has been reviewed and the following comments are offered for your consideration.

The Department of Commerce feels that this Draft Environmental Impact Statement, on page 76, Flood Warning and Emergency Protection (Plan 1) as described, is not effective nor descriptive of the river and flood forecasting services of the National Weather Service. It is suggested, therefore, that this statement be eliminated and substitution made of paragraphs 56 and 57, pages 23 and 24, Plan I - Flood Warning and Emergency Protection of Draft Design Memorandum No. 2, Phase 1 - General Plan Formulation, September, 1974. These paragraphs are as follows:

56. PLAN 1 - FLOOD WARNING AND EMERGENCY PROTECTION

Flood warning consists of predicting the timing and magnitude of floods to allow for evacuation of flood-prone areas or erection of emergency flood protective measures. The National Weather Service currently provides area officials and local news media with flood forecasts and warnings. 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. 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.

57. Implementation of this plan would have no significant beneficial impacts on the economic development, environmental quality, and social well-being objectives of the study area. Flood warnings with subsequent emergency actions could alleviate about 5 percent of the total flood damages in the Wild Rice and Marsh River watersheds. Over $1,025,000 average annual flood damages would remain. Because of the uncertain nature of the costs for providing flood warnings and emergency protective actions, the net benefits of this plan cannot be estimated and it is not known whether such a plan would be truly beneficial. Accuracy of the flood warnings and adequacy of the emergency actions taken would play a large role in determining actual costs and benefits of such a plan. On a short-term basis and in the absence of any other means of flood damage reduction, flood warning and subsequent emergency actions may prove beneficial in reducing flood damages in the urban areas. However, as a means of permanent flood damage reduction and as a long-term solution to flood problems in the Wild Rice and Marsh River basins, this plan is not effective.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving a copy of the final statement.

Sincerely,

John Sullivan for

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

United States Department of the Interior

OFFICE OF THE SECRETARY
NORTH CENTRAL REGION
230 S. DEARBORN STREET, 32nd FLOOR
CHICAGO, ILLINOIS 60604

ER 74/1463 January 27, 1975

Colonel Max W. Noah
District Engineer
U.S. Army Engineer District
St. Paul
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

The Department of the Interior has reviewed the Draft Phase 1 Design Memorandum No. 2 and the Draft Environmental Statement for the Twin Valley Lake Project, Norman County, Minnesota, as requested in your transmittal letter of November 26, 1974, to our Assistant Secretary--Program Policy. Our comments follow.

DRAFT PHASE 1 DESIGN MEMORANDUM NO. 2

Based upon our analysis of the general plan, Appendix C - Recreation, the Souris-Red-Rainy River Basins Comprehensive Study, and the 1974 Minnesota State Comprehensive Outdoor Recreation Plan (SCORP) which was approved in June 1973, we believe several matters regarding the need for providing recreation opportunities at the proposed project should be clarified.

On page C-9 of the Recreation Appendix, we note that the projected water-based recreation demand is based on the presently available water surface area (5,195 acres) within the four-county zone of influence. Due to the close proximity of the northern portion of the Detroit Lakes area to the zone of influence, it is unclear why these well-known recreation lakes were omitted as an available supply of water surface area. Because a significant number of these natural lakes are located within a 50-mile radius of the Fargo-Moorhead area, and are readily accessible via Interstate 94 and U. S. 10, it would appear reasonable to consider them as valuable local resources for meeting recreational needs within the zone of influence. This point is supported by the 1974 Minnesota SCORP in which it is stated that: "Region 4 (which includes Clay County) supports a well-established resort industry as well as a large, seasonal home complex providing 'summer commuter residency' for vacationers from Fargo-Moorhead and other Red River Valley communities."

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Although the proposed project would add water acreage to the recreation resources of the region, it is questionable whether it would function as a viable alternative for other than recreationists which reside in local communities, such as Twin Valley and Ada, Minnesota.

The Minnesota SCORP indicates planning Region 1 has a scarcity of available water surface acreage for recreation purposes. However, one of the high priorities in the region's five-year action program is to

> "...guard against losing the region's natural landscape features, and hence reducing the quality of life in the region..." "Public and private development projects have in many cases diminished the region's aesthetic qualities. Planning, zoning, acquisition and development activities should include a greatly increased protection emphasis in order to preserve and enhance floodplains, wetlands, hillsides, riverbanks, hilltops, etc. Many such features are being lost through impoundments, ditching projects, roadways, dredging and intensified agricultural land and water uses. The protection and improvement of aesthetics, wildlife habitat, recreational opportunities, etc., should be included as an essential ingredient for all projects having local or regional significance."

Although the Souris-Red-Rainy River Basins Comprehensive Study acknowledges the need for the Twin Valley Project, it cites the serious problem of alteration of the landscape by man, and the considerable potential for recreation opportunities in the wooded environmental corridors paralleling the Red River and its major tributaties. The study recommends that attempts to expand the water resource base through reservoir development be considered where feasible and ecologically compatible.

In order to assure that planning and development efforts of the project, including recreation, will provide optimum benefits without significantly altering character of the resource base, we suggest an analysis be made of the recreation benefits which would occur without the project and further, that the merits of a dry bed reservoir be fully evaluated.

The following comments on the draft Design Memorandum relate to the intent of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.):

The U. S. Fish and Wildlife Service first reported on this project in April 1966. Their report described anticipated effects of the reservoir on fish andwildlife resources of the area and offered general recommendations to preserve these resources. Their comments at that time were oriented toward forecasting general project effects on hunting and fishing values of the area, rather than estimating total environmental losses to the project, and thus, did not include specific recommendations to compensate for such losses.

As a result of new policies and laws coupled with a re-evaluation of project effects on natural resources, the U. S. Fish and Wildlife Service informed the Corps in early 1974 that additional measures would be required to compensate for anticipated losses of a stream fishery and of terrestrial bottom land ecosystems and in March, 1974, outlined some of these measures in a letter. Subsequent correspondence from your office indicated that several of the Service's recommendations were not acceptable to you and, as a result, the U. S. Fish and Wildlife Service opposed installation of the project in a letter dated May 1, 1974. It should be noted that the draft Design Memo does not discuss these recommended features in depth, but merely defers their consideration until later stages of post-authorization studies.

It has since become evident to the U. S. Fish and Wildlife Service that this project even with the inclusion of their recommendations, will still generate substantial permanent environmental losses which override any short-term economic gains associated with selection of the reservoir approach to flood control. Accordingly, they remain opposed to the Twin Valley Reservoir at both the alternate and authorized sites and emphasize thay they are willing to assist you in the selection of an alternative that will have less adverse impacts on environmental resources of the area.

General Comments:

We find that the draft design memorandum does not provide an adequate assessment of project impacts on fish and wildlife resources in the Wild Rice River basin. In comparison, the accompanying EIS provides a relatively good description of anticipated impacts which at times appears contradictory to conclusions reached in the design memorandum. One could conclude from these contradictions that environmental values of the project area were not seriously considered in selection of the reservoir alternative. We strongly suggest that the final Phase 1 Design Memorandum draw more heavily from environmental information contained in the draft EIS.

The following aspects of the draft design memorandum particularly concern us:

1. Fish and wildlife losses from the project will be far more significant than has been indicated by the design memorandum. The design memorandum de-emphasizes the environmental losses resulting from the selected plan

by concluding in paragraph 113 that the net effects to the environmental quality account may be "slightly negative" because "...the exchange of about 7 miles of free-flowing stream and about 530 acres of wildlife habitat for about 555 acres of lake and associated aquatic habitats would not provide environmental gains in those areas of environmental quality most needed in the basin."

Although the last sentence in paragraph 132 acknowledges that "The percentage of land left as wildlife habitat in the project area is considerably less than in the eastern portion of the basin," no significance is attached to the increased value of remaining habitat, and the implication given in succeeding paragraphs is that the exchange of terrestrial wildlife habitat and aquatic stream habitat for a reservoir will not have much impact if mitigative features are included in the project.

The environmental losses within the reservoir area assume more importance when they are related to trends of habitat reduction in the area, specific values of remaining habitat, and patterns of surrounding land use. According to the draft EIS, Norman County has experienced a 99 percent reduction in forty-acre parcels which were predominantly marsh, a 64 percent reduction in forties predominantly forested, and a 94 percent reduction in forties predominantly grassland. Further, agriculture is the dominant land use in Norman County and the area surrounding the Wild Rice River Valley is under intensive cultivation. Under these trends of diminishing habitat, we believe that it is imperative to protect what little that remains from further development. Actually, the reservoir area itself comprises an ecotone between the prairie region to the west and forest communities to the east.

In contrast to the draft design memorandum, the draft EIS points out the diversity of both plants and animals associated with this ecotone and stresses its importance: first, because it is an ecotone, and second, because it represents high quality wildlife habitat in the midst of an intensely cultivated area. The EIS further indicates that the value of the stream side vegetation in this area is "...immeasurable in regard to wildlife populations and species diversity."

From a specific standpoint, the proposed Twin Valley project will destroy prime deer wintering habitat and ruffed grouse habitat in an area where such habitat is already at a premium. Elimination of the game habitat also will destroy non-game populations of birds, mammals, herps, and invertebrates associated with northern floodplain forests.

The 7-mile section of stream to be inundated supports rock bass, northern pike, walleyes, forage species, and a rather high diversity of unionid clams. Few of these species would be likely to survive in the impoundment.

The final Phase 1 Design Memorandum should attach more significance to the above-mentioned losses.

2. It is unlikely that fish and wildlife values ascribed to the project would be as great as indicated in the design memo. The Twin Valley Project will create a reservoir of questionable fishery value just west of the prime northern Minnesota lake country where excellent fishing opportunity already abounds. The reservoir will have steep sides, thus providing little productive littoral area for spawning and feeding. Spawning success will be further reduced by the water level fluctuations inherent in managing the pool for flood control. Benthic production also will be limited due to sediment deposition from the upper reaches of Wild Rice River. We suspect that fishery quality will decline drastically after the first several years of reservoir operation with the ultimate fish population being composed primarily of rough fish. Water quality will likewise diminish as nutrients are trapped in the reservoir pool. We do not believe that establishment of a reservoir fishery of declining quality justifies elimination of a stream fishery which could persist unchanged for centuries if undisturbed, and which could be expected to improve markedly if land treatment measures and wetland reclamation are accomplished in the upper watershed.

The design memorandum indicates in paragraph 35 that "The demands in the basin for hunting are above the capacity of the resources to support them at a desirable quality level. This problem is aggravated by a marked downward trend in the amount and quality of wildlife habitat and subsequent decrease in carrying capacity." The problem would be aggravated further by the establishment of the reservoir. Its construction would result in extensive losses of existing deer and ruffed grouse habitat, further reducing the capability of this basin to support hunting demand. Likewise, the reservoir will provide little increase in waterfowl hunting opportunity because its utility to waterfowl would be limited to a migratory rest area--length of stay would depend on the availability of food in the croplands above. The reservoir itself could not be expected to produce any quantity of waterfowl food organisms due to the limited littoral area. Lack of protective nesting and brood cover, coupled with low food availability, would limit or eliminate waterfowl production use.

Specific Comments:

SELECTING THE PLAN

119. SELECTED PLAN

It is stated in this section that "The environmental quality changes which would occur with this plan are not so adverse as to offset the beneficial aspects and render this plan unacceptable." Such a statement reflects a very subjective viewpoint and should not be included in a summary of plan selection justification. The U. S. Fish and Wildlife Service cannot accept the selected plan because of the serious adverse environmental impacts expected from its implementation.

SCALE OF DEVELOPMENT

132. ENVIRONMENTAL AND AESTHETIC CONSIDERATIONS

This section concludes that "The major environmental and aesthetic impacts and effects of the selected plan on fish and wildlife resources would occur directly in the project area with no direct or indirect effects on valuable fish and wildlife resources in the eastern portion of the Wild Rice River basin." This statement is misleading and oversimplifies the anticipated environmental effects of the project. It should be recognized that wildlife displaced by the reservoir either will perish or attempt to move to some other area. Many of these latter individuals can be expected to move to the remaining easterly habitat which already supports wildlife populations to a maximum degree of its carrying capacity. Ensuing competition to meet food and cover requirements would have significant adverse effects on the competing populations and the habitat base available to support them.

ECONOMIC IMPACTS

172. FISH AND WILDLIFE BENEFITS

Table 12 summarizes fish and wildlife values of the reservoir at the authorized site. Some comments regarding this table seem warranted. The EIS indicates that in 1972 "...at least 150-200 man-days of hunting were supported by the area." These figures, being more recent than the 1966 estimates, are probably more representative of the current annual day use for big game hunting. The U. S. Fish and Wildlife Service would accept these figures for the "Without Project" category of annual day use.

Lake fishing day use is estimated at 2,000 annual days with $2.00 being the estimated value of the user day. The "net difference in average annual dollars" column lists a benefit of $6,030. Although footnote (3) claims that "Average annual fishing benefit calculations recognize that the best fishing would occur during early stages of the project life," this figure seems too high. Even if fishing benefits remained constant throughout the project life, only $4,000 could be claimed as an average annual dollar figure. Because fishing must be expected to decline throughout the project, some figure less than $4,000 should reflect the net difference in average annual dollars.

A figure of $5,600 is shown for "Total net fish and wildlife benefits" in Table 12. Apparently, lake fishing benefits have cancelled out hunting losses. According to Department of the Army Regulation ER 1105-2-129, "One type of fish and wildlife benefit will not be used as an offset for another type of fish and wildlife damage, nor will only the net effect be shown. Thus, if a project results in a net damage to one category of fish and wildlife and benefit to another category, the damage should not be said to be cancelled out. The damage to the first category should appear on the cost side and the benefits to the latter on the benefit side of the cost-benefit comparison, and both effects adequately discussed." We recommend that Table 12 be revised to reflect some needed changes in figures.

This section also should recognize that, although lake fishery benefits appear positive monetarily, losses of game, habitat, and opportunities for hunting are more significant because hunting demand cannot be met by existing huntable areas, whereas lake fishery resources in the area already exceed demand.

ENVIRONMENTAL IMPACTS

194. IMPACTS UPON LAND USE

This section indicates that a net loss of about 120 acres of terrestrial wildlife habitat would occur with the project. Derivation of this figure should be explained. It is unclear how 555 acres of terrestrial wildlife habitat could be altered by the reservoir and project structures with a loss of only 120 acres expressed.

Table 20 shows the impact of the selected plan at the alternate site on land use within the Wild Rice and Marsh River basin. Figures shown in the lowland woods and brush segment of the woodland land use category are questionable. The "Land use changes affected by conservation pool and structure" column shows a loss of 515 acres, while the column for "Land use changes affected by flood control storage" indicates a gain of 490 acres. It is not clear how this 490-acre figure was derived and some explanation should be given. It is mentioned in footnote (4) that "Due to reforestation of a portion of the agricultural lands and changed land use mentioned previously, there would be a gain in woodlands and brush, the major portion probably in the lowlands category." This still does not fully explain the 490-acre figure. The "Net change" column then shows a net loss of 25 acres. Showing a net figure of gains and losses here does not negate the loss of 515 acres of lowland woods and brush. Even if 515 acres of another land use category are planted in lowland woods and brush there will still have been a net loss of 515 acres. We believe the net change figure here should be -515 acres.

DRAFT ENVIRONMENTAL IMPACT STATEMENT

1. PROJECT DESCRIPTION

Land Use

1.07 - The second full sentence of this paragraph on page 4 notes that if no public agency expresses interest to manage available project lands for wildlife purposes, "... other uses could be made of the 2,750 acres." We wish to emphasize that a non-managed area retains its fish and wildlife values and should not be relegated to other uses simply because it is not managed. Management maximizes production of the species under consideration--its absence does not diminish any existing fish and wildlife values.

Fish and Wildlife

1.11 - Does the "active fishery management and appropriate reservoir management" alluded to in this paragraph include provisions for complete reservoir drawdown when conditions warrant it?

2. ENVIRONMENTAL SETTING WITHOUT THE PROJECT

Geology

2.06 - This paragraph notes that sand and gravel comprise the only economic mineral deposits in the watershed, and tabulated data elsewhere in the statement indicates that neither the authorized dam and lake nor the several alternate proposals should affect mineral resources. The commitment, but not the source, of raw materials for construction is mentioned. The statement, however, does not describe mineral resources of the project area itself, does not discuss the significant potential for undiscovered resources that may underlie the site, nor does it indicate the quality of studies upon which conclusions about mineral resources are based.

So far as known mineral resources are concerned, our review, without benefit of field investigation, indicates that the project would have no significant adverse effect. Sand and gravel, the only mineral commodities produced in Norman County in recent years, are not produced within the project area, and any of such resources lost because of the project would be insignificant compared with abundant supplies available nearby. However, we are concerned about potential mineral resources that may be committed under the proposed reservoir.

According to maps prepared by the U. S. Geological Survey (e.g., GP-325, -471, -725), a pronounced northeast-trending linear aeromagnetic anomaly, similar to anomalies over known iron-formation in northeastern Minnesota, traverses the region just east of Twin Valley. The state geological map (Sims, P.K., 1970) shows that the project area is underlain by undivided metavolcanic rocks including, perhaps, iron-formations and greenstones, host rocks for vast deposits of iron and other metals elsewhere in Minnesota. Although the chance that major metallic deposits occur beneath the 3,500-acre site probably is not great, this possibility should not be ignored nor dismissed too lightly. We recognize that the project would affect but a small part of the anomalous region.

The Bureau of Mines has indicated low potential for metallic mineral resources in Precambrain rocks in the Red River Basin (Souris-Red-Rainy River Basins Comprehensive Study, App. K - Minerals, 1972). Nevertheless, we believe that a survey to assess both known and potential mineral resources at the Twin Valley Lake site should be made by qualified personnel before the land is committed to uses that would preclude future development of mineral resources. For this project, a survey seems necessary at least to support the conclusion in the reports that mineral resources would not be affected; conceivably, such a survey might alter that conclusion. At any rate, the results of the mineral survey should be incorporated into the final environmental statement.

One additional point relevant to mineral resources requires clarification in the statement: the physiographic setting of the project. Figure 3 indicates that the lake would lie in the shoreline area of the Red River lowland where important sand and gravel deposits are most abundant (par. 2.06), but par. 2.62 says, "The site . . . is located in the upland plain of glacial till east of the beach ridges."

Historical and Archaeological

2.59 - This paragraph indicates that an archaeological reconnaissance survey of the project area has been completed. In the event that this survey did not cover all of the 3,500 acres of project lands (including borrow areas, road and utility relocations, and recreational facilities) the State Archaeologist should again be contacted for recommendations relating to the need for further survey. The final environmental statement should present in a detailed form the results of this survey and present plans for any necessary salvage mitigation.

The final environmental statement also should reflect measures to be taken in the event that previously unknown cultural resources are encountered during construction.

No established or studied unit of the National Park Service or any National Landmark (natural or historic) would be adversely affected by the proposed action.

Stream Resources - Physical Aspects

2.61 - This paragraph should describe drainage practices in the upper watershed which contribute runoff to the Wild Rice River, thereby aggravation flooding conditions in the lower reaches. An attempt should be made to quantify this increased runoff and its effect on flood stages. Wetland reclamation in the upper watershed may reduce flood crests of the Wild Rice River below Twin Valley and could, in combination with non-structural measures, provide a viable alternative to the environmentally destructive Twin Valley Reservoir. If wetland reclamation is combined with adequate land treatment measures in the upper watershed, the biological productivity of this stream could be considerably improved as a result of decreased sediment loading.

Plant Resources

Three potential natural landmarks, which are located in the morainal uplands of the Wild Rice River Basin, appear to be beyond the area of influence of the Twin Vally project. The presence of these significant natural areas, which have been identified in National Park Service theme studies for both Inland Wetlands and Northern Hardwoods, should be recognized in the description of the basin environment (page 36). They are:

1. Hellickson Prairie, located west of Ogema in Becker County.

2. Waubun Prairie, located southwest of Waubun in Mahnomen County.

3. Marshall Bog, located west of Zerkel in Clearwater County.

6. ALTERNATIVES TO THE PROPOSED ACTION

Structural Alternatives

We note that the analysis of structural alternatives does not include the concept of a "dry dam" to intercept flood flows. Although this alternative also could have environmental drawbacks, we believe that its feasibility should be investigated and compared with other structural measures. Of particular concern would be the expected duration and degree of floodplain inundation for various frequency floods and the attendant environmental effects. The disposition of trapped sediment in this type of structure also should be discussed.

Sincerely yours,

Madonna F. McGrath

Madonna F. McGrath
Acting Special Assistant
to the Secretary

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 5
18209 DIXIE HIGHWAY
HOMEWOOD, ILLINOIS 60430
December 27, 1974

IN REPLY REFER TO 5-00.5

Colonel Max W. Noah
District Engineer
St. Paul District, Corps of Engineers
1210 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

As requested in your November 26, 1974 letter, we have reviewed the draft environmental statement for Twin Valley Lake, Wild Rice River, Minnesota.

The statement appears to adequately discuss effects on highways and highway improvements required as a result of construction of the proposed improvement. We therefore have no comments on the draft statement for the proposed project.

The opportunity to review and comment on the draft environmental statement is appreciated.

Sincerely yours,

H. L. Anderson
Regional Administrator

By: [signature]

W. G. Emrich, Director
Office of Environment and Design

AD-A139 543 TWIN VALLEY WILD RICE RIVER MINNESOTA ADDENDUM(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT MAY 76 3/4

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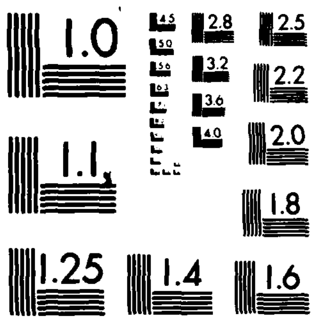
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FEDERAL POWER COMMISSION
REGIONAL OFFICE

31st Floor, Federal Building
230 South Dearborn Street
Chicago, Illinois 60604

January 9, 1975

Colonel Max W. Noah
District Engineer
U.S. Army Engineer District, St. Paul
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Your Reference: NCSED-PB

Dear Colonel Noah:

This is in response to Major Norman C. Hintz's letter of November 26, 1974 requesting our comments on preliminary copies of the "Design Memorandum No. 2, General-Plan Formulation" and the draft "Environmental Impact Statement" for the Twin Valley Lake project on the Wild Rice River, Minn.

These reports show that the plan selected to meet the water and related land resource needs of the basin involves the construction of an earth dam with a total storage of 52,200 acre feet near Twin Valley, Minnesota. Two sites for the dam are under consideration, one an authorized site one mile east of the City of Twin Valley, and the other being an alternative site one river-mile further upstream. Both appear to be feasible and desirable for development. The plan of improvement, as recommended in Design Memorandum No. 2, involves the construction of an 84-foot high earth dam having 44,700 acre feet of storage capacity for flood control and 7,500 acre feet of storage for recreation, conservation and silt retention.

In 1968, the Commission staff made studies of the power possibilities of the Twin Valley project, which as then proposed for construction at the authorized site, would have a total controlled storage of 47,000 acre feet. In its letter of June 10, 1968 to the Chief of Engineers, the Commission advised that staff studies showed that essentially no dependable hydroelectric power could be developed with the project constructed and operated as planned without regulatory storage, modification of the project to increase the power potential would not be warranted, and local terrain is not suitable for pumped storage development. Based on the review of previous staff studies and Design Memorandum No. 2, which indicates that project operation will be essentially the same although flood control storage is increased by 5,200 acre feet, it is our opinion that the recommended project operated as planned does not provide opportunity for the economical development of hydroelectric power.

Our comments on the draft Environmental Impact Statement, which we note is considered applicable for development of either the authorized or alternate dam sites because of the similar nature of the sites and projects, are made in accordance with the National Environmental Policy Act of 1969 and the August 1, 1973 Guidelines of the Council on Environmental Quality. Our primary concern with developments affecting land and water resources is the possible effect of such developments on bulk electric facilities, including potential hydroelectric developments, and on natural gas pipeline facilities. Our review of the draft Environmental Impact Statement and the information available in this office indicates that the proposed project would not have significant adverse effects on such facilities.

The above comments are those of the Chicago Regional Office and, therefore, they do not necessarily reflect the views of the Federal Power Commission.

Very truly yours,

Lenard B. Young
Regional Engineer

LAND OF QUALITY FOODS

STATE OF MINNESOTA

DEPARTMENT OF AGRICULTURE
STATE OFFICE BUILDING
SAINT PAUL, MINN. 55155

December 20, 1974

Department of the Army
St. Paul District
Corps of Engineers
1210 U.S. Post Office
St. Paul, Minnesota 55101

ATTENTION: Major Norman C. Hintz

Dear Major Hintz:

The Department of Agriculture wishes to thank you for the opportunity of reviewing and commenting upon the Plan Formulation and draft Environmental Impact Statement for the Twin Valley Lake Project on the Wild Rice River, Minnesota NCSED-PD. The Minnesota Department of Agriculture recognizes the need for flood control on the Wild Rice River and supports this project which the Corps is proposing. In these times of severe nutritional shortages, we must take every wise and prudent measure to increase food production, both now and in the future.

On the whole, the Plan Formulation and draft Environmental Impact Statement are very well done and meet the needs for scientific and rational decision making. There are a few areas, however, which cause the department concern.

First, if the permanent lake alternative is used, economic benefit should be credited in the cost/benefit ratio for the sale of the timber which will be cut for the lake. It would certainly seem that this should be considered against the cost of the dam.

Second, there seems to be a question as to the actual recreational benefits which will be derived from a permanent reservoir. With the variations in water levels during the spawning season and the fact that this is an artificial lake which will be lacking many of the habitat requirements found in a natural setting, the ability of fish to live in this reservoir is questionable. Also, when considering the fact that over 500 acres of woodland wildlife habitat will be lost to the reservoir, additional study should be given to the problems surrounding the reservoir and stronger consideration should be given to a dry dam.

Third, in the draft Design Memorandum No. 2, the section on soil treatment indicates that 40% of the agricultural and woodland in the basin would have proper land treatment. Because of the fact that increased drainage upstream has been a contributing factor in the increased frequency and severity of flooding of the Wild Rice River, consideration should be given to a concentrated effort to improve the land treatment of the upper basin. This would provide for suitable drainage and minimize the increasing volume on the river.

Although these three items cause the department some concern, they do not diminish its support for the proposed project or the concept of flood control for the benefit of the total citizens and the state and nation as a whole.

Sincerely,

MINNESOTA DEPARTMENT OF AGRICULTURE

Rollin M. Dennistoun, Ph.D.
Department Administrator

RMD:hk

cc: Randall Young, MDA

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING • ST. PAUL, MINNESOTA • 55155

February 24, 1975

Colonel Max Noah
District Engineer
St. Paul District Corps
of Engineers
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Re: NCSED-PB

Dear Colonel Noah:

We have reviewed the Design Memorandum No. 2, Phase I, General Plan Formulation and Draft Environmental Impact Statement for the Twin Valley Lake Project on the Wild Rice River, as requested in your November 26, 1974 letter.

The Department of Natural Resources continues to support the need for a flood control project at the Twin Valley Site to provide for partial control of flood waters on the Wild Rice River and the Red River of the North. However, legislation passed in the interim at both the federal and the state level, namely the National Environmental Policy Act of 1969 and the Minnesota Environmental Policy Act of 1973, requires public agencies to weigh and document the environmental consequences of proposed actions before making a decision on how to proceed on a proposed project.

After our analyses and evaluation, it is the opinion of the Department of Natural Resources that implementation of the proposed project would result in the following adverse impacts:

1. The project would destroy or adversely affect an appreciable amount of existing meandering free-flowing river which possesses unique aesthetic and environmental parameters for this area. The river and the valley provide fishing, hunting, canoeing, and various other opportunities such as environmental education.

2. The existing stream fishery would be replaced with a reservoir fishery. A man-made reservoir typically supports a good fishery for only about 15-20 years because eventually, erosion, siltation, turbidity, algal blooms and lack of shallow littoral zone create a habitat in which game fish cannot successfully compete with rough fish. Alternately, the existing stream fishery, left in its natural state, could be expected to last indefinitely.

3. The project would permanently interrupt an important biological corridor that brings a diverse woodland wildlife habitat into an intensively farmed area where such habitat resources are scarce and can ill afford to be lost. Approximately 555 acres of woodland would be consumed in the conservation pool while an additional 1,100 acres would be so adversely affected as to be considered as having minimal value for wildlife habitat.

4. Implementation of the proposed plan would create a habitat of limited value for waterfowl. A minor amount of resting use by migrating waterfowl may occur but the lack of shallow littoral waters, in addition to siltation, turbidity, algal blooms and rough fish populations, would greatly reduce or eliminate aquatic plant growth. The plants are necessary for food production and protective cover for both waterfowl and game fish. Similarly, agricultural practices, such as eall plowing, limit the food production capabilities on lands adjacent to the reservoir. In addition, the steep sides of the proposed reservoir would make the site unattractive for ingress and egress of waterfowl.

   Other environmentally related problems which could result from project implementation include:

   1. increased bank erosion within the project area;

   2. impetus for increased drainage in the watershed;

   3. increased potential for upstream degradation caused by fluctuating water levels.

Some of the benefits attributed to this project appear to us to be of dubious value. For example, there are 3,279 lakes of 10 acres or greater within a 2-hour drive or an 80-mile radius of Twin Valley. The attempt to use the creation of a new lake as a justification for this project is obviously unwarranted. Furthermore, the recreational and fishery benefits would be relatively limited and of short duration, especially in light of the fact that there are so many excellent natural lakes nearby.

The calculation of the benefit-cost ratio, with particular regard to the costs of negative environmental impacts, is another subject of great concern to us. While it appears that positive benefits accrued to the project were considered in the tabulation of the "benefit" value, it does not appear that the costs of the fish, wildlife and forest resources and aesthetic values which will be destroyed have been included in the "cost" value. Thus, we would anticipate that the true benefit-cost ratio will be presented prior to implementation.

To mitigate and compensate for the environmental losses and to attempt to enhance the environmental situation that will exist if the proposed plan is implemented, we offer the following recommendations:

1. To increase the likelihood that the existing fisheries value can be maintained, or even enhanced, we recommend that the Corps develop an operational plan for discharge release when the reservoir stage increases by five feet or more during the spawning season. If feasible, these efforts should be made to protect spawning areas for approximately 50 days. Consideration should also be given to the construction of wing dams downstream from the main dam to provide resting places for fish.

2. Stipulation should be made that Norman County and the Cities of Ada and Twin Valley use available data to adopt flood plain regulations concurrently with project approval. Furthermore, lands adjacent to the project should be zoned to prohibit any type of development which would be detrimental to either the projects effectiveness or habitat enhancement.

3. In the final design of the structure, every effort should be made to blend with the natural landscape and thus, provide an aesthetically pleasing project, rather than a distortion on the landscape.

4. If the project is utilized as a local recreational resource we recommend that the size of the recreational sites be developed and if possible to be increased, to provide maximum recreational benefits; that a trail be established around the entire project area and that an adequate public access system be established. We believe that through these actions, the recreational values of the project can be enhanced.

5. In an effort to enhance wildlife habitat and, in part, to compensate for the habitat that would be either lost or adversely affected by implementation of this project, we recommend that approximately 1,000 acres be acquired and added to the nearby DNR Faith Wildlife Management Area. Furthermore, we recommend that an additional 400 acres be acquired so that the area to be managed, including both the Faith Wildlife Management and the additional acreage to be acquired, is contiguous with the project area lands.

6. To provide for the development and management of good habitat in the project area, we recommend that a border of land at least ¼ mile in depth and totally around the uppermost perimeter of the flood control reservoir be acquired in fee and turned over to the Department of Natural Resources to manage. We would like to express our interest in managing any lands which are made available, as discussed in the draft environmental impact statement on pp. 3-4.

7. Purchase in fee or by easement, a strip of land approximately 660 feet wide (1/8 mile) on both sides of the Wild Rice River (about 480 acres) from the proposed dam to the Village of Twin Valley, for angler access and other recreational uses.

Concerning our recommendations 5, 6, and 7, a further explanatory note could be helpful. We are recommending that these lands be acquired and monies be made available for development because we consider them to be very important and necessary to compensate for the loss of habitat, both wildlife and stream, and also, because they are key elements in making the project proposal acceptable and beneficial to the people of the State.

8. For the area that is acquired under recommendations 5, 6, and 7, the boundaries should be squared so as to provide for manageable tracts of land. Again, zoning and limited development of adjacent lands would be vital to maintain the integrity of these areas.

In closing we feel that our recommendations form the basis of a sound mitigation and enhancement plan. It is in this manner that the project can truly be in the best interests of the citizens of the State of Minnesota.

Sincerely,

Robert L. Herbst, Commissioner
Department of Natural Resources

RLH

cc: Governor Wendell R. Anderson
Mr. Ed Herold, Chairman
Citizens Advisory Committee
Merlyn Wesloh, Regional Administrator
PERT Members

STATE OF MINNESOTA
DEPARTMENT OF HIGHWAYS
ST. PAUL, MINN. 55155

January 2, 1975

U.S. Corps of Engineers
1210 U.S. Postoffice and Custom House
180 East Kellogg Blvd.
St. Paul, Minnesota 55101

Attention: Major Norman G. Hintz,
Acting District Engineer,

Re: Design Memorandum #2
Phase 1 - General Plan Formulation
Draft Environmental Impact Statement
Twin Valley Lake

Dear Major Hintz:

As requested by your letter dated November 26, 1974, representatives from our Department have reviewed the above referenced reports, and have participated in meetings and field studies involving the proposed project. Our comments are as follows:

It does not appear that trunk highways will be materially affected by the proposed project. If anything, some benefits could be derived downstream from the proposed dam site, by the control of discharges during flood periods, and releasing the waters more uniformly over a longer period of time. Any benefits derived would be along T.H. 200 and T.H. 9 where the Marsh or Wild Rice Rivers cross these highways. It is doubtful if any areas on T.H. 75 that are subject to backup of the Red River would be significantly affected by this project.

On the other hand it appears that flood related damages on the secondary road systems (CSAH, CR and Twp. Road) will be considerably less if the proposed project was completed.

The two County State Aid Highways upstream of the dam site that would require reconstruction, namely CSAH 29 and CSAH 36 were viewed in the field. Local County Officials have been working closely with the Corps in the design phase of this project, and are satisfied with the proposals for changing these routes as shown in the Corps plan.

We were asked to state our views to the Corps of Engineers whether it would be desirable and whether there is a need for a public highway across the dam. We are of the opinion that it is not desirable or necessary to have a public road across the dam. The area is served adequately by a road system that provides access to all those proposing to use the site without a road across the dam.

We thank you for the considerations shown involving us in this project and ask you to feel free to contact us if there are any questions either through Ellen Temple,

U.S. Corps of Engineers
Attn: Major Norman G. Hintz,
Acting District Engineer,
January 2, 1975
Re: Design Memorandum #2
Phase 1 - General Plan Formulation
Draft Environmental Impact Statement
Twin Valley Lake
Page: 2

Office of Environmental Policy and Programs, and/or J. R. Isaacson, Senior Engineer, Bemidji, District Office.

Sincerely,

Ray Lappegaard,
Commissioner

UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Anthropology
215 Ford Hall
Minneapolis, Minnesota 55455

December 18, 1974

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

Ref: NCSED-ER

Dear Col. Noah:

I have reviewed the draft environmental impact statement on the Twin Valley Lake project on the Wild Rice River, Minnesota. Though no significant archaeological sites were located in the project area surveyed, I strongly support the need for additional detailed survey when the borrow areas for the earth dam fill are located and if the site of the dam is altered because of public opinion or engineering changes.

Sincerely,

Elden Johnson
State Archaeologist

EJ:ml
CC: Alan Woolworth

East Agassiz Soil & Water Conservation District

Twin Valley, Minnesota 56584

January 24, 1975

Department of the Army
St. Paul District Corps of Engineers
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Sir:

In reference to the Twin Valley Lake project, Draft Design Memorandum No. 2 and Draft Environmental Impact Statement the Supervisors of the East Agassiz Soil & Water Conservation District wish to indicate their unanimous support toward the earliest possible construction of a flood control dam on the Wild Rice River east of Twin Valley. The dam and resevior is needed to effectively control the discharge of the river. With a controlled flow, projects to stabilize the river banks, provide suitable road crossings and development of agricultural lands previously subject to flooding can be made with little hazard to their distruction.

The East Agassiz Soil & Water Conservation District was organized in 1941 to provide technical assistance to landowners on management of soil and water problems. Approximately one-half of the farmers of Norman County are District Cooperators interested in the proper management of soil and water. There are undoubtedly many others that are following minimum conservation guidelines who have not requested assistance through the SWCD.

Since 1970 there has been a joint effort by East Agassiz SWCD, Norman County Wild Rice Watershed District and Norman County ASC Committee to place the highest priority of planning and financial support toward the development of flood water control projects. Since then 10 such dams have been built. Nine of these are with drainage areas of less than 2500 acres each, one with a drainage area of over 13,000 acres. Landowner cooperation has been a very important item in the development of these projects.

We feel these small retention dams provide benefits to lands and roads below each structure and overall will compliment the benefits of the dam on the Wild Rice River.

While a vast system of small dams will provide local benefits to tributaries of the Wild Rice River, we do not feel there are enough sites nor would they be adequate to harness the flood flows of the Wild Rice River to provide the degree of protection desired in the flood plan.

We therefore support the construction of the flood control dam on the Wild Rice River and will continue to work with local landowners and governmental agencies towards soil and water management practices on the land.

Lowell Koch, Chrm.

Oliver Sorenson Jr., Reporter

Wally Bernhardson, Sec'y

David Mickelson, Vice Chrm.

Donald Skaurud, Treas.

Twin Valley, Minn.
January 8,1975

Dept. of Army

U. S. Corps of Engineers
St. Paul, Minn.
RE: Twin ValleyLake Project
Twin Valley, Minn.

Dear Sirs;

As a member of theCitizens Advisory Committee and as a landowner that would be affected by the implementation of the Twin Valley Lake project I would like to pose the following questions and make the following observations in connection with the Environmental Impact Statement.

1. RE: Pg 38 & 39 Paragraph 2.107 &2.108.

I have lived on the bank of the Wild Rice River all my life; I Own land that would be flooded by either site of the proposed dam. It appears to me the number of deer living in the river bottomland of the area is vastly underestimated. Within the past 3 years I have personally seen herds of 20 or more at one time and have heard reports of sightings of as many as 140 at one time. I also have personal knowledge of at least 4 times the deer kill in hunting season (1 to 3 days, restricted firearms) that is listed in the report.

Acording to other parts of the report this wildlife population would be virtually driven from the area entirely due to the fact of loss of cover and brush type growth. Not only in the lakebed itself but according to the report in most of the design flood pool area also due to periodic inundation. Ref. also pgf. 5.08, 5.09, 8.06.

2. RE: Pg. 5 Paragraph 1.13 & Pg. 27 Paragraph 2.68.

There is a question in my mind as to- the level of the permanent pool being maintained constant. With a body of water the size of the lake and the shoreline area it would encompass and knowing the flow of the river feeding into the proposed lake from having observed it over my lifetime I seriously question whether there would be any water available for discharge during some periods in the summer. The periods of low flow on the river usually coincide with warm weather when the evaporation and seepage factors would almost always be greatest.

Associated with this is the information in pgf. 4.11 pg. 51 with regard to changes in groundwater level. Knowing the area this rise in groundwater would be detrimental in effect as far as agricultural considerations are concearned but as is stated in this paragraph "these will require further study", and no further figures, damages or costs in regard to this were found in the statement.

3. RE: Pg.49, Paragraph 4.03, 4.05 & Pg. 50 Paragraph 4.09,&Pg.51 Paragraph 4.12 & pg. 53, Paragraph 4.21.

These paragraphs all deal with cost or benefit figures.

4.03; "recreation, fish and wildlife benefit $99,200. Is any value assigned to the present value of these that would be destroyed by the implementation of this project? Also just what is meant by "area redevelopment?"

4.05; I am one of those involved in the last part of this paragraph. If the way in which I have been approached on this project so far is any indication of the way in which these "hardships" and "adverse social effects" are going to be dealt with it would appear it is going to be pretty heavy handed as so far I have been neither contacted officially or unofficially regarding any of the property required for the project, yet what is going to be allowed for the acquisition and relocation is allready decided in the cost estimated.

pg.1

4.09; "The proposed project would therefore reduce the average flood damages while it would increase the damages froma any one very large flood." Has the increased damage from " a very large flood" been taken into account in the cost or benefit figures for the project? It appears not as far as I can determine.

4.12; This refers to "action to avoid loss of archeological resources". Has cost of any such action been included? Again it appears not.

4.21; Again has the cost of multiple level outlet structures been taken into account?

4. RE: Pg. 52, Paragraph 4.15 and related paragraphs in this section.

What is really meant by "thermally stratify?" Is this the same thing essentially that happened to the lakes in North Dakota this past summer which resulted in the death of so many fish?

Again by reading these paragraphs I gain the impression that the "cure" or thing to do to aleviate this situation is to discharge water from various levels and at various velocities, but again this period is associated with low flow into the lake and what would happen to thelake level? The reason I seem to be concearned with the lake level is that as far as I can see the only real benefit to the people of the immediate area is that we will have a recreation lake facility closer by than at present.

5. RE: Pg. 65 Paragraph 4.65.

This paragraph states that there are significant environmental problems with the Homme and Orwall dams that probably will occur if the Twin Valley Lake dam is built. What are the nature of some of these problems? I assume whenever there are problems that require solutions there is a cost involved.

CONCLUSION:

Most of the charts and studies state they are for the reservior area, yet it states again and again in the report "*some quantatative changes ---- on uplands adjacent to the reservoir will occur*".(Pgf. 4.58).

It seems to me that in regard to the wildlife aspect, the actual design and operation of the dam structure and pool,and the cost estimates, not only of the whole project but hidden hinted at costs we are not being given the whole picture. It seems from what has been referenced to in this letter that the benefits have been overrated, and the adverse effects and costs have been treated as lightly as possible. In other words on the basis of the report I cannot but come to the conclusion that I must oppose the project.

Sincerely,

Harold Habedank

Harold Habedank, Twin Valley, Mn.

Pastor Percy J. Smerek
Phone 584-8686
Wild Rice Lutheran Parish
Twin Valley, Minnesota 56584

Army Corps of Engineers

St. Paul District

Refering to NCSED-PB
Environmental Impact Statement on Twin Valley Lake

Dear Sirs:

O As I read the statement there were only two things I noticed that struck me.

1) general decrease in woodlands and in woodlands flora and fauna. Especially hit were old stands of such trees as Bur Oak and some birches along with amphibians and some woodland birds. My question about thisis: would they truthfully be destroyed or just moved up river? The trees cannot move, the rest can.

2) I wondered about the responsibility of a statement where on page D-2 Poison Ivy is listed as being the following things: a very common plant with importance as "wildlife cover" and more interesting, that it has "major value for cultural, Aesthetic and scientific purposes". I am sure that whatever scientific purposes they might find for the plant can plant can be carried on outside the lake project since there is an abundance of the stuff in many areas.

Other than that, it seems as if the report does take into account many of the variables that it is supposed to question and so far as I can see it concludes that a lake is different from a stream with a few less trees.

Yours truly,

Pastor Percy J. Smerek,

Citizen's Advisory Committee

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FINAL

ENVIRONMENTAL IMPACT STATEMENT

APPENDIXES

TWIN VALLEY LAKE
WILD RICE RIVER, MINNESOTA

U.S. ARMY ENGINEER DISTRICT, ST. PAUL
St. Paul, Minnesota
February 1975

FINAL

ENVIRONMENTAL STATEMENT

TWIN VALLEY LAKE

APPENDIXES

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APPENDIX A

WATER QUALITY DATA - WILD RICE RIVER BASIN

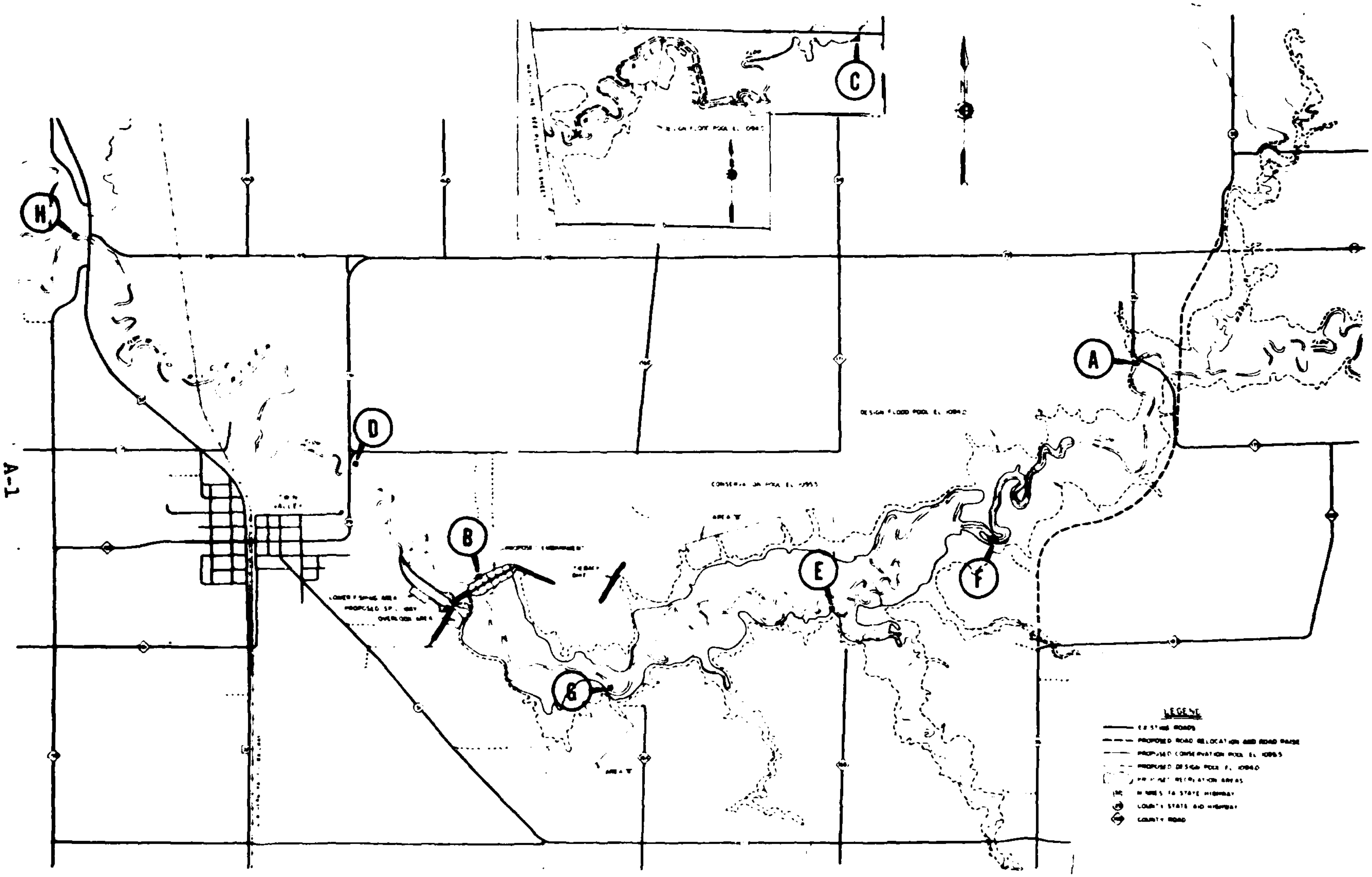


Figure A-1 Reservoir Area Aquatic Sampling Stations. (WR)

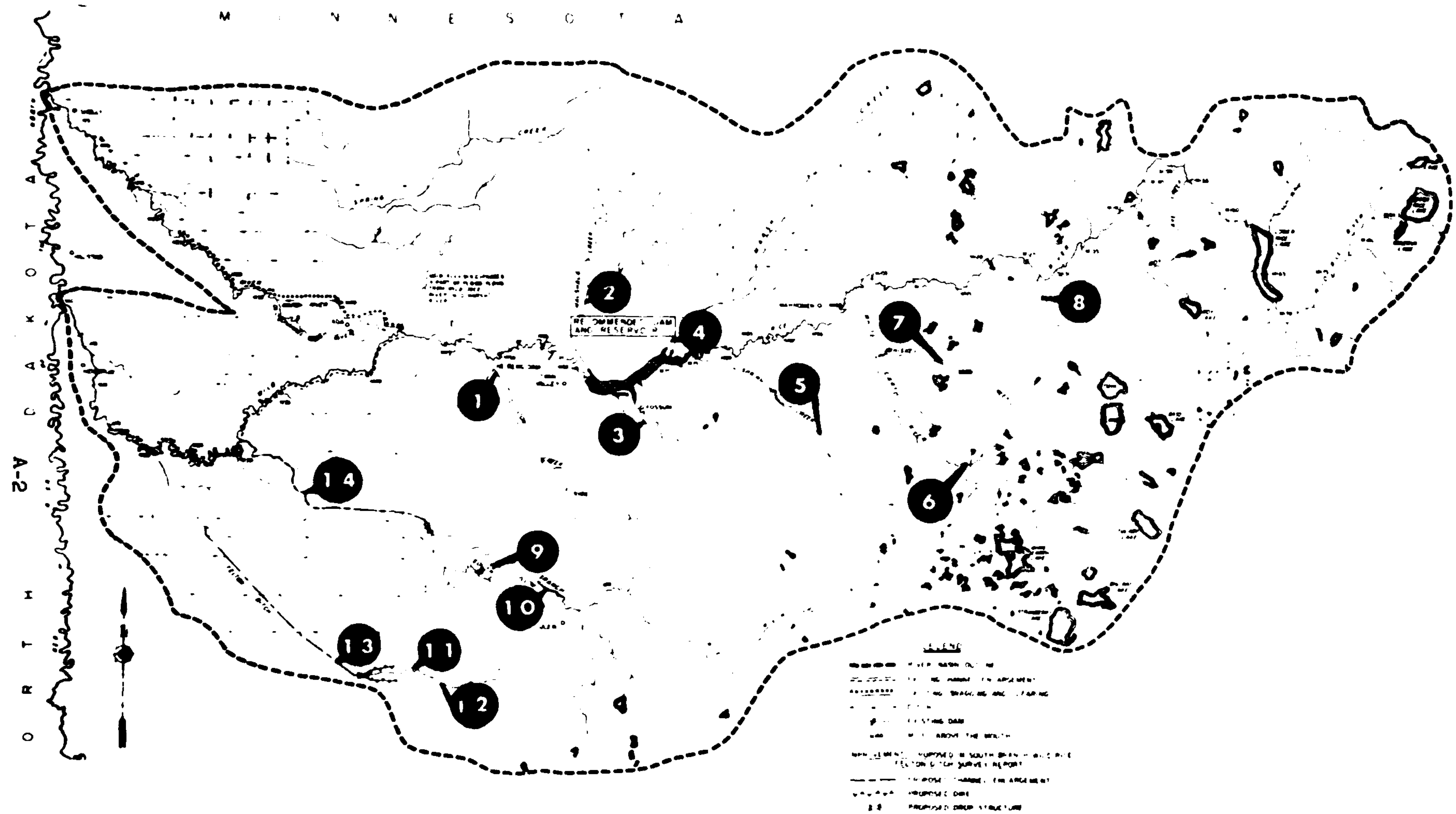


Figure A-2 Alternate Site Aquatic Sampling Stations. (AS)

TABLE A-1 DETERMINATIONS OF TEMPERATURE, ALKALINITY, PHOSPHATE AND BIOCHEMICAL OXYGEN DEMAND FOR THE WILD RICE RIVER AND SOME OF ITS HEADWATERS AND TRIBUTARIES - Summer, 1972[a]

Location	Date	Time	Temperature Air	Temperature Water	Alkalinity CO_3[b]	Alkalinity HCO_3	BOD[c]	PO_4[d]
Tributaries			(degrees centigrade)		(ppm)		(ppm)	
AS #1 Coon Creek	8-31	1830	20.0	21.0	12	227	1.5	0.20
AS #2 Maushaug Creek	9- 1	1130	15.2	15.5	0	322	2.5	0.17
AS #3 Flom Creek	8-31	1700	21.5	22.0	12	261	1.3	0.08
AS #4 Marsh Creek	9- 1	1330	17.5	18.0	+	267	2.5	0.09
	8-25	1600	25.0	20.0	-	-	-	-
AS #5 Spring Creek	8-31	1500	22.5	21.0	0	354	1.4	0.20
AS #6 White Earth River	8-31	1600	24.2	27.0	8	154	1.4	0.01
AS #7 Whiskey Creek	8-30	1500	22.0	27.3	0	286	-	-
AS #8 Twin Lake Creek	8-30	1200	21.0	25.0	0	158	1.0	0.03
AS #9 So. Br. Wild Rice R.	8-29	1500	26.0	33.0	8	275	2.1	0.02
AS #10 So. Br. Wild Rice R.		-	-	-	-	-	-	-
AS #11 Felton Creek	8-28	1200	22.0	17.0	14	276	2.1	0.02
AS #12 Felton Creek		-	-	-	-	-	-	-
Wild Rice River								
WR-A Peterson Bridge	8-25	1600	25.0	21.0	-	-	1.6	0.05
WR-C Faith Bridge	8-25	1600	25.0	21.0	-	-	1.3	0.05
WR-D Gauging Station	8-30	1030	24.0	22.5	8	231	2.1	0.03
	8-25	1600	25.0	21.0	-	-	-	-
East of Ada		-	-	-	-	-	1.4	0.02

[a]Measurements of biochemical oxygen demand and phosphate were taken only on September 29, 1972.

[b]Carbonates determined by phenolpthalein-methyl orange method; [c]BOD determined by standard method using azide; [d]phosphates determined via phosphomolybdate method.

TABLE A-2 CONCENTRATION OF NITRATES, SULFATES, AND DISSOLVED OXYGEN IN THE WILD RICE RIVER AND SOME OF ITS LARGER TRIBUTARIES - Summer, 1972[a]

Location	Date	Time	NO_3	Fe[c]	SO_4[d]	Temperature Air	Temperature Water	Dissolved Oxygen[e] A	Dissolved Oxygen[e] B	Dissolved Oxygen[e] Saturation
			(ppm)	(ppm)	(ppm)	(degrees centigrade)	(degrees centigrade)	(ppm)	(ppm)	(ppm)
So. Br. Wild Rice River (AS-9)	9-19	1540	*	.00	57.0	27.5	21.0	11.7	-	9.0
Peterson Bridge (WR-A)	9-18	1430	*	.02	23.0	23.0	15.0	10.5	10.9	10.2
Faith Bridge (WR-C)	9-18	1600	*	.05	22.0	24.0	17.5	10.9	10.5	9.6
Gauging Station (WR-D)	9-18	1315	*	.02	27.0	22.0	16.0	11.6	10.9	10.0
Heiberg Dam (WR-H)	9-19	1315	*	.05	35.0	18.0	23.0	9.9	10.3	8.7
Marsh River	9-21	1530	*	.20	195.0	13.5	17.0	9.9	10.0	9.7
Wild Rice River E. of Perley	9-21	1200	*	.16	37.0	9.0	10.5	11.4	11.0	11.2
Wild Rice River W. of Twin Valley	9-19	1410	*	.02	25.0	24.0	19.0	9.2	9.3	9.4
So. Br., W.R.R., S.E. of Borup	9-20	1400	*	.03	57.0	18.5	18.0	10.5	-	9.5

* - Less than 0.05 ppm.

[a]Measurements of nitrates (NO_3) were taken only on September 29, 1973.

[b]Nitrates (NO_3) determined by brucine method; [c]iron determination by 1,10-phenathroline method; [d]sulfates determined turbidimetrically; [e]dissolved oxygen (DO) by (A) standard Winkler and (B) azide modification.

TABLE A-3 WATER QUALITY MONITORING DATA, WILD RICE RIVER, MINNESOTA[a]

Item	Unit	Date Collected 8-25-71	9-22-71	11-9-71	4-26-72	5-10-72
Time Collected		1700	1530	1530	1600	1530
Temperature	Degrees Fahrenheit	74	57	33	51	60
Coliform						
group (confirmed M.P.N. per 100 ml.)		5,400	13,000	16,000	4,900	390
organisms (fecal M.P.N. per 100 ml.)		3,500	1,400	20*	20	110
Fecal Streptococci			10			
Total Solids			250			
Total Volatile Matter			64			
Suspended Solids		35	12	52	290	150
Suspended Volatile Matter			3			
Turbidity		19	3	24	92	50
Color			40			
Total hardness as $CaCO_3$		250	300	320	260	280
Alkalinity as $CaCO_3$		240	250	220	210	230
pH value		7.5	7.8	8.4	7.3	7.3
Chloride		5	5	9	5	4
Dissolved Oxygen		7.7	9.4	12.5	10.4	9.8
Five-day Biochemical Oxygen Demand		2.9	1.2	3.6	1.4	1.2
Total Phosphorus		0.08	0.11	.36	.38	.32
Ammonia Nitrogen		0.07	0.08	.18	.07	.06
Organic Nitrogen			0.85			
Nitrite Nitrogen			0.02			
Nitrate Nitrogen		0.1	0.05*	.3	.48	.06
Methylene Blue Active Sub. as ABS		0.45	.1 *	.25	.1 *	.1 *
Spec. Cond. uohms/cm @ 25°C.		480	510	560	420	470
Copper	ppm or ug/1	13	10 *	10 *	10 *	10 *
Cadmium	ppm or ug/1	10 *	10 *	10 *	10 *	10 *
Nickel	ppm or ug/1	10 *	10 *	10 *	14	10 *
Zinc	ppm or ug/1	25	15	13	28	12

TABLE A-3 (continued)

Item	Unit	Date Collected 8-25-71	9-22-71	11-9-71	4-26-72	5-10-72
Lead	ppm or ug/l	22	10 *	10 *	38	10 *
Manganese	ppm or ug/l		48	75	170	32
Iron	ppm or ug/l		790	2000	6700	370
Pesticide	ppm or ug/l		.01*		.01*	.01*
Mercury	ppm or ug/l	2.1	.05	.05*	.05*	1.0
Arsenic	ppm or ug/l	40	10 *	10 *	10 *	10 *
Selenium	ppm or ug/l	10 *	10 *	10 *	10 *	10 *
Calcium		130	100	160	130	130
Flouride		0.1	0.1	0.1	0.1	0.1
Sodium		13	11	11	8	9
Potassium		7	7		8	4
PCB's	ppm or ug/l				.05*	.05*
Gross Alpha	pCi/L		3 *			
Gross Beta	pCi/L		13 + 3			
Total Chromium	ppm or ug/l		10⁻*			
Hexavalent Chromium	ppm or ug/l		10 *			
Cyanide	ppm or ug/l		5 *			
Phenol	ppm or ug/l		5 *			
Boron	ppm or ug/l		70			
Magnesium as $CaCO_3$			200			
Sulfate			38			
Silver	ppm or ug/l		.002*			
Silicate			18			
Barium			.02*			
Sulfide			.05*			
Oil and Grease			.3 *			

*less than value indicated

[a]Data collected by Minnesota Pollution Control Agency at U.S. Highway #75, Hendrum, Minnesota.

APPENDIX B

STREAM RESOURCES DATA - WILD RICE RIVER BASIN

TABLE B-1 OCCURRENCE AND DENSITY OF FAMILIES OF BOTTOM INVERTEBRATES IN THE WILD RICE RIVER PROPERTY ARRANGED IN A GRADIENT OF STREAM VELOCITY.[a]

Item	Unit	Average Stream Velocity (Feet/Seconds)																			
		4.0	4.0	3.7	2.5	2.5	2.0	2.0	1.7	1.6	1.3	1.3	1.1	.9	--	.8	.8	.8	.3	vs	vs
		Riffles									Sand Flats							Pools			
Stream Width	Feet	55	30	48	88	55	60	65	40	60	45	30	85	65	--	--	--	32	35	40	--
Average Depth	Feet	.8	1.2	.7	.7	1.0	.7	1.1	1.5	1.4	1.9	1.7	1.1	2.0	--	1.1	3.0	2.8	1.8	1.0	--
Substrate																					
Composition																					
Boulder	Percent	30	80	..	10	10	..	5	5	10	50	..	10	..	..	..	..	2	15	..	..
Cobble	Percent	70	..	40	50	80	..	90	75	80	..	20	5	..	..	40	..	2	15	..	..
Pebble	Percent	..	..	60	40	10	90	5	20	10	..	..	5	..	10	20	..	2	..	..	5
Gravel	Percent	..	..	..	..	..	5	..	..	..	..	..	10	40	20	30	80	4	..	30	5
Sand	Percent	..	20	..	..	..	5	..	..	..	50	80	70	50	50	10	10	15	..	..	70
Silt	Percent	..	..	..	..	..	..	..	..	..	..	..	..	10	20	..	10	75	15	70	20
Insecta																					
Ephemeroptera																					
Baetidae		..	2	12	37	31	59	4	..	4	..	..	..	..	..	..	..	..	..	..	..
Ephemeridae		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	3	3	1
Heptageniidae		..	..	3	2	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Potomanthidae		..	..	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Siphloneuridae		..	..	3	5	6	15	6	1	..	..	..	..	..	..	..	..	..	..	..	..
Tricorythidae		..	..	2	..	1	1	..	..	..	..	..	..	1	..	..	..	..	1	..	..
Odonata																					
Gomphidae		1	..	2	..	..	1	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Plecoptera																					
Perlidae		2	2	..	5	1	2	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Pteroneidae		2	4	3	2	..	2	5	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE B-1 (continued)

Avg. Vel. (ft/sec)		4.0	4.0	3.7	2.5	2.5	2.0	2.0	1.7	1.6	1.3	1.3	1.1	.9	--	.8	.8	.8	.3	vs	vs
Item	Unit	Riffles									Sand Flats							Pools			
Hemiptera																					
Corixidae		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Megaloptera																					
Sialidae		..	..	..	..	..	..	..	..	..	..	..	..	6	..	..	..	..	..	..	..
Trichoptera																					
Hydropsychidae		6	9	9	14	15	37	9	3	..	..	..	..	..	..	..	..	..	..	..	..
Brachycentridae		5	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Coleoptera																					
Elmidae		..	4	1	3	8	5	2	..	4	..	..	..	..	..	..	..	..	..	..	..
Diptera																					
Chironomidae		2	8	16	24	26	25	18	..	1	..	..	..	3	..	..	19	15	..	2	43
Rhagionidae		10	12	13	8	26	7	16	1	1	..	..	..	..	..	..	..	..	..	..	..
Tabanidae		..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..
Tipulidae		..	..	..	..	..	1	2	10	..	..	..	..	..	..	..	..	..	..	..	..
Mollusca																					
Pelecypoda																					
Sphaeriidae		..	1	..	..	..	2	5	..	..	..	..	..	2	5	..	..	2	6	..	2
Unionidae		..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
Gastropoda																					
Ancylidae		..	..	..	..	1	1	..	..	..	..	..	..	..	1	..	..	1	..	..	..
Amnicolidae		..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	2	1	29	..	1
Chordata																					
Petromyzontidae		..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..

[a]All Sampling by Petersen Dredge or Surber Sampler and all organisms expressed as organisms per three square-feet.

TABLE B-2 CHECK LIST OF ALGAE COLLECTED IN THE WILD RICE RIVER AND SELECTED TRIBUTARIES

	Coon Creek	So. Br. Wild Rice River	White Earth River	Flom Creek	Marsh Creek	Peterson Bridge Rapids	Peterson Bridge Pool	Faith Bridge
	Tributaries					Wild Rice River		
Chlorophyceae								
Ankistrodesmis					X			
Chaetophora				X				
Characium		X						
Cladophora	*	*	*	*		*		*
Oedogonium		X	X	X	X	X		
Pediastrum							X	
Scenedesmus		X						X
Stigeoclonium								X
Conjugateophyceae								
Mougeotia		X			X		X	
Spirogyra	X	X					X	
Closterium						X		X
Cosmarium						X	X	X
Euglenophyceae								
Distigma	X							
Cryptophyceae								
Cryptomonas					X			
Cyanophyceae								
Anabaena		X						X
Anabaenopsis		X						
Aphanotheca		X						
Chamaesiphon				X				
Gloeocapsa				X				
Lyngbya			X					
Merismopoedia							X	
Myxosarcina		X						
Oscillatoria			X		X	X	X	X
Phormidium	X			X				X

TABLE B-2 (continued)

	Coon Creek	So. Br. Wild Rice River	White Earth River	Flom Creek	Marsh Creek	Peterson Bridge Rapids	Peterson Bridge Pool	Faith Bridge
	Tributaries					Wild Rice River		
Bacillariophyceae								
Amphora		X	X		X		X	
Brebissonia		X						
Cocconeis	*	*	*	*	*	*	*	*
Cymatopleura						X	X	
Cyclotella		X		X	X	X	X	
Cymbella	X	X	X			X	X	
Diatoma		X	X	X		X	X	X
Epithemia		X	X	X		X	X	X
Eunotia			X					
Fragilaria	X	X	X	X			X	X
Gomphonema	*		*	*	*		*	*
Hantzchia		X		X				
Melosira			X	X	X	X	X	
Navicula	X		X	X	X	X	X	X
Nitzchia	X	X	X	X	X		X	X
Pinnularia			X				X	
Pleurosigma		X					X	
Rhopalodia		X	X				X	
Rhoicosphenia							X	
Synedra	X		X					
Surirella			X	X				
Tabellaria			X	X		X	X	X

*Association of *Cladophora* and periphytes *Cocconeis* and *Gomphonema*

TABLE B-3 OCCURRENCE AND RELATIVE ABUNDANCE OF THE AQUATIC MACROBIOTA, EXCLUDING FISHES, OF THE WILD RICE RIVER AND SOME OF ITS TRIBUTARIES - Summer, 1972

	Wild Rice River Sites							Headwater, Tributary, Alternate Sites											
	A	B	C	D	E	F	G	1	2	3	4	5	6	7	8	9	10	11	13
Plantae																			
Bryophyta - mosses																			
Hygrohypnum spp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tracheata - vascular plants																			
Lemnaceae - Duckweeds																			
Lemna minor - Lesser Duckweed	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Hydrocharitaceae - Frogbit																			
Anacharis canadensis - Waterweed	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Haloragidaceae - Water Milfoil																			
Hippuris vulgaris - Mare's Tail	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
Najadaceae - Pondweeds																			
Potamogeton illinoensis	.	1	.	.	.	.	.	.	.	2	.	.	.	.	.	2	1	.	.
Potamogeton pectinatus	.	2	.	.	.	.	.	.	.	2	.	.	.	.	1	1	1	.	.
Potamogeton pusillus	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
Potamogeton sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Animalia																			
Platyhelminthes																			
Turbellaria - planarians	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Annelida																			
Hirudinea - leeches																			
Placobdella ru[illegible]*a*	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Erpobdella punct[illegible]	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Arthropoda																			
Crustacea																			
Decapoda - Crayfish																			
Orconectes virilis	2	2	1	1	2	1	2	3	2	2	1	3	3	1	1	3	3	1	3

TABLE B-3 (continued)

	Wild Rice River Sites A	B	C	D	E	F	G	Headwater, Tributary, Alternate Sites 1	2	3	4	5	6	7	8	9	10	11	13
Insecta																			
Ephemeroptera - Mayflies																			
Baetidae																			
<u>Baetis</u> <u>vagans</u> and/or <u>Baetis</u> <u>brunneicolor</u>	.	1	2	.	2	2	1	.	3	2	2	2	2	.	.	2	.	.	3
<u>Pseudocleon</u> <u>anoka</u> <u>P.</u> <u>parvulum</u> <u>P.</u> <u>dubium</u> P. <u>punctiventris</u>	2	2	2	1	3	3	3	.	.	.	.	.	.	.	.	.	.	.	.
Ephemeridae																			
<u>Ephemera</u> <u>simulans</u>	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
<u>Hexagenia</u> <u>limbata</u>	2	2	1	.	.	1	3	.	.	2	3	.	2	.	3	2	1	.	2
Heptageniidae																			
<u>Stenonema</u> <u>nepotellum</u> and/or <u>Stenonema</u> <u>vicarium</u>	.	1	2	.	1	.	1	.	.	.	.	.	.	.	.	2	.	.	2
Potomanthidae																			
<u>Potomanthus</u> sp.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Siphloneuridae																			
<u>Isonychia</u> <u>bicolor</u> or <u>rufa</u> <u>Isonychia</u> (<u>sadleri?</u>) sp.	2	2	2	.	2	3	2	.	.	.	.	.	2	.	.	.	.	.	2
Tricorythidae																			
<u>Tricorythodes</u> sp.	1	1	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Odonata - Dragonflies																			
Corduliidae																			
<u>Tetragonuria</u> <u>canis</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

TABLE B-3 (continued)

	Wild Rice River Sites							Headwater, Tributary, Alternate Sites											
	A	B	C	D	E	F	G	1	2	3	4	5	6	7	8	9	10	11	13
Gomphidae																			
Gomphus notatus and/or Gomphus externus	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.
Ophiogomphus rupinsulensis	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Plecoptera - Stoneflies																			
Perlidae																			
Acroneuria abnormis	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acroneuria lycorias	2	.	.	1	1	2	2	.	.	2	.	.	.	.	.	.	.	2	2
Pteronarcidae																			
Pteronarcys sp.	2	.	2	2	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.
Hemiptera - True Bugs																			
Bellostomatidae - Giant Water Bugs																			
Lethocerus americanus	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Corixidae - Water Boatmen																			
Hesperocorixa atopodonta	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gerridae - Water Striders																			
Gerris remigis	2	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Notonectidae - Backswimmers																			
Notonecta undulata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Megaloptera																			
Sialidae - Alder Flies																			
Sialis sp.	.	2	.	.	.	.	2	.	.	.	.	.	1	.	2	.	.	.	.
Trichoptera - Caddis Flies																			
Hydropsychidae																			
Hydropsyche bifida	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Hydropsyche bifida and slossonae	2	1	2	2	2	2	2	.	3	3	2	1	1	.	.	2	.	2	2

TABLE B-3 (continued)

	Wild Rice River Sites							Headwater, Tributary, Alternate Sites											
	A	B	C	D	E	F	G	1	2	3	4	5	6	7	8	9	10	11	13
Brachycentridae																			
Brachycentrus numerosus	2	.	.	1	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2
Coleoptera - Beetles																			
Elmidae - Riffle Beetles																			
Optioservus fastiditus and/or																			
Stenelmis vittipennis	.	1	.	2	2	1	.	.	.	.	.	.	.	.	.	1	.	2	1
Optioservus sp.																			
Stenelmis sp. larvae	1	1	1	1	2	2	2	.	.	.	.	.	.	.	.	2	.	1	2
Diptera - Flies																			
Chironomidae - Midges																			
Chironomus sp.																			
Strictochironomus sp.																			
Cricotopus sp.	2	1	2	2	3	2	2	.	2	3	2	.	2	.	.	2	.	3	2
Dixidae																			
Dixa sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Rhagionidae - Snipe Flies																			
Atherix sp.	2	1	2	2	3	2	2	.	.	3	.	.	.	.	.	3	.	.	3
Tabanidae - Horse and Deer Flies																			
Chrysops sp.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	2	.
Tabanus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Tipulidae - Crane Flies																			
Hexatoma sp.	1	2	.	.	.	1	.	.	1	.	.	.	1	.	1	.	.	.	.
Tipula sp.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2

TABLE B-3 (continued)

	Wild Rice River Sites A	B	C	D	E	F	G	Headwater, Tributary, Alternate Sites 1	2	3	4	5	6	7	8	9	10	11	13
Mollusca																			
Pelecypoda																			
Sphaeriidae - Fingernail clams																			
<u>Sphaerium</u> <u>sulcatum</u> and <u>Sphaerium</u> spp.	2	2	2	1	2	2	+	3	.	3	3	.	.	.	.	2	2	2	2
<u>Pisidium</u> spp.	+	+	.	+	.	.	.	2	.	2	3	2	.	.	2	1	1	2	.
Unionidae - Freshwater mussels																			
<u>Fusconaia</u> <u>flava</u> - Wabash Pig Toe	2	2	+	.	2	2	2	.	.	.	.	.	.	.	.	.	.	.	.
<u>Amblema</u> <u>costata</u> - Three-Ridge	+	1	+	.	+	1	1	.	.	.	.	.	.	.	.	.	.	.	.
<u>Lasmigona</u> <u>compressa</u>	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<u>Lasmigona</u> <u>complanata</u> - White Heel Splitter	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.
<u>Anodonta</u> <u>grandis</u> - Floater	+	+	.	.	+	.	+	.	.	2	+	.	+	.	.	1	.	.	.
<u>Anodontoides</u> <u>ferussacianus</u> Cylindrical Paper Shell	.	.	.	.	.	+	.	.	.	1	+	.	.	.	.	1	1	.	.
<u>Strophitus</u> <u>rugosus</u> - Squaw Foot	+	+	.	.	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.
<u>Ligumia</u> <u>recta</u> - Black Sand Shell	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<u>Lampsilis</u> <u>siliquoidea</u> - Fat Mucket	2	2	1	.	2	+	2	.	.	2	.	.	+	.	.	2	1	.	.
<u>Lampsilis</u> <u>ventricosa</u> - Pocketbook	+	+	.	.	+	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Gastropoda																			
Ancylidae - Limpet																			
<u>Ferrissia</u> sp.	.	.	.	.	2	2	.	.	.	1	.	.	.	.	.	1	.	.	.
Amnicolidae																			
<u>Amnicola</u> spp.	2	.	1	1	1	2	.	.	.	3	2	2	.	.	3	2	1	.	.
Planorbidae																			
<u>Armiger</u> ? spp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<u>Heliosoma</u> <u>campanulata</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.

TABLE B-3 (continued)

	Wild Rice River Sites							Headwater, Tributary, Alternate Sites											
	A	B	C	D	E	F	G	1	2	3	4	5	6	7	8	9	10	11	13
Physidae																			
Physa sp.	.	.	.	.	.	.	.	.	.	2	.	2	.	.	.	2	2	1	.
Lymnaeidae																			
Stagnicola sp. (rivulet near river)	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viviparidae																			
Campeloma sp.	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Chordata																			
Amphibia																			
Ranidae																			
Rana spp. (*tadpole*) (sylvatica?)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Reptilia																			
Chelydridae																			
Chelydra serpentina - Snapping Turtle	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Testudinidae																			
Chrysemys picta - Painted Turtle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Mammalia																			
Mustelidae																			
Mustela vison - Mink	.	2	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	2	.
Castoridae																			
Castor canadensis - Beaver	+	+	.	+	.	+	.	.	.	.	.	.	+	.	+	+	+	.	.

Symbols: 1 - uncommon, 2 - common, 3 - very common, + sign - including tracks, cuttings, valves, etc.

TABLE B-4 CHECK LIST OF THE FISHES SEINED OR OBSERVED IN THE WILD RICE RIVER AND SOME OF ITS TRIBUTARIES (ALTERNATE SITES) - Summer, 1972

	River Proper Collecting Stations								Headwaters and Tributaries (Alternate Sites)												
	A	B	C	D	E	F	G	H	1	2	3	4	5	6	7	8	9	10	11	13	14
Class: Agnatha																					
Order: Petromyzontiformes																					
Family: Petromyzontidae																					
<u>Ichthyomyzon castaneus</u> Chestnut Lamprey	.	1*	.	.	.	.	.	.	.	.	.	.	.	1*	.	1	.	.	.	.	.
Class: Osteichthyes																					
Order: Clupeiformes																					
Family: Esocidae																					
<u>Esox lucius</u> Northern Pike	.	.	.	.	1	.	.	.	1	1	1	.	3	1	1	.	2	.	1	2	.
Family: Umbridae																					
<u>Umbra limi</u> Central Mudminnow	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.
Order: Cypriniformes																					
Family: Catostomidae																					
<u>Catostomus commersoni</u> White Sucker	.	1	.	.	1	.	.	3	2	3	3	2	2	.	.	.	3	3	2	2	1
<u>Carpiodes cyprinus</u> Quillback Carpsucker	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Symbols: 1 - uncommon, 2 - common, 3 - very common, 1R - rare
0 - observed
* - dredged in bottom samples were an ammocoete (larva) at "B" and an adult at "6".

TABLE B-4 (continued)

	River Proper Collecting Stations								Headwaters and Tributaries (Alternate Sites)												
	A	B	C	D	E	F	G	H	1	2	3	4	5	6	7	8	9	10	11	13	14
Class: Osteichthyes																					
Order: Cypriniformes																					
Family: Catostomidae																					
Moxostoma macrolepidotum Northern Redhorse	.	2	2	.	2	2	.	.	.	.	.	.	.	2	.	1	2	.	.	.	.
Family: Cyprinidae																					
Chrosomus Phoxinus eos Northern Redbelly Dace	.	.	.	.	.	.	.	.	.	1	2	2	.	.	.	.	.	1	.	.	.
Hybopsis biguttata Hornyhead Chub	2	1	1	1	1	1	.	.	2	1	2	1	.	2	.	1	3	2	.	.	1
Notropis cornutus Common Shiner	3	3	2	3	3	3	1	3	2	3	3	3	.	1	.	2	3	3	.	2	3
Notropis stramineus Sand Shiner	2	1	2	1	2	2	.	1	.	1	.	.	.	.	.	.	1	1	.	.	2
Notropis heterodon Blackchin Shiner	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Notropis heterolepis Blacknose Shiner	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Notropis dorsalis Bigmouth Shiner	1	1	.	1	2	2	1	2	.	.	3	1	.	.	.	1	3	2	.	.	2
Notropis rubellus Rosyface Shiner	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Symbols: 1 - uncommon, 2 - common, 3 - very common, 1R - rare
0 - observed

TABLE B-4 (continued)

	River Proper Collecting Stations								Headwaters and Tributaries (Alternate Sites)												
	A	B	C	D	E	F	G	H	1	2	3	4	5	6	7	8	9	10	11	13	14
Class: Osteichthyes																					
Order: Cypriniformes																					
Family: Cyprinidae																					
Pimephales promelas Fathead Minnow	2	1	1	2	2	2	1	1	1	3	3	3	1	1	.	2	2	3	1	1	.
Rhinichthyes atratalus Blacknose Dace	1	.	2	.	1	.	.	1	.	1	3	.	.	1	.	.	2	2	2	.	3
Rhinichthyes cataractae Longnose Dace	1	1	3	.	1	2	1	.	.	.	1	.	.	1	.	.	1	.	1	2	.
Semotilus atro-maculatus Creek Chub	1	1	1	1	2	2	.	2	.	2	1	1	.	2	.	2	3	3	1	3	2
Semotilus margarita Pearl Dace	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.
Family: Ictaluridae																					
Noturus flavus Stonecat	0	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.
Noturus gyrinus Tadpole Madtom	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Order: Gasterosteiformes																					
Family: Gasterosteidae																					
Culaea inconstans Brook Stickleback	1	.	.	.	.	.	.	.	.	1	.	.	.	1	3	1	.	.	.	.	.

Symbols: 1 - uncommon, 2 - common, 3 - very common, 1R - rare
0 - observed

TABLE B-4 (continued)

	River Proper Collecting Stations								Headwaters and Tributaries (Alternate Sites)												
	A	B	C	D	E	F	G	H	1	2	3	4	5	6	7	8	9	10	11	13	14
Class: Osteichthyes																					
Order: Percopsiformes																					
Family: Percopsidae																					
Percopsis omiscomaycus Trout-Perch	1	2	.	.	2	1	0	2	.	1	.	.	.	.	.	.	.	.	.	.	.
Order: Perciformes																					
Family: Centrarchidae																					
Ambloplites rupestris Rockbass	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	.	.	.	.
Lepomis macrochirus Bluegill	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Family: Peridae																					
Etheostoma exile Iowa Darter	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	.	.
Etheostoma nigrum Johnny Darter	.	.	.	.	1	.	.	.	.	1	3	1	1	1	1	1	3	3	.	.	.
Perca flavescens Yellow Perch	.	.	1	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Family: Percidae																					
Percina maculata Blackside Darter	.	.	1	1	.	.	1	.	.	1	1	.	.	.	.	.	1	1	1	1	.
Stizostedion vitreum Walleye	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Symbols: 1 - uncommon, 2 - common, 3 - very common, 1R - rare
0 - observed

TABLE B-4 (continued)

	River Proper Collecting Stations								Headwaters and Tributaries (Alternate Sites)												
	A	B	C	D	E	F	G	H	1	2	3	4	5	6	7	8	9	10	11	13	14
Class: Osteichthyes																					
Order: Perciformes																					
Family: Scianidae																					
Aplodinotus grunniens Freshwater Drum	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Symbols: 1 - uncommon, 2 - common, 3 - very common, 1R - rare
0 - observed

APPENDIX C

The following technical appendix presents the text and data of Hibbard (1973), including the descriptions of plant community types found within the Wild Rice River Basin as well as the density dominance and frequency of various species within each community.

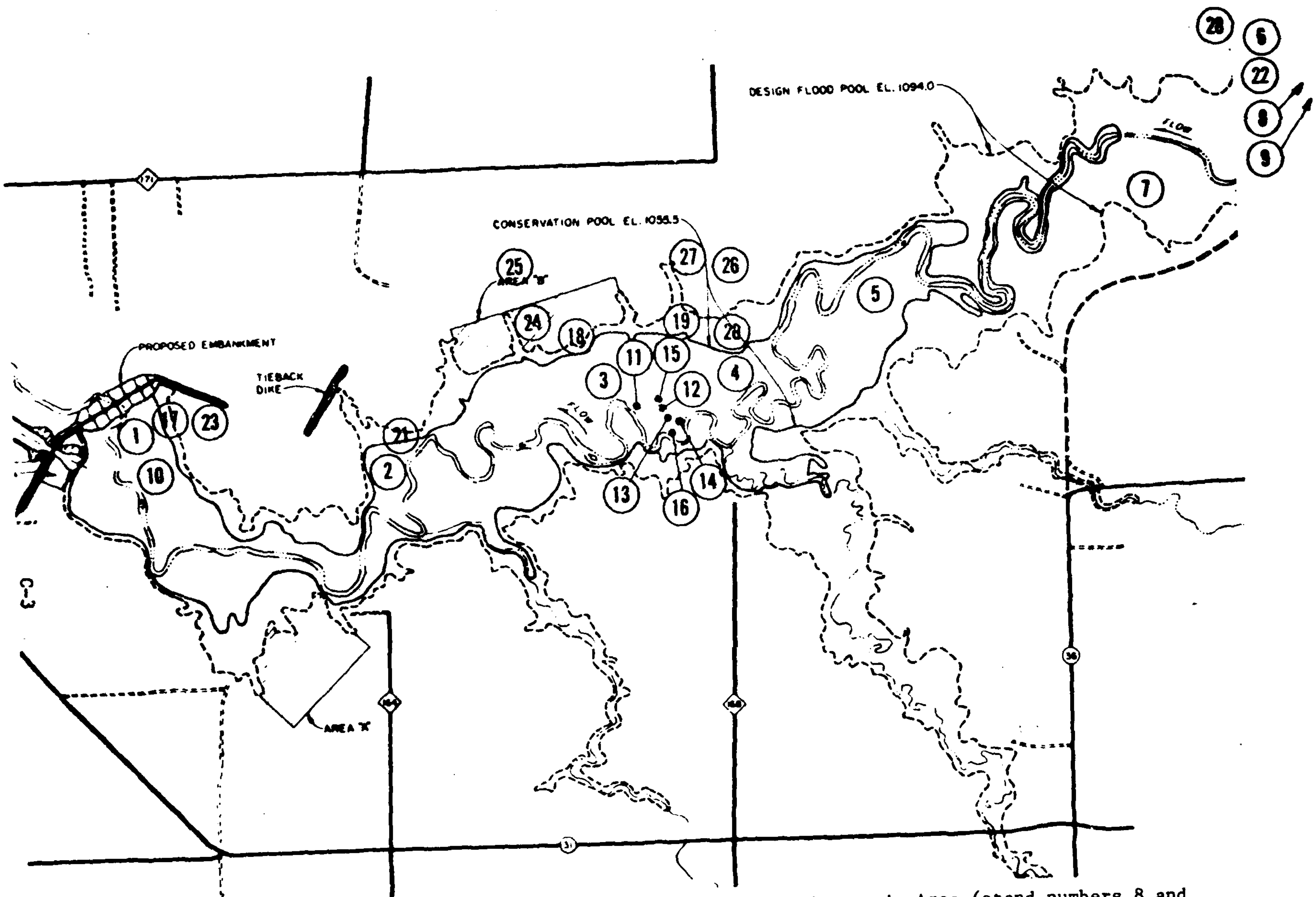
SITE DETERMINATION AND SAMPLING PROCEDURE

The stand surveys were not restricted to a fixed area. The size of the minimal area necessary to adequately sample a stand varies for different kinds of communities. It can only be determined when a greater area than the minimal is available within a uniform plant stand. Minimal areas for stands studied were determined by following a procedure which provides data for species area curves. This involves choosing a random point near the middle of a stand. The point serves as the center of circular plots which were successively increased in size. The areas (determined in the field by measuring their corresponding radii) of the circular plots were (in meters squared) 0.001, 0.005, 0.01, 0.02, 0.05, 0.10, 0.25, 0.50, 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 300.0, 400.0, 500.0, and 1000.0. A species list was kept as the plots were increased in size. It was found that when a certain plot size (depending on the stand) was reached, relatively few, if any, new species were added to the list. This plot size is the minimal area for the stand. The minimal areas for stands examined ranged from a few square meters to several hundred square meters. In 20 of the stands additional quantitative data was collected for the woody species (trees, saplings, and shrubs). Using the point-quarter method (Curtis and Cottam, 1958), with 40 points per stand when possible, information was obtained on density, frequency, and basal area of the tree species, and the density and frequency of the shrubs and saplings.

Stands of vegetation were sampled from a variety of habitats in the proposed reservoir area. The stands were subjectively located so that the entire range of variation in the terrestrial vegetation would be represented. A total of 28 stand surveys were made. Figure C-1 shows the location of the stands and table C-1 gives their legal description and some site characteristics.

METHODS OF SYNTHESIS

Using the qualitative data on species composition of the stands a tabular comparison of stand surveys was made (table C-2). Stands were arranged in a table to reflect, as closely as possible in a one-dimensional arrangement, similarity in terms of species composition. In developing this table relative abundance of species was not considered as important as species presence or absence. The vertical columns represent stands. Stand identification numbers appear at the top of each column. In this synthesis table, stands which appear most similar in terms of floristic composition occur side-by-side while those which are least similar occur at opposite ends of the table. Species are listed alphabetically by family and by genus and species within the family. A symbol appearing in the line opposite the species name indicates the presence of that species in the stand corresponding to the vertical column in which the symbol appears.



FigureC-1 Location of Vegetation Stand Surveys in the Proposed Reservoir Area (stand numbers 8 and 9 are located off the map, approximately one mile east of the Peterson Bridge (see also Table).

TABLE C-1 LOCATION AND PHYSICAL DESCRIPTION OF STANDS SURVEYED IN THE VEGETATION ANALYSIS NORMAN COUNTY, MINNESOTA.

Stand No.	Location Sect. Town. Rge.	Date	Plot Size(M^2)	Slope
1	NE-¼ SW-¼-26-144-44	8-08-72	1,000	level
2	SW-¼ SW-¼-25-144-44	8-29-72	300	-
3	NW-¼ SE-¼-25-144-44	7-27-72	500	-
4	NW-¼ SW-¼-30-144-43	8-17-72	1,000	-
5	SE-¼ NW-¼-30-144-43	8-16-72	1,000	-
6	NE-¼ SE-¼-20-144-43	8-11-72	1,000	-
7	NE-¼ NW-¼-29-144-43	8-15-72	-	-
8	SE-¼ NE-¼-21-144-43	8-14-72	1,000	-
9	SW-¼ NE-¼-21-144-43	8-16-72	1,000	-
10	SE-¼ SW-¼-26-144-44	8-09-72	1,000	-
11	NW-¼ SE-¼-25-144-44	8-24-72	1,000	-
12	NE-¼ SE-¼-25-144-44	8-24-72	-	-
13	SE-¼ SE-¼-25-144-44	8-25-72	300	-
14	SE-¼ SE-¼-25-144-44	8-25-72	200	-
15	NE-¼ SE-¼-25-144-44	8-24-72	1,000	-
16	SE-¼ SE-¼-25-144-44	8-31-72	100	-
17	NE-¼ SE-¼-26-144-44	8-04-72	1,000	10-15°S
18	NW-¼ SE-¼-25-144-44	7-25-72	500	12°S
19	SE-¼ NE-¼-25-144-44	8-24-72	400	10°S
20	SW-¼ NW-¼-30-144-43	8-17-72	1,000	10°S
21	SW-¼ SW-¼-25-144-44	8-29-72	500	10-15°S
22	NE-¼ SE-¼-20-144-43	8-30-72	200	25-30°N
23	NE-¼ SW-¼-26-144-44	8-08-72	1,000	Upland

TABLE C-1 (continued)

Stand No.	Location Sect. Town. Rge.	Date	Plot Size(M^2)	Slope
24	SW-¼ NE-¼-25-144-44	8-01-72	300	Upland
25	SW-¼ NE-¼-25-144-44	8-03-72	1,000	Upland
26	SW-¼ NW-¼-30-144-43	8-23-72	300	Upland
27	SE-¼ NE-¼-25-144-44	8-23-72	300	Upland
28	NE-¼ SW-¼-20-144-43	7-24-72	200	Upland

Table C-2

PLANT COMMUNITY TYPES	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
ACERACEAE																											
Acer negundo	+	.	.	+	4	3	1	4	1	+	2	4	+	.	.	7	4	4	+	+	.	1	4	1	+	R	2
ALISMATACEAE																											
Alisma plantago-aquatica	.	2	1	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sagittaria latifolia	*	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AMARANTHACEAE																											
Amaranthus retroflexus	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Amaranthus tuberculatus	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ANACARDIACEAE																											
Rhus radicans var. rydbergii	.	.	.	.	.	.	1*	2	1	2	2	1	3	2	.	.	2	.	2	2	2	2	4	6	3	3	5
APOCYNACEAE																											
Apocynum androsaemifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	2	.	1	+	1	2	.	2	R	+	.
ARACEAE																											
Arisaema triphyllum	.	.	.	.	2	1	3	2	.	.	.	.	2	.	.	.	.	2	R	.	.	1	+	.	.	.	.
ARALIACEAE																											
Aralia nudicaulis	.	.	.	.	.	.	.	.	2	1	1	.	.	1	.	3	2	1	3	4	R	4	3	4	3	3	4
ARISTOLOCHIACEAE																											
Asarum canadense	.	.	.	.	.	2	3	1	2	2	.	.	.	.	.	3	.	1	3	3	2	.	*	.	.	3	.
ASCLEPIADACEAE																											
Asclepias incarnata	.	2	+	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	:	.
Asclepias syriaca	.	.	.	R	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
BALSAMINACEAE																											
Impatiens biflora	+	.	3	4	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.

Table C-2 (cont.)

PLANT COMMUNITY TYPES	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
BERBERIDACEAE																											
Caulophyllum thalictroides	.	.	.	.	1	.	1	2	1	2	+	+	.	R	.	R	1	1	+	2	.	3	1	.	R	.	.
BETULACEAE																											
Betula papyrifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	4	.	.	.	.	.
Corylus americana	.	.	.	.	.	.	.	.	+	.	2	+	.	2	.	.	.	.	2	2	1	+	.	5	2	1	.
Corylus cornuta	.	.	.	.	.	.	3	.	+	1	4	+	+	3	.	.	+	1	R	+	+	.	2	.	+	1	4
Ostrya virginiana	.	.	.	.	4	.	.	.	+	1	+	+	+	4	.	1	5	8	6	6	6	6	5	.	1	.	.
BORAGINACEAE																											
Hackelia virginiana	.	.	.	.	.	.	+	+	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.
Lithospermum latifolium ?	.	.	.	.	2	.	+	.	.	.	.	R	R	.	+	.	2	.	.	.	.	.	.	.	.	.	.
CAPRIFOLIACEAE																											
Lonicera dioica	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	+	.	.	.	2	.	.	.
Lonicera tatarica	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.
Symphoricarpos albus	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Symphoricarpos occidentalis	.	.	.	R	+	.	R	+	+	+	2	R	4	3	6	.	2	1	2	.	1	1	2	.	.	1	.
Triosteum perfoliatum var. americanum	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viburnum lentago	.	.	.	.	R	1	2	1	1	1	3	1	+	+	.	.	.	.	.	+	.	R	.	.	.	.	.
Viburnum opulus var. americanum	.	.	.	.	.	.	.	1	.	1	2	1	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.
Viburnum rafinesquianum var. rafinesquianum	.	.	.	.	.	.	2	+	2	1	3	1	1	1	.	.	+	1	2	3	2	3	3	3	1	2	.
CARYOPHYLLACEAE																											
Lychnis alba	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria media?	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	+	.	.	.	.	.	.	.	.	R
CELASTRACEAE																											
Celastrus scandens	.	.	.	.	.	.	.	.	1	R	R	R	1	.	.	.	.	2	3	.	2	2	3	.	.	.	.

Table C-2 (cont.)

PLANT COMMUNITY TYPES	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
CERATOPHYLLACEAE																											
Ceratophyllum sp.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CHENOPODIACEAE																											
Chenopodium rubrum	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
COMPOSITAE																											
Arctium minus	.	.	R	.	2	.	.	R	1	R	R	R	+	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Achillea Millefolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Ambrosia artemisiifolia	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Ambrosia psilostachya	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Ambrosia trifida	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia absinthium	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia biennis	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia serrata	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Aster ericoides	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.
Aster ciliolatus	.	.	.	.	2	.	.	.	1	+	2	1	+	2	.	1	3	.	1	.	1	2	+	2	1	+	1
Aster lateriflorus	3	.	.	4	+	+	.	1	1	.	1	2	1	1	.	1	3	+	1	1	1	R	+	.	1	1	.
Aster simplex var. simplex	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aster umbellatus?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.
Bidens cernua	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bidens frondosa	1	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium discolor	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.
Cirsium Flodmanii	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium sp.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Conyza canadensis	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erigeron philadelphicus	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erigeron strigosus var. strigosus	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Helenium autumnale	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.

Table C-2 (cont.)

PLANT COMMUNITY TYPES

	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
COMPOSITAE cont.																											
Helianthus laetiflorus?	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helianthus sp.	.	.	.	.	.	+	.	.	.	1	.	R	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Lactuca biennis	.	.	.	.	.	.	+	1	1	+	.	1	R	.	.	.	1	.	.	.	+	.	1	1	+	+	.
Petasites frigidus var. palmatus	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prenanthes alba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.	R	R	.	.	.	.	.
Rudbeckia laciniata var. laciniata	.	.	.	2	3	3	3	2	1	2	1	1	2	1	3	1	4	1	1	2	1	1	+	3	2	2	.
Solidago canadensis	2	.	.	4	.	.	.	.	1	1	.	1	.	1	3	.	.	.	.	.	.	.	1	3	.	.	.
Solidago flexicaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	3	.	.	.	.	.	.	.
Solidago graminifolia	1	.	.	2	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Sonchus arvensis	1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Taraxacum officinale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.
Tragopogon dubis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.
Xanthium strumarium	2	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Unknown	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CONVOLVULACEAE																											
Convolvulus sepium	R	.	.	+	.	.	.	.	.	.	.	R	.	1	.	.	.	.	.	.	.	.	.	.	R	.	.
CORNACEAE																											
Cornus alternifolia	.	.	.	.	.	.	.	1	R	1	3	.	.	.	.	R	.	.	.	1	R	1	R	.	3	1	.
Cornus racemosa	.	.	.	.	.	.	.	R	.	.	.	+	.	+	.	.	1	1	2	1	R	1	.	4	.	+	1
Cornus stolonifera	.	.	+	1	.	.	.	.	.	1	R	+	.	R	.	.	.	.	.	.	.	.	.	+	+	+	.
CRASSULACEAE																											
Penthorum sedoides	3	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CUCURBITACEAE																											
Echinocystis lobata	*	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table C-2 (cont.)
PLANT COMMUNITY TYPES

	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
CYPERACEAE																											
Carex pensylvanica	.	.	.	.	3	6	6	5	7	7	4	8	6	6	.	3	7	8	6	5	6	7	6	8	6	4	3
Carex vesicaria	2	.	4	3	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus acutus	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus atrovirens	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EQUISETACEAE																											
Equisetum arvense	4	.	.	4	.	.	.	.	1	.	.	3	.	3	.	.	.	2	.	.	+	2	2	3	.	.	.
Equisetum hymale	.	.	.	.	.	.	.	2	1	.	.	1	3	.	.	.	.	1	.	.	.	.	+	.	.	.	.
ERICACEAE																											
Monotropa uniflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	2	.	.
Pyrola asarifolia?	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pyrola elliptica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.
EUPHORBIACEAE																											
Euphorbia esula	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FABACEAE																											
Amorpha fruticosa	1	.	+	1	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Amphicarpa bracteata	.	.	.	+	R	.	+	1	5	+	2	3	+	2	.	.	3	1	2	R	3	4	3	2	+	1	.
Desmodium canadense	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.
Desmodium glutinosum	.	.	.	.	.	.	.	.	1	.	2	R	.	2	.	R	2	+	3	3	3	3	1	.	+	+	.
Glycyrrhiza lepidota var. lepidota	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.
Lathyrus ochroleucus	.	.	.	.	.	.	.	.	.	.	+	1	.	2	.	.	1	+	+	.	+	R	+	3	1	+	.
Medicago lupulina	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melilotus alba	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium repens	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia americana	*	.	.	.	.	.	.	.	.	.	.	R	.	2	.	.	.	.	.	.	.	R	.	1	.	.	.

Table C-2 (cont.)

PLANT COMMUNITY TYPES	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
FAGACEAE																											
Quercus macrocarpa	.	.	.	.	.	.	.	.	1	+	4	+	R	4	.	3	1	+	3	2	1	1	1	2	2	4	2
GENTIANACEAE																											
Gentiana andrewsii	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GRAMINEAE																											
Agropyron repens	.	.	.	.	.	.	.	.	.	+	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis stolonifera	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachyelytrum erectum	.	.	.	.	R	+	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	R	.
Bromus ciliatus	R	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.
Bromus purgans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Calamagrostis canadensis	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Echinochloa microstachya	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elymus canadensis	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Elymus virginicus	.	.	.	2	.	.	.	.	.	.	.	.	3	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Eragrostis hypnoides	4	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glyceria grandis	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hystrix patula	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.
Muhlenbergia racemosa	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.
Oryzopsis asperifolia	.	.	.	.	2	.	3	1	2	3	2	.	.	.	.	1	3	1	4	2	3	3	3	1	3	4	1
Panicum capillare	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phalaris arundinacea	.	4	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa pratensis	.	.	.	.	.	.	.	.	.	.	.	.	1	7	9	.	.	.	.	.	.	.	.	.	.	.	.
Setaria glauca	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spartina pectinata	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Unknown	1	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HIPPURIDACEAE																											
Hippuris vulgaris	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table C-2 (cont.)

PLANT COMMUNITY TYPES

	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
JUNCACEAE																											
Juncus sp.	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LABIATAE																											
Agastache foeniculum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Agastache scrophulariaefolia	.	.	.	.	.	.	.	.	+	.	.	.	R	R	.	.	.	R	+	.	R	.	.	.	.	.	.
Lycopus americanus	1	.	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycopus uniflorus	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mentha arvensis	1	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monarda fistulosa	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Physostegia virginiana	.	.	2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunella vulgaris	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scutellaria galericulata	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scutellaria lateriflora	2	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stachys tenuifolia	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LILIACEAE																											
Allium tricoccum	.	.	.	.	R	+	.	.	R	.	R	.	.	.	.	.	1	+	R	1	.	.	.	.	.	.	.
Maianthemum canadense	.	.	.	.	.	1	.	2	2	+	3	2	2	1	.	1	2	1	2	2	2	3	1	3	2	3	1
Polygonatum biflorum	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	+	R	2	2	2	2	1	1	1
Smilacina racemosa	.	.	.	.	+	1	+	.	.	+	+	+	.	R	.	1	.	1	1	2	.	3	.	.	.	+	1
Smilacina stellata	.	.	.	.	+	+	2	1	1	.	+	3	.	1	.	.	.	.	3	1	1	2	2	.	.	R	.
Smilax herbacea	.	.	.	.	3	.	+	2	2	1	+	3	1	2	R	1	2	1	1	1	2	3	2	2	1	1	1
Trillium cernuum	.	.	.	.	+	.	+	+	.	+	R	1	.	.	.	1	.	1	R	1	1	.	.	.	.	.	.
Uvularia grandiflora	.	.	.	.	.	.	.	3	1	3	3	2	.	.	.	.	.	.	3	3	.	.	.	.	.	.	.
Uvularia sessilifolia	.	.	.	.	.	.	1	1	1	1	+	1	.	1	.	2	3	1	1	2	2	3	3	3	2	2	3
MENISPERMACEAE																											
Menispermum canadense	.	.	.	.	3	.	1	1	2	3	.	.	3	.	.	.	3	.	1	+	R	1	1	.	.	.	.
MORACEAE																											
Humulus lupulus	.	.	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	R	1	.	.	.	.	.	.

Table C-2 (cont.)

PLANT COMMUNITY TYPES	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
NYMPHAEACEAE																											
Nuphar variegatum	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oleaceae																											
Fraxinus nigra	.	.	.	.	.	7	.	6	5	5	.	4	.	.	.	R	.	.	.	.	.	.	.	.	.	4	.
Fraxinus pennsylvanica var. lanceolata	R	.	+	1	4	6	4	4	3	5	4	4	+	2	.	2	.	.	4	1	4	.	3	3	1	5	.
ONAGRACEAE																											
Circaea canadensis	.	.	.	.	2	+	3	1	3	3	+	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.
Epilobium ciliatum	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oenothera biennis var. canescens	*	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
OPHIOGLOSSACEAE																											
Botrychium virginianum var. virginianum	.	.	.	.	.	.	.	.	R	+	+	+	.	.	.	.	1	+	R	.	R	2	+	1	.	.	.
ORCHIDACEAE																											
Cypripedium Calceolus var. pubescens	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
OXALIDACEAE																											
Oxalis stricta	1	.	.	R	.	.	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
PAPAVERACEAE																											
Sanquinaria canadensis	.	.	.	.	3	.	1	2	1	3	1	2	+	1	.	1	3	2	1	2	2	3	3	.	1	2	1
PHRYMACEAE																											
Phryma leptostachya	.	.	.	.	3	.	.	2	1	+	2	1	+	R	.	2	2	1	1	1	3	3	2	.	2	1	2
PLANTAGINACEAE																											
Plantago major	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table C-2 (cont.)

PLANT COMMUNITY TYPES	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
POLYGONACEAE																											
Polygonum pensylvanicum?	*	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum sp.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex crispus	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
POLYPODIACEAE																											
Athyrium Filix-femina var. Michauxii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.
Matteuccia struthiopteris var. pensylvanica	.	.	.	.	.	2	.	2	3	2	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pteridium aquilinum var. latiusculum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	2	2	.
PRIMULACEAE																											
Lysimachia ciliata	.	.	.	.	.	.	.	.	.	.	.	2	R	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Trientalis borealis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	3
RANUNCULACEAE																											
Actaea rubra	.	.	.	.	1	.	.	.	2	1	.	+	+	.	.	2	.	.	R	1	.	.	2	1	R	+	.
Anemone canadensis	*	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anemone cylindrica	.	.	.	.	.	.	.	.	1	1	+	1	.	R	.	.	.	.	+	.	.	.	R	.	.	.	.
Anemone virginiana	.	.	.	.	.	.	.	.	.	.	.	R	.	1	.	.	+	1	.	R	1	2	R	+	+	.	.
Aquilegia canadensis	.	.	.	.	.	.	.	+	.	1	1	R	.	.	.	+	2	2	1	2	1	2	1	.	.	.	.
Caltha palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.
Clematis virginiana	.	.	.	.	.	.	.	.	1	.	R	2	R	1	.	.	1	R	.	.	.	.	+	R	.	.	.
Ranunculus pensylvanicus?	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus sp.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	R	.	R	.	.	.	.	.	.	.	.	.
Thalictrum dioicum	.	.	.	.	3	1	1	2	2	2	3	1	.	3	R	1	1	+	1	1	1	2	+	.	R	2	1
Thalictrum dasycarpum	.	.	.	.	.	+	.	+	1	1	+	3	1	1	.	.	.	.	.	.	.	.	.	3	.	R	.
ROSACEAE																											
Amelanchier sp.	.	.	.	.	.	.	.	2	+	.	+	1	.	3	.	+	+	1	2	1	2	2	1	4	+	+	2

Table C-2 (cont.)

PLANT COMMUNITY TYPES	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
ROSACEAE cont.																											
Agrimonia pubescens	.	.	.	.	.	.	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crataegus sp.	.	.	.	.	R	.	.	.	.	.	R	R	1	R	.	.	.	.	R	.	.	.	.	.	.	.	.
Fragaria virginiana	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	R	+	2	3	3	2	.
Geum canadense	.	.	.	.	1	3	2	3	3	3	.	.	3	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Geum macrophyllum	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla norvegica	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunus americana	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunus pensylvanica	.	.	.	.	.	.	.	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Prunus virginiana	.	.	.	.	2	R	2	2	+	1	2	1	2	2	2	3	1	1	2	1	1	1	3	3	2	+	2
Rosa blanda?	.	.	.	.	.	.	.	.	.	.	2	.	1	+	.	.	.	.	.	R	R	.	1	3	R	R	1
Rubus pubescens	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus strigosus	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	R	.	R	1	+	.	2	1	3	2	2	.
RUBIACEAE																											
Galium boreale	.	.	.	.	.	.	.	1	.	.	.	3	1	3	2	.	.	.	.	.	.	.	1	1	.	R	2
Galium trifidum var. trifidum	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium triflorum	.	.	.	.	.	1	.	2	2	2	+	2	.	.	.	2	1	+	.	.	1	.	.	3	2	2	.
RUTACEAE																											
Zanthoxylum americanum	.	.	.	.	+	.	.	+	1	1	+	4	7	3	+	.	3	+	2	4	2	4	2	.	5	5	1
SALICACEAE																											
Populus balsamifera	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	2	.	.	.	.	.	.	.	.	.	1
Populus deltoides	.	.	.	4	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.
Populus tremuloides	.	.	.	.	.	.	.	.	.	.	7	8	.	2	.	.	2	4	4	6	4	.	.	7	8	6	8
Salix amygdaloides	4	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix Bebbiana?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Salix interior	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAXIFRAGACEAE																											
Ribes americanum	.	.	.	.	.	+	.	2	1	1	.	+	.	.	.	1	.	.	.	.	1	.	.	2	.	.	.

Table C-2 (cont.)
PLANT COMMUNITY TYPES

	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
SAXIFRAGACEAE cont.																											
Ribes cynosbati	.	.	.	.	.	3	.	R	.	1	+	R	2	2	.	4	.	R	1	1	.	.	R	.	.	.	.
Ribes missouriense?	.	.	.	.	3	.	.	2	1	.	+	1	.	.	.	.	1	.	.	.	.	1	.	2	R	1	.
SCROPHULARIACEAE																											
Mimulus ringens	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scrophularia lanceolata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Verbascum Thapsus	*	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.
Veronicastrum virginicum	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	R	.	.	.	.	.	.	.	+
SOLANACEAE																											
Physalis heterophylla	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum nigrum	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPARGANIACEAE																											
Sparganium chloracarpum	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sparganium eurycarpum	.	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TILIACEAE																											
Tilia americana	.	.	.	.	9	4	5	6	8	6	6	+	+	4	.	6	5	2	7	4	6	7	5	4	+	6	.
ULMACEAE																											
Ulmus americana	.	.	R	1	.	4	+	R	1	4	3	4	+	+	+	4	4	.	3	4	3	4	.	+	.	.	.
UMBELLIFERAE																											
Cicuta maculata	.	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cryptotaenia canadensis	.	.	.	1	4	3	3	3	2	3	2	3	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.
Heracleum lanatum	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	2	.	.	+	.	.	.	.
Osmorhiza Claytoni	.	.	.	.	.	+	3	1	.	1	2	+	.	R	.	2	2	1	1	2	1	2	2	R	.	1	2
Osmorhiza longistylis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	3	.	.	+	.	+	.	.	.	1	1	.
Sanicula marilandica	.	.	.	.	1	+	2	1	.	1	2	1	1	.	.	.	2	1	1	2	.	2	1	1	+	3	2
Sium suave	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table C-2 (cont.)

PLANT COMMUNITY TYPES

	BOTTOMLANDS. TYPE I.															SLOPES. TYPE II.						UPLANDS. TYPE III.					
	A	B			C						D		E	F	G	A	B				C	A		B			
Stand Identification No.	16	12	13	14	1	2	3	4	5	6	8	9	11	10	15	22	17	18	19	20	21	23	24	25	26	27	28
UMBELLIFERAE cont.																											
Zizia aurea	.	.	.	.	.	+	.	2	1	+	1	2	R	T	2	.	.	1	2	2	2	R	+	.	.	1	.
URTICACEAE																											
Laportea canadensis	.	.	+	1	8	10	8	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Urtica dioica var. procera	.	.	.	1	2	2	1	.	.	1	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
VERBENACEAE																											
Verbena hastata	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Verbena urticifolia	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
VIOLACEAE																											
Viola palustris	R	.	.	.	.	.	.	.	1	.	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Viola sp.	.	.	.	.	1	1	3	2	1	1	+	R	+	1	.	.	.	+	1	.	.	2	.	3	.	1	.
VITACEAE																											
Parthenocissus vitacea	R	.	.	.	3	+	1	2	3	3	+	1	1	2	.	.	4	1	2	3	2	3	4	2	3	1	.
Vitis riparia	.	.	.	R	.	.	1	1	2	+	+	1	2	1	.	.	+	+	.	1	2	2	.	+	R	R	.

Stand surveys also include estimates of abundance, usually in the form of percentage of ground covered by foliage. A modified Domin scale (Evans and Dahl, 1955) for cover estimates was used. The breakdown of cover classes using this scale is as follows:

R = single individual, with reduced vigor. Cover less than 0.001 percent.

+ = 1 or 2 individuals, cover less than 0.1 percent.

1 = few individuals, normal vigor. Cover less than 0.01 percent.

2 = several individuals. Cover less than 1 percent.

3 = numerous individuals. Cover less than 4 percent.

4 = cover 5 - 10 percent.

5 = cover 11 - 20 percent.

6 = cover 21 - 33 percent.

7 = cover 34 - 50 percent.

8 = cover 51 - 75 percent.

9 = cover 76 - 90 percent.

10 = cover 91 - 100 percent.

An examination of the table reveals that species are not uniformily distributed within the study area. While some are nearly ubiquitous, most occur in only a fraction of the stands. By examining the table it can be seen that many of these species are distributed in a continuous or overlapping fashion. When this is the case the vegetation pattern is one of continual change. Sharp differences do, however, exist between the vegetation of the bottomland or floodplain in comparison with that of the slopes and adjacent uplands. A similar relationship has been described by Wikum and Wali (1972) for the Forest River and by Wanek (1967) for the Red River. While much of the variation in the vegetation pattern appears to be continuous it is still possible to establish arbitrary community types for classification purposes. A classification system was arrived at after the final arrangement of stands had been made.

While there is considerable overlap in the distribution of many of the species, careful examination of the table reveals amplitude similarity for a few of the species. These species were used as criteria to differentiate the stands into abstract stand or community types. In the synthesis, table lines have been drawn to indicate the "boundaries" of these types.

The synthesis and presentation of data in such a way has some disadvantages. One of the more obvious is the fact that the arrangement presented in the table is basically a linear one, whereas most vegetation-environmental relationships are multidimensional. There are a number of methods available which allow one to present data in a muli-dimensional scheme, and such methods have been used in analyzing gallery forest vegetation in the region (Johnson, 1971; Keammerer, 1972; Lago, 1971; Nelson, 1964; Wikum and Wali, 1972). While these methods are valuable for studying vegetation-environmental relationships they have the disadvantage of obscuring an important property of vegetation, namely the species composition of each stand. The composition of each stand remains visible in the method employed and it is relatively easy to follow changes in this vegetation property. It is much easier to compare these stands with those of other investigators because the species composition is apparent.

In the synthesis table the pattern of terrestrial vegetation in the area of the proposed reservoir is shown to consist of twelve community types, some of which are more easily defined than others. These types fall into three broad groups, the distribution of which corresponds to the primary topographic features of the area. Group I includes community types restricted to the bottomlands or the floodplain. Group II includes communities developed on the slopes adjacent to the bottomland, and Group III includes types present on the level uplands adjacent to the slopes. The general types recognized in the study area are similar to those recognized by Wikum and Wali (1972) and by Janssen (1967). Lago (1971) restricted his study to the floodplain forest which is comparable to Group I in the scheme. Wanek (1967) studied the whole gallery forest from the river's edge to the outer margin of the forest but he did not attempt to delimit community types. The general distribution of species which he describes is, however, similar to that of this study area. In the description of community types which follows, similarities as well as differences in the vegetation pattern of the proposed reservoir area with that of areas examined by the previously mentioned investigators will be discussed.

Bottomland Vegetation

As defined here, the approximate upper limit of bottomland vegetation corresponds to the 1,055.5 contour interval, the upper limit of the conservation pool. The pattern of vegetation on the bottomland is relatively complex and includes at least seven recognizable community types, however, four of these (types I-A, I-E, I-F, and I-G) account for only a small percentage of the total area. While these four types are not extensive they are important since they contain a number of species which are not found in the other community types.

Community Type I-A

This type occurs on sandy bars and along the shores of the river. One stand survey (No. 16) was the basis for recognition of the type. This stand was located on a sand bar near the middle of the proposed reservoir. The type appears to be rather well-defined in that a number of species which occurred in this stand did not occur in any of the others. Included in this group are Bidens cernua, Epilobium ciliatum, Ranunculus pensylvanicus, Panicum capillare, Salix interior, Mimulus ringens, Verbena hastata, and Verbena urticifolia all of which occur throughout much of the area on muddy or sandy shores. Also present in the stand were a number of weedy species which are not necessarily typical of shores but instead occur in a variety of habitats, from wet to dry, which have been recently disturbed. A number of other species were found in type I-A and also in community type I-B nowhere else in the area. These were Sagittaria latifolia, Bidens frondosa, Sonchus arvensis, Xanthium strumarium, Penthorum sedoides, Echinocystis labata, Agrostis stolonifera, Eragrostis hypnoides, Lycopus americanus, Lycopus uniflorus, Mentha arvensis, Scutellaria lateriflora, Polygonum pensylvanicum, and Salix amygdaloides. Except for individuals of the genus Salix (willow) which may be fairly abundant, the characteristic species of this type are herbs. The community is not extensively developed in the area since it is restricted to the edges of the river.

Community Type I-B

The presence of different stages of hydrach succession in abandoned oxbows accounts for much of the vegetation pattern on the bottomlands. The process of ecological succession is one of continuing change beginning when a new site becomes available for colonization and ending when a mature community in equilibrium with its environment has become established. In the bottomland along much of the Wild Rice River, oxbows have been cut off from the main channel. These abandoned oxbows are sites available for colonization. Since the river presently meanders back and forth continually, new sites are always available as are successional stages of varying ages. Three stands (Nos. 12, 13 and 14) were surveyed which represent a few of these stages. The three stands were located along a transect on the bottomland near the middle of the proposed reservoir. Stand 12 was located in a wet area near the edge of an oxbow, stand 13 was located farther from the edge, and stand 14 was still farther away.

For the purposes of this report these stands have been grouped into one community "type", namely that pattern characteristic of oxbow succession prior to the establishment of a mature bottomland forest. As can be seen from the synthesis table there is considerable variation in species composition of the three stands. This is due, of course, to the fact that they represent different seral stages. Further study would probably suggest recognition of several types corresponding to these different stages as well as indicating where the community boundaries might be drawn. While there is considerable variation among the three stands surveyed with regard to floristic composition, there are several species present in the three stands surveyed which were not found in any of the other stands. There are also several species found only in this type although they may not have been encountered in all three stands. Species characteristic of the type, as it is defined here, include Alisma plantago-aquatica, Ceratophyllum sp., Elymus virginicus, Glyceria grandis, Phalaris arundinacea, Hippuris vulgaris, Scutellaria galericulata, Stachys tenuifolia, Rumex crispus, Galium trifidum, Sparganium chloracarpum, Sparganium eurycarpum, and Sium suave. Another group of species with a restricted distribution occurs in type I-A as well as in this type. These were listed when that type was described. Except for stand 14 where a few trees have become established, the vegetation of type I-B is predominantly herbaceous. Density, dominance, and frequency values for the tree species and density and frequency values for the shrubs and sapling species, based on data from stand 14, are given in tables C-3, C-4, and C-5.

Community Type I-C

The most extensive plant community within the boundaries of the proposed reservoir is type I-C, the bottomland or floodplain forest. As described here, type I-C is considered to be close to or in a climax condition since the species making up the community are able to reproduce under the conditions they have created. This community represents the terminal stage of succession on the bottomlands in this region.

Portions of this forest type have been cut over for fuel and fence posts, as evidenced by stump sprouting of several species, especially bur oak, but much of this harvesting probably occurred early in this century. Sufficient time has since elapsed for the forest to reach conditions approaching maturity. Other portions of type I-C have probably only been selectively cut since some rather large specimens of trees can be found. American elms may reach a d.b.h. (diameter breast height) of 41 inches with bur oaks and basswoods up to 25 inches or more. Birch trees with a d.b.h. of 21 inches were also observed.

At the proposed damsite this community occurs below the 1,050-foot contour line. It extends to slightly higher elevations as one goes upstream from the dam. Six stands were surveyed which belong to this type (Nos. 1, 2, 3, 4, 5 and 6). Because of their topographic position, all six sites are subject to periodic flooding. One of the conspicuous features of this mature floodplain forest was a rather poorly developed shrub layer. This feature was also mentioned by

Wanek (1967) for the floodplain forest of the Red River, by Lago (1971) for the floodplain forests of the upper Mississippi near Bemidji, and by Wikum and Wali (1972) for the floodplain forests of the Forest River in northeastern North Dakota. In general, the community consists of a well-developed overstory of tree species and a well-developed heraceous stratum. Density, dominance, and frequency values for the trees, and density and frequency values for the shrubs and saplings are presented in tables C-6, C-7 and C-8. The dominant tree species in this community are Black Ash, Green Ash, Basswood, American Elm and Box Elder. These species are all somewhat water tolerant and able to withstand the periodic inundation to which they are subjected during spring floods. Also present, but of lesser importance, are Bur Oak, Ironwood, Trembling Aspen, Birch and Balsam Poplar. Many of these same tree species also occur in other communities, but not necessarily in the same order of importance.

While there are no herbaceous species completely restricted to this community type, there are a number which characteristically occur here and are found only occasionally in other stands. These include Hackelia virginiana, Brachyelytrum erectum, Circaea canadensis, Matteuccia struthiopteris var. pensylvanica, Geum canadense, Cryptotaenia canadesis, Laportea canadensis, and Urtica dioica. Laportea canadensis completely dominated the ground cover in four of the six stands.

TABLE C-3 DENSITY, DOMINANCE, AND FREQUENCY VALUES FOR TREE SPECIES IN COMMUNITY TYPE I-B.[a]

SPECIES	Density (trees/acre)	Dominance (in^2/acre)	Frequency (%)
Green Ash	11.3	377.1	40.0
Peach-leaf Willow	95.9	8,449.1	100.0
Cottonwood	5.6	1,126.2	20.0
TOTAL	112.8	9,952.4	

[a]Values based on one stand.

TABLE C-4 DENSITY AND FREQUENCY VALUES FOR SAPLING SPECIES IN COMMUNITY TYPE I-B.[a]

SPECIES	Density (no./acre)	Frequency (%)
American Elm	2,071.8	100.00
Green Ash	1,553.8	80.00
Box Elder	776.92	20.00
Willow	258.9	
TOTAL	4,661.42	

[a]Values based on one stand.

TABLE C-5 DENSITY AND FREQUENCY VALUES FOR SHRUB SPECIES IN COMMUNITY TYPE I-B.[a]

SPECIES	Density (no./acre)	Frequency (%)
Prickly Ash	518.0	40.0

[a]Value based on one stand.

TABLE C-6 DENSITY, DOMINANCE, AND FREQUENCY VALUES FOR TREE SPECIES IN COMMUNITY TYPE I-C.[a]

SPECIES	Density (trees/acre)	Dominance (in^2/acre)	Frequency (%)
Basswood	82.1	5,991.3	68.3
Green Ash	46.9	1,748.5	38.0
American Elm	24.3	2,013.4	30.4
Trembling Aspen	22.2	1,752.4	16.0
Box Elder	34.6	1,563.4	40.4
Bur Oak	8.4	287.9	12.5
Ironwood	5.8	238.1	10.4
Black Ash	63.6	1,943.7	47.5
White Birch	1.8	211.2	2.5
Balsam Poplar	4.6	240.9	4.1
TOTAL	294.3	15,990.8	

[a]Values are averages for six stands.

TABLE C-7 DENSITY AND FREQUENCY VALUES FOR SAPLING SPECIES IN COMMUNITY TYPE I-C.[a]

SPECIES	Density (no./acre)	Frequency (%)
American Elm	28.7	5.0
Bur Oak	17.0	3.3
Green Ash	377.5	20.8
Basswood	77.8	9.1
Trembling Aspen	60.9	6.7
Ironwood	106.0	10.8
Box Elder	78.2	9.2
Black Ash	217.7	14.2
Balsam Poplar	60.2	3.8
Willow	11.7	
TOTAL	1,035.7	

[a]Values are averages for six stands.

TABLE C-8 DENSITY AND FREQUENCY VALUES FOR SHRUB SPECIES IN COMMUNITY TYPE I-C.[a]

SPECIES	Density (no./acre)	Frequency (%)
Arrow wood	118.5	11.7
Prickly Ash	280.5	15.0
Hazel	233.0	17.9
Dogwood	212.5	13.3
Red Osier	40.1	3.8
Chokecherry	265.3	17.5
Virginia Creeper	621.9	35.4
Grape	107.6	6.7
Bittersweet	49.0	5.0
Juneberry	73.8	6.2
Red Raspberry	12.0	1.2
Dwarf Blackberry	4.1	1.2
Ribes (Gooseberry)	339.1	26.7
Buckbrush	175.9	16.7
Thornapple	8.6	1.2
High-bush Cranberry	29.3	3.8
Black Haw	32.8	3.8
Snowberry	4.5	0.8
Plum	4.1	0.8
TOTAL	2,612.6	

[a]Values are averages for six stands.

Wikum and Wali (1972) recognized a type (their community type 5) comparable to I-C in their Forest River Study. In their floodplain forest stands the dominant tree species are Box Elder and American Elm. Green Ash occurred in only one of their floodplain stands although no study found it in all of type I-C stands. Basswood, one of the dominants in the floodplain forest was found only on the slopes in their study. Aspen, Bur Oak, Ironwood, Balsam Poplar, and Paper Birch, tree species also present in floodplain forests but of relatively low importance, were encountered only on the slopes in the Forest River Study. Black Ash, one of the floodplain forest dominants, is near the western edge of its range in the Twin Valley area and does not get into the Forest River area. The type I-C is also similar to the floodplain forests of the Upper Mississippi River studied by Lago (1971). Tree species encountered in his 20 stands, in order of decreasing importance, were Green Ash, American Elm, Silver Maple, Balsam Poplar, Basswood, Paper Birch, Bur Oak, Aspen, Box Elder, White Spruce and Balsam Fir. Included are several species which do not extend as far west in Minnesota as the Twin Valley area. In his classification of lowland vegetation in northwestern Minnesota, Janssen (1967) recognized several orders including the Fraxinetalia nigrae (Black Ash type) which he subdivided into two alliances. One of these, the Laportea-Ulmion (Wood Nettle-American Elm type) is equivalent to type I-C. Character-species for this alliance are Cryptotaenia canadensis, Rudbeckia lacinata, Laportea canadensis, and Menisperum canadensis. All of these were also important in type I-C, although Rudbeckia laciniata and

and *Menispermum canadensis* were found in several slope and upland stands above the floodplain proper. Janssen further subdivides the *Laportea-Ulmion* alliance into two associations, the *Fraxino-ulmetum americanae* and the *Osmorhizete-Ulmetum*. The separation was based on the presence of certain groups of species which he feels are typically upland which occur in the latter group and the absence of these species in the former group. On the basis of present data this separation is questionable. Interestingly, the bottomland stands surveyed by Janssen which belong to *Laportea-Ulmion* alliance came from the floodplain of the Wild Rice River just east of the proposed reservoir. Janssen mentions that this was the "only river in the area big enough to form a real floodplain." The uniqueness of type I-C in the immediate area should be recognized.

Community Type I-D

This community type differs from the mature floodplain forest, in that it has been subject to more recent disturbance than type I-C, probably the result of selective logging. While no ages were determined for trees in any of the stands, evidence of disturbance can be obtained from the density, dominance and frequency tables (tables C-9, C-10 and C-11) for the tree species. In the three stands sampled (Nos. 7, 8 and 9) which were placed in this community type the average density of basswood was only 14.9 trees per acre. This tree is a climax dominant in type I-C and its average density based on six stands was 82.1 trees per acre. Basswood is a desirable timber tree and would no doubt be one of the first species taken if the area was logged. At present it is being sold for cooperage at a stave-making plant in Mahnomen. A similar difference between type I-C and I-D exists for Black Ash, American Elm, Green Ash, Bur Oak and Balsam Poplar. Ironwood is similar to both stands. A major difference is that community type I-D contains approximately six times as many Trembling Aspen trees (129.2 trees/acre vs. 22.2 trees/acre) as type I-C. Aspen is not a climax species and comes in only after a forest canopy has been opened up. Differences also exist with respect to tree reproduction. There were about five times as many saplings of American Elm (140.8/acre vs. 28.7/acre) in type I-D as I-C. There were also about three times as many Bur Oak saplings (55.9/acre vs. 17.0/acre) in stands belonging to type I-D. There were approximately six times as many Aspen saplings (340.7/acre vs. 69.9/acre) and about three times the number of Ironwood saplings (364/acre vs. 106.0/acres) in type I-D. Black Ash seemed to be reproducing much more successfully in type I-C than in type I-D (227.7/acre vs. 14.0/acre). Sapling densities of Green Ash, Basswood, Box Elder, and Balsam Poplar are similar in both types. There are also differences between these community types for some shrub species. Prickly Ash, Hazel, Blackberry and Buckbrush seem to be significantly more abundant in type I-D than I-C, whereas Dogwood, Virginia Creeper and Gooseberry are more abundant in type I-C than in I-D. There were only two herbs found exclusively in this type, Pyrola asarifolia and Gentiana andrewsii. Missing from stands in this community are a number of herbs such as Hackelia virginiana, Brachyelytrum erectum, *Geum canadense*, *Matteuccia struthiopteria*, *Laportea canadensis*, and *Urtica dioica* which seem to characterize the more mature bottomland forests.

TABLE C-9 DENSITY, DOMINANCE, AND FREQUENCY VALUES FOR TREE SPECIES IN COMMUNITY TYPE I-D.[a]

SPECIES	Density (trees/acre)	Dominance (in^2/acre)	Frequency (%)
Basswood	14.9	1,793.8	16.7
Green Ash	40.3	2,495.3	37.5
American Elm	26.2	2,519.2	33.3
Trembling Aspen	129.2	6,462.5	65.8
Box Elder	25.0	1,608.1	28.3
Bur Oak	7.2	497.1	10.0
Ironwood	5.2	120.4	7.5
Black Ash	5.4	176.1	5.8
White Birch	7.8	617.6	10.8
Balsam Poplar	6.4	646.1	5.8
TOTAL	267.6	16,936.2	

[a]Values are average for three stands.

TABLE C-10 DENSITY AND FREQUENCY VALUES FOR SAPLING SPECIES IN COMMUNITY TYPE I-D.[a]

SPECIES	Density (no./acre)	Frequency (%)
American Elm	140.8	14.2
Bur Oak	55.9	3.3
Green Ash	379.6	30.0
Basswood	60.2	3.3
Trembling Aspen	340.7	21.7
Ironwood	364.0	10.0
Box Elder	93.4	7.5
Black Ash	14.0	0.8
Balsam Poplar	60.0	4.2
TOTAL	1,508.6	

[a]Values are averages for three stands.

Community Type I-E

This type is of relatively minor importance in the area of the proposed reservoir. Only 3 to 4 acres were found and one stand was surveyed. It was located between the river bank and a large open area of the floodplain. The only two mature tree species present (see table C-12) were Bur Oak, with a density of 26.6 individuals/acre, and Balsam Poplar, with a density of 505.3/acre. Balsam Poplar was found in only three other community types, I-C, I-D and III-B and never with a density of more than 6.4 individuals/acre. The community probably represents another example of disturbance in a bottomland stand. The one stand sampled represents a relatively early successional stage which will lead eventually to occupancy of the site by type I-C. While most of the climax species have not yet reached the sapling stage on this site, Box Elder (1,195.2 individuals/acre) and Green Ash (2,390.1 individuals/acre) are coming in (table C-13). The most unusual feature of the one stand in this community type was its very high shrub density, 20,361.4 individuals/acre compared with 9,160.3 individuals/acre in community type III-B, the next closest value (table C-14). While the total number of individual shrubs was quite high, they represented only eight species.

Table C-11 - Density and frequency values for shrub species in community type I-D[a]

Species	Density (No./acre)	Frequency (percent)
Arrow-wood	123.5	5.8
Prickly Ash	651.8	35.8
Hazel	432.7	21.7
Dogwood	73.7	10.0
Red Osier	95.6	4.2
Chokecherry	371.1	26.7
Virginia Creeper	303.2	20.0
Grape	82.6	5.8
Bittersweet	68.6	4.2
Juneberry	199.1	13.3
Honeysuckle	11.5	0.8
Red Raspberry	134.8	7.5
Ribes (Gooseberry)	100.1	6.7
Buckbrush	337.4	23.3
Thornapple	12.8	2.5
High-bush Cranberry	14.0	0.8
Black Haw	71.2	4.2
TOTAL	3,083.7	

[a] Values are averages for three stands.

Table C-12 - Density, dominance and frequency values for tree species in community type I-E[a]

Species	Density (trees/acre)	Dominance (in^2/acre)	Frequency (percent)
Bur Oak	26.6	3,008.5	20.0
Balsam Poplar	505.3	13,810.7	100.0
TOTAL	531.9	16,819.2	

[a] Values based on one stand.

TABLE C-13 DENSITY AND FREQUENCY VALUES FOR SAPLING SPECIES IN COMMUNITY TYPE I-E.[a]

SPECIES	Density (no./acre)	Frequency (%)
Green Ash	2,390.1	20.0
Box Elder	1,195.2	20.0
TOTAL	3,585.3	

[a]Values based on one stand and only five points.

TABLE C-14 DENSITY AND FREQUENCY VALUES FOR SHRUB SPECIES IN COMMUNITY TYPE I-E.[a]

SPECIES	Density (no./acre)	Frequency (%)
Prickly Ash	2,390.1	40.0
Chokecherry	4,780.2	80.0
Virginia Creeper	3,585.2	40.0
Grape	1,195.2	20.0
Ribes (Gooseberry)	3,585.2	20.0
Buckbrush	2,390.1	40.0
Rose	1,195.2	20.0
Thornapple	1,195.2	20.0
TOTAL	20,316.4	

[a]Values based on one stand.

Community Type I-F

This is another community of relatively minor importance in the study area. This community may best be described as a recently pastured bottomland forest. Total acreage in the proposed reservoir area is estimated to be less than 40 acres. Only one stand (No. 10) belonging to this type was surveyed. As expected, this stand contained fewer species than the less recently disturbed bottomland forests. In addition, many of the heraceous species which occur here are typically weedy and occur in a variety of plant communities in our area following disturbance. However, this was the only community in which several of these species were found in the proposed reservoir area. Bur Oak, Trembling Aspen, a few Cottonwood and Ironwood were the mature tree species found on the one stand representative of this type.

Community Type I-G

The last bottomland community type, and again a relatively minor one in the study area, is the cleared bottomland. Only a few acres were encountered. The one stand surveyed (No. 15) had apparently been used as a field or pasture a number of years ago but it showed no evidence of recent usage. Long abandoned fences scattered throughout the study area attest to the fact that at one time this practice was formerly quite prevalent. For most of the area, however, pasturing in the bottomland has long since ceased. Several of the older farmers indicated that it has been 35 years or more since much of the bottomland has been under pasturage. The open stand (No. 15) contained many herbs typical of the prairie. While the mature trees had been removed, seedlings of American Elm occurred along with scattered shrubs. The stand appears to be in the very early stages of reverting back to a typical bottomland forest.

Vegetation on Slopes Adjacent to the Bottomlands

A primary topographic feature of the study area are the slopes which form the banks of the river valley. The slope begins at about the 1,055 contour interval and goes up to approximately the 1,100 foot interval. The actual number of acres involved was not determined. "Side hill" sampling was nearly always on sites of a generally southerly exposure on the north side of the river. The reason for such a restriction was that in the area of the proposed reservoir the river usually lies close to the southern edge of the floodplain. This tends to produce bluffs or steep banks on most north-facing slopes.

The pattern of vegetation on the slopes seems to be less complex than that of the bottomlands. Only three community types have been recognized and these have many species in common. While the pattern may, in fact, be more homogeneous on the slopes than on the bottomlands the total number of stands sampled on the slopes was relatively small (six) and some of the variation may have been overlooked. An examination of Wikum and Wali's conclusions for the Forest River area would suggest that the latter may be true. Four of their five community types occurred on slopes with differences apparently due to aspect, slope angle and position on the slope. A similar relationship may or or may not exist in the Twin Valley area. Since the regional climatic conditions in our area are more favorable for forest development than in the Forest River area, the effects of slope exposure, angle and position on the slope exposure, angle and position on slope on tree distribution may not be as pronounced as these authors observed. This study, however, recognized three community types on the slopes, two of which seem to be related to differences in a slope property, namely aspect. The third type is best explained by a past history of disturbance.

Community Type II-A

This community type occurs on north-facing slopes adjacent to the bottomland. Most of the north-facing slopes along the Wild Rice River in the area of the proposed reservoir are quite steep, badly eroded, and support little vegetation. Where the slope has been stable for a long enough time, a forested community may develop. One survey was made in such a stand (No. 22). The slope was steep (25-30°) and the stand was located near the top of the slope. American Elm, Box Elder, and Bur Oak were the dominant tree species. Box Elder reached its highest relative dominance in this stand (table C-15, as did American Elm and Bur Oak. Basswood, Green Ash, Aspen, Ironwood, and White Birch were also present but were not abundant. This is somewhat surprising since Basswood and Green Ash are relatively common on north-facing slopes along the Forest River in North Dakota (Wikum and Wali, 1972) and since Basswood, at least, is common on the south-facing slopes as well as bottomlands and the level uplands in our area. This stand also had the lowest shrub density of all the

the stands examined (table C-16). Shrubs present included Arrowwood, Hazel, Chokecherry, Juneberry and Gooseberry. Hazel, Juneberry and Chokecherry also occurred on north-facing slopes in the Forest River area. None of the shrub species present in this community are exclusive to it nor do any reach their highest density here. There are no herbaceous species unique to this community type although several species characteristic of the bottomland were found above the floodplain only in the stand 22 (C-17). In addition, many of the herbs typical of the south-facing slopes and uplands are absent from the north-facing slopes. Wikum and Wali (1972) discuss this relationship in some detail for the Forest River area.

TABLE C-15 DENSITY, DOMINANCE, AND FREQUENCY VALUES FOR TREE SPECIES IN COMMUNITY TYPE II-A.[a]

SPECIES	Density (trees/acre)	Dominance (in^2/acre)	Frequency (%)
Basswood	17.6	2,514.9	20.0
Green Ash	8.8	566.8	10.0
American Elm	30.7	5,027.2	50.0
Trembling Aspen	8.8	595.3	20.0
Box Elder	52.7	5,383.2	70.0
Bur Oak	30.7	4,927.7	50.0
Ironwood	17.6	460.5	20.0
White Birch	8.8	915.8	20.0
TOTAL	175.7	20,391.4	

[a]Values based on one stand.

TABLE C-16 DENSITY AND FREQUENCY VALUES FOR SAPLING SPECIES IN COMMUNITY TYPE II-A.[a]

SPECIES	Density (no./acre)	Frequency (%)
American Elm	54.8	20.0
Green Ash	438.4	90.0
Ironwood	88.2	30.0
Black Ash	109.6	40.0
TOTAL	691.0	

[a]Values based on one stand.

Community Type II-B

The four stands representative of this type (Nos. 17, 18, 19 and 20) were located near the middle of the south-facing slopes with slope angles from 10 to 15 degrees. These stands were between the 1,055 and 1,100 foot contour intervals. Among the overstory species, Basswood had the highest density and dominance values. Absolute dominance values for Basswood in this community are exceeded only by community type III-A. Other tree species encountered in this community in order from highest to lowest absolute dominance were American Elm, Trembling Aspen, Ironwood, Box Elder, Bur Oak, Green Ash, and White Birch. Four of these species, American Elm, Bur Oak, Green Ash and Basswood are also found on slopes with a southerly aspect to the Forest River area but their order of importance is somewhat different. The shrub layer is well developed in this type. In the four stands sampled there was an average of 4,400.4 individuals/acre. A number of shrub species are represented including Arrow-wood, Prickly Ash, Hazel, Dogwood, Chokecherry, Virginia Creeper, Grape, Bittersweet, Juneberry, Honeysuckle, Blackcherry, Raspberry, Gooseberry, Buckbrush, and Black Haw. Shrub composition is similar to that for Wikum and Wali's community type I, from south-facing slopes. There are no herbaceous species unique to this community type although several reach their greatest abundance in these stands. This community appears to be relatively undisturbed at the present and is approaching the potential for the sites it occupies.

Table C-17 - Density and frequency values for shrub species in community type II-A[a]

Species	Density (No./acres)	Frequency (percent)
Arrow-wood	88.2	20.0
Hazel	27.4	10.0
Chokecherry	88.2	20.0
Juneberry	88.2	30.0
Ribes (Gooseberry)	137.0	50.0
TOTAL	429.0	

[a] Values based on one stand.

Table C-18 - Density, dominance, and frequency values for tree species in community type II-B[a]

Species	Density (trees/acre)	Dominance (in^2/acre)	Frequency (percent)
Basswood	100.6	6,234.4	75.0
Green Ash	16.2	727.6	19.2
American Elm	26.9	2,372.4	30.8
Trembling Aspen	37.8	1,531.8	23.3
Box Elder	22.4	1,342.7	25.8
Bur Oak	20.1	866.9	22.5
Ironwood	57.0	1,132.3	53.3
White Birch	1.9	141.5	3.3
TOTAL	232.9	14,449.6	

[a] Values are averages for three stands.

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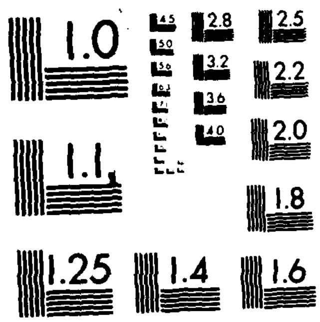

MICROCOPY RESOLUTION TEST CHART
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TABLE C-19 DENSITY AND FREQUENCY VALUES FOR SAPLING SPECIES IN COMMUNITY TYPE II-B.[a]

SPECIES	Density (no./acre)	Frequency (%)
American Elm	28.1	1.7
Bur Oak	152.5	9.2
Green Ash	118.5	7.5
Basswood	143.5	7.5
Trembling Aspen	140.6	8.3
Ironwood	609.2	30.0
Box Elder	178.0	13.3
TOTAL	1,370.4	

[a]Values are averages for three stands.

TABLE C-20 DENSITY AND FREQUENCY VALUES FOR SHRUB SPECIES IN COMMUNITY TYPE II-B.[a]

SPECIES	Density (no./acre)	Frequency (%)
Arrow-wood	225.1	11.7
Prickly Ash	1,012.1	44.2
Hazel	467.4	23.3
Dogwood	387.3	18.3
Chokecherry	244.9	14.2
Virginia Creeper	766.6	30.8
Grape	290.6	9.2
Bittersweet	356.9	20.8
Juneberry	160.5	10.0
Raspberry	21.8	1.7
Ribes (Gooseberry)	127.6	5.8
Buckbrush	302.3	14.2
Black Haw	36.7	3.3
TOTAL	4,399.8	

[a]Values are averages for three stands.

TABLE C-21 DENSITY, DOMINANCE AND FREQUENCY VALUES FOR TREE SPECIES IN COMMUNITY TYPE II-C.[a]

SPECIES	Density (trees/acre)	Dominance (in^2/acre)	Frequency (%)
Basswood	77.5	4,220.8	65.0
Green Ash	74.9	1,775.8	55.0
American Elm	19.9	1,107.2	20.0
Trembling Aspen	174.9	6,080.5	77.5
Box Elder	5.0	262.1	5.0
Bur Oak	17.6	855.5	17.5
Ironwood	9.9	267.3	10.0
Black Ash	2.7	64.1	2.5
TOTAL	382.4	14,633.3	

[a]Values based on one stand.

TABLE C-22 DENSITY AND FREQUENCY VALUES FOR SAPLING SPECIES IN COMMUNITY TYPE II-C.[a]

SPECIES	Density (no./acre)	Frequency (%)
Bur Oak	109.3	5.0
Green Ash	163.6	5.0
Basswood	109.3	5.0
Trembling Aspen	762.7	27.5
Ironwood	109.3	5.0
Black Ash	54.2	2.5
TOTAL	1,308.4	

[a]Values based on one stand.

Community Type II-C

While much of the vegetation on the slopes adjacent to the river is close to maturity, some stands showed signs of past logging. One stand (No. 21) was sampled which had less American Elm and Ironwood and more Green Ash and Aspen than the other south-facing slopes examined. This stand also had a number of stump-sprouting Basswood and some old Bur Oak stumps suggesting that it had been logged in the past. It is now in the process of reverting to Type II-B. Density, dominance and frequency values for the tree species, and density and frequency values for the sapling and shrub species from stand 21 are given in tables C-21, C-22 and C-23.

None of the slope types fit well in the classification scheme proposed by Janssen (1967). They fit best in the Uvularia-Aceretalia order except that Sugar Maple, for which the order is named, does not occur as far west as the Twin Valley site. It is common to the east in Mahnomen County. Sugar Maple was, however, absent from many of Janssen's Ulmo-Tilion americanae alliance. Within the order, however, the stands do not fit clearly into any of his alliances. They contain characteristic elements of the Ulmo-Tilion americanae alliance and of the Diervilleto-Quercion alliance.

The Ulmo-Tilion americanae includes stands close to maturity whereas the Diervilleto-Quercion alliance represents several stages in forest succession. It appears that most of the slope stands are approaching the Ulmo-Tilion americanae stage but they still contain some relicts from earlier stages, particularly Trembling Aspen and a number of shrub species.

TABLE C-23 DENSITY AND FREQUENCY VALUES FOR SHRUB SPECIES IN COMMUNITY TYPE II-C.[a]

SPECIES	Density (no./acre)	Frequency (%)
Arrow-wood	490.7	13.0
Prickly Ash	980.5	30.0
Hazel	762.7	25.0
Dogwood	163.6	7.5
Chokecherry	381.4	17.5
Virginia Creeper	1,634.8	47.5
Grape	599.2	20.0
Bittersweet	435.6	15.0
Juneberry	653.4	20.0
Red Raspberry	163.6	7.5
Ribes (Gooseberry)	163.6	5.0
Buckbrush	708.5	35.0
Rose	54.2	2.5
TOTAL	7,191.8	

[a]Value based on one stand.

Vegetation on the Uplands Above the Slopes

The topography above the 1,100-foot contour invervals tends to be rather level to gently rolling. The general upland area above this contour immediately adjacent to the reservoir consists of some agricultural land, either in crops, hay, or pasturage with a small amount of marshland. Most of the area is woodland, however, at least on the north side of the river. In contrast, the upland areas adjacent to the south side of the proposed reservoir contain little woodland, except along tributary coulees, and beyond the bordering fringe of gallery forest the uplands are chiefly agricultural. The chief agricultural crops grown in this area are small grains, corn and sunflowers. On the lighter soils especially, hay crops are also important. With the five sections of land through which the major portion of the river flows in the proposed reservoir site plus three adjacent sections paralleling these to the north (sections 23, 24, 25 and 26 T141 N. R 44 W) and sections 19, 29, 21 and 30 T141 N, R 43 W) the percent of woodland as indicated on aerial photos and geological quadrangle maps varies from 42 percent to 82 percent and averages 63 percent. Within this level upland region six forested stands were surveyed and two community types were recognized.

Community Type III-A

This type represents stands whose characteristics suggest that they have been relatively undisturbed for a number of years. Two such stands were surveyed, Nos. 23 and 24. The dominant overstory species in these stands was Basswood (table C-24). By far the highest absolute dominance values for both Basswood and Bur Oak were obtained in this type. Ironwood was also very abundant. Ironwood had an absolute dominance four times that of the value in the next closest community. American Elm, Aspen, Box Elder and White Birch were found but these species are of relatively minor importance in this type. The shrub layer was well developed (5,742.4 shrubs/acre) and included Arrow-wood, Prickly Ash, Hazel, Dogwood, Chokecherry, Virginia Creeper, Grape, Bittersweet, Juneberry, Raspberry, Gooseberry, Buckbrush, Rose and Cranberry (table C-25). There are no unique herbs. While herbs are abundant, the heraceous species in this community also occur in several other communities, notably other upland and slope types.

TABLE C-24 DENSITY, DOMINANCE AND FREQUENCY VALUES FOR TREE SPECIES IN COMMUNITY TYPE III-A.[a]

SPECIES	Density (trees/acre)	Dominance (in^2/acre)	Frequency (%)
Basswood	76.4	9,021.4	67.5
Green Ash	16.6	743.8	18.8
American Elm	35.0	3,129.1	31.2
Trembling Aspen	29.4	2,467.7	27.5
Box Elder	5.6	175.6	7.5
Bur Oak	43.5	4,041.0	37.5
Ironwood	80.1	5,305.4	57.5
White Birch	5.4	310.2	5.0
TOTAL	292.0	25,194.2	

[a]Values are averages for two stands.

TABLE C-25 DENSITY AND FREQUENCY VALUES FOR SAPLING SPECIES IN COMMUNITY TYPE III-A.[a]

SPECIES	Density (no./acre)	Frequency (%)
American Elm	27.4	1.2
Bur Oak	174.2	6.2
Green Ash	450.8	18.8
Basswood	73.4	5.0
Trembling Aspen	192.0	11.2
Ironwood	322.5	16.2
Box Elder	28.9	1.2
TOTAL	1,269.2	

[a]Values are averages for two stands.

TABLE C-26 DENSITY AND FREQUENCY VALUES FOR SHRUB SPECIES IN COMMUNITY TYPE III-A.[a]

SPECIES	Density (no./acre)	Frequency (%)
Arrow-wood	378.5	18.8
Prickly Ash	1,246.2	42.5
Hazel	1,005.9	31.2
Dogwood	408.0	17.5
Chokecherry	394.0	16.2
Virginia Creeper	1,292.1	48.8
Grape	103.7	8.8
Bittersweet	203.1	8.8
Juneberry	261.7	11.2
Red Raspberry	87.1	1.2
Ribes (Gooseberry)	116.8	5.0
Buckbrush	28.9	2.5
Rose	108.2	2.5
High-bush Cranberry	108.2	2.5
TOTAL	5,742.4	

[a]Values are averages for two stands.

Community Type III-B

In general most of the flat upland stands show evidence of relatively recent (e.g., 30 to 50 years) disturbance either as a result of logging or of fire. These upland stands have less Basswood, less Green Ash, less American Elm, less Bur Oak and more Aspen than the forest on the upland which are closer to maturity. Type III-B represents forest stands more recently disturbed. Four stands belonging to this type were studied. The absolute dominance of Aspen (table C-27, 15,743 in^2/acre) sets these stands well apart from type III-A. Shrub density (table C-29, 9,160.3/acre) is also much higher here than in any community except type I-E. The species composition of the shrub layer is similar to that of type III-A except for a few species. There are, however, some significant differences in absolute densities for some of these shrubs. A few herbaceous species were found only in this community type. These include _Aster umbellatus_, _Taraxacum officinale_, _Athyrium filix-femia_ var. _michauxii_. Most of the herbs also occur in type III-A and on the upper slopes.

Table C-27 - Density, dominance and frequency values for tree species in community type III-B[a]

Species	Density (trees/acre)	Dominance (in^2/acre)	Frequency (percent)
Basswood	11.6	690.7	12.5
Green Ash	11.4	414.5	10.8
American Elm	17.1	1,233.2	15.8
Trembling Aspen	343.1	15,743.3	89.1
Box Elder	1.3	58.2	1.7
Bur Oak	46.9	2,396.0	34.1
Ironwood	.6	7.5	0.8
White Birch	1.0	81.2	0.8
Balsam Poplar	.6	106.0	0.3
Peach-leaf Willow	1.0	24.5	0.8
TOTAL	434.6	20,755.1	

[a] Values are averages for three stands.

Table C-28 - Density and frequency values for sapling species in community type III-B[a]

Species	Density (No./acre)	Frequency (percent)
American Elm	18.4	0.8
Bur Oak	219.5	9.2
Green Ash	130.8	5.0
Basswood	122.6	4.2
Trembling Aspen	529.3	20.8
Ironwood	142.5	4.2
Balsam Poplar	65.4	2.5
Willow	77.1	3.3
TOTAL	1,305.6	

[a] Values are averages for three stands.

Table C-29 - Density and frequency values for shrub species in community type III-B[a]

Species	Density (No./acre)	Frequency (percent)
Arrow-wood	569.1	14.2
Prickly Ash	1,839.0	28.3
Hazel	2,828.7	55.8
Dogwood	520.2	14.2
Red Osier	55.2	2.5
Chokecherry	339.9	10.0
Virginia Creeper	1,235.6	20.0
Bittersweet	141.1	4.2
Juneberry	1,080.5	32.5
Red Raspberry	73.6	2.5
Ribes (Gooseberry)	94.0	3.3
Rose	102.2	2.5
High-bush Cranberry	138.7	5.8
Pinchberry	18.4	0.8
Black Haw	47.0	1.7
TOTAL	9,083.2	

[a] Values are averages for three stands.

Both types of upland stands fit reasonably well into Janssen's Diervilleto-Quercion alliance which is part of the Uvulari-Acretalia order, except that they lack Sugar Maple and Diervilla lonicera. As discussed earlier, the alliance represents several intermediate successional stages in the regeneration of forest following logging or fire. The two community types recognized in this study represent at least two of these stages.

APPENDIX D

PLANTS FOUND IN THE WILD RICE WATERSHED

PLANT INVENTORY TABLE

Common Name	Abundance In Project Area	Importance As Wildlife Habitat	Value for Cultural, Aesthetic, Scientific Purposes	Project Impact
Bur oak *Quercus macrocarpa*	Very Common	Food, Cover	Major aesthetic	Major decrease
Cottonwood *Populus deltoides*	Common	Food, Cover	Major aesthetic	Moderate decrease
Currant *Ribes americanum*	Uncommon, Common	Food	Major aesthetic, and cultural	Moderate - major decrease
Hazel *Corylus americana*	Common	Food, Cover	Major aesthetic, and cultural	Moderate - major decrease
High-bush cranberry *Vibernum americanum*	Uncommon, Common	Food, Cover	Major aesthetic, and cultural	Major decrease
Prickly ash *Zanthoxylum americanum*	Very common	Food, Cover	Major aesthetic	Major decrease
American elm *Ulmus americana*	Common, Very Common	Cover	Major aesthetic	Major decrease
Balsam poplar *Populus balsamifera*	Uncommon, Common	Food, Cover	Major aesthetic	Minor decrease
Basswood *Salix bebbiana*	Uncommon	Food, Cover	Major aesthetic	Minor - moderate decrease
Box elder *Acer negundo*	Very common	Food, Cover	Major aesthetic	Major decrease
Dogwood *Cornus alternifolia*	Common	Cover	Major aesthetic	Moderate decrease

PLANT INVENTORY TABLE (cont)

Common Name	Abundance In Project Area	Importance As Wildlife Habitat	Value for Cultural, Aesthetic, Scientific Purposes	Project Impact
Poison ivy *Rhus radicans*	Very Common	Cover, Food	Scientific	Decrease
Blackberry *Rubas sp.*	Common	Food, Cover	Major aesthetic, cultural	Moderate decrease
Chokecherry *Prunus virginiana*	Very Common	Food, Cover	Major aesthetic, clutural	Major decrease
Ash *Fraxinus spp.*	Uncommon, Common	Food	Major aesthetic	Moderate decrease
Basswood *Tilia americana*	Common, Very Common	Food, Cover	Major aesthetic	Moderate - major decrease

PLANT INVENTORY TABLE (cont)

Common Name	Abundance In Project Area	Importance As Wildlife Habitat	Value for Cultural Aesthetic, Scientific Purposes	Project Impact
Greater duckweed [illegible]	Uncommon	Food, Cover	Minor	Increase
Lesser duckweed *Lemna minor*	Uncommon	Food, Cover	Minor	Increase
Waterweed [illegible]	Uncommon	Food, Cover	Minor	Increase
Mare's tail [illegible]	Uncommon	Food, Cover	Minor	Increase
Pondweed [illegible]	Common	Food, Cover	Minor	Increase
Pondweed [illegible]	Common	Food, Cover	Minor	Increase
Pondweed [illegible]	Common	Food, Cover	Minor	Increase
Green Algae	Uncommon, Common	Food for larvae and juvenile fish and invertebrates	Minor	Major increase
Euglenoid Algae	Uncommon	Food for larvae and juvenile fish and invertebrates	None - Minor	Major increase
Cryptophyceae algae	Uncommon	Food for larvae and juvenile fish and invertebrates	None - Minor	Major increase
Blue green algae	Very common	Food for larvae and juvenile fish and invertebrates	None - Minor	Major increase

APPENDIX E

MAMMALS FOUND IN THE WILD RICE WATERSHED

MAMMAL INVENTORY TABLE

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Masked shrew *Sorex cinereus*	Moist condition, open country, forests, brush	Northern	Statewide	Common	Moderate
Arctic shrew *Sorex arcticus*	Moist lands, bog	Northern one-third and Alaska	Northern half	Uncommon	None-Minor
Short-tailed shrew *Blarina brevicauda*	Unrestricted	West into Texas and South Dakota	Statewide	Common	Moderate
Little brown bat *Myotis lucifugus*	Caves, mine tunnels, hollow trees or buildings	Northern two-third	Statewide	Common	Moderate
Eastern cottontail *Sylvilagus floridanus*	Heavy brush, open areas, forests, edges of swamps	Arizona to North Dakota eastward	Statewide	Common	Minor
White-tailed jackrabbit *Lepus townsendii*	Prairie	Illinois-Nevada, Arizona to Canada border	Statewide	Uncommon	None-Minor
Snowshoe hare *Lepus americanus*	Coniferous forests	New England States North-west and Southern Alaska	NW one-third	Rare	None
Eastern Chipmunk *Tamias striatus*	Deciduous forests, brushy areas	LA to Minnesota eastward	Statewide	Common	Moderate
Woodchuck *Marmota monax*	Open woods, brushy areas, rocky ravines	Arkansas and South Carolina northward	Statewide	Uncommon	Minor
Richardson's ground squirrel *Citellus richardsonii*	Sage brush, grassland	Colorado-Wyoming to Montana-North Dakota north ward	Western one-fifth	Rare	None
Thirteen-lined ground squirrel *Spermophilus tridecemlineutus*	Short grass prairies, golf courses	Texas north to Montana and Ohio	Absent in north-eastern corner	Common	Moderate

MAMMAL INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Gray squirrel *Sciurus carolinensis*	Hardwood forests, river bottoms	Texas-North Dakota eastward	Statewide	Uncommon	Minor
Fox squirrel *Sciurus niger*	Hardwood woodlots, pine forests	Texas-North Dakota eastward	Statewide	Rare	None
Red squirrel *Tamiasciurus hudsonicus*	Pine, spruce, mixed hardwood forests, forest swamps	Northeast and West Central	Statewide	Very common	Moderate
Plains pocket gopher *Geomys bursarius*	Grasslands, alfalfa fields, roadsides	Louisiana-Arizona-North Dakota-Indiana	Absent in northeastern corner	Common	Moderate
Beaver *Castor canadensis*	Streams, lakes with trees or alders on bank	Northwest and Arkansas	Statewide	Common	Moderate
Prairie deer mouse *Peryomyscus maniculatus*	Open, brushy areas, woodland (forests), dry	Absent in southeast	Statewide	Very common	Moderate
Woodland deer mouse *Peryomyscus maniculatus (gracilis)*	Open, brushy areas, woodland (forests), dry	Absent in southeast	Statewide	Not found in Norman County	None
White footed mouse *Peromyscus leucopus*	Woodland forests, brushy areas, open	Arizona-Montana-New England to Georgia	Southern two-thirds	Very Common	Moderate
Northern grasshopper mouse *Onychomys leucogaster*	Prairie	Western one-half	Western one-fourth	Rare	None
Boreal redbacked vole *Clethrionomys gapperi*	Coniferous forests, damp places	Scattered in east, north and west	Statewide	Very Common	Moderate

MAMMAL INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Meadow vole *Microtus pennsylvanicus*	Moist, grassland, lakes, streams, swamps	Southeast-northwest Wyoming-New Mexico	Statewide	Very Common	Moderate
Southern bog lemming *Synaptomys cooperi*	Low dam bogs with heavy vegetation	Kansas-Minnesota eastward	Absent in far northwest corner	Not found in Norman County	None
Muskrat *Ondatra zibethica*	Marsh, ponds, lakes, stream, cattails	Absent in Florida	Statewide	Uncommon	Minor
Norway rat *Rattus norvegicus*	Unrestricted	Northwest	Statewide	Uncommon	Minor
House mouse *Mus musculus*	Unrestricted	Northwest	Statewide	Common	Moderate
Meadow jumping mouse *Zapus hudsonius*	Unrestricted	Georgia-Montana northward	Statewide	Common	Moderate
Long-tailed weasel *Mustela frenata*	Near water - unrestricted	Northwest	Absent in far northeast corner	Uncommon	Minor
Least weasel *Mustela nivalis*	Meadows, brushy areas, open, woodland (forests)	Montana-West Virginia northward	Statewide	Rare	None
Mink *Mustela vison*	Streams, lakes	Northwest and Arkansas	Statewide	Common	Moderate
Badger *Taxidea taxus*	Grassland, deserts	Texas-Ohio westward	Absent in far northeast corner	Uncommon	Minor
Striped skunk *Mephitis mephitis*	Semi open, mixed woods, prairie, brushy areas	Northwest	Statewide	Common	Moderate

MAMMAL INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
White-tailed deer *Odocoileus virginiana*	Woodland forests, swamps, open, brushy areas	Northwest	Statewide	Common	Moderate
Coyote *Canis latrans*	Prairie, woodland forests, brushy areas, boulder stream area	LA-New York westward	Statewide	Uncommon	Minor
Red fox *Vulpes vulpes*	Mixture of woodland forests and open	Northwest and Arkansas	Statewide	Common	Moderate
Gray fox *Urocyon cinereoargenteus*	Chaparral, open, woodland forests, rim rock country	Absent in northwestern one-fourth	Absent in far northeast corner	Rare	None
Black bear *Ursus americanus*	Woodland forests	Absent from Rocky Mountain States	Statewide	Rare	None
Raccoon *Procyon lotor*	Streams, lakes, woodland forests, rock cliffs	Northwest	Statewide	Common	Moderate
Ermine *Mustela erminea*	Woodland forests, open	Minnesota-New England northward	Statewide	Common	Minor-Moderate
Moose *Alces alces*	Woodland forests, lakes, swamps	Northern parts of Idaho, Minnesota, Wisconsin, Michigan	Northeastern one-third	Rare	None
Elk (Wapiti) *Cervus canadensis*	Semi-open forest, meadows, foothills, plains	Rocky Mountain States, Pacific Coast	Reintroduced in northwest	Absent	-
Bison *Bison bison*	Prairie	Restricted to reservation land	Absent	Extinct	-

APPENDIX F

BIRD SPECIES FOUND ALONG THE FLOODPLAIN FORESTS OF THE WILD RICE RIVER

BIRD INVENTOPY TABLE

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Great blue heron *Ardea herodias*	Shallow water	North of central america	Statewide - summer resident	Uncommon	Possible minor increase
Mallard *Anas platyrhyncos*	Prairie, meadow wetlands	Western one-half	Statewide	Uncommon	No change-minor increase of migrant individuals
Wood duck *Aix sponsa*	Woodland, lakes, bottomland	Nationwide	Statewide - summer resident	Common	Moderate decrease
Goshawk *Accipiter gentilis*	Woodlands	Absent in southern one-fourth	Statewide	Uncommon migrant only	No change
Cooper's hawk *Accipiter cooperii*	Undetermined	Nationwide	Statewide	Common	Minor-moderate decrease
Red-tailed hawk *Buteo jamaicensis*	Woodlands near open areas	Nationwide	Statewide	Common	Minor-moderate decrease
Hairy woodpecker *Dendrocopos villosus*	Woodlands particularly dead timber	Nationwide	Statewide	Common	Possible minor increase
Great crested flycatcher *Myiarchus crinitus*	Woodlands	Eastern one-half	Absent in north-eastern one-fourth	Common	Moderate decrease
Eastern phoebe *Sayornis phoebe*	Near farm buildings and bridges	Nationwide	Statewide	Uncommon	Minor decrease
Least flycatcher *Empidonax minimus*	Shrub growth, margin woods, unsprayed orchards	Eastern two-thirds	Statewide	Common	Moderate decrease
Bark swallow *Riparia riparia*	River banks and gravel pits	Nationwide	Statewide	Very Common	Moderate decrease

BIRD INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Blue jay *Cyanocitta cristata*	Woodlands	Eastern two-thirds	Statewide	Common	Moderate decrease
Broad-winged hawk *Buteo platypteras*	Dry forests, woodlands	Texas and gulf coast to New Brunswick, Quebec	Statewide - summer resident	Common	Minor decrease
Marsh hawk *Circus cyaneus*	Grasslands, marsh	Nationwide	Statewide	Uncommon	Minor decrease
Sparrow hawk *Falco sparverius*	Open country	Nationwide	Statewide	Common	No change - minor decrease
Ruffed grouse *Bonasa umbellus*	Young, thinned forest	Northern North America	Statewide	Common	Moderate decrease
Greater prairie chicken *Tympanuchus cupido*	Prairie, open woodlands	Midwestern and western States, eastern Colorado to southern Illinois	Northwestern one-third	Uncommon	No change - minor decrease
Ring-necked pheasant *Phasianus colchicus*	Grassy areas	Northern North America	Statewide	Rare	No change - minor decrease
Marbled godwit *Limosa fedoa*	Prairie	North Dakota-South Dakota, western Minnesota	Western one-fourth, Red River Valley	Uncommon	No change - minor decrease
Mourning dove *Zenaidura macroura*	Unrestricted	Nationwide	Statewide	Common	Moderate - major decrease
Great horned owl *Bubo virginianus*	Heavy timber near lakes and streams	Nationwide	Statewide	Common	Moderate - major decrease

BIRD INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Barred owl *Strix varia*	Woodlands	Nationwide	Statewide	Common	Moderate - major
Belted kingfisher *Megaceryle alcyon*	Streams and ponds	Nationwide	Statewide	Common	Moderate decrease
Pileated woodpecker *Hylatomus pileatus*	Woodlands	Eastern one-half	Statewide	Uncommon	Minor increase
Gray partridge *Perdix perdix*	Marshy areas - near water	Northwestern one-fifth	Absent in north-eastern one-fourth	Uncommon	Minor decrease
Sandhill crane *Grus canadensis*	Prairies	Northwestern one-fourth	Statewide - summer resident	Migrant only	No change - minor decrease
Killdeer *Charadrius vociferus*	Fields, pastures far from water	Nationwide	Statewide	Common	No change
American woodcock *Philohela minor*	Moist woods, swamps, thickets	Eastern one-half	Absent in northern one-fifth	Rare	No change
Upland plover *Bartramia longicauda*	Local and uncommon in grass	Eastern two-thirds	Statewide	Uncommon	No change
Spotted sandpiper *Actitus macularia*	Prairies	South to Oklahoma - south Indiana and Virginia	Western one-fourth	Common	No change - minor decrease
Red eyed vireo *Vireo olivaceus*	Woodlands	Absent in southwestern one-fourth	Statewide	Very common	Moderate - major decrease
Warbling vireo *Vireo gilvas*	Woodlands	Nationwide	Statewide	Common	Moderate - major decrease

BIRD INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Population	Project Impacts
Yellow warbler *Dendroica petechia*	Woodlands	Northern U.S.	Statewide	Common	Moderate - major decrease
Ovenbird *Seiurus aurocapillus*	Woodlands	Eastern one-half	Statewide	Common	Moderate - major decrease
American redstart *Setophaga ruticilla*	Woodlands	Absent in Pacific coast	Statewide	Very common	Moderate - major decrease
Western meadowlark *Sturnella neglecta*	Unrestricted	Western one-half	Statewide	Uncommon	Minor decrease
Red-winged blackbird *Agelaius phoeniceus*	Marshes, fields	Nationwide	Statewide	Common	Possible increase
Baltimore oriole *Icterus galbula*	Tall elms, shade trees	Eastern one-half	Statewide	Common	Moderate decrease
Rose-breasted grosbeak *Pheucticus ludovicianus*	Woodlands, old orchards	Eastern one-half	Statewide	Common	Moderate decrease
Baird's sparrow *Ammodramus bairdii*	Prairies and plains	Central States only	Western one-fourth	Rare	No change - minor decrease
Common crow *Corvus brachyrhynchos*	Absent in arid regions	Nationwide	Statewide	Common	Moderate decrease
Black-capped chickadee *Parus atricapillus*	Woodlands	Northern one-half	Statewide	Very common	Moderate decrease
Black-billed magpie *Pica pica*	Open country, near brush or trees	Western one-half	Absent in north-eastern one-third	Rare	No change

BIRD INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Population	Project Impacts
White-breasted nuthatch *Sitta carolinensis*	Woodlands	Nationwide	Absent in northeastern one-fifth	Common	Moderate decrease
House wren *Troglodytes aedon*	Shrubbery and brush	Nationwide	Statewide	Common	Moderate decrease
Veery *Hylocichla fuscenscens*	Woodlands, wet habitats	Absent in Pacific coast	Statewide during migration	Common	Moderate decrease
Sprague's pippit *Anthus spraguei*	Tall grass, northern plains	Central U.S. only, Canada-Mexico	Absent in eastern one-third	Rare	No change
Yellow-throated vireo *Vireo flavifrons*	Woodlands near water or clearings	Eastern one-half	Absent in northeastern one-fifth	Uncommon	Minor decrease

APPENDIX G

AMPHIBIANS AND REPTILES FOUND IN THE WILD RICE WATERSHED

AMPHIBIAN AND REPTILE INVENTORY TABLE

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impact
Tiger salamander *Ambystoma tigrinum*	Wide range of habitats that have breeding pools	Central U.S. to Gulf and eastern seaboard to New Jersey	Absent in northeast one-fourth	Common	No change - minor increase
American toad *Bufo americanus*	Anywhere breeding pools are available	Eastern and mid-western U.S.	Statewide	Common	Decrease
Plains toad *Bufo cognatas*	Grasslands	Midwestern plains states and southwest	Western one-half	Common	Decrease
Manitoba toad *Bufo hemiophrys*	Pools, lakeside streams	Northwest Minnesota and northern North Dakota and Montana only	Northwestern one-fourth	Common	Decrease
Chorus frog *Pseudacris nigrita*	Wet meadows, moist woodlands	Absent in west and southwest only	Statewide	Very Common	Decrease
Common tree frog *Hyla versicolor*	Arboreal near or on shallow bodies of water	Eastern and mid-western U.S. to Gulf	Absent in far north and south-west only	Uncommon	Minor decrease
Leopard frog *Rana pipiens*	Near water	Absent in west only	Statewide	Common	Moderate decrease
Wood frog *Rana sylvatica*	Moist woodlands	North Dakota and Maine to Georgia	Absent in south-western one-half	Very Common	Decrease
Snapping turtle *Chelydra serpentina*	Fresh water	Absent in western one-third	Statewide	Uncommon	No change - Minor decrease
Painted turtle *Chrysemys picta*	Ponds, sloughs, shallow lakes	Michigan to New York to Alabama	Statewide	Uncommon	Minor moderate decrease
Black-banded skink *Eumeces septentrionalis*	Sandy soils, low forests, scrub oak	Central U.S. only, Minnesota south to eastern Texas	Absent in north-eastern one-third	Common	Decrease

AMPHIBIAN AND REPTILE INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impact
Western hog-nosed snake *Heterodon nasicus*	Dry, sandy prairies	Midwestern and western states	Western one-third	Uncommon	Minor decrease
Red bellied snake *Storeria occipitomaculata*	Open woods	Eastern one-half of U.S.	Statewide	Common	Moderate decrease
Plains garter snake *Thamnophis radix*	River valley prairie ponds	Wisconsin, south to Missouri and Indiana	Statewide	Common	Moderate decrease
Common garter snake *Thamnophis sirtalis*	Wide variety of moist habitat	Minnesota to Maine, Texas to [illegible]	[illegible]	Common	Moderate [illegible]
Smooth green snake *[illegible]*	Moist, grassy sections of prairie	North Dakota to [illegible] to Kansas [illegible] west	Absent in northeastern [illegible]	Uncommon	No change - Minor decrease

AMPHIBIAN AND REPTILE INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impact
Western hog-nosed snake *Heterodon nasicus*	Dry, sandy prairies	Midwestern and western states	Western one-third	Uncommon	Minor decrease
Red bellied snake *[illegible]*	Open woods	Eastern one-half of U.S.	Statewide	Common	Moderate decrease
Plains garter snake *[illegible]*	River valleys prairie ponds	Wisconsin, south to Missouri and Indiana	Statewide	Common	Moderate decrease
Common garter snake *[illegible]*	Wide variety of moist habitat	Minnesota to Maine Texas to [illegible]	Western [illegible]	Common	Moderate [illegible]
Smooth green snake *[illegible]*	Moist, grassy sections of prairie	North Dakota to [illegible] to Kansas, [illegible] west	Absent in northeastern [illegible]	Uncommon	No change Minor [illegible]

APPENDIX H

CHECK LIST OF FISHES SEINED OR OBSERVED IN THE WILD RICE RIVER AND ITS TRIBUTARIES

FISH INVENTORY TABLE

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Chestnut lamprey *Ichthyomyzon castaneus*	Large rivers and streams and some lakes of Minnesota and neighboring States	Upper Mississippi Valley Great Lakes and Hudson Bay	Lake Pepin	Uncommon	No change
Northern pike *Esox lucius*	Cool, clear water	Northern parts	Statewide	Common-Very common	Moderate increase
Central mudminnow *Umbra limi*	Muddy streams and pools with aquatic vegetation	Minnesota thru Great Lakes south to Kansas and Tennessee	Statewide	Uncommon	None - minor increa
White sucker *Catostomus commrysoni*	Low water quality, silty, soft mud bottoms	Eastern two-thirds	Statewide	Common-Very common	Minor - moderate increase
Quillback carpsucker *Carpiodes cyprinus*	Streams, lakes and rivers	Lake of the Woods, all Great Lakes (except Superior), south to Alabama and Texas	Statewide	Uncommon	None - minor increa.
Fathead minnow *Pimephales promelas*	Streams	Eastern Nebraska and South Dakota thru Ohio into Pennsylvania and south to Alabama, Oklahoma, and Texas	Statewide	Common-Very common	Minor increase
Brook stickleback *Culaea inconstans*	Spring-fed brooks	Kansas to Maine and northward to Canada	Statewide	Uncommon-Very common	Minor
Northern redhorse *Moxostoma macrolepidotum*	Clear, vegetated waters	Central North America and eastern United States	Statewide	Common	Minor - moderate increase
Silver redhorse Moxostoma anisurum	Clear, vegetated waters	Canada south to northern Alabama and to Missouri	Statewide	Common	Minor - moderate increase
Carp Cyprinus carpio	Eutrophic waters	Introduced, all areas	Statewide	Uncommon	Moderate increase
Northern redbelly dace *Chrosomus phoxinus eos*	Non-acid streams	Canada south to Colorado, Nebraska, Minnesota and east to New Jersey	Statewide	Uncommon-Common	Minor - moderate increase

FISH INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Hornyhead chub *Hybopsis biguttata*	Streams	North Dakota east and south to Oklahoma and Ohio River drainage	Statewide	Uncommon-Very common	No change - minor decrease
Common shiner *Notropis cornutus*	Streams and lakes	Canada south to Colorado, Nebraska and Iowa	Statewide	Uncommon-Very common	No change - minor increase
Sand shiner *Notropis stramineus*	Streams	Minnesota south to Iowa and Ohio Valley	Statewide-though most common in northern parts	Uncommon-Common	No change - minor decrease
Blacknose dace *Rhinichthyes atratalus*	Clear brooks	Lake of the Woods to Ohio, south to Iowa and Nebraska	Northern and eastern parts	Common-Very common	No change - minor decrease
Longnose dace *Rhinichthyes cataractae*	Small streams and lakes	Canada south to North Carolina, Iowa and Oregon	Northern and eastern parts	Uncommon-Very common	No change - minor increase
Creek chub *Semotilus atromaculatus*	Small rivers and large creeks	Montana south to Gulf States	Central and southern parts	Common-Very common	No change - minor decrease
Pearl dace *Semotilus margarita*	Bog streams	Rocky Mountains, Minnesota, Wisconsin, eastward to Maine	Absent in northeastern and southern parts	Common	No change - minor decrease
Black bullhead Ictalurus melas	Lakes and sluggish rivers	North Dakota and upper St.Lawrence tributaries south and west to Texas and northern Mexico	Statewide	Uncommon	Minor - moderate increase
Stonecat *Noturus flavus*	Under stones and logs in swift water	East of Rocky Mountains	Statewide	Observed	Minor decrease
Tadpole madtom *Noturus gyrinus*	Still, muddy water and vegetation and debris	North Dakota to New York, south to Texas and Florida	Upper Mississippi and Red River drainages	Uncommon	Minor - moderate increase
Blackchin shiner *Notropis heterodon*	Lakes	Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio and New York	Statewide	Uncommon	Moderate increase

FISH INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Bigmouth shiner *Notropis dorsalis*	Sandy streams	Wyoming, North Dakota east to New York and Pennsylvania	Central and southern parts	Uncommon-Very common	Moderate decrease
Rosyface shiner *Notropis rubellus*	Streams and lakes	North Dakota south to Virginia, Ohio Valley and Missouri	Statewide	Uncommon	No change - minor increase
Brassy minnow Hybognathus hankinsoni	Streams			Uncommon	Minor increase
Trout perch *Percopsis omiscomaycus*	Clear, deep lakes, large streams	Northern states of Kansas, Missouri, Kentucky and Virginia	Statewide	Uncommon-Common	Minor-Moderate increase
Rockbass *Ambloplites rupestris*	Lakes, clear streams	Dakotas south to North Carolina and northern Arkansas	Statewide	Common	Minor-Moderate increase
Bluegill *Lepomis macrochirus*	Lakes, streams	North Dakota south to Gulf States	Statewide - except Lake Superior drainage	Uncommon	Minor-Moderate increase
Pumpkinseed Lepomis gibbosus	Lakes, slow rivers	Southern Canada south to Florida & Gulf States	Statewide	Uncommon	Minor - Moderate increase
Iowa darter *Etheostoma exile*	Weedy margins of lakes and streams	Canada south to Colorado, Iowa, Indiana, Illinois and Ohio	Northern lake region	Uncommon-Common	Minor-Moderate increase
Johnny darter *Etheostoma nigrum*	Lakes, streams	West of Alleghenies to Oklahoma	Statewide	Uncommon-Very common	Minor-Moderate increase
Yellow perch *Perca flavescens*	Cool water, clear water with low oxygen	Eastern North America	Statewide	Uncommon-Common	Minor-Moderate increase
Blackside darter *Percina maculata*	Streams	New York south to Oklahoma and Alabama	Northwestern and southern parts	Uncommon	Minor decrease

FISH INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Walleye *Stizostedion vitreum*	Warm, clear water	Northern North America	Statewide	Observed	Minor-Moderate increase
Freshwater drum *Aplodinotus grunniens*	Bottom dwellers in muddy waters	Mississippi and Great Lakes drainage	Red River drainage and southern parts	Uncommon	No change - minor increase

APPENDIX I

INVERTEBRATES FOUND IN THE WILD RICE WATERSHED

INVERTEBRATE INVENTORY TABLE

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Leech *Placobdella rugosa*	Streams, lakes	Nationwide	Statewide	Common	Major increase
Leech *Erpobdella punctata*	Streams, lakes	Nationwide	Statewide	Common	Major increase
Crayfish *Orconectes virilis*	Streams, lakes	Nationwide	Statewide	Very Common	Major increase
Mayfly *Baetis vagans*	Freshwater, rapid flowing streams	Nationwide	Statewide	Very Common	Major increase
Mayfly *B. brunneicolor*	Freshwater, rapid flowing streams	Nationwide	Statewide	Very Common	Major increase
Mayfly *Pseudocleon anoka*	Freshwater, submerged vegetation	Nationwide	Statewide	Common	Major increase
Mayfly *Pseudocleon parvulum*	Freshwater, submerged vegetation	Nationwide	Statewide	Very Common	Major increase
Mayfly *P. dubium*	Freshwater, submerged vegetation	Nationwide	Statewide	Very Common	Major increase
Mayfly *P. punctiventris*	Submerged vegetation	Nationwide	Statewide	Very Common	Major increase
Mayfly *Ephemera simulans*	Burrower in mud	Nationwide	Statewide	Uncommon	Major increase
Midge *Hexagenia limbata*	Freshwater, bottom dweller	Nationwide	Statewide	Very Common	Major increase

INVERTEBRATE INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Stonefly *Acroneuria abnormis*	Running freshwater, masses of debris	Nationwide	Statewide	Uncommon	Increase
Stonefly *Acroneuria lycorias*	Running freshwater, nasses of debris	Nationwide	Statewide	Common	Increase
Giant waterbug *Lethocerus americanus*	Lakes and streams	Nationwide	Statewide	Uncommon	Increase
Water boatman *Hesperocorixa atopodonta*	Shallows of ponds, lakes, streams	Nationwide	Statewide	Common	Increase
Water strider *Gerris remigis*	Edges of ponds, floating vegetation	Nationwide	Statewide	Common	Increase
Backswimmers *Notonecto undulata*	Ponds and lakes	Nationwide	Statewide	Uncommon	Increase
Alder fly *Sialis sp.*	Edges of ponds and lakes	Nationwide	Statewide	Common	Increase
Caddis fly *Hydropsyche bifida*	Lakes, streams	Nationwide	Statewide	Very common	Increase
Caddis fly *Hydropsyche slossonae*	Lakes, streams	Nationwide	Statewide	Very common	Increase
Crane fly *Hexatoma sp.*	Debris at bottom of ponds, lakes	Nationwide	Statewide	Common	Increase
Crane fly *Tipula sp.*	Debris at bottom of ponds, lakes	Nationwide	Statewide	Common	Increase
Fingernail clam *Sphaerium sulcatum*	Shallow water high in carbonates	Nationwide	Statewide	Very common	Increase

INVERTEBRATE INVENTORY TABLE (cont)

Common Name	Habitat	Range in U.S.	Range in State	Notes on Local Populations	Project Impacts
Midge *Chironomus sp.*	Aquatic vegetation, bottoms of all types of freshwater	Nationwide	Statewide	Common	Increase
House and deer fly *Chrysops sp.*	Shallow ponds, slow brooks and streams	Nationwide	Statewide	Uncommon	Increase
Fingernail clam *Pisidium*	Shallow water high in carbonates	Nationwide	Statewide	Common	Increase
Wabash pig toe clam *Fusconaia flava*	Shallow water high in carbonates	Nationwide	Statewide	Common	Increase
Three ridge clam *Amblema costata*	Shallow water high in carbonates	Nationwide	Statewide	Uncommon	Increase
Fat mucket *Lampsilis siliquoidea*	Shallow water of rivers and lakes, soft substrates	Nationwide	Statewide	Common	Increase
Pocketbook *Lampsilis ventricosa*	Shallow water of rivers and lakes, soft substrates	Nationwide	Statewide	Uncommon	Increase
Riffle beetles *Optioservus fastiditus*	Rocky, gravel bottoms, swift streams	Nationwide	Statewide	Common	Increase

APPENDIX J

ARCHAEOLOGICAL INFORMATION

United States Department of the Interior
NATIONAL PARK SERVICE
Midwest Archeological Center
2605 North 27th Street
Lincoln, Nebraska 68504

IN REPLY REFER TO:
H2219

April 24, 1974

Mr. Henry J. Langer
Chief, Recreational Planning Section
Corps of Engineers, St. Paul District
1210 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Mr. Langer:

This is in response to your April 23 telephone conversation with Mr. Thomas Thiessen of this office, regarding National Park Service involvement in archeological investigations in the area of the proposed Twin Valley reservoir, Minnesota.

The Service has sponsored no archeological investigations within the proposed reservoir area. Funds in the amount of $8,000 were programmed for Fiscal Year 1973 to provide for salvage excavation in the project area. This project was subsequently deleted from the FY 73 program at the recommendation of the State Archaeologist, Dr. Elden Johnson, who indicated in a letter of November 29, 1972 that a previous survey of the project area had not revealed the presence of cultural remains. However, Dr. Johnson expressed concern that a mound and associated occupational site situated below the proposed dam on gravel deposits of the Campbell Beach of glacial Lake Agassiz may be destroyed by borrow operations associated with construction activities. I would suggest that you contact Dr. Johnson directly for further details about the survey and the potentially endangered archeological sites below the proposed damsite.

As you know, funding levels and policy preclude our funding archeological survey investigations for environmental inventory purposes. However, we would advise further communication on this project if adverse impact to any archeological remains is defined in the future, so that we may program funds for salvage excavations to assist in the necessary mitigation.

I appreciate your continuing cooperation.

Sincerely,

Carl R. Falk
Chief

MINNESOTA HISTORICAL SOCIETY
690 Cedar Street, St. Paul, Minnesota 55101 221-6126

22 August 1972

Mr. Roger G. Fast
Chief, Engineering Division
Department of the Army
St. Paul District Corps of Engineers
1210 U. S. Post Office and Custom House
St. Paul, Minnesota 55101

RE: NCSED-PB
Wild Rice River Dam and Reservoir
Twin Valley, Minnesota (Norman and Clay Counties)

Dear Mr. Fast:

Your proposal for construction of a dam and reservoir on the Wild Rice River near Twin Valley, Minnesota has been reviewed by the Historic Sites Department of the Minnesota Historical Society. This review has taken into consideration all existing and potential sites of both historical and archaeological nature in this area.

Historic Sites: Only one site of historical significance is known to exist within the project area. This is the Faith Mill begun in the early 1870's and reconstructed after a fire in 1893. This mill is the last of three such mills once located in Norman County. It is the opinion of this department that serious consideration be given to possible adverse effects on this mill by this dam and reservoir project.

Archaeological Sites: Only two archaeological sites have been recorded within the vicinity of the proposed projects.

It appears that both these presently recorded sites would escape disturbance by the projects outlined in your correspondence of 9 August 1972. These two sites, however, represent only a fraction of the total evidence of human occupation in the area of these water courses in the last 10,000 years. Therefore it would be necessary to conduct a survey of the affected areas in an attempt to locate new archaeological sites before construction work begins.

The segment of the Wild Rice River which will become the reservoir is, of course, of prime concern. The possibility exists, however, that channelization of the South Branch of the Wild Rice River and Felton Ditch could also destroy archaeological sites along their banks. Therefore, the segments of these water courses affected by the projects should also be included in the archaeological survey.

The Archaeology Department at the Minnesota Historical Society could conduct the field survey and prepare the data for your office. The Twin Valley Reservoir area itself could be surveyed by two MHS staff archaeologists in eight working days at a cost of approximately $770. A survey of the lower fourteen miles of the South Branch of the Wild Rice River and the lower seventeen miles of Felton Ditch could be concluded by a crew of two in eighteen working days at an approximate cost of $2,200.

Any salvage proposals would necessarily rely on the data gathered during the survey and therefore can not be drafted at this time.

At such time as more information is available to us concerning the exact scope of your projects, time available, etc., a more exact detailed budget could be prepared.

It is hoped that the above information will facilitate preparation of the Environmental Impact Statement for this project.

Respectfully,

Russell W. Fridley
Director
Minnesota Historical Society
State Liaison Officer
National Park Service

RWF/clm

United States Department of the Interior

NATIONAL PARK SERVICE
MIDWEST REGION
1709 JACKSON STREET
OMAHA, NEBRASKA 68102

IN REPLY REFER TO:

L7423 MWR CL

[illegible] 1 1975

Colonel Max W. Noah
District Engineer
St. Paul District, Corps of Engineers
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

Reference your letter of December 6, 1974, pertaining to your study to provide flood control on the Wild Rice River, Minnesota. We apologize for the late reply, however, your announcement was only received in this office recently.

No registered natural landmarks are located within the project area, however, three potential natural landmarks are located within the study area. Brief descriptions are attached. They are Hellickson Prairie Tract, Waubun Prairie (Waubun Marsh), and Marshall Bog.

Evaluations of Waubun Prairie and Hellickson Prairie have been made and recommended by the evaluator, however, no action has been taken as yet by the Secretary of the Interior.

The National Park Service Midwest Archeological Center has no records of any archeological sites in the immediate area of the proposed action. Our only comment is that in the event archeological remains are revealed by construction activities, operations should be suspended and immediate notification provided to Dr. Elden Johnson, State Archeologist, Department of Anthropology, University of Minnesota, Minneapolis, Minnesota 55455.

The State Historic Preservation Officer for Minnesota, Mr. Russell W. Fridley, Director, Minnesota Historical Society, 690 Cedar Street, St. Paul, Minnesota 55101, should be contacted for information on other properties eligible for or already entered on the National Register of Historic Places.

Sincerely yours,

Merrill D. Beal
Acting Regional Director

Enclosures

APPENDIX K

IMPACTS AND EFFECTS OF ALTERNATIVE WATER MANAGEMENT

PLANS ON PRINCIPAL PLANNING ACCOUNTS,

WILD RICE RIVER BASIN, MINNESOTA

Table K-1 - Impacts and effects of alternative water management plans on principal planning accounts, Wild Rice River basin, Minnesota

		Nonstructural						Structural								
		Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6	Plan 7	Plan 8	Plan 9	Plan 10	Plan 11	Plan 12	Plan 13	Plan 14	Plan 15
Water resources planning accounts	No action	Flood warning and emergency protection	Permanent flood-plain evacu-ation	Flood proofing	Flood insur-ance	Flood-plain regu-lation	Combination of floodplain evacuation, flood proofing and floodplain regulation	Channel modifi-cations on Wild Rice River	Channel modifi-cations on Marsh River	Levee-floodway system	18-mile diver-sion channel	Twin Valley Lake	Series of eight small reser-voirs	Twin Valley Lake plus series of small reser-voirs	Twin Valley Lake plus channel modifi-cations	[illegible] Valley [illegible]
I. National Economic Development[1]																
A. Total first cost ($million)[2]	0	?	57	13	-	0.1	14	9.8	6.0	12.6	8.9	[illegible]	11.9	27.0	24.[illegible]	14.[illegible]
1. Federal first cost ($million)	0	?	46	10.4	-	0.06	11.2	9.1	5.6	9.9	5.5	[illegible]	9.6	24.5	[illegible]	14.[illegible]
2. Non-Federal first cost ($million)	0	?	11	2.6	-	0.04	2.8	0.7	0.4	2.7	3.4	0.2	2.3	2.5	[illegible]	
B. Total annual OM&R costs ($1,000)	0	?	0	33	300 to 1,750	20	53	95	65	80	70	56	58	[illegible]	[illegible]	[illegible]
1. Federal annual OM&R cost ($1,000)	0	?	0	0	100 to 1,125	0	0	0	0	0	0	45	58	103	[illegible]	[illegible]
2. Non-Federal OM&R cost ($1,000)	0	?	0	33	200 to 625	20	53	95	65	80	70	11	0	11	[illegible]	
C. Total average annual cost ($1,000)[3]	0	?	3,380	819	300 to 1,750	50	900	724	450	888	641	[illegible]	821	1,840	1,742	[illegible]
D. Total average annual benefits ($1,000)	0	55	410	240	0	90	345	550	330	470	355		440	1,045	1,285	[illegible]
1. Average annual flood control benefits ($1,000)	0	55	410	240	0	90	345	550	330	470	355	[illegible]	440	945	[illegible]	[illegible]
a. Urban flood control benefits ($1,000)	0	44	270	130	0	50	190	90	50	105	30	[illegible]	165	425	[illegible]	[illegible]
b. Agricultural flood control benefits ($1,000)	0	11	140	110	0	40	155	435	270	345	315	[illegible]	265	[illegible]	[illegible]	[illegible]
c. Transportation flood control benefits ($1,000)	0	0	0	0	0	0	0	25	10	20	10		10	25	[illegible]	[illegible]
2. Average annual recreation benefits ($1,000)	0	0	0	0	0	0	0	0	0	0	0	100	0	100	100	
E. Net average annual benefits ($1,000)[4]	0	?	-2,970	-579	0	+40	-555	-174	-120	-618	-286	[illegible]	-381	-795	-457	-117
F. Remaining average annual flood damages ($1,000)[5]	1,082	1,027	672	842	1,082	992	737	532	752	612	727	[illegible]	782	372	110	427
G. Benefit-cost ratio	-	-	0.1	0.3	-	1.8	0.4	0.8	0.7	0.5	0.5	[illegible]	0.5	0.6	0.[illegible]	[illegible]
II. Environmental Quality[1]																
A. Woodland lost or gained (± acres)																
1. Upland	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	-25	-25	
2. Lowland	0	0	0	0	0	0	0	-595	-320	-100	-20	[illegible]	-390	-880	-1,195	[illegible]
3. Windbreak	0	0	-760	0	0	0	0	0	0	0	0	0	0	0	0	0
B. Wetlands lost or gained (± acres)																
1. Meadow or marsh	0	0	0	0	0	0	0	0	0	0	0	-40	-120	-160	-40	0
2. Conifer bog	0	0	0	0	0	0	0	0	0	0	0	0	-10	-10	0	0
C. Lake area lost or gained (± acres)																
1. Fish	0	0	0	0	0	0	0	0	0	0	0	+555	+790	+1,345	+555	0
2. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Streams affected																
1. Existing unchannelized																
a. Linear miles of stream	0	0	0	0	0	0	0	20	12	13	0	14	46	60	34	14
b. Low-flow water surface area (± acres)	0	0	0	0	0	0	0	-95	-50	0	0	-40	-20	-60	-135	-1
c. Secondary channel and bank area (± acres)[6]	0	0	0	0	0	0	0	-60	-70	+255	0	+50	+120	+170	-10	-1
2. Existing channelized																
a. Linear miles of stream	0	0	0	0	0	0	0	15	3	15	2	0	0	0	15	[illegible]
b. Low-flow water surface area (± acres)	0	0	0	0	0	0	0	+95	+25	0	0	0	0	0	+95	[illegible]
c. Secondary channel and bank area (± acres)[6]	0	0	0	0	0	0	0	+745	+370	0	+30	0	0	0	+745	[illegible]

Table K-1 - Impacts and effects of alternative water management plans on principal planning accounts, Wild Rice River basin, Minnesota (cont)

Water [illegible] planning [illegible]	No action	Nonstructural: Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6	Structural: Plan 7	Plan 8	Plan 9	Plan 10	Plan 11	Plan 12	Plan 13	Plan 14	Plan 15
		Flood warning and emergency protection	Permanent floodplain evacuation	Flood proofing	Flood insurance	Floodplain regulation	Combination of floodplain evacuation, flood proofing and floodplain regulation	Channel modifications on Wild Rice River	Channel modifications on Marsh River	Levee-floodway system	18-mile diversion channel	Twin Valley Lake	Series of eight small reservoirs	Twin Valley Lake plus series of small reservoir	Twin Valley Lake plus channel modifications	Twin Valley dry dam
II. Environmental Quality[1] (cont)																
D. Stream affected (cont)																
3. Drainage ditches																
a. Linear miles of ditch	0		0	0	0	0	0	0	10	[illegible]	16	0	0	0	0	0
b. [illegible] water surface [illegible] (acres)	[illegible]	[illegible]	0	[illegible]	[illegible]	0	0	0	+30	0	0	[illegible]	[illegible]	0	0	0
[illegible] secondary channel [illegible] (acres)						[illegible]	0	0	+150	0	+535	[illegible]	0	0	0	0
[illegible] drainage [illegible] and [illegible]			[illegible]			[illegible]	[illegible]	0	[illegible]	0	0	[illegible]	0	0	0	0
[illegible] water [illegible]	Same	Same	Temporary reduction	Same	Same	Same	Same	Temporary reduction	Temporary reduction	Temporary reduction	Temporary reduction	Temporary reduction	Temporary reduction	Temporary reduction	Temporary reduction	Temporary reduction
[illegible]	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Rare, endangered, threatened [illegible] affected	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Rare [illegible] habitat [illegible] affected	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
[illegible] areas affected	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Historical and archeological sites affected	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Effect on stream erosion	None	None	None	None	None	None	None	Minor	Minor	None	Minor	Moderate	Moderate	Moderate	Moderate	Moderate
Mineral resources affected	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
III. Social Well-being																
A. [illegible]																
1. Residences protected							[illegible]	[illegible]	220	220	220	570	175	610	610	570
2. Businesses protected			[illegible]				[illegible]	35	35	35	35	90	30	100	100	[illegible]
3. Farmsteads protected			[illegible]	[illegible]			38	120	120	120	120	305	100	325	325	305
4. Persons protected			[illegible]	[illegible]			[illegible]	1,400	1,400	1,400	1,400	3,000	900	3,150	3,150	3,000
5. Total flood damage reduction in Wild Rice and Marsh River watersheds (percent)	[illegible]		38	[illegible]		8	32	50	31	43	33	[illegible]	28	66	89	61
a. Urban		14	[illegible]	[illegible]		19	[illegible]	34	18	39	10	[illegible]	28	86	86	74
b. Agricultural	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	19	56	36	45	41	[illegible]	28	60	91	59
c. Transportation	0	[illegible]	[illegible]	0	0	0	0	49	15	39	26	[illegible]	18	41	77	36
6. Agricultural lands protected (acres) (1,000)	0	0	0	0	0	0	0	38	38	38	38	99	31	106	106	99
7. Flood protection provided for downstream areas along Red River of the North	None	None	None	None	None	None	None	None	None	None	None	Yes	Yes	Yes	Yes	Yes
B. Relocations required																
1. Farmsteads	0	0	380	0	0	0	0	0	0	30	0	4	9	13	4	3
2. Residences	0	0	715	0	0	0	40	0	0	5	0	0	5	5	0	0
3. Businesses	0	0	140	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Persons	0	0	3,700	0	0	0	140	0	0	130	0	15	55	70	15	15
5. Highways and roads (miles)	0	0	20	0	0	0	0	0	0	0.1	0	3	3	6	3	3
6. Utilities[9] (miles)	0	0	290	0	0	0	0	0	0	0	0	3	0	3	3	3

Table K-1 - Impacts and effects of alternative water management plans on principal planning accounts, Wild Rice River basin, Minnesota (cont)

Water resources planning accounts	No action	Nonstructural: Plan 1 Flood warning and emergency protection	Plan 2 Permanent flood-plain evacuation	Plan 3 Flood proofing	Plan 4 Flood insurance	Plan 5 Flood-plain regulation	Plan 6 Combination of floodplain evacuation, flood proofing and floodplain regulation	Structural: Plan 7 Channel modifications on Wild Rice River	Plan 8 Channel modifications on Marsh River	Plan 9 Levee-floodway system	Plan 10 18-mile diversion channel	Plan 11 Twin Valley Lake	Plan 12 Series of eight small reservoirs	Plan 13 Twin Valley Lake plus series of small reservoirs	Plan 14 Twin Valley Lake plus channel modifications	
III. Social Well-Being (cont)																
C. Lands required (acres)																
1. Cropland	[illegible]	0	0	0	[illegible]	[illegible]	0	90	135	1,81[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	
2. Pasture	0	0		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	20	[illegible]		[illegible]	[illegible]	[illegible]	
3. Natural habitat	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,290	335	2,680	[illegible]		1,78[illegible]	[illegible]	4,72[illegible]	
4. Park and open space	0	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	0	0		[illegible]				
5. Other lands(10)	[illegible]	[illegible]	0	[illegible]	[illegible]	0	0	Trace	145	120	80		[illegible]	[illegible]		
6. Total	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	0	1,380	815	4,63[illegible]		[illegible]	[illegible]	6,[illegible]	4,[illegible]	
D. Bridge modifications	0	[illegible]	[illegible]	[illegible]	0	[illegible]		[illegible]	7	7	[illegible]9		[illegible]	[illegible]		
E. Roads severed	[illegible]	0	[illegible]	0	0	[illegible]	0	0	0	[illegible]	[illegible]					
F. Socially important sites affected(11)	0	0	Several	0	0	0	0	0	0	0	[illegible]	[illegible]				
G. Aesthetic change	None	None	Major	[illegible]	None	Minor	Minor	Moderate	Moderate	Minor	Minor	[illegible]	[illegible]	[illegible]	[illegible]	
H. Effect on community patterns	None	None	Major	Minor	None	None	Minor	Minor	Minor	Moderate	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
I. Improvement of public health and safety	None	Minor	Major	Minor	None	Minor	Minor	Moderate	Moderate	Moderate	Moderate	Major	Moderate	[illegible]	[illegible]	
J. Increased potential for usable water supply	None	None	None	None	None	None	None	None	None	None	None	Major	Major	[illegible]	[illegible]	
K. Recreation opportunities affected																
1. Hunting	No change	No change	No change	No change	No change	No change	No change	Minor decrease	Minor decrease	No change	No change	Moderate decrease	Moderate decrease	Moderate decrease	Moderate decrease	
2. Fishing	No change	No change	No change	No change	No change	No change	No change	Minor decrease	Minor decrease	No change	No change	Major increase	Minor increase	Major increase	Major increase	
3. Boating	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	Major increase	No change	Major increase	Major increase	
4. Camping	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	Major increase	Minor increase	Major increase	Major increase	
5. Canoeing	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	Minor increase	No change	Minor increase	Minor increase	
6. Hiking and biking trails	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	Moderate increase	Moderate increase	Moderate increase	Moderate increase	
7. Picnicking	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change	Major increase	Minor increase	Major increase	Major increase	
IV. Regional Economic Development																
A. Loss in area tax base	None	None	None	None	None	None	None	Slight	Slight	Minor	Minor	Minor	Minor	Minor	Minor	[illegible]
B. Area redevelopment benefits	None	None	Yes	Yes	None	None	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	[illegible]
C. Increased recreation expenditures	No	No	No	No	No	No	No	No	No	No	No	Yes	No	Yes	Yes	[illegible]
D. Increased expenditures by construction workers	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E. Effect on regional economic growth	No change	No change	Decrease	Slight decrease	Slight increase	Slight decrease	Slight decrease	Increase	Increase	Increase	Increase	Increase	Increase	Increase	Increase	Increase

(1) Principal planning objective used in the evaluation of Water Resources projects to assure promotion of the quality of life as reflected by society's preferences.
(2) Based on January 1974 price levels.
(3) Includes annual OM&R costs plus interest and amortization charges based on a 100-year economic life and a 5 7/8 percent interest rate.
(4) Total average annual benefits minus total average annual cost.
(5) In the Wild Rice and Marsh River watershed.
(6) Does not include lowland woods and brush area.
(7) Includes county drains.
(8) Flood protection refers to reduction of threat to safety and well-being of individuals due to floods; does not imply complete flood protection from intermediate regional flood; does not include protection to downstream areas along the Red River of the North.
(9) Includes water, sewer, electric, and telephone lines.
(10) Includes urban area, farmsteads, roads, highways, railroads, windbreaks, existing drainage ditches, etc.
(11) Includes cultural sites, cemeteries, developed parks, town halls, etc.

APPENDIX L

PERTINENT DATA

FOR PROJECT AT

AUTHORIZED DAMSITE

PERTINENT DATA

FOR PROJECT AT

AUTHORIZED DAMSITE

Project document: House Document No. 366, 90th Congress, 2d session.

Project authorization: Flood Control Act of 31 December 1970 (Public Law 91-611).

Project purpose: Flood control, recreation, and fish and wildlife.

TWIN VALLEY LAKE

General

Location	Wild Rice River near Twin Valley, Minn.
Total drainage area	888 square miles
Contributing drainage area	888 square miles

Reservoir

	Storage (ac-ft)	Elevation (ft)	Surface area (acres)
Storage for recreation, conservation, and silt retention	7,500	1056.0	555
Flood control storage	44,700	1097.0	1,720
Total storage	52,200		

Dam

Type	Rolled earth
Elevation, top of dam	1107.0
Length	4,280 feet
Height	91 feet
Side slopes	
Downstream face	1V on 3H
Upstream face	1V on 4.5H
Freeboard	5 feet
Fill volume	1.18 million cubic yards

Spillway

Type	Concrete chute with tainter gates
Number of gates	Three
Size of gates	40 feet by 19 feet
Elevation of crest	1079.0
Length of crest	120 feet
Stilling basin	
Width	144 feet
Length	118 feet
Spillway design flood (maximum inflow)	53,900 cfs
Spillway design flood (maximum outflow)	53,900 cfs
Reservoir design flood (maximum inflow)	7,000 cfs
Reservoir design flood (maximum outflow)	1,700 cfs

Low-flow outlet works

Type	Gated rectangular conduit through spillway gate pier
Number	Two
Size	3 feet wide by 14 feet high
Length	80 feet

Low-flow conduit

Invert elevation	1030.0
Discharge capacity at conservation pool level	1,700 cfs

PROJECT ECONOMICS

First cost:

Federal	$14,929,000
Non-Federal	152,000
Total first cost	15,081,000

Average annual costs: (based on a 100-year economic life and 5 7/8-percent interest rate)

Federal	$1,016,500
Non-Federal	10,500
Total average annual costs	1,027,000

Average annual benefits:

Flood control	933,200
Recreation and fish and wildlife	99,200
Local employment	135,700
Total average annual benefits	1,168,100

Benefit-cost ratio: 1.14

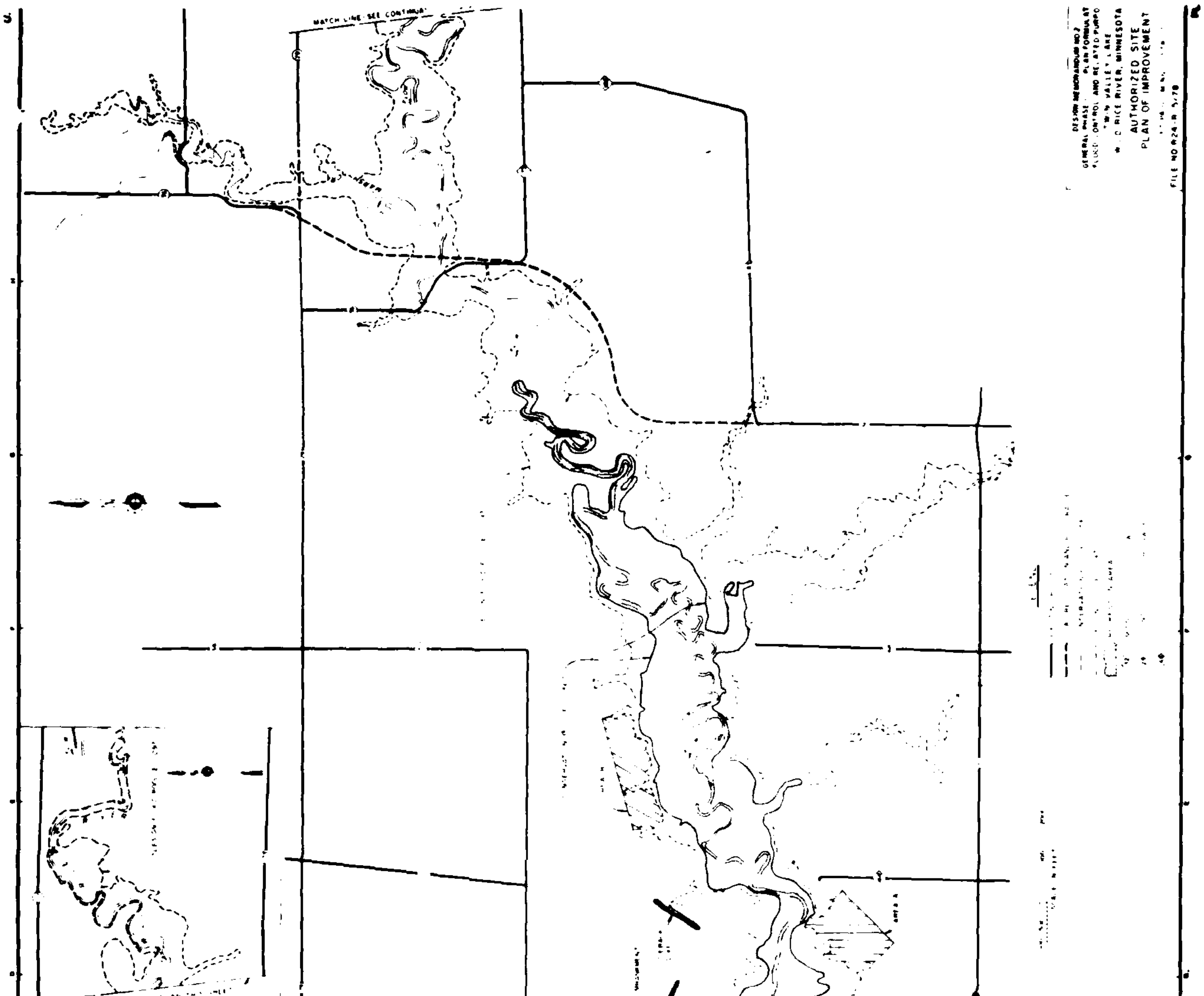

FIGURE L-1 AUTHORIZED SITE PROJECT MAP

APPENDIX M

COMPARISON OF TWIN VALLEY LAKE PROJECT DEVELOPED AT THE AUTHORIZED AND RECOMMENDED SITES

Planning objectives parameters	site	site
I. NATIONAL ECONOMIC DEVELOPMENT[2]		
A. Total first cost ($ million)[3]	15.1	13.3
1. Federal first cost ($ million)	14.9	13.1
2. Non-Federal first cost ($ million)	0.2	0.2
B. Total annual OM&R costs ($1,000)	56	56
1. Federal annual OM&R costs ($1,000)	45	45
2. Non-Federal annual OM&R costs ($1,000)	11	11
C. Total average annual cost ($1,000)[4]	1,027	912
D. Total average annual benefits ($1,000)	1,168	1,116
1. Average annual flood control benefits ($1,000)	933	933
a. Urban benefits ($1,000)	392	392
(1) Wild Rice and Marsh Rivers ($1,000)	212	212
(2) Red River of the North ($1,000)	180	180
b. Agricultural benefits ($1,000)	523	523
(1) Wild Rice and Marsh Rivers ($1,000)	472	472
(2) Red River of the North ($1,000)	51	51
c. Transportation benefits ($1,000)	18	18
2. Average annual recreation benefits ($1,000)	99	99
3. Average annual area redevelopment benefits ($1,000)	136	84
E. Net average annual benefits ($1,000)[5]	+141	+204
F. Remaining average annual flood damages ($1,000)[6]	379	379
G. Benefit-cost ratio	1.14	1.2[illegible]
II. ENVIRONMENTAL QUALITY[2]		
A. Woodland lost or gained (± acres)		
1. Upland	-25	[illegible]
2. Lowland	-490	-51[illegible]
3. Windbreak	0	
B. Wetlands lost or gained (± acres)		
1. Meadow or marsh	-40	[illegible]
2. Conifer bog	0	[illegible]
C. Lake area lost or gained (± acres)		
1. Fish	+555	+5[illegible]
2. Marginal	0	[illegible]
D. Streams affected		
1. Existing unchannelized		
a. Linear miles of stream	14	14
b. Low-flow water surface area (± acres)	-40	-4[illegible]
c. Secondary channel and bank area (± acres)[7]	+50	+50
E. Wildlife management area and refuges lost or gained (± acres)	Potential gain	Potential gain
F. Effect on water quality in river	Temporary reduction	Temporary reduction
G. Effect on air quality	None	None
H. Rare, endangered, or threatened animal species affected	None	None
I. Rare or unique vegetation systems affected	None	None
J. Scenic, recreation or wilderness areas affected	None	None
K. Historical and/or archeological sites affected	None known	None known
L. Mineral resources affected	None	None
III. SOCIAL WELL-BEING		
A. Flood protection[8]		
1. Residences protected	570	57[illegible]
2. Businesses protected	90	90
3. Farmsteads protected	305	305
4. Persons protected	3,000	3,[illegible]
5. Total flood damage reduction in Wild Rice and Marsh River watershed (percent)	66	66
a. Urban	79	79
b. Agricultural	62	62
c. Transportation	37	37
6. Agricultural lands protected (1,000 acres)	99	99
B. Relocations required		
1. Farmsteads	4	[illegible]
2. Residences	0	[illegible]
3. Businesses	0	0
4. Persons	10	10
5. Highways and roads (miles)	3	3
6. Utilities (miles)[9]	3	3
C. Lands required (acres)		
1. Cropland	365	400
2. Pasture	210	200
3. Natural habitat	2,435	2,820
4. Park and open space	0	0
5. Other lands[10]	70	80
6. Total	3,080	3,500
D. Bridge modifications	1	2
E. Socially important sites affected[11]	0	0
F. Aesthetic change	Major	Major
G. Effect on community patterns	Major	Major
H. Improvement of public health and safety	Major	Major
I. Increased potential for usable water supply	Major	Major
J. Recreation opportunities affected		
1. Hunting	Moderate decrease	Moderate decrease
2. Fishing	Major increase	Major increase
3. Boating	Major increase	Major increase
4. Camping	Major increase	Major increase
5. Canoeing	Minor increase	Minor increase
6. Hiking and biking trails	Moderate increase	Moderate increase
7. Picnicking	Major increase	Major increase
IV REGIONAL ECONOMIC DEVELOPMENT		
A. Loss in area tax base (percent)[12]	0.25	0.37
B. Increased recreation expenditures	Yes	Yes
C. Increased expenditures by construction	Yes	Yes
D. Effect on regional economic growth	Positive	Positive

(1) Based on controlled maximum reservoir release rate of 1,700 cfs.
(2) Principal planning objective used in evaluation of water resource projects to assure promotion of the quality of life as reflected by society's preferences.
(3) Based on January 1974 price levels.
(4) Includes annual OM&R costs plus interest and amortization charges based on a 100-year life and a 5 7/8 percent interest rate.
(5) Total average annual benefits minus total average annual cost.
(6) In the Wild Rice and Marsh River basins.
(7) Does not include lowland woods and brush areas.
(8) Flood protection refers to reduction of threat to safety and well-being of individuals due to floods; does not imply complete flood protection from intermediate regional flood; does not include protection to downstream areas.
(9) Includes water, sewer, electric power, and telephone lines.
(10) Includes urban areas, farmsteads, roads, highways, railroads, windbreaks, existing drainage ditches, etc.
(11) Includes cultural sites, cemeteries, developed parks, townhalls, etc.
(12) Based on percent of Norman County tax base.

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