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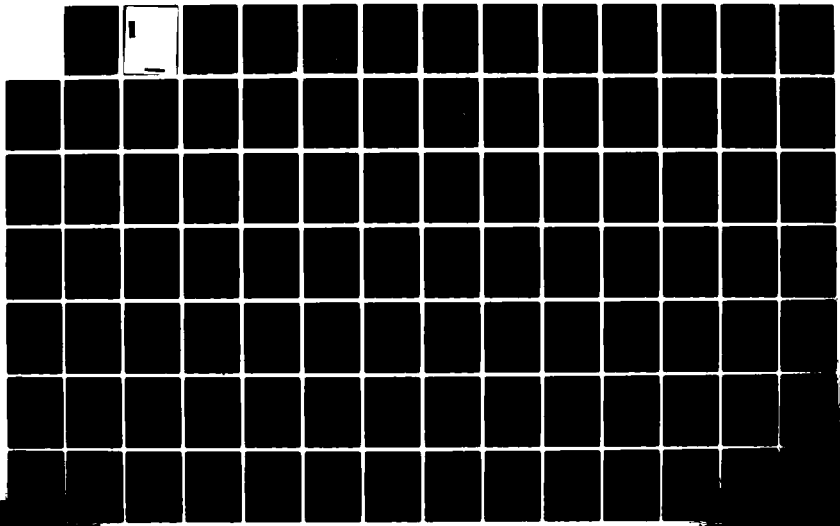

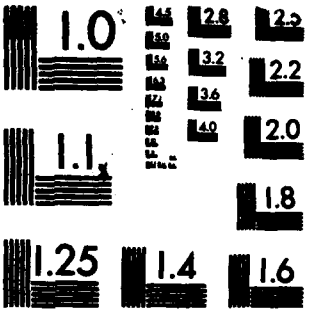

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin. The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and

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problems, to determine priorities for immediate and longrange action, and to identify the capabilities of various governmental units for implementing the actions.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

The Turtle River Subbasin is an irregularly shaped area about 50 miles in length and ranging in width from six miles at its western and to 28 miles at its eastern end. It is one of the smallest of the subbasin occupying only 613 square miles of Grand Forks, Nelson, and Walsh counties in the central North Dakota portion of the Red River Basin.

The Turtle River Subbasin is bordered on the east by the Main Stem Subbasin, on the north by the Forest River Subbasin, on the west by the Devils Lake and Sheyenne subbasins, and on the south by the Goose and Main Stem subbasins. Although water management districts have been formed in Grand Forks and Nelson counties, the subbasin itself does not have any legal status.

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Final Report

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I. THE STUDY AND REPORT

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North Study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin.

The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and problems, to determine priorities for immediate and long-range action, and to identify the capabilities of various governmental units for implementing the actions.

The Turtle River Subbasin is a water resource planning unit located in the central North Dakota portion of the Red River Basin. This report describes the social, economic, and environmental resources of the subbasin, identifies the water-related problems, needs, and desires, and suggests measures for meeting the needs, particularly in the area of flood control.

The report was prepared almost entirely on the basis of secondary information. However, some telephone contacts were made to verify information and to acquire a more complete picture of local conditions. Published sources on the subbasin include:

1. Flood Hazard Analyses, City of Manvel and Vicinity, Turtle River, Grand Forks County, North Dakota, which was published in 1977 by the U.S. Department of Agriculture, Soil Conservation Service, and defines the flood characteristics of the Turtle River near Manvel.
2. Work Plan for Watershed Protection and Flood Prevention, Upper Turtle River Watershed, Grand Forks and Nelson Counties, which was published in 1971 by the Soil Conservation Service and describes the work plan for the watershed.

In addition, the subbasin received partial coverage in the Souris-Red-Rainy River Basins Comprehensive Study, which was published by the Souris-Red-Rainy River Basins Commission in 1972, and in the Red River of the North Basin Plan of Study, which was published by the St. Paul District Corps of Engineers in 1977.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

II. DESCRIPTION OF STUDY AREA

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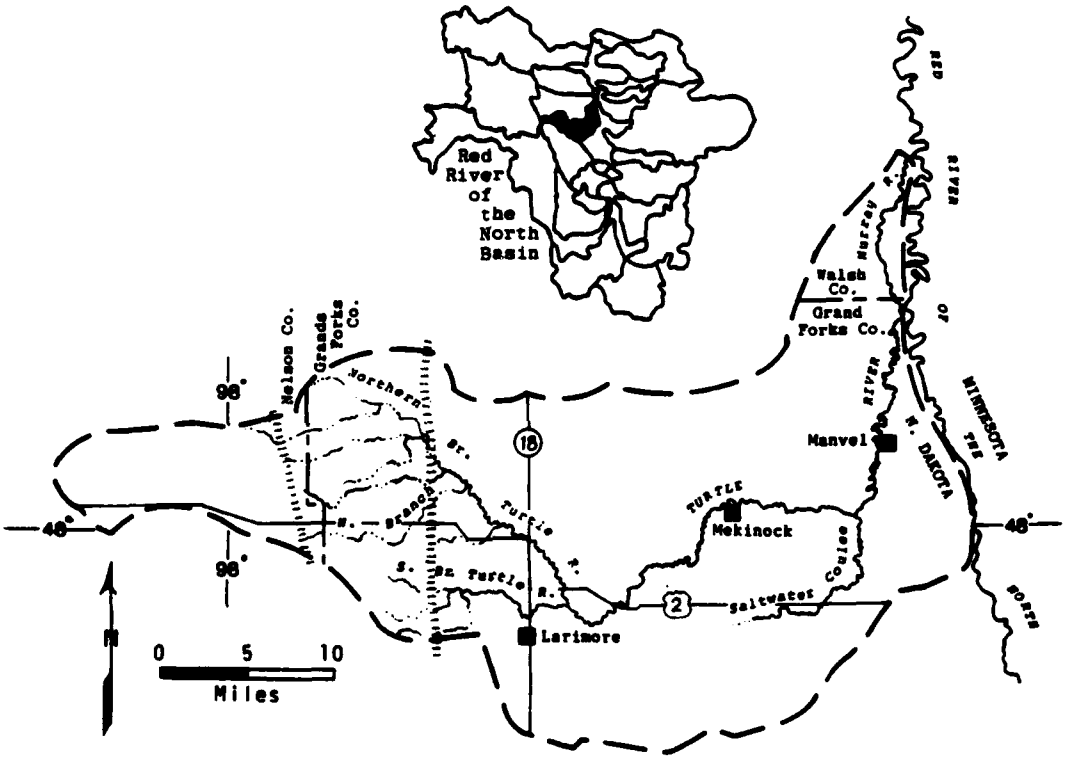
The Turtle River Subbasin is an irregularly shaped area about 50 miles in length and ranging in width from six miles at its western end to 28 miles at its eastern end (Figure I). It is one of the smallest of the subbasin occupying only 613 square miles of Grand Forks, Nelson, and Walsh counties in the central North Dakota portion of the Red River Basin.

The Turtle River Subbasin is bordered on the east by the Main Stem Subbasin, on the north by the Forest River Subbasin, on the west by the Devils Lake and Sheyenne subbasins, and on the south by the Goose and Main Stem subbasins. Although water management districts have been formed in Grand Forks and Nelson counties, the subbasin itself does not have any legal status.

Physiographically, the subbasin lies within the western lake section of the Central Lowlands Province, an area of glacial drift and lacustrine plains formed by continental ice sheets during the Wisconsin Stage ice invasion. The western half of the subbasin is a rolling glacial till prairie dotted with shallow lakes and includes the Pembina Escarpment with its incised drainage. The eastern half is composed of the nearly level, south-sloping Elk River delta and a level lake plain broken by beach lines, both of which were formed by glacial Lake Agassiz.

The major streamwater features are the Turtle River and its two branches: the North Branch and the South Branch. The river flows east and then to the north, paralleling the Red River for 20 miles before actually entering it. The two branches have numerous tributaries that drain the upland portion of the subbasin, and numerous intermittent streams enter the Turtle River below the escarpment. Besides the small lakes in the upland portion of the subbasin, there are a few small lakes and marsh areas on the lake plain in the vicinity of Kelly's Slough National Wildlife Refuge.

Elevations within the subbasin range from approximately 1,500 feet above mean sea level in the upland portion to 785 feet at the junction of the Turtle River and the Red River. The two branches have their source in the gently rolling till plain immediately west of the east-facing Pembina



Source: Gulf South Research Institute.

Figure I. TURTLE RIVER SUBBASIN

Escarpment, where they are deeply entrenched. Upon leaving the escarpment, the north Branch flows southeastward and the South Branch flows eastward across the nearly level Elk River delta. The two branches become entrenched again north of Larimore and join to form the Turtle River about three miles northeast of Larimore. The Turtle River itself is fairly well entrenched in the beach ridge area between Larimore and Mekinock, but meanders thereafter and has low banks until nearing the Red River.

III. PROBLEMS, NEEDS, AND DESIRES

III. PROBLEMS, NEEDS, AND DESIRES

The primary water-related problems, needs, and desires in the Red River Basin are flood control, fish and wildlife conservation and enhancement, recreation, water supply, water quality, erosion control, irrigation, wastewater management, and hydropower. Various water-related problems, needs, and desires have been identified for the Turtle River Subbasin in previous planning reports on the basis of analysis of conditions and public agency comments. The list of problems, needs, and desires for the subbasin is the same as the list for the Red River Basin as a whole. Each problem is discussed separately below, with an emphasis on flooding problems.

Flooding Problems

Nature of the Problems

The principal flooding problem in the subbasin is the inundation of agricultural land by excess flow overtopping existing channel banks and flowing across extensive flat land areas. Most flooding occurs virtually on an annual basis in the spring of the year during March, April, or May as a result of snowmelt, sometimes combined with rainfall. This causes delayed planting and results in depressed yields. With the short growing season, water standing on the land too long sometimes precludes planting operations altogether.

Damaging floods also result from high intensity rainstorms during the months of May through September. Although they occur less often than spring snowmelt floods, these summer floods are characterized by high peak flows that damage maturing crops or hamper harvest operations.

Two separate types of flooding occur: the most damaging type associated with river bank overflow (overbank flooding) and another type caused by runoff from snowmelt or heavy rainfall impounded by plugged culverts and ditches within sections of land bounded by roadways on earthern fill (overland flooding). In overland flooding, the trapped water slowly accumulates until it overflows the roadways and inundates section after section of land as it moves overland in the direction of the regional slope until reaching river or stream channels.

Topography also influences flooding problems. The western half of the subbasin consists of glacial till prairie, extending eastward and including the Pembina Escarpment. This area is characterized by incised drainage. In the eastern half of the subbasin, however, excess flows overtop existing channels and spread out over the nearly level, south-sloping Elk River delta (formed in glacial Lake Agassiz). The area around Manvel is an essentially flat, glacial lake plain.

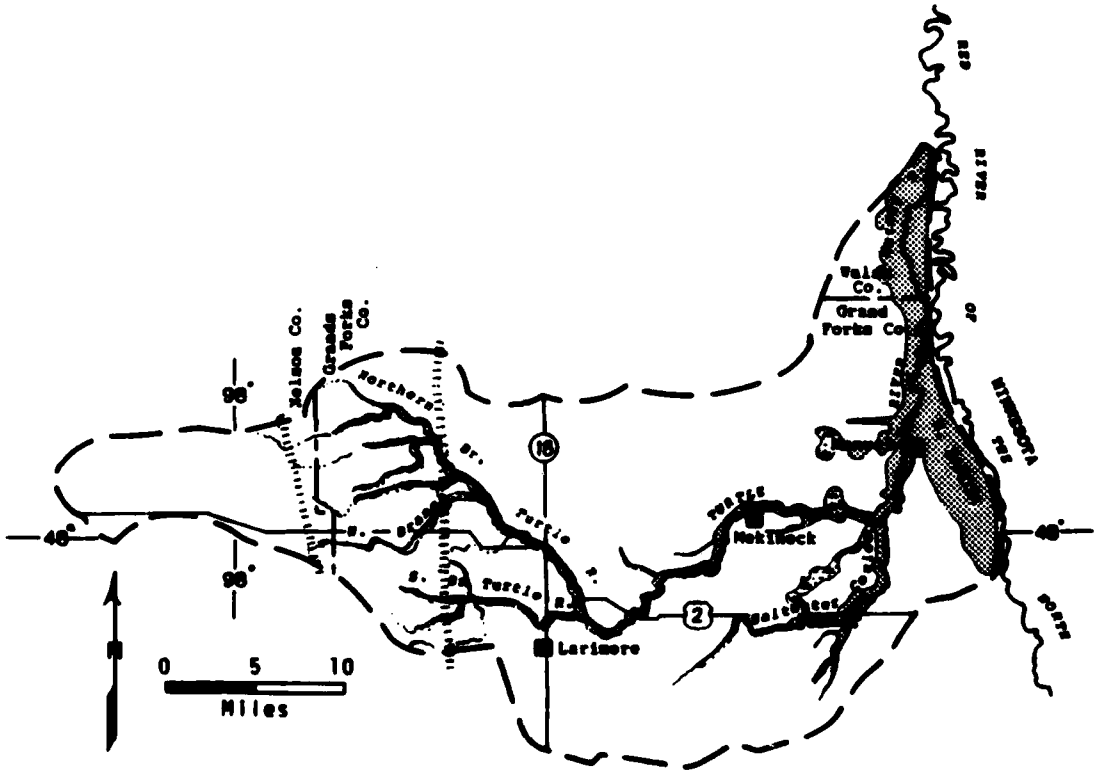
The Turtle River Subbasin constitutes only 1.6 percent of the Red River Basin. Consequently, it contributes only 2.1 percent of the total flow at the Canadian boundary. Red River flooding, however, contributes to flooding problems in the subbasin from the confluence of the two streams to a point two and a half miles south of Manvel.

Location and Extent

Figure II depicts the 100-year floodplain for the subbasin. Prior to this study, no attempt had been made to publish even a generalized delineation of the entire subbasin. A number of sources were investigated in order to produce the present delineation. Among these were: (1) U.S. Geological Survey (USGS) Flood Prone Area Maps at 1:24,000 scale; (2) Corps of Engineer photomosaics of the 1979 flood; (3) Federal Insurance Administration flood maps; (4) published secondary sources describing flooded areas; and (5) USGS 7 1/2 minute topographic maps.

The map is thus a composite of available sources supplemented by inferences where necessary. Because the sources were incomplete and based on surveys differing in purpose and accuracy, it should be understood that Figure II constitutes a generalized delineation and is intended only for planning purposes. A more complete description of sources and limitations is given in Appendix A.

According to this preliminary delineation, the total floodplain comprises approximately 56,000 acres. This figure is in agreement with that stated in the Souris-Red-Rainy Comprehensive Study. North and South Branches account for 2,000 acres; Channel B west of Manvel, 2,000 acres; Freshwater and Saltwater Coulees, 4,000 acres; and the Turtle River, 48,000 acres.



Source: Gulf South Research Institute.

Figure II. 100-YEAR FLOODPLAIN

The North and South Branch floodplains range downward from about a quarter mile in width after emerging from the Pembina Escarpment. Their confluence marks the beginning of the Turtle River at a point some two and a half miles northeast of Larimore. From this point downstream approximately the same distance south of Manvel, the floodplain totals 6,000 acres, a third of which is comprised of associated wetland. Maximum widths are generally less than one half mile.

The remainder of the floodplain covers an expanse of 42,000 acres and is generally associated with the main stem Red River. This area is 25 miles long and up to four miles wide (Figure II).

Flood Damages

Throughout the subbasin's floodplain, the following three principal areas are affected by flooding: urban, agricultural, and environmental. The small communities of Manvel and Mekinock are located in the floodplain, and the cities of Emerado and Arvilla are flood prone. Urban and rural damages are the damage categories taken into account in the computation of average annual damages.

Present average annual damages in the subbasin are estimated at $201,900. This is one of the smallest average annual damage figures for an individual subbasin, accounting for less than one percent of the Red River of the North basin total. Average annual damages are divided into two basic classifications: urban and rural. Rural damages include damages to crops, other agricultural assets (fences, machinery, farm buildings, etc.) and transportation facilities. Urban damages include damages to residences, businesses (industrial and commercial) and public facilities (streets, sewers, utilities, etc.). There are no urban damages reported for the Turtle River Subbasin for the 1975 or 1979 flood events, and average annual damages are reported as minor. Thus, rural damages account for 100 percent of the average annual damages reported in the Turtle River Subbasin.

Average annual rural flood damages and the rural flood damages caused by the flood event of 1979 are presented in Table 1. The 1979 flood event was the second largest flood recorded and rural damages sustained were more than five times greater than the average annual damage figure for the subbasin. Flood

Table 1

TURTLE RIVER SUBBASIN, ESTIMATED 1979 AND
AVERAGE ANNUAL RURAL FLOOD DAMAGES
(Thousands of 1979 Dollars)

	Rural Flood Damages	
Category	1979	Average Annual
Crop	$ 805.0	$117.2
Other Agricultural	138.0	39.1
Transportation	112.0	45.6
Total	$1,055.0	$201.9

Sources: Red River of the North Basin Plan of Study, April, 1977; Post Flood Report, 1979; and Gulf South Research Institute.

damages sustained in the flood event of 1979 included $805,000 in crop damages, $138,000 in other agricultural damages and $112,000 in transportation damages. Average annual rural flood damages are estimated at $117,200 in crop damages, $39,100 in other agricultural damages and $45,600 in transportation damages. Total average annual rural flood damages totaled $201,900, and the damages reported for the flood event of 1979 totaled $1.1 million.

Environmental Concerns

The principal wildlife problem in the subbasin is and has been the elimination or alteration of woodlands, wetlands, and native prairie to agricultural and other land uses. Most native woodlands are confined to narrow, linear corridors along the floodplains of the Turtle River and its main tributaries. The Soil Conservation Service (1969) indicated that of the 157,825 total acres in the Upper Turtle River Watershed, only 1.1 percent, or 1,685 acres, were comprised of woodlands. This figure consisted of native forests and field and farmstead windbreaks. Most wetlands are now found in the rolling plains west of the Pembina Escarpment; in the eastern portion of the subbasin, agricultural development has converted nearly all of the wetlands to cropland. The Soil Conservation

Service (1969) estimated that 9.1 percent (14,365 acres) of grassland occur in the Upper Turtle River Watershed. Some prairie remnants may be found in this area, as well as in other isolated areas such as abandoned farmlands, roadsides, etc., but the areal extent is probably very limited. These three major habitat types—woodlands, wetlands, and prairie—represent the most productive environs for wildlife in the subbasin. Because of this value and the fact that they have been depleted to such a great extent, there is a pressing need to protect, conserve, and enhance these communities whenever possible.

Problems associated with aquatic biota and wildlife that utilize the surface water of the subbasin relate to flows and water quality degradation. The Soil Conservation Service (1969) indicated that factors that have been detrimental to fish production are low flows in the subbasin's streams during late summer and fall and flooding with associated siltation in spring and early summer. The U.S. Fish and Wildlife Service (1979) stated that the quality of the waters in the Turtle River has been reduced because of agricultural and feedlot runoff and channelization in the subbasin. Even with these problems, however, the Turtle River has a high priority fishery value as a result of its moderate sport fishery, moderate production of sport fishes, and heavy recreational use, particularly in the Turtle River State Park. Thus, there is a need to improve water quality conditions for biota and to improve year-round flows where possible.

Recreation Problems

Existing recreation resources are concentrated in the eastern portion of the subbasin and are relatively close to population centers; however, there are no major lakes or artificial impoundments providing water based recreational opportunities in the area.

Although there are many streams and tributaries in the subbasin, intermittent flows in most of the streams have lowered fishery productivity. Fishing in Saltwater Coulee, and the South and North Branches of Turtle River has been affected by channelization projects. Although the Turtle River main stem supports a substantial fishery, decreased water quality because of channelization and agricultural runoff are significant problems because of the almost total lack of fishing resources elsewhere in the subbasin.

Water Quality Problems

Serious water quality problems have occurred on the river as a result of municipal effluent and agricultural runoff, especially during the late summer, fall, and winter months when insufficient streamflows reduce the river's ability to assimilate wastes. Wastewater treatment problems will be discussed in a later section. High chloride levels, which occur naturally in the subbasin, degrade the river's water quality, also, and impair municipal water supply, irrigation, and fish propogation uses (Upper Mississippi River Basin Commission, 1977; North Dakota Statewide 208 Water Quality Management Plan, 1978). Limited water quality data is available for the Turtle River.

Excessive TDS levels are present in a few aquifers utilized by communities within the subbasin. Most of the aquifers, however, are considered to be adequate in quality as well as quantity (Souris-Red-Rainy River Basin Commission, 1972).

Water Supply Problems

Water supply is generally adequate throughout the subbasin. Water for domestic purposes is obtained from shallow aquifers; however, water is not always potable, and some of the farms in the area haul water for domestic use. The city of Arvilla relies completely on water from Emerado as a supply and uses approximately 3,285,000 gallons annually, according to the North Dakota State Department of Health. Water supply in Michigan is sufficient, although there is a high content of dissolved solids. Other cities in the subbasin have few problems since their consumption rate is fairly low.

Erosion Problems

Sheet and wind erosion are prevalent problems throughout the subbasin. The major source of sediment is from sheet erosion of cultivated fields, the majority of which moves within the field or farm. Deposits of treated soil entering streams can lead to pollution of waterways. Fields lacking protective measures are also subject to wind erosion. Sediment fill of waterways and drainage systems reduces the water holding capacity

and increases farm maintenance expenses. Scouring of cultivated fields has occurred during major floods. However, the areas are small and damages are considered negligible. Streambank and gully erosion are not considered significant problems.

Irrigation

Many farmers in North Dakota are using irrigation to improve the yield and quality of their crops. Most of the irrigation, however, takes place along the Missouri River, which is located west of the Red River Basin.

The subbasin is located within North Dakota's Planning Region IV, which includes the counties of Grand Forks, Nelson, Pembina, and Walsh. There are approximately two hundred thousand acres of potentially irrigable land in the region. The development of these lands will depend on the availability of water, which is not presently abundant for the potentially irrigable land throughout the region. The major sources of water for irrigation in the subbasin are the Elk Valley and Inkster aquifers located in Grand Forks County.

In 1974, only one thousand acres of land in the entire region were irrigated; therefore, the irrigation potential in the subbasin has yet to be fully realized.

Wastewater Management

Many communities within the subbasin have inadequate waste treatment facilities that contribute to the pollution of the river. The town of Larimore is producing more wastewater than its facilities are designed to control. Another community within the subbasin, Emerado, is operating at near capacity. Overflows from these and other treatment facilities create serious water quality problems. These facilities should be modified immediately in order to adequately treat the wastewater before it is discharged into the river (Upper Mississippi River Basin Commission, 1977; Shewman and North Dakota State Department of Health, no date). Table 2 presents the wastewater treatment and needs of five communities in the subbasin.

Table 2

WASTEWATER TREATMENT AND NEEDS OF FIVE COMMUNITIES WITHIN THE TURTLE RIVER SUBBASIN

Community	Population Served	Design Flow (MGD)	Actual Flow (MGD)	Type Treatment	Surface Area (Total Acres)	Needs or Comments
Emerado	515	0.036	0.034	Secondary	5.64	Reline existing cell
Larimore	1,469	0.086	0.096	Secondary	13.50	Reline existing cell
Manvel	265	0.038	0.017	Secondary	6.05	Enlarge lagoon
Michigan	447	0.111	0.029	Secondary	15.00	Construct new lagoon
Petersburg	266	0.030	0.017	Secondary	4.00	--

Source: Shewman and North Dakota State Department of Health, No date; North Dakota Statewide 208 Water Quality Management Plan, 1978.

Hydropower

There is a dam located on the South Branch Turtle River that was built for flood control purposes. The dam is a small-scale facility identified by the U.S. Army Corps of Engineers' Institute for Water Resources as having minimal potential for hydroelectric development.

Public Perception of Problems and Solutions

The public's perception of problems and solutions in the subbasin is probably not adequately defined because the Corps of Engineers has not conducted public meetings in this area. However, the subbasin has been divided into upper and lower watersheds for planning, and solutions to problems have been suggested by both public and private parties.

The primary document for the identification of public perceptions is the Upper Turtle River Watershed Work Plan, originally published in 1969 by the North Dakota Soil Conservation Service. Since the document was prepared by Nelson County and West Grand Forks County Soil Conservation Districts and the Nelson County and Grand Forks County Water Management Districts, it reflects local interest and desires.

At that time, the primary problem was watershed flooding causing damage to crops, roads and bridges. Local sponsors also cited the need for water based recreation. The sponsoring districts stated a desire that recreational development be a goal for future watershed projects. Other water related needs of the subbasin are conservation of fish and wildlife and improvement of water quality. Soil Conservation Service (SCS) nonstructural improvements in the upper watershed will contribute towards meeting these needs. Nonstructural land treatment improvements should include, but not be limited to the following: (1) maintain existing riparian vegetation along the Turtle River and tributary stream to preserve existing wildlife habitat, help control wind and streambank erosion, retain the soil on the land and reduce the amount of sediment, nutrients and other pollutants entering the waterways; (2) maintain grassed waterways and eliminate stream channelization practices (straightening, deepening or widening), which provide only localized flood protection while moving floodwaters downstream for other areas to contend with; (3) establish vegetation windbreaks adjacent to tributary streams (greenbelts) and in other appropriate areas to reduce erosion and help to retain the soil on the land; (4) apply more cover crops and utilize minimum tillage practices to reduce erosion, the rate of snow melt and increase subsurface moisture; and (5) provide incentives to local landowners within the Turtle River Subbasin so that sound land-use practices will be implemented. Implementation of these alternatives will improve the water quality and enhance the fish and wildlife resources currently found in the Turtle River Upper Watershed.

IV. DESCRIPTION OF SUBBASIN RESOURCES

IV. DESCRIPTION OF SUBBASIN RESOURCES

This section of the report discusses the primary resource conditions within the subbasin that are water-related and that would be affected by a comprehensive water and related land resources plan centering on flood control measures.

Social Characteristics

Between 1950 and 1970, there was a steady decline in the farm population of the subbasin and an increase in the number of persons living in incorporated places. This was the result of a decrease in the number of farms and an increase in the average size of the farms remaining in operation. The change to mechanization replaced farm laborers to a great extent, and large-scale farm consolidation was prevalent. In spite of the decrease in the farm population, there was a slight increase in the subbasin's total population. During the 1970's, the rate of farm consolidation slowed, and the substantial outmigration of people from the rural areas to the incorporated places decreased. Each of the counties within the subbasin increased in population. Nelson County had a natural decrease which was more than offset by a net in-migration rate of 5.8 percent. The increases in Grand Forks and Walsh counties were due mainly to natural increase. Grand Forks had a net out-migration rate of -3.6 percent, and Walsh had a very low net in-migration rate of 0.2 percent. Between 1970 and 1977, the population of the subbasin increased less than one percent (from 12,785 to 12,792). The population density remained at approximately 21 persons per square mile.

The largest towns in the subbasin are Larimore and Michigan. Larimore's population was 1,559 in 1977, which was a 6.1 percent increase over 1970. The 1977 population of Michigan was 606, which was a 26.8 percent increase from 1970. The rest of the towns in the subbasin have populations of less than 300. Many of the subbasin's residents are of Norwegian background. The minority population is too small to be identified. Communities are close-knit, as can be seen by home ownership, length of residence, and county of employment. Fewer people

(51 percent) own their homes in Grand Forks County than in Walsh (78.6 percent) or Nelson County (78.4 percent). In addition, only 38 percent of the Grand Forks County 1970 population occupied the same residence since 1965, and 55 percent lived in the same county. Sixty-nine percent of the Nelson County and 71 percent of the Walsh County residents occupied the same residence since 1965; and 87 and 88 percent of the respective county populations lived in the same county. The Grand Forks County figures include the city of Grand Forks and probably do not accurately reflect the essentially rural characteristics and stability of the Grand Forks County portion of the subbasin. Most people live and work in the county of residence, with statistics ranging from 88.8 percent in Grand Forks County to 94.3 percent in Nelson County.

Economic Characteristics

Employment

Between 1950 and 1970, agricultural employment in the subbasin decreased (by 40 percent) as a result of mechanization replacing farm laborers and a move to large-scale farming. Employment in other sectors, primarily in Grand Forks County, increased sufficiently to offset the decline in farm employment. The result was a small increase in total employment for the subbasin. Agricultural employment has become more stable, and other sectors have continued to increase. Total employment increased from 3,856 in 1970 to 4,840 in 1977, which was a 25 percent increase.

Agriculture is still very important to the subbasin's economy, and it is expected to continue as the main economic base in the years ahead.

Unemployment in the subbasin has averaged about 5.5 percent during the 1970's. Employment is high during the spring, summer, and fall when the crops are planted and harvested. Employment declines in the winter when agricultural activities are drastically curtailed.

Income

Total personal income for the subbasin increased from $62 million to $75 million between 1969 and 1977 (expressed in 1979 dollars). Farm income accounts for more than half of the total personal income, and cash grain sales amount to more than 70 percent of the total farm income.

Average per capita income during the same years increased from $5,661 to $6,775, which was only two percent lower than the 1979 average income figure of $6,859 for the state of North Dakota. Although there has been an upward trend in both total personal and per capita income, fluctuating farm prices affect income from year to year.

Business and Industrial Activity

Agriculture

Agriculture is the most important element of the subbasin's economy, and the production of small grains is the primary agricultural activity. Approximately 79 percent (or 309,933 acres) of the subbasin's land area is under cultivation, and another 11 percent is devoted to pasture. Livestock production is not as important in this subbasin as it is in some subbasins to the west and south of the area. Most of the livestock production is found in the eastern part of the subbasin.

The major crops grown in the subbasin are identified in Table 3. Wheat and barley are the leading crops, accounting for 39 percent and 24 percent, respectively, of the total harvested acreage. Other important crops include sunflowers, potatoes, hay, sugarbeets, and oats, which collectively account for 31 percent of the harvested acreage. There are also minor acreages of soybeans, corn, and flax which account for the remaining six percent. During the 1970's, sunflowers have become increasingly important in the subbasin (as well as in the whole state). The production of this crop increased more than 50 percent between 1977 and 1978. Grand Forks County, which constitutes the major part of the subbasin, ranked fourth in the state in 1978 in sunflower production. Both Grand Forks and Walsh counties were in the top ten counties that year for the production of barley.

The eastern third of the subbasin is dominated by nearly level to steep soils, with reduced available moisture capacity. This area is devoted to the growth of small grains, flax, grasses, and legumes, and there is also some pasture land. The central portion contains significant acreages of poorly drained soils with some pasture, and there are areas of prime farmland also. The major crops grown are small grains, flax, sunflowers, potatoes, soybeans, and sugarbeets. Most of the western third of the subbasin is composed of rich soils that are good for growing small grains, sunflowers, potatoes, and corn.

Table 3

1978 CROP STATISTICS, TURTLE RIVER SUBBASIN

Crop	Harvested Acres	Yield Per Acre	Total Production
Wheat	121,550	33 bushels	4,011,150
Barley	75,540	44.6 bushels	3,369,084
Sunflowers	58,960	1,270 pounds	74,879,200

Source: Gulf South Research Institute.

Cropping patterns within the floodplain of the subbasin are similar to those throughout the area. More pasture land is found in the eastern part of the floodplain, and small grains are grown. In the central and western areas, sunflowers and small grains are the most important crops.

Manufacturing

The nineteen manufacturing establishments in the subbasin are primarily involved in processing agricultural products. Four of the plants produce fertilizer; four process beans, potatoes, or grain; and two are engaged in custom slaughtering. Almost half of the manufacturers are located in the subbasin's largest town, Larimore. The non-agricultural establishments are listed in Table 4 according to their Standard Industrial Code (SIC). Only four percent of the subbasin's employment is within the manufacturing sector.

Table 4

NONAGRICULTURAL ESTABLISHMENTS, TURTLE RIVER SUBBASIN

SIC	Description	Estimated Employment
13	Oil and Gas Extraction	9
14	Mining of Nonmetallic Minerals	9
15	Building Construction	9
27	Printing and Publishing	18
32	Stone, Clay, Glass, and Concrete Products	9
34	Fabricated Metal Products	9
42	Motor Freight Transportation/Warehousing	60
51	Wholesale Trade-Nondurable Goods	39
76	Miscellaneous Repair Services	18
TOTAL		180

Source: 1978-1979 Directory of North Dakota Manufacturing.

Trade

In 1977, total trade receipts for the subbasin exceeded $98 million (expressed in 1979 dollars). Nearly 60 percent (or $56.7 million) of the receipts were wholesale trade. Retail trade and selected service receipts were $42.0 million and $5.0 million, respectively, in 1977.

Transportation Network

The most important north to south routes in the western part of the subbasin are State Highways 35 (through Michigan), 32 (through Niagara), and 18 (through Larimore), all of which intersect Federal Highway 2, a direct east to west route to the city of Grand Forks. The major north to south routes in the eastern part of the subbasin are Federal Highway 81 and Interstate 29. Both of these routes provide direct access to Grand Forks. Federal Highways 2 and 81 and I-29 cross the Turtle River and may be subject to flooding.

The Burlington Northern Railroad has four rail lines which cross the subbasin and pass through most of the towns. Rail service is provided into Grand Forks. Several of the lines cross the river and are subject to damage during the spring floods. There is a small airport with limited facilities located at Larimore. A few other airports are within the subbasin, but they provide only restricted use.

Land Use

Approximately 79 percent of the subbasin is under cultivation, and 11 percent is pasture. Most of the pasture is located in the western part of the subbasin. Urban development amounts to almost five percent of the total land area. Water areas account for only 1.2 percent of the land, and only 0.9 percent is forest. Most of the forest is located along the river.

Land use in the floodplain of the Turtle River does not differ from land use in the subbasin. The floodplain is an important agricultural area, and the small amount of forest acreage is found mainly along the river. Manvel and Mekinock are the only towns within the floodplain.

Environmental Characteristics

Climate

Records of climatological data can be obtained from the weather station in Larimore. The subbasin's climate is subject to wide seasonal variations. Records show mean monthly temperatures ranging from 70.3°F in the summer to 5.4°F in the winter. The growing season averages 122 days, with the average date of the last killing frost on May 21 and the earliest on September 20. However, the long hours of summer sunshine make it possible to grow and mature many different crops. Average annual precipitation is 18.05 inches. The mean annual snowfall is approximately 34.6 inches, equivalent to about 3.5 inches of precipitation. Snowmelt runoff can cause damaging floods during March, April, or May. Excessive rainstorms may cause damage to surrounding areas from May to September.

Geology

The subbasin lies within the Western Lake Section of the Central Lowlands Province in the Interior Plains Division. Bedrock consists primarily of undifferentiated Ordovician Limestone and dolomite overlain by Cretaceous deposits of the undifferentiated Dakota Group, the shale and limestone Colorado Group, and the Pierre Shale. Glacial activity produced two distinct regions in the subbasin. The western portion of the area is upland till prairie. This area contains the Pembina Escarpment, which divides the uplands from the nearly level lacustrine plain in the eastern portion of the subbasin.

Biology

The potential natural vegetation of the Turtle River Subbasin consists of the Northern Floodplain Forest along the Red River and the Turtle River and its tributaries, and Bluestem Prairie throughout most of the grassland areas, except in the extreme western portion where Wheatgrass-Bluestem-Needlegrass Prairie occurs. Agricultural development in the form of cropland and pastureland has altered or eliminated most of these native communities. Woodlands are now confined to field and farmstead windbreaks and to the floodplains and steep slopes along streams. Trees

such as American elm, boxelder, green ash, willow, and cottonwood are common in the floodplain. Shrub species are represented by chokecherry and gooseberry; Pennsylvania sedge, nettle, violets, and grasses are probably typical understory species. On the slopes, basswood and bur oak are dominant, with aspen, boxelder, and green ash as common associates. Shrubs are comprised of species such as chokecherry, snowberry, and Juneberry. The herbaceous layer is composed of Pennsylvania sedge, goldenrod, meadow rue, aster, and various grasses. Some characteristic prairie vegetation is found in the grasslands in areas such as railroad rights-of-way, roadsides, fence lines, and abandoned farmlands (Kuchler, 1964; Stewart, 1975; Soil Conservation Service, 1969; U.S. Fish and Wildlife Service, 1979).

In 1969, the Soil Conservation Service reported that potholes and marshes could be found in the rolling plains west of the Pembina Escarpment in the subbasin. Some areas in this region supported up to 50 Type 3 and Type 4 wetlands/square mile. Wetlands are not common in the eastern portion, where agricultural development is most prevalent. Wetland types which have been identified in the three counties (Walsh, Grand Forks, and Nelson) included by the subbasin's boundaries include Type 1--seasonally flooded basins or flats, Type 3--shallow fresh marshes, Type 4--deep fresh marshes, Type 5--open fresh water, Type 10--inland saline marshes, and Type 11--inland open saline marshes (U.S. Fish and Wildlife Service, 1979).

Habitats of importance to wildlife in the subbasin include the remaining woodlands, wetlands, and grasslands. The woodlands and brushy areas provide den and nesting sites, territories, winter and escape cover, and winter food for many of the resident and migratory wildlife species in the region. They also furnish a travel corridor for animals moving from the upper reaches of the subbasin to the developed areas of the eastern portion. Forests afford breeding and nesting areas for birds and rank second only to wetlands in breeding bird population densities, with 336.0 pairs/km^2. Forests contain a greater variety of wildlife species than any other major habitat type; thus, there is a very real need to protect the woodlands of the subbasin. Wetlands furnish breeding, nesting, feeding, and resting areas for waterfowl; breeding and rearing

habitat for big and small game, furbearers, and other wildlife such as passerine and wading birds; spawning and nursery areas for fishes and aquatic invertebrates; and a high-yield food source for many resident species. As indicated above, they rank first in breeding bird densities, with average populations reported at 337.0 pairs/km^2. Native grasslands or prairie, when found in combination with wetland complexes, form a dynamic and varied ecosystem which supports diverse and abundant populations of birds, mammals, invertebrates, and plants. Average breeding bird densities of 142.7 pairs/km^2 have been recorded in this highly productive community. Like the woodlands, both the remaining wetlands and prairies of the subbasin need to be protected, conserved, and enhanced wherever possible (U.S. Fish and Wildlife Service, 1979, 1980).

The white-tailed deer is the most important big-game animal in the subbasin. Greatest abundance occurs along the Red River and along the Turtle River and its tributaries east of Larimore to the upper reaches of the subbasin. The wooded areas along the North and South Branches are known to be important for food and winter cover. Population densities along these wooded areas range from <0.5-<1.5 deer/square mile. Some mule deer are harvested, but they are definitely ranked second behind the white-tail in importance. Waterfowl occur throughout the subbasin in areas with suitable habitat, which is confined primarily to the potholes and marshes west of the Pembina Escarpment. However, in the few wetlands still remaining in the eastern portion (such as the Waterfowl Production Area in the northeast), waterfowl utilization is heavy. During years with adequate water supply in wetlands, large numbers of mallards, blue-winged teal, pintails, and gadwalls and lesser numbers of redheads, canvasbacks, ruddy duck, and others are produced. Spring waterfowl densities vary from 4.0-9.0 breeding pairs/square mile in the western part of the subbasin to <4.0 breeding pairs/square mile in the eastern portion. Wood ducks utilize the riparian forests for nesting along the Turtle River and its main tributaries, and both geese and ducks use the wetlands of the subbasin during migration (data from North Dakota Game and Fish Department in U.S. Fish and Wildlife Service, 1970; Soil Conservation Service, 1969).

The principal upland game are the mourning dove, Hungarian partridge (12-31 birds/1,000 miles of rural mail carrier route), sharp-tailed grouse (<3.0 sharptails/square mile), gray and fox squirrel, and the cottontail. Pheasant populations are considered low, with densities of <1.0 hens/square mile. Common fur animals include the mink, muskrat, raccoon, beaver, skunk, and red fox. Population densities for the red fox vary from 5.0-13.0 families/township. Certain sections of the upper subbasin provide excellent habitat for furbearers (data from North Dakota Game and Fish Department in U.S. Fish and Wildlife Service, 1979; Soil Conservation Service, 1969). Table 5 gives harvest data for many of the game and furbearing species mentioned above in Walsh and Grand Forks counties from 1970-1975.

Approximately 273 species of birds have been reported from the northeastern region of North Dakota, which includes Pembina, Grand Forks, Nelson and Walsh counties. A total of 168 species have been identified as breeding birds; characteristic species include the killdeer in croplands, western meadowlark in grasslands, eastern kingbird in shelterbelts, brown thrasher in thickets, Savannah sparrow in wetlands, and the eastern wood pewee in the forest community. About 31 nongame mammals have been identified from the area and include the short-tailed shrew, big brown bat, Richardson ground squirrel, northern pocket gopher, meadow vole, and deer mouse. Amphibians are represented by nine species and reptiles by seven species. Typical herpetofauna include the Dakota toad, chorus frog, wood frog, and red-sided garter snake (Willis, 1977; Steward, 1975).

The subbasin drains an area of approximately 613 square miles, which is contained in portions of Nelson, Grand Forks, and Walsh counties. The North and South Branches form the main stem Turtle River at their confluence near Larimore, Grand Forks County. The numerous streams within the subbasin have varying degrees of productivity. Salt Water Coulee, a major tributary of the Turtle River, and the North and South Branches have been classified as Class IV streams with a limited fishery resource. These reaches provide no sport fishery and only a limited amount of forage fish production. Channelization and intermittent

Table 5

HARVEST DATA FOR GAME AND FURBEARING ANIMALS IN WALSH, NELSON, AND GRAND FORKS COUNTIES, 1970-1975, TURTLE RIVER SUBBASIN

Species	Number Harvested[a]											
	1970		1971		1972		1973		1974		1975	
Red Fox (trapped and hunted)	117	(131)	745	(833)	650	(727)	1,721	(1,925)	805	(900)	996	(1,114)
Coyote (trapped and hunted)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	2	(2)
Sharp-tailed grouse	670	(781)	625	(156)	454	(151)	947	(95)	241	(52)	333	(666)
Ring-necked pheasant	0	(224)	0	(191)	185	(64)	75	(150)	141	(0)	132	(132)
Cottontail	2,105	(3,991)	707	(1,550)	991	(1,908)	1,033	(2,396)	913	(2,702)	1,765	(3,102)
White-tailed deer	147	(164)	412	(461)	336	(376)	461	(516)	297	(332)	305	(342)
Hungarian partridge	3,175	(2,948)	2,163	(2,671)	2,369	(3,769)	4,702	(2,796)	2,793	(2,438)	2,065	(2,091)
Fox squirrel	3,812	(3,119)	1,911	(2,478)	3,394	(3,795)	2,750	(3,966)	3,414	(2,442)	2,999	(4,396)

[a]Numbers outside of parenthesis are for Walsh County; those within are for Grand Forks County.

Source: Data from North Dakota Game and Fish Department in U.S. Fish and Wildlife Service, 1979.

flows are the primary reasons for the low productivities on these reaches. The main stem Turtle River (from the confluence of the North and South Branches to the Red River) has been classified as a stream with high priority fishery resources (Class II). The rationale for this evaluation is the moderate production of northern pike, walleye, and panfishes and the heavy recreational use this reach receives. Feedlot and agricultural runoff combined with channelization has degraded the water quality in the main stem. The Marais River is listed as a Class III stream, which means that it provides a substantial fishery resource. This reach, which is actually an old meandered channel of the Red River, produces only a limited sport fishery and a moderate forage fish production. Except during the spring, the Marais River is cut off from the Red River on both ends so that it is similar to an oxbow lake. Most of the fish in this reach suffer from winterkill every year (U.S. Fish and Wildlife Service and North Dakota Game and Fish Department, 1978).

Game fishes common to the subbasin include walleye, northern pike, channel catfish, yellow perch, and sauger. Carp, common shiner, fathead minnow, common white sucker, brook stickleback, johnny darter, and freshwater drum comprise the more common rough and forage fishes that have been reported from the subbasin (Copes and Tubb, 1966).

Cvancara (1970) reported seven different species of mussels from the Turtle River. Three of these were represented and identified from fossils: (1) Fusconaia flava, (2) Lasmigona compressa and (3) Strophitus rugosus. Lasmigona complanta, Anodonta grandis, Anodontoides ferussacianus, and Lampsilis siliquoidea were all represented by at least one live specimen.

Water Supply

Generally, an adequate quantity of water is available for communities in the subbasin. Water for domestic use is obtained from shallow aquifers. The yield is usually sufficient for domestic and farm use, but the quality is poor in some areas. Well water is available for livestock; however, where this water is not potable, farmers must haul water for domestic purposes.

Three communities in the subbasin have water supplies and all use groundwater. The primary water user is Larimore (North Dakota State Department of Health), with an average consumption rate of 730,000,000 gallons annually. The aquifer which serves Larimore has a large potential yield and good water quality. The city of Emerado uses approximately 14,600,000 gallons annually. The water supply of Michigan is somewhat high in dissolved solids, but is otherwise sufficient.

Water Quality

The North Dakota State Department of Health considers the Turtle River a Class II, Effluent Limited, stream. It is supposed to support fish and wildlife populations and provide body-contact recreation, but is sometines limited due to intermittent flows. Limited water quality data is available for the Turtle River. Naturally occurring chlorides and municipal and agricultural pollution have been reported as degrading the river's water quality (Upper Mississippi River Basin Commission, 1977; North Dakota Statewide 208 Water Quality Management Plan, 1978).

Three communities in the subbasin have groundwater supplies. Larimore is the primary water user in the subbasin; its supply is considered to be of a very good quality and quite adequate to meet future demands. Data are not available on the quality of Emerado's supply, but it is thought to be adequate. Michigan's water supply is sufficient, although it contains excessive TDS concentrations (Souris-Red-Rainy River Basins Commission, 1972). Table 6 presents the water quality data for two of these three communities.

Aesthetics

Most of the land in the subbasin has been cleared for agricultural purposes. The upland areas in the escarpment region, however, provide topographical relief and are also criss-crossed by many streams and small tributaries. Some wooded corridors providing wildlife habitat and areas of aesthetic appeal are located long the floodplains of these streams.

Turtle River State Park is the most significant aesthetic attraction in the subbasin. Located near Larimore, the park provides 640 acres of camping, swimming, fishing, and picnicking opportunities for residents of the subbasin.

Table 6

GROUNDWATER QUALITY FROM TWO COMMUNITIES WITHIN THE TURTLE RIVER SUBBASIN

Parameter	Larimore		Michigan			
	Well #1	Well #2	Well A	Well B	Well #1	Well #4
Total Dissolved Solids	346	329	2246	1626	1342	1050
Hardness ($CaCo_3$)	166	210	55	23	135	13
Iron	0.4	7.2	0.1	0.4	Trace	0.0
Manganese	0.7	0.4	0.0	0.0	0.0	0.0
pH (Standard Units)	8.3	8.3	7.9	8.2	8.7	8.2
Sodium	15	10	640	460	430	325
Fluoride	0.2	0.4	0.3	0.4	0.6	0.6
Chloride	10	13	403	210	180	45
Nitrates	4	0	4	4	4	11

Note: Unless otherwise stated, all units of measure are in mg/l.

Source: North Dakota State Department of Health, 1964.

Cultural Elements

The subbasin is transected by a series of elevated geological features called beach ridges, or strandlines, which are associated with the formation of glacial Lake Agassiz. Not until sometime after 7000 B.P. did much of the region become available for human habitation (see Elson, 1964:36-95). As elsewhere in the Red River Valley, the beach ridges of Lake Agassiz became suitable, sometimes preferred, sites for human settlement (Johnson, 1962:126; Saylor, 1975:251).

Many of the archeological resources of the subbasin appear to be of a relatively late prehistoric context. Most notable are those sites associated with the Arvilla Woodland culture. The Arvilla type-site was first discovered in the 1930's during graveling operations along the Turtle River (Cole, 1968:10). The Arvilla focus, and its characteristic burial mode, have been widely associated with glacial strandlines throughout the Red River Valley (Wedel, 1961:226; Johnson, 1973:3-58).

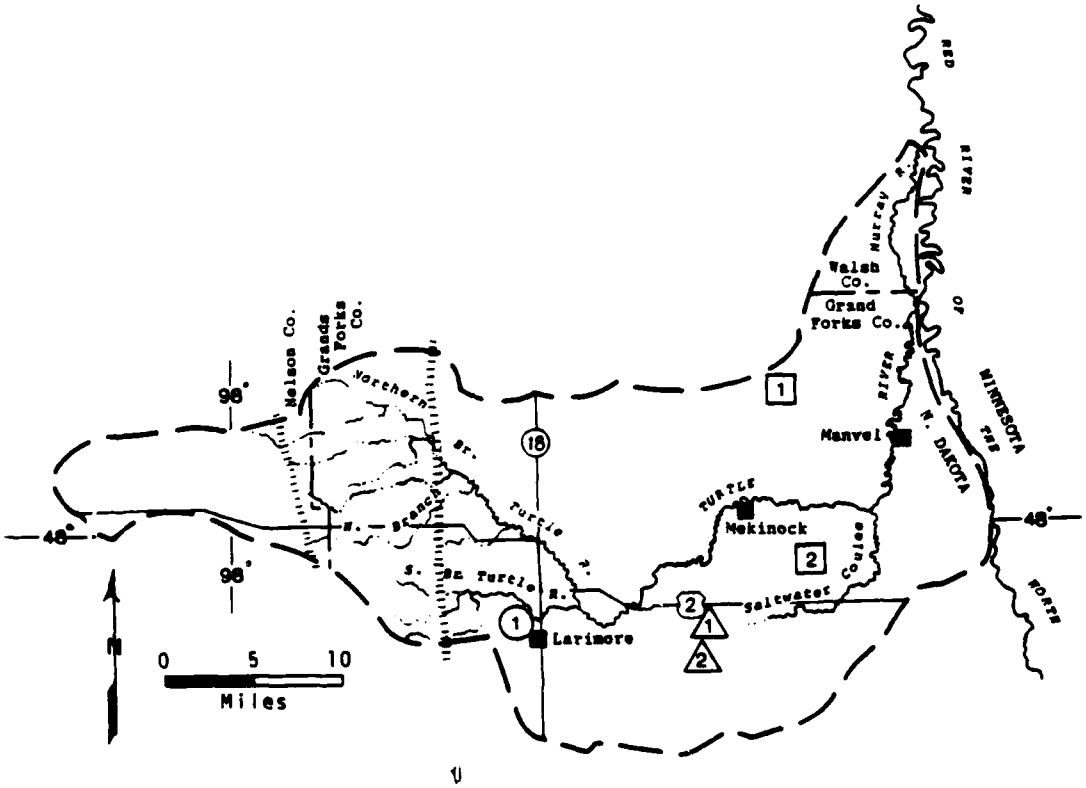
Woodland mounds are relatively prominent, but poorly understood, archeological features in the subbasin, and in the whole of eastern North Dakota as well. Many mound sites were recorded by Cole (1968) on the high bluffs and terraces which edge parts of the Forest and Park Rivers. However, one possible mound site recorded by Loendorf and Good (1974:12) along the Turtle River was located in the bottomlands adjacent to the channel. It is often difficult, therefore, to predict the possible impact of flood control measures upon archeological resources without an on-site survey.

Cole (1968:42) alleged that there was little indication of prehistoric occupancy along the Turtle River (or the Goose River), and Loendorf (1977) and Loendorf and Good (1974) recorded very few prehistoric sites along portions of the Turtle River. Loendorf (1977) tentatively attributed this fact to (1) survey techniques; and (2) the nature of the proposed construction projects. Archeological surveys here, as elsewhere, tend to be site-specific in scope. Therefore, our archeological knowledge of the subbasin is often limited to the riverine system itself.

The subbasin was historically inhabited by the Yanktonai Dakota Indians and also perhaps by the Plains Chippewa (Robinson 1966:24-26). The Fort Abercrombie-Fort Garry Trail cut through the present town of Manvel in the eastern portion of the subbasin. This trail funneled trappers, soldiers, fur traders and Red River Carts through the study area. Following the Homestead Act of 1862 and subsequent railroad building and land speculation, the subbasin was settled rapidly by European-Americans. There are no sites listed or eligible for listing on the National Register of Historic Places at this time.

Recreational Resources

Recreational sites within the subbasin are not abundant; however, the distribution of recreation areas in fairly close proximity to population centers assures extensive use of available resources. The location of the subbasin's recreational sites larger than 15 acres is illustrated in Figure III. These areas comprise a total of approximately 5,381 acres or about 99 percent of the subbasin recreation resources. An inventory of facilities at these locations is presented in Appendix B of this report.



EXISTING WILDLIFE AREAS

1 Prairie Chicken WMA

2 Kelly's Slough National Wildlife Refuge

EXISTING RECREATION AREAS

1 Turtle River State Park

2 Villa Vista Ski Area

OTHER EXISTING RECREATION AREAS

1 Larimore Golf Course

Source: Gulf South Research Institute.

Figure III. RECREATIONAL RESOURCES

The Turtle River State Park and Kelly's Slough National Wildlife Refuge are the most important recreational resources in the subbasin. Icelandic State Park in the Pembina Subbasin and Lake Metigoshe State Park in the Sheyenne Subbasin are the only state parks in the North Dakota portion of the Red River Basin.

Hunting is popular within the subbasin, with many game and waterfowl species represented in the area, including deer, fox, sharp-tailed grouse, and partridge.

Fishing is limited in the subbasin; however, several species of game and forage fish are found in subbasin rivers, including walleye, northern pike, perch, sauger and catfish. The main stem of Turtle River is heavily used for recreational fishing.

There are several small parks and school athletic fields that provide additional non-water based recreational opportunities in the subbasin. Proposed recreational developments are limited to improvements in existing facilities, such as extending boat ramps and increasing picnicking facilities at Larimore Dam and other municipal parks.

Significant Environmental Elements

Social

Larimore and Michigan are the major population centers of the subbasin. The flood control structures constructed in the subbasin have alleviated urban flooding problems to a large degree. The town of Manvel, located on the Turtle River in the valley portion of the subbasin, is still subject to minor flooding problems. Flooding results in damages to low-lying residential areas and commercial establishments, roads and bridges, and sewage systems. At present, flooding of agricultural areas constitutes the primary flooding problem of the subbasin. Damages to agricultural areas include loss of topsoil, delays in planting, reduced yields, and repairs to farm structures and equipment.

Cultural

Archeological information (as elsewhere in the Red River Basin) is restricted chiefly to the riverine system. Although relatively few archeological sites have been found in comparison to the Park River

Subbasin, the Turtle River Subbasin has the distinction of containing the archeological type-site for the Arvilla focus. The subbasin was traversed by the Fort Abercrombie-Fort Garry Trail; but, there is no indication that historic features associated with this, and other historic events and places, have been adequately recorded. No sites are listed on the National Register of Historic Places, but a more systematic survey may locate other potentially eligible properties.

Soils

Glacial till forms the surface mantle over the upland in the western portion of the subbasin. Soils in the glaciated uplands are deep, and moderately permeable, with slopes usually less than six percent. The soils are predominantly medium textured, consisting of sandy loam, loam, and silt loam. Soils in the delta and beachlines are underlain in shallow depths by sand and gravel. Soils in the depressions are predominantly clay or clay loams, which are sometimes flooded by runoff from adjacent areas. Near the depressions, soils are often calcareous at the surface and may be saline. Throughout the subbasin, soils are subject to sheet and wind erosion (especially the lighter, unprotected soils).

Water

Approximately 1.2 percent of the subbasin's total land area is occupied by water. The rivers and lakes are important for recreation, water supply, and fish and wildlife.

Woodlands

The woodlands and brushy areas of the subbasin are considered significant because of their value as wildlife habitats and because of their limited areal extent in the subbasin. For example, in 1969, woodlands comprised only 1.1 percent, or 1,685 acres, of the total land area (157,825 acres) in the Upper Turtle River Watershed (Soil Conservation Service, 1969). It is probable that this figure has decreased, as well as the extent of woodlands in the lower watershed, with increased clearing for other land uses (primarily agricultural related uses). Some offset may have occurred as a result of windbreak and shelterbelt plantings, but these

are frequently not of the quality of the native woodlands which have been removed. Thus, there is a very apparent need to protect this habitat type and to enhance forestlands,where possible, within the subbasin's limits.

Wetlands

The wetlands of the subbasin are significant because of their many beneficial uses and values as habitats for flora and fauna, waterfowl production, water storage during spring runoff and periods of extreme precipitation, groundwater recharge, sediment traps, and nutrient traps (Cernohous, 1979; U.S. Fish and Wildlife Service, 1979; E.O. 11990, dated 24 May 1977). They are also significant because of the limited amount remaining, as compared to their original number and acreage, and should be conserved and enhanced where possible.

Table 7 gives the number and area extent of wetlands in the North Dakota counties included by the subbasin. The most recent figures obtained were from a 1964 inventory based on a 25 percent sampling of the wetlands within these counties. This information is likely outdated. The number and acreage of all Type 3, 4, 5, 10, and 11 wetlands were multiplied by four to expand the 25 percent sample to 100 percent. Type 1 wetlands were not measured in the 1964 survey. The number and acreage of Type 1 wetlands, however, were estimated based on previous studies which indicated that they comprise about 60 percent of total wetland numbers and 10-15 percent of the total wetland acres in the Prairie Pothole Region. Although no acreage figures are available for wetlands drained and converted to cropland, most have been drained in eastern North Dakota. Current annual wetland drainage estimates are thought to be less than two percent of the remaining wetland base, except in isolated areas where it may be higher (U.S. Fish and Wildlife Service, 1979).

As of 1964, a total of 26,877 wetlands comprising 66,974 acres remained within the three counties encompassed by the subbasin's limits.

Waterfowl Production Areas

Waterfowl Production Areas (WPAs) are wetland areas that the U.S. Fish and Wildlife Service (FWS) has either acquired through fee title, or obtained an easement interest in, to preserve valuable breeding, nesting and feeding habitat for migratory waterfowl. These wetland areas are

Table 7

1964 WETLAND INVENTORY DATA FOR THE THREE COUNTIES INCLUDED IN THE TURTLE RIVER SUBBASIN

	WETLAND TYPES[a]													
	1		3		4		5		10		11		TOTAL	
County	Number[b]	Acres[c]	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Walsh	2,120	1,759	3,500	10,982	30	700	4	45	0	0	0	0	5,654	13,486
Grand Forks	772	927	1,270	3,936	8	680	0	0	8	1,562	0	0	2,058	7,105
Nelson	7,184	6,050	10,760	16,925	1,062	12,240	104	4,844	20	1,204	28	5,120	19,158	46,383
TOTAL	10,076	8,736	15,530	31,843	1,100	13,620	108	4,889	28	2,766	28	5,120	26,870	66,974

[a]Type 1 - Seasonally flooded basins and flats.
Type 3 - Shallow fresh marshes.
Type 4 - Deep fresh marshes.
Type 5 - Open fresh marshes.
Type 10 - Inland saline marshes.
Type 11 - Inland open saline marshes.

[b]Calculated at 60 percent of total wetland numbers.

[c]Calculated at 15 percent of total wetland acres.

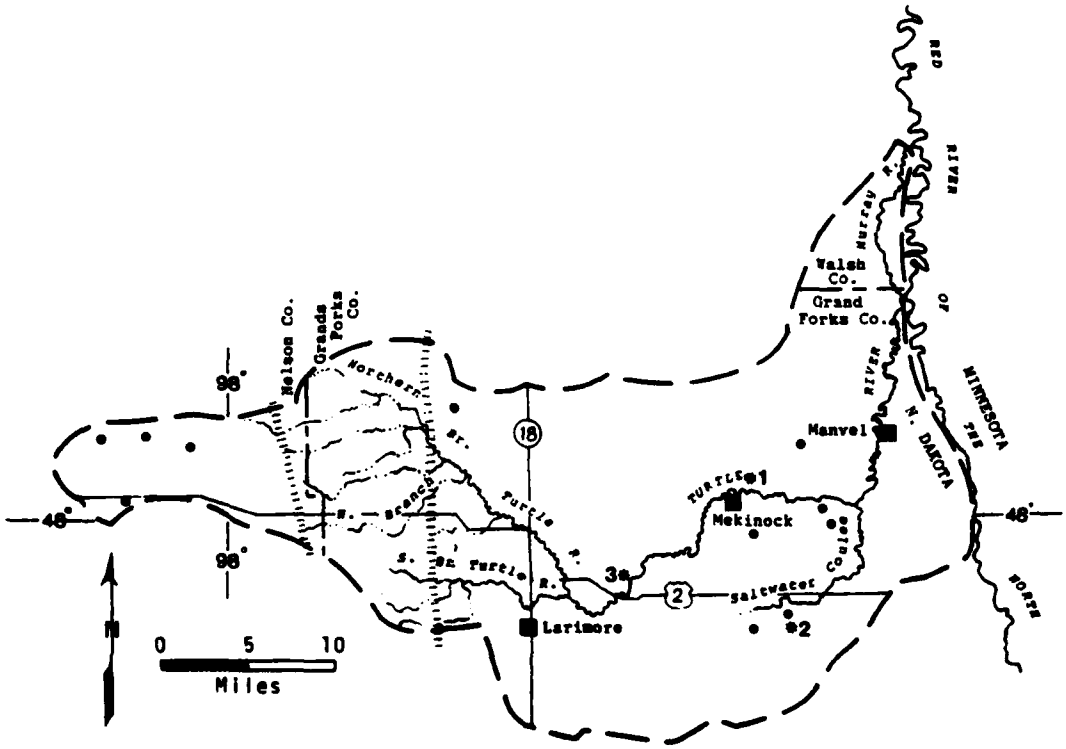
purchased, or an easement interest obtained, with funds received from the sale of migratory bird hunting and conservation stamps (Duck Stamps). These WPAs are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities, as well as providing valuable habitat for migratory waterfowl and many other forms of wildlife. FWS is responsible for the compatibility determinations (uses) and the issuance and denial of permits involving these lands. WPAs acquired in fee title are managed for optimum wildlife production, particularly waterfowl. On easement WPAs, the rights acquired are limited to the burning, draining and filling of wetland basins and right of access. All other property rights remain with the landowners. The approximate locations of the WPAs acquired in fee within the subbasin are shown in Figure IV. Total acreage of these WPAs, fee and easement, included in the subbasin are listed in Table 8.

Wildlife Management Areas

There are two wildlife management areas found within the subbasin. A list of these areas and their acreages and locations were presented in the Existing Conditions section for recreation. These areas are considered significant because of the opportunities provided for outdoor recreation and protection and management given to biological resources within their confines.

Threatened or Endangered Species

Two fishes and three birds that occur within the subbasin have been listed as endangered or threatened species by North Dakota, only. The two fishes, the pugnosed shiner and banded killifish, require clear, quiet streams or pools that have an abundance of aquatic vegetation. The pug-nose shiner is very sensitive to turbidity. Due to siltation and reduction in aquatic vegetation from agricultural developments and other stream alterations (e.g., channelization, etc.), the populations of both fishes have been drastically reduced. The banded killifish is now limited to Kelly's Slough National Wildlife Refuge in Grand Forks County. The bald eagle and American peregrine falcon have declined because of loss of habitat and pesticide pollution, especially DDT and its derivatives. Although



• SCIENTIFIC AND NATURAL AREAS

1 Grand Forks County Prairie Chicken Range
2 Oakville Prairie Biology Station
3 Turtle River State Park

• WATERFOWL PRODUCTION AREAS (Fee Tracts)

*Exact locations and numbers of WPA's are on file at the U.S. Fish and Wildlife Service, Area Office, Bismarck. No copies of these maps have been published or released but can be reviewed at the above office.

Source: State Comprehensive Outdoor Recreation Plan, 1975; Kantrud, 1973.

Figure IV. WATERFOWL PRODUCTION AREAS

Table 8

WATERFOWL PRODUCTION AREAS AND WETLAND EASEMENT AREAS OF THE COUNTIES INCLUDED IN THE TURTLE RIVER SUBBASIN

County	WPAs (Acres)	Wetland Easement Areas (Acres)	Total (Acres)
Grand Forks	4,585	867	5,452
Nelson	3,053	37,885	40,938
Walsh	1,323	8,758	10,081
TOTAL	8,961	47,510	56,471

Source: U.S. Fish and Wildlife Service Fee and Easement Interests in Real Property, 1979.

no recent breeding records of the bald eagle or American peregrine falcon have been reported from the subbasin, both of these birds include the subbasin in their migratory flyways (McKenna and Seabloom, 1979). The greater prairie chicken is the other threatened bird which is found within the subbasin. The areas along the Turtle River, especially in the central portion of the subbasin, support one of the few remaining populations of prairie chickens in North Dakota (Nelson County Soil Conservation District, et al., 1970).

Other Important Species

The blackchin shiner is a peripheral species that is presumed to be within the major tributaries of the Red River. However, this species, like the pug-nose shiner, is very sensitive to turbidity and could have been extirpated from this extreme portion of its range. The pileated woodpecker is primarily an eastern species that is living in its extreme western range limits along the Red River. It has been reported from the wooded areas along the major tributaries of the Red River (McKenna and Seabloom, 1979). Wood ducks in North Dakota are commonly found along woody reaches of the Red River and its tributaries. However, the wood duck has been reported breeding in the ambered areas that border the Turtle River and some of its major tributaries (Nelson County Soil Conservation District, et al, 1970).

Rare and Unique Plants

Only one plant species, *Carex prarisa*, that has been classified as a rare or unique plant in North Dakota by Barker, *et al*. (1976) has been reported from the subbasin. This unique sedge is found in wet meadows and boggy areas. Its limited occurrence within North Dakota is because it is on the limits of its natural distribution.

Natural Areas

Three natural areas are located within the subbasin (Figure IV). They include: (1) Oakville Prairie Biology Station (University of North Dakota) located two miles east of Emerado, North Dakota. This tract contains 800 acres of lowland and upland prairie; (2) Grand Forks County Prairie Chicken Range located 2½ miles north of Mekinock, North Dakota. This tract is comprised of a low prairie grassland type habitat which supports a small population of prairie chickens; and (3) Turtle River State Park located one mile northwest of Arvilla, North Dakota. This is a 475-acre woodland forest consisting of bur oak, green ash, American elm, and basswood (Kantrud, 1973).

V. FUTURE CONDITIONS

V. FUTURE CONDITIONS

The subbasin's future economic, social, and environmental conditions and resources are discussed below in terms of "most probable" and "without project" conditions.

Most Probable Economic Conditions

The small community of Larimore will continue to serve the needs of the surrounding agriculture-based rural areas and as a bedroom community for the military population at the Grand Forks Air Force Base. Population, which remained the same between 1970 and 1977, will grow slightly as will employment and per capita income, which is shown in Table 9, largely due to the influence of Grand Forks.

Table 9

TURTLE RIVER SUBBASIN, POPULATION, EMPLOYMENT, AND PER CAPITA INCOME PROJECTIONS, 1980-2030

Parameter	1970	1977	1980	1990	2000	2010	2020	2030
Population	11,018	11,000	11,100	11,200	11,300	11,400	11,500	11,600
Employment	3,856	4,840	5,000	5,100	5,200	5,300	5,400	5,500
Per Capita Income (Dollar)	5,661	6,775	8,200	10,700	13,900	18,000	23,400	30,400

Sources: U.S. Water Resources Council, 1972 OBERS Projections, Series E; and Gulf South Research Institute.

Population and employment projections were developed by GSRI based on recent trends. OBERS E figures appear to underestimate growth trends for the non-city portions of the Grand Forks area, since agricultural employment has stabilized and a slow reversal in population and employment decreases has been established. OBERS E and E' projections were, however, designated as most probable for per capita income and agricultural activity estimates.

A predominantly governmental and agricultural economy is forecasted to continue. Recurring flooding problems that affect some 56,000 acres and large reliance on military employment (lack of diversification) are viewed by local leaders and planners as the biggest obstacles to economic growth and development.

Most Probable Agricultural Conditions

Roughly 309,900 acres within the subbasin are currently under cultivation, and wheat, barley and sunflowers are the principal crops produced. The total production of these three crops alone is estimated to be worth $26.4 million in 1980 (using October 1979 Current Normalized Prices for North Dakota). This total value of production figure is projected to increase to $44.3 million by the year 2030 (using October 1979 Current Normalized Prices for North Dakota). Projected production of these three principal crops is presented in Table 10.

Table 10

TURTLE RIVER SUBBASIN, PRINCIPAL CROPS
AND PROJECTED PRODUCTION, 1980-2030
(Production in Thousands)

Year	Wheat (Bushels)	Barley (Bushels)	Sunflowers (Pounds)
1980	4,131	3,471	77,125
1990	4,793	4,025	89,466
2000	5,454	4,581	101,806
2010	5,867	4,928	109,518
2020	6,280	5,275	117,231
2030	6,941	5,830	129,571

Sources: OBERS E'; and Gulf South Research Institute.

Evaluation of Flood Damages--Future Conditions

A summary of present and future average annual flood damages is presented in Table 11. Using a discount rate of 7 1/8 percent, equivalent average annual damages are $228,900. Urban flood damages were reported to be minor in the subbasin and, therefore, all of the average annual damages are rural in nature.

Flood damages to residences, businesses, industrial structures, churches, schools, automobiles, trailers, and public property and contents are included in the urban damages category. Damages to streets and utilities (including water, gas, electricity, sanitary sewers, storm sewers, and

Table 11

TURTLE RIVER SUBBASIN, SUMMARY OF PRESENT AND FUTURE AVERAGE ANNUAL DAMAGES, URBAN, AGRICULTURAL, AND TRANSPORTATION
(October, 1979 Prices, 7 1/8 Percent Interest)

	Flood Damages									
Category	1980	1990	2000	2010	2020	2030	Increase 1980-2030	Average Annual Equivalency Factor	Average Annual Equivalency of Increase	Equivalency Average Annual Damages
Urban	*	*	*	*	*	*	*	----	*	*
Agricultural										
Crop	117,200	136,000	154,700	166,400	178,100	196,900	79,700	.2903	23,100	140,300
Other Agricultural	39,100	42,200	45,400	47,300	49,300	52,400	13,300	.2903	3,900	43,000
Transportation	45,600	45,600	45,600	45,600	45,600	45,600	----	----	----	45,600
TOTAL	201,900	223,800	245,700	259,300	273,000	294,900	93,000	.2903	27,000	228,900

*Average annual urban damages were reported to be minor for Turtle River Subbasin in the Red River of the North Basin Plan of Study, April, 1977.

Source: Gulf South Research Institute.

telephone systems) are also taken into consideration. This category also includes loss of wages, loss of profits, expenditures for temporary housing, cleanup costs, and extra expenses for additional fire and police protection and flood relief.

Agricultural flood damages consist of crop and pasture damage, which may include costs of replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other related flood losses.

Other agricultural damages consist of land damage from scour and gully erosion and deposition of flood debris; livestock and poultry losses; damages to machinery and equipment, fences, and farm buildings and contents (excluding residences); and damages to irrigation and drainage facilities.

Transportation damages include all damages to railroads, highways, roads, airports, bridges, culverts, and waterways not included in urban damages. In addition, all added operational costs for railroads and airlines and vehicle detours are included.

Agricultural crop flood damages were projected to increase at the same rate as crop income projections published in the 1972 OBERS Series E projection report. These crop income projections were prepared by the U.S. Economic Research Service (ERS) for the Red River of the North region. Other agricultural flood damages were projected to increase at one-half of this rate.

Transportation damages are not expected to change throughout the project life because of the long-term economic life associated with such structures as bridges, railways, roads, and culverts. In addition, it has been found that repairs to these types of structures rarely exceed the cost of a new structure, even with frequent flooding.

Most Probable Environmental Conditions

Improvements in water quality will occur with the successful implementation of point and nonpoint source pollution abatement plans. The nonpoint source plan, which will attempt to rectify problems associated with agricultural runoff, will take substantially longer to implement. These improvements will benefit both aquatic biota and wildlife. Periodic problems with low streamflows are expected to continue to restrict the fisheries in the Turtle River.

Native woodlands and wetlands are expected to decrease with the continued conversion of these habitats to agricultural and other land uses. Woodland losses may be offset to some degree with windbreak and greenbelt plantings; however, these may not be of the same quality as the forest lands that are lost. Declines in the areal extent of woodlands and wetlands will result in decreases of the floral and faunal populations dependent wholly or in part upon these communities.

Without Project Conditions

It is likely that the scenario set forth as the most probable future of the subbasin will prevail during the 50-year planning period in the absence of a plan to alter resource management programs.

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

Institutions

The development of effective water resources management practices in the subbasin is affected by a large number of Federal, state, and local agencies involved in project planning and implementation. There are 44 Federal agencies with various types of jurisdictions, and 14 directly involved in the water and related land resource planning process. At the state level, seven agencies are involved. There are also regional commissions, county agencies, and municipal entities. Differences in perspective and problems of coordination hamper the effective and speedy resolution of problems.

Water resources development is hampered in the subbasin by the lack of a unified resource management program. There are two water management districts representing Grand Forks and Nelson counties with authority in the subbasin. The districts have a broad range of water resource management interests in the area, including flood control, water supply, and water conservation. The districts, however, have not adopted individual overall plans or one that addresses the problems of the subbasin as a hydrologic unit. In addition, the Grand Forks and Nelson County Soil Conservation districts are important in water resource planning in the subbasin.

The Corps of Engineers has not developed any flood control projects in the area; however, SCS is presently constructing retarding structures and channel improvements in the Upper Turtle River Watershed. A total of eight reservoirs have been constructed in the subbasin, which has substantially reduced flooding problems. Additional efforts in flood control planning should include the Corps of Engineers, SCS, the water management districts and soil conservation districts with jurisdiction in the subbasin, and the town of Manvel. It should be noted that the Red River Regional Planning Council has developed a comprehensive land plan that includes the subbasin.

Structural Measures

Under the authority of Public Law-566, the Soil Conservation Service (SCS) has under construction a watershed project, the Upper Turtle River

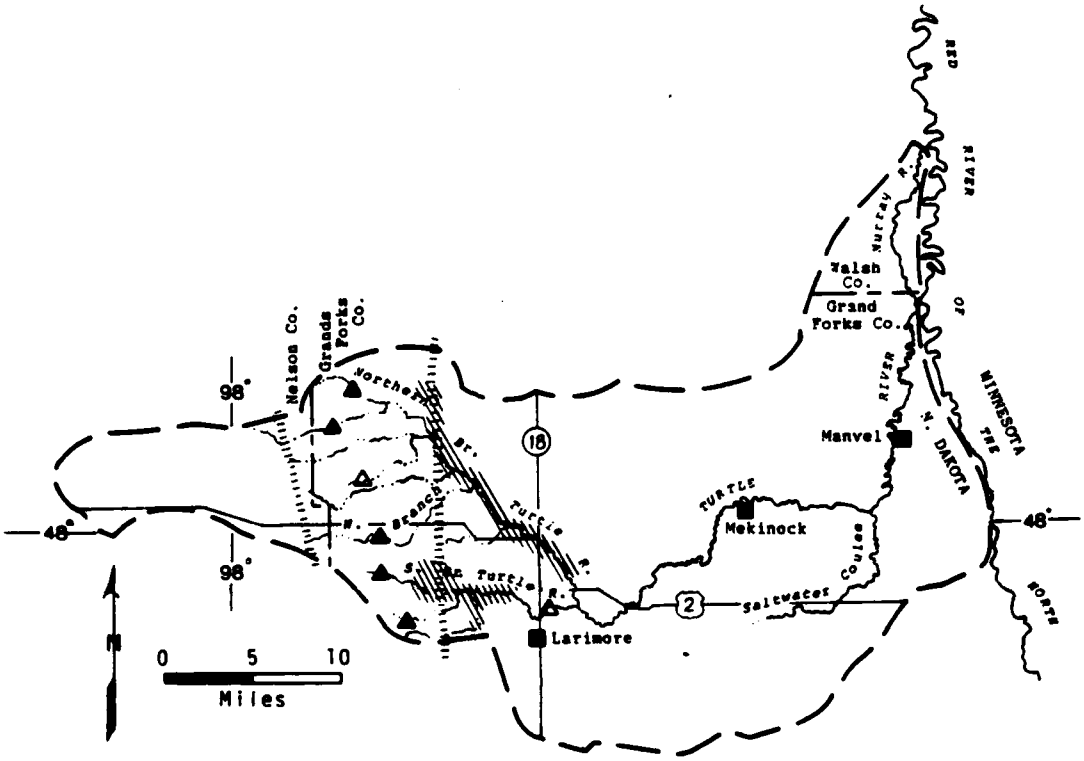
Watershed, which includes land treatment, floodwater retarding structures, a multi-purpose structure and channel modifications. Other structural measures for flood prevention and control in this subbasin include a limited number of private, state, and county drainage ditches and channels. The Corps of Engineers has no existing or planned water resources projects in the subbasin. The locations of existing floodwater control and agricultural water management (drainage) measures included in the SCS project are shown on Figure V.

The Upper Turtle River Watershed project was authorized in September, 1970 and is estimated to be completed in FY-82. This watershed covers 247 square miles in Grand Forks and Nelson counties, North Dakota. Both land treatment and structural measures for flood control are included in the project. Structural measures are seven floodwater retarding structures, one multi-purpose structure, and 26.5 miles of channel improvements. The total flood storage capacities of the eight reservoirs is 14,095 acre-feet. Six of the reservoirs have been completed and the other two are nearing completion. The structural improvements included in this project are designed to provide the entire watershed with protection against the 12.5 percent (eight-year) flood.

The SCS has a planning study in progress for the Lower Turtle River Watershed, which is expected to be completed shortly. However, this study is not expected to provide any economically feasible structural measures for flood control. The SCS has also investigated three additional floodwater retarding dam sites in this subbasin that were unacceptable because of varying reasons.

Nonstructural Measures

Nonstructural flood control measures are measures that reduce or eliminate flood damages through procedures that involve little if any construction efforts. The major types are flood warning, floodplain zoning, flood insurance, flood proofing and floodplain evacuation. These measures are primarily applicable to urban areas. Nonstructural measures modify the susceptibility of land, people, and property to damage or losses. In addition, they modify the impact of flooding upon people and communities. Nonstructural measures do not attempt to modify the behavior of floodwaters.



Subbasin Boundary

EXISTING AND PROPOSED PROJECTS

SCS Channel Improvements

SCS Completed Reservoirs

SCS Reservoirs under construction

Source: Gulf South Research Institute.

Figure V. EXISTING FLOOD CONTROL MEASURES

The towns in the floodplain participate in the Red River Valley flood warning system. The flood warning system for the Red River Valley is a cooperative network organized by the National Weather Service in Fargo, North Dakota. Fifty volunteers throughout the basin report to the national weather service on a weekly basis during winter and fall and on a daily basis during spring and summer. The reportage covers all precipitation of 0.1 inch or more, including amounts of snow and water equivalent. This information is transmitted to the River Forecast Center in Minneapolis, where it is run through a computer system to determine probable flood stages. The predictions are then transmitted to the National Weather Service in Fargo, which releases them to the public through the news media. Communities are then able to engage in emergency actions to protect themselves from flood damages. Contacts with local officials indicate that the flood warning system generally works quite well in the subbasin.

There are other types of measures that have been implemented in the subbasin to reduce flood damages but that are not directly applicable to urban areas. These measures are commonly referred to as land treatment measures. Land treatment measures basically consist of improved conservation cropping systems with emphasis on crop residue management in combination with stripcropping, cover crops, buffer strips, reduced field sized, and field windbreaks.

Cover crops and crop residue use have reduced erosion hazards, helped maintain organic matter and soil tilth, and increased the water holding capacity of the soils. Field windbreaks were implemented to provide protection for cultivated fields by reducing wind velocities and the transportation of snow or soil which might be deposited in field ditches and drainage channels. Land treatment measures implemented to improve and maintain good grass cover included pasture improvement, pasture planting and rotation grazing. Pasture plantings have helped control erosion and have increased infiltration. Pasture improvements have assured protection and maintenance of grass stands and grassed waterways and diversion construction have helped control runoff and have reduced erosion. Additional nonstructural alternative study recommendations have been included in Section XI on

pages 62-64 of this report. In particular, Study Recommendation Nos. 7, 10, 12, and 27 should be totally explored to reduce flooding throughout the subbasin.

Adequacy of Existing Measures

Flood prevention measures already completed in the Upper Turtle River Watershed project provide a substantial reduction in flood damages for this watershed, which comprises about 40 percent of the Turtle River Subbasin. When completed, this project will provide 12.5 percent (eight-year) flood protection for this 247 square mile watershed. Structural flood prevention measures will reduce the Turtle River one percent (100-year) flood discharge at Manvel from 33,000 cfs to about 26,000 cfs, a 22 percent reduction. Minor flooding occurs at Manvel at elevation 820.0 msl, which is the one percent flood crest elevation. The structural measures will reduce this elevation by about 0.5 feet to 819.5 msl and provide the town one percent protection. Also, these measures will provide the entire subbasin with 34 percent (three year) flood protection.

Although the Upper Turtle River Watershed project does provide significant flood damage reduction, floods exceeding 34 percent frequency will result in extensive flood damages in rural areas. Recurring flooding will continue to be a problem in this subbasin. Additional flood control measures would be required to further reduce flood damages.

VII. CRITERIA AND PLANNING OBJECTIVES

VII. CRITERIA AND PLANNING OBJECTIVES

Floodplain Management Criteria

Technical, economic, and environmental criteria must be considered when formulating and evaluating alternative floodplain management measures for the subbasin.

The technical criteria used in formulating and evaluating alternatives for this report consisted of the application of appropriate engineering standards, regulations, and guidelines.

Economic criteria entailed the identification and comparison of benefits and costs of each measure. Tangible economic benefits must exceed costs; however, in certain instances, considerations of appropriate gains in the other accounts (environmental quality, social well-being and regional development) could alter this requirement. All alternatives considered are scaled to a design which optimizes benefits. Annual costs and benefits are based on an interest rate of 7 1/8 percent and price levels and conditions existing in October 1979. A 50-year amortization schedule is used for the features considered.

Environmental considerations call for the formulation of measures that minimize objectionable or adverse environmental effects and maximize environmental benefits. Also, limited consideration was given to modifications based on coordination with state and Federal agencies, local interests, and citizen groups.

Planning Objectives

The primary planning objective of this study was to contribute to flood reduction needs in the subbasin and thereby provide protection from or reduction of flood losses. In conjunction with this economic objective, the study attempted to develop contributions to the environmental quality of the subbasin.

The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin from the information that was available. On the basis of this analysis of the problems, needs, and desires that could be identified, the following planning objectives were established:

1. Contribute to protection from and prevention, reduction, or compensation of flood losses for the flood prone areas of the subbasin during the period of analysis.

2. Contribute, to the maximum extent possible, to the preservation of the quality of the existing riverine environment and enhance the environmental potential of the subbasin as a whole.

3. Contribute to the enhancement of recreational opportunities throughout the subbasin.

4. Contribute to the improvement of water quality in the Turtle River and its tributaries.

5. Contribute to the improvement of water supply throughout the subbasin.

6. Contribute to the reduction of wind and water erosion throughout the subbasin.

7. Contribute to the developing trend toward increased irrigation throughout the subbasin.

8. Contribute to the reduction of wastewater management problems, particularly insofar as they relate to water quality.

9. Contribute to the development of small hydroelectric installations along the Turtle River.

VIII. FORMULATION OF ALTERNATIVE MEASURES

VIII. FORMULATION OF ALTERNATIVE MEASURES

This section discusses management measures that have been identified to satisfy the resource management objectives. Prime consideration was given to the resolution of flooding problems in the formulation of alternative measures. Measures to satisfy the other planning objectives were considered exclusively as components of the flood control measures.

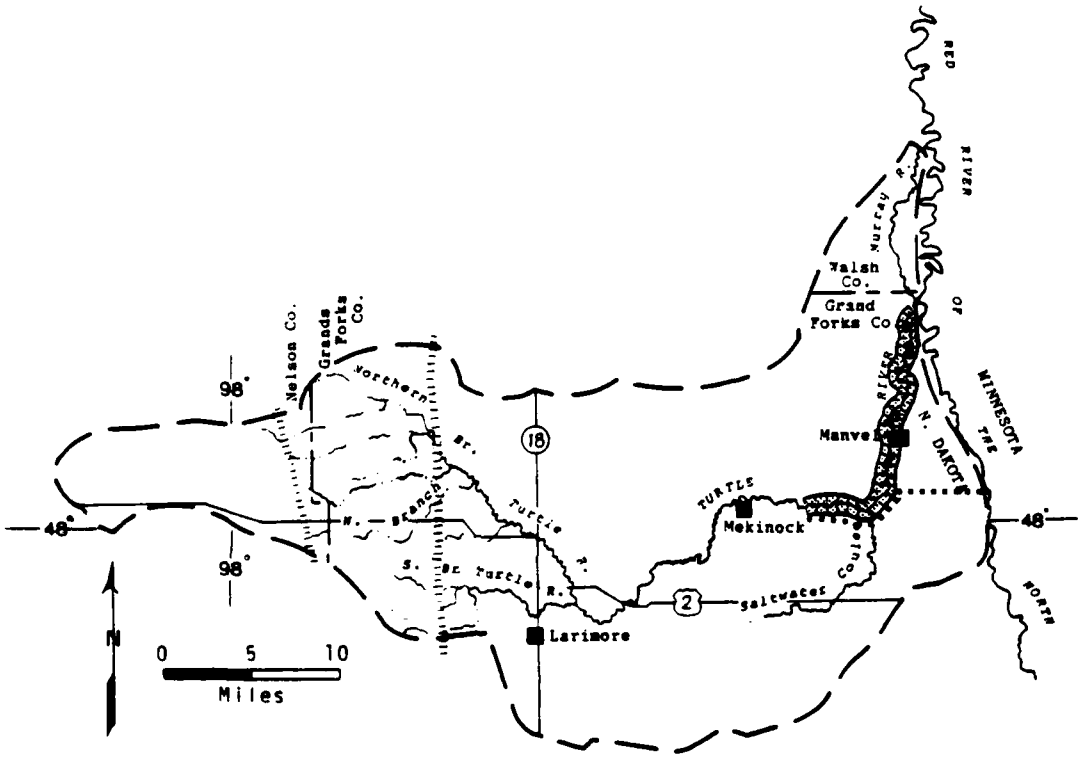
The following measures, which are illustrated in Figure VI, were devised in response to the flood control planning objective:

1. Agricultural levees constructed along each side of the main stem of the Turtle River for about 35 miles upstream from its mouth to high ground. The levee system would be set back from the channel in order to satisfy the recently devised Minnesota-North Dakota agricultural levee criterion stipulating that the one percent (100-year) flood stage would not be increased more than 0.5 feet. This levee arrangement protects about 24,000 acres in the one percent floodplain, which is approximately 45 percent of the existing floodplain. The average annual area flooded would be about 5,280 acres, of which 4,752 acres would be cropland and other improved areas. The remaining acreage is in woodlands. The implementing agency would be the Corps of Engineers.

2. Improving 35 miles of the existing Turtle River channel to contain the 10 percent (10-year) flood. This measure would provide the entire subbasin with 10 percent flood protection and protect about 23,800 acres from the 10 percent flood. The average annual area flooded would be about 2,050 acres, of which about 1,845 acres would be cropland and other improved areas. This measure provides a higher level of flood protection than Alternative 1, the levee system.

3. Improving eight miles of the existing Turtle River channel to contain the 10 percent (10-year) flood and constructing a diversion channel to contain (in conjunction with the existing channel) the 10 percent flood. The benefits from this measure would be the same as those shown for Alternative 2, the 35 mile channel modification scheme. The implementing agency for this measure would be the Corps of Engineers.

4. Construction of farmstead levees around individual farmsteads in the one percent floodplain. These levees would protect individual farmsteads from the one percent flood and could be constructed by the SCS, Corps of Engineers, or private interests.



Subbasin Boundary

ALTERNATIVES

Channel Improvement

Diversion Channel

Agricultural Levees

Source: Gulf South Research Institute.

Figure VI. ALTERNATIVE FLOOD CONTROL MEASURES

Engineering Methodology

Information used as a base in this analysis was extrapolated from prior studies and reports. Flood probability vs. discharge curves for the Turtle River at Manvel were developed for the conditions "with" and "without" structural improvements included in the Upper Turtle River Watershed project. These curves were used to determine the effect of the SCS structural measures on stream discharges for various frequencies. Channel capacities were estimated using actual stream cross-sections and USGS Quadrangle maps. Stage-discharge curves were developed from this data showing flood stages at Manvel without the SCS structural measures and with structural measures. Generalized curves developed during the course of this study were used to estimate floodplain reduction resulting from implementing the levee and channel modification measures. Curves were derived from all of this data showing area flooded vs. percent chance of occurrence in one year, which were used to estimate average annual area flooded and average annual benefits for the levee and channel modification schemes. The levee scheme was based on containing the one percent flood and the channel modification schemes on containing the 10 percent flood. This analysis was based on floods in the Turtle River Subbasin occurring independently of flooding caused by Red River of the North backwater and/or overland flooding from other streams.

The farmstead levee alternative is based on data obtained from studies by the Corps of Engineers. Capital costs for all alternatives are based on October, 1979 unit construction costs developed in this study. Farmstead levee capital costs assume that individual owners will build their own levees. Capital costs for the levee scheme are based on use of portable pumping facilities. Costs of the combination channel diversion-modification scheme (Alternative 3) include the cost of railroad and highway bridges where the diversion channel crosses the Great Northern Railroad and U.S. Highway 81. The effect of woodlands was taken into account in estimating average annual benefits and damages. The capital cost of pumping facilites was based on pumps sized to accommodate the 20 percent (five-year) flood.

It should be emphasized that there is limited hydrological and stream flow data and descriptive materials for the Turtle River Subbasin. Also, there are gaps in the USGS Quadrangle maps covering the subbasin, and some of the information used was obtained from Corps of Engineers 1:250,000 scale maps. This analysis and resulting estimates of flood stage reductions, floodplain reductions, effectiveness of alternative structural measures, flood damages and benefits, and capital costs have been based on this limited data, generalized data developed in the course of this study, and the contractor's experience and judgement.

Nonstructural Measures

The only nonstructural measures considered in previous reports were the extensive land treatment measures studied and implemented by the Soil Conservation Service (SCS). These measures were discussed in detail in Section VI.

Floodpain regulation and flood insurance are currently required by Federal policies and are encouraged by the state of North Dakota. Local governmental units were required to participate in the flood insurance program by 1 July 1975 or no later than one year after the date of issuance of floodplain hazard boundary maps, whichever is later. Once flood insurance rate studies are completed, permanent land use controls must be adopted by local communities within six months. Over a long period of time, all nonconforming floodplain structures would be eliminated, thereby reducing flood damages. However, because home and business owners in flood prone areas can obtain structural improvement loans through the purchase of flood insurance, and because the value of the contents of these structures can be expected to increase, flood damages will increase in the near future even with floodplain regulations in effect. No existing information is available to verify the status of this alternative in the subbasin.

Unsubsidized crop insurance is available through the U.S. Department of Agriculture Federal Crop Insurance Program, which covers all natural disasters including floods. However, actual crop damages could be reduced only to the extent that intensive farming practices would be discouraged over a long period of time in the floodplain. Because of the highly

productive nature of floodplain farming, it is very doubtful that any long-term shifts away from the intensive farming of floodplain areas would occur.

Flood warning and forecasting services in conjunction with emergency protection have been used with reasonable success. However, the amount of time between the flood warning and forecasting and the actual flood event is critical to the type of emergency works that can be implemented. Also, the larger the magnitude of the flood, the greater the structural stability problems caused by underlying soil conditions. In addition, the greater danger of failure would increase the potential for loss of life. Emergency protection measures would continue to inconvenience and disrupt the biological system and scenic quality of the area. Therefore, this alternative would have serious social, environmental and economic problems in being seriously considered as an acceptable solution to the total flood problem.

Permanent evacuation of flood prone areas would consist of the acquisition of lands, relocation of improvements, and resettlement of the population, ultimately resulting in the conversion of land use to a state less susceptible to flood damages. Impacts of the implementation of this alternative would primarily be cultural and economic in nature. Flood proofing would involve structural changes and adjustments to properties in an effort to reduce or eliminate flood damages. This is most effective when applied to new construction, but can be applied to existing structures in some instances. Permanent evacuation would result in the disruption of long-established social and cultural relationships, but could eliminate flood damages to structural units, providing floodplain regulations were enforced. Furthermore, the health and safety of floodplain residents would be benefited and natural habitats would be improved. However, the residual damages to agriculture, and the economic, social, and cultural impacts would more than likely offset the benefits.

The preceeding discussion summarized some of the major nonstructural alternatives most commonly analyzed in similar subbasins by the Corps of Engineers.

IX. ASSESSMENT OF ALTERNATIVES

IX. ASSESSMENT OF ALTERNATIVES

Economic Assessment

Flood waters overtop existing channel banks and flow across the extensive flat land areas. Recurrent inundation of the agricultural lands constitutes the major flooding problem. In assessing flood control alternatives, it should be emphasized that hydrologic and streamflow data for the subbasin is limited. Estimates of flood stage reduction, flood plain reduction, effectiveness of alternative structural measures, flood damages and benefits, and capital costs have been based on this limited data, generalized data developed in the course of this study, and the contractor's experience and judgement. Average annual benefits (updated to October 1979 levels) were developed using weighted damages per acre from the Sheyenne River, North Dakota, Phase 1 General Design Memorandum, Flood Control and Related Purposes, completed by the Corps of Engineers in February, 1980. The effects of the flood control alternatives for the subbasin and their costs and benefits are presented in Table 12.

Alternative one consists of the construction of levees along each side of the Turtle River for a distance of 35 miles upstream from its mouth to high ground. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.09.

Alternative two consists of 35 miles of channel improvements to the existing Turtle River channel. This alternative would provide the entire subbasin with 10 percent flood protection and protect about 23,800 acres. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.56.

Alternative three consists of improving eight miles of existing Turtle River channel to contain the 10 percent (10-year) frequency flood and constructing a diversion channel to contain, in conjunction with the existing channel, the 10 percent flood. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.56.

Table 12

ECONOMIC EVALUATION OF ALTERNATIVES, TURTLE RIVER SUBBASIN

Alternatives	Acres Protected	Average Annual Acres	Capital Costs	Average Annual Costs	Average Annual Rural Benefits	Average Annual Urban Benefits	Total Average Annual Benefits	B/C Benefits
1. Agricultural Levees (1 percent flood)	24,000	5,280*	$6,997,000	$515,000	$ 47,600	----	$47,900	0.09
2. Channel Modification (10 percent flood)	23,800	2,050*	5,990,000	440,900	247,900	----		0.56
3. Combination Channel Modification and Diversion Channel (10 percent flood)	23,800	2,050*	4,854,000	357,300	247,900	----		0.56
4. Farmstead Levees (Per levee)	----	----	5,600	400	840	----	840	2.10

*Calculation of average annual benefits is based on the amount of average annual cleared acres (cleared average annual acres for Alternative 1 is 4,752 and Alternatives 2 and 3 is 1,845).

Source: Gulf South Research Institute.

Alternative four consists of the construction of farmstead levees around individual farmsteads in the one percent floodplain. These levees would protect individual farmsteads from the one percent frequency flood and could be implemented by private individuals. Economic evaluation of this alternative yielded a benefit/cost ratio of 2.10.

Impact Assessment

Four measures were investigated for their anticipated effects on key resource elements in the event of implementation. The following discussion elaborates on the rationale pursued in the assignment of ratings presented in Table 13.

Agricultural Levees-Turtle River

The Turtle River agricultural levees would afford protection to 24,000 acres and thus would be moderately beneficial from an economic and social standpoint. The levees would provide primary benefits in the way of economic advantages to most of the agricultural lands in the flood prone areas of the Turtle River (reduced flooding, earlier planting dates, fewer crop losses, etc.). Most of the social benefits would accrue from reduced flood damages to residences and farmsteads, fewer rural community disruptions, and reduced threats to public health and safety during flood periods. Adverse social effects would occur because largely agricultural lands would be needed to provide for rights-of-way and easements.

Moderate to maximum beneficial effects are anticipated for wildlife resources, since the large setbacks would induce development of a riparian community. Adverse effects would occur to land use (possible induced clearings) and to water quality as a result of increased turbidity from construction activities, but the effects would be minimal. It is not known how water supply and cultural elements would be affected. Minimum beneficial recreation benefits would accrue from fishing activities in borrow areas.

Channel Modifications and a Diversion Channel

Two channel improvements and a diversion channel (separate measures) would yield moderately beneficial social and economic effects, some moderate to maximally adverse biological effects, and short-term adverse results for water quality elements. It is not known what effects would take

Table 13

ASSESSMENT OF MEASURES, BY RESOURCE ELEMENT, TURTLE RIVER SUBBASIN

Measures	Social	Economics	Land Use	Biology	Water Quality	Water Supply	Cultural	Recreation
Agricultural Levees	MoB	MoB	MiA	MoA	MiA	NkE	NkE	MiB
Channel Modification (10% Flood)	MoB	MoB	NkE	MaA	MoA	NkE	NkE	MiB
Channel Modification and Diversion Channel	MoB	MoB	NkE	MoA	MiA	NkE	NkE	MiB
Farmstead Levees	MiB	MiB	NkE	NkE	NkE	NkE	NkE	NkE

Note: NkE = No Known Effect
MiA = Minimally Adverse
MoA = Moderately Adverse
MaA = Maximally Adverse
MiB = Minimally Beneficial
MoB = Moderately Beneficial
MaB = Maximally Beneficial

Source: Gulf South Research Institute.

place with respect to land use, water supply and cultural elements, while minimally positive recreation benefits would result from such actions.

Social and economic benefits would accrue from the flood protection and flooding reductions that would stem from the project. Some 24,000 acres in the subbasin would be afforded such protection under either alternative selected. Possible oxbow lakes and trails for summer and winter use would yield recreational benefits. Biological and water quality elements would be affected negatively by dredging activities, placement of dredged material, vegetation removal, and temporary turbidity. Two endangered fishes are found in these reaches. Water quality should, however, improve in the long run as stream flows are enhanced.

Farmstead Levees

Localized minimally beneficial economic and social effects would result from the protection of farmsteads from frequent floods by development of ring levees. Other resource elements would not be notably affected, although aesthetic, sanitary, and maintenance factors would need to be considered.

X. EVALUATION

X. EVALUATION

Only the farmstead levees have benefits that exceed unity. These measures are also the only ones that maximize economic benefits for the subbasin, but they afford only extremely localized protection. The average annual costs for agricultural levees and channel modification measures are much larger than the average annual benefits. The channel improvement measures considered for the Turtle River had benefit/cost ratios of 0.56, the highest following the farmstead levees.

The greatest environmental enhancement would result from the agricultural levees on the Turtle River, where the large setbacks would provide protection to the riparian belt and would create or expand habitats.

National Economic Development (NED) and Environmental Quality (EQ) plans will be tentatively formulated in association with the Red River of the North Basin reconnaissance report.

XI. ADDITIONAL STUDY NEEDS

XI. ADDITIONAL STUDY NEEDS

This report was developed almost entirely on the basis of secondary information from readily available planning documents. Data available from state and Federal agencies was not fully canvassed, and only a limited number of calls were made to the area. In particular, state university libraries and department resources could not be fully utilized. Thus, the document aims only at a broad-brush perspective. In order to provide a more detailed and in-depth analysis of subbasin resources, problems, and potential solutions, the following additional study needs would have to be fulfilled:

1. A literature search should be conducted to obtain available biological data for the subbasin. Fieldwork should be planned to fill in any data gaps which exist with the end result of obtaining good baseline data for the subbasin. This is particularly necessary in those areas where flood control measures have been proposed.
2. Areas of high environmental quality (e.g., prairie remnants and reparian woodlands) should be identified and inventoried within the subbasin.
3. Updated knowledge of the location, areal extent, and types of wetlands occurring within the specific subbasin boundaries would be extremely useful in determining whether wetland restoration would assist in alleviating flooding problems, as has been indicated by Cernohous (1979), and would provide a comparison for documenting wetland losses since the 1964 inventory.
4. Primary water and sediment quality data are needed to update baseline conditions in the streams of the subbasin, particularly in those areas where flood control measures have been proposed.
5. Information pertaining to wastewater management needs to be updated.
6. The information obtained in items 1-5 above would provide an important data base upon which an impact evaluation of proposed flood control measures can be performed and would provide information relative to the cumulative effects of flood control projects on environmental resources in the subbasin. These projects include those that are in place or proposed.
7. Nonstructural flood damage reduction measures should be thoroughly explored such as those listed below.

- Establishment of buffer areas and curtailment of inappropriate residential, commercial, and other development in floodplains.
- Maintenance and enhancement of existing riparian vegetation along the Turtle River and tributaries to conserve and restore wildlife habitats, help contr wind and streambank erosion, retain soil on the land, and reduce the amount of sediment, nutrients, and other pollutants entering waterways.
- Maintenance of grassed waterways to reduce erosion.
- Establishment of vegetation in areas of critical erosion.
- Determination of the feasibility of installing water control structures at existing culverts to retain water in drainage ditches for longer periods of time during critical runoff periods to minimize flooding in downstream areas.
- Determination of the feasibility of utilizing "onfarm storage" to control runoff through such means as natural storage areas and control structures on exist: culverts.
- Prevention of overgrazing on grasslands and utilizati of sound agricultural land use practices.
- Provision for strict enforcement of floodplain manager programs within the subbasin.
- The potentiality for land treatment measures (e.g. erosion control measures such as cover crops, green belts, reduction in fall tillage, etc.) needs to be thoroughly investigated.

8. The people of the subbasin need to be included in further water resource planning efforts. A public involvement program would provide more complete information on water resource problems and opportunities than is presently available.
9. More study is needed to determine the precise nature of the water supply problems and potential solutions.
10. Potentialities for floodwater storage in present drainage ditches need to be investigated.
11. The effect of drainage works on flood discharges and stage: is unknown at present. It would take additional, more detailed studies to determine the extent and effect of reduced natural storage.
12. Land use within the floodplain needs to be precisely ident:

13. An adequate 100-year floodplain map needs to be developed. Also, the extent of floodplains for smaller frequency storms needs to be delineated.

14. More gauging stations need to be developed to provide hydrologic data for establishing flood frequencies and rating curves.

15. Channel cross-sections of the various streams need to be prepared for flood control planning purposes.

16. Crop distribution in the floodplain needs to be precisely identified through contact with county agents, and average annual rural damages need to be updated.

17. The irrigation potentials of the subbasin soils need to be investigated.

18. A comprehensive and up-dated inventory of recreation sites would be required to accurately identify resources.

19. Studies are needed to determine additional demand for recreational facilities, usage of existing facilities, and potential sites.

20. A regional supply and demand analysis for hunting, fishing, and other water based or related recreational pursuits is needed.

21. Whether forested acreages in the floodplain are increasing or declining needs to be precisely determined.

22. A detailed study of the objectives, goals, and programs of the many institutional entities involved in water resources planning, particularly at the local level, is needed to determine the most efficient institutional approach to the resolution of flooding problems.

23. A detailed institutional analysis of the subbasin is needed.

24. A detailed social profile of the subbasin is needed.

25. Urban damages need to be recomputed in a systematic fashion.

26. A review of secondary sources and systematic field reconnaissance is needed to identify archaeological and historical sites and to determine their eligibility for nomination to the National Register of Historic Places.

27. The potential for land treatment measures (e.g., erosion control measures such as cover crops, greenbelts, reduction of fall tillage, etc.) needs to be thoroughly investigated.

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Appendix A
FLOODPLAIN DELINEATION

Appendix A

FLOODPLAIN DELINEATION

Prior to this study, no attempt was made to publish even a generalized delineation of the entire Turtle River floodplain. In undertaking this task, the present study utilized all known sources to provide the best available data for generalized delineation of the subbasin at a scale of 1:250,000. Principal sources were: USGS Flood Prone Area Maps (scale 1:24,000), Federal Insurance Administration flood maps, published secondary sources, U.S. Geological Survey (USGS) 7½ minute topographic maps, and other sources, including derived data where necessary.

The Flood Prone Area Maps published by the USGS provided detailed and highly accurate information along the main stem Red River and the area east of the town of Emerado. Six USGS 7½ minute topographic maps providing additional coverage in the main stem Red River area and the central part of the subbasin were available for consideration.

Unlike the extensive coverage of the Minnesota side provided by Federal Insurance Administration flood maps, only selected incorporated areas are generally available in North Dakota. Grand Forks and Walsh counties joined the emergency program in 1974 and 1978, respectively, but are not yet mapped. Nelson County is not listed in the program. Available community maps include: Manvel, Emerado, Michigan, and Petersburg. The first two provided small segments of the Turtle River floodplain at those locations.

Secondary sources, such as the Souris-Red-Rainy River Basins Type II Study, were also utilized. Published floodplain descriptions and acreage estimates in the Manvel flood hazard study published in 1977 and the 1971 Upper Turtle Watershed Work Plan were also utilized. The total area delineated in Figure II coincides with the 56,000 acres listed in the Souris-Red-Rainy report.

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS) TURTLE RIVER SUBBASIN

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES[1]
TURTLE RIVER SUBBASIN

Number	Name	Administration	Location	Acres	Campgrounds[2]	Playground	Athletic Field[3]	Golf Courses[4]	Boat Ramps	Picnic Tables	Beach	Pool	Trails[5]
1	Prairie Chicken WMA	State	Grand Forks County Manvel	3,151.0									
2	Kelly's Slough NWR	Federal	Grand Forks County MeKinock	1,265.0									
△1	Turtle River State Park	State	Grand Forks County Larimore	640.0	95	1	1			295		1	6
△2	Villa Vista Ski Area	Private	Grand Forks County Arvilla	150.0									
(1)	Larimore Golf Course	Municipal	Grand Forks County Larimore	125.0			2	9	1	4	1		

[1] Facilities included are those with 15 or more acres.

[2] Number of campsites.

[3] Number of fields.

[4] Number of holes.

[5] Number of miles.

Source: North Dakota State Parks and Recreation Department, Inventory of North Dakota Outdoor Recreation Facilities, 1979.

Gulf South Research Institute.

Appendix C
COMMENTS

Appendix C
COMMENTS

The purpose of this subbasin report was to provide an overview of the water and related resource problems and needs and to assess potential solutions. Toward this end, draft copies of this report were circulated to Federal, State, and local agencies and comments were sought.

This review resulted in complete and factual documentation. Thus, the study should serve as a building block for the timely completion of future water resource efforts within the subbasin. Further cooperative efforts are, however, needed to evaluate these tentative results and to develop potential solutions.

A distribution list and copies of the comments made with respect to the draft report are included as part of this appendix. Comments that resulted in specific modifications to the draft text are marked by an asterisk.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL MINNESOTA 55101

REPLY TO
ATTENTION OF:
NCSED-PB

17 September 1980

Mr. Mike Liffmann
Project Manager
Gulf South Research Institute
8000 GSRI Avenue
Baton Rouge, Louisiana 70808

Dear Mr. Liffmann:

The draft Turtle River subbasin report was distributed for review and comment. Most of the reviewers have sent their comments to us.

a. Inclosure 1 includes letters from various Federal and State agencies. Other letters, when received, will be provided under separate cover.

b. Inclosure 2 is the general office comments that need to be considered when preparing the final Turtle River subbasin report and the remaining subbasin reports and the overall document.

c. Inclosure 3 identifies specific office concerns that are applicable to the Turtle River subbasin report.

If you have any questions on our comments or proposed modifications, please contact us.

Sincerely,

3 Incl
As stated

LOUIS E. KOWALSKI
Chief, Planning Branch
Engineering Division

AD-A140 703 RED RIVER OF THE NORTH RECONNAISSANCE REPORT: TURTLE RIVER SUBBASIN(U) GULF SOUTH RESEARCH INST BATON ROUGE LA DEC 80 DACW37-80-C-0017 2/2

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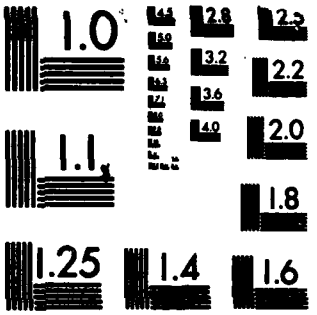


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 1458, Bismarck, ND 58502

August 22, 1980

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

Dear Colonel Badger:

Following are our comments concerning the Red River of the North reconnaissance study being conducted for the Turtle, Goose, Elm and Rush subbasins.

Turtle River:

* Page 9, Flood Damages - The city of Emerado and the small community of Arvilla, located in the subbasin, are also flood prone.

* Page 14, Public Perception of Problems and Solutions, first paragraph - We believe the problems in the subbasin are well known. Many solutions have been suggested by various parties, both public and private. Further, if the statement that problems and solutions are not well defined and this reconnaissance report does not spell them out, Gulf South Research Institute did not complete their research.

* Second paragraph - The Upper Turtle River Watershed Work Plan was prepared by the sponsors with assistance by U.S. Department of Agriculture, Soil Conservation Service and Forest Service, not by the Minnesota Soil Conservation Service.

Goose River:

Page 42, Threatened or Endangered Species - We question the inclusion of the black bear if it prefers extensive stands of forests. The Turtle River subbasin has 0.7 percent forest (Pages 24 and 25). How long ago was the bear reported for Traill County?

Elm River:

Page 13, Public Perception of Problems and Solutions, first paragraph - This trite statement appears in several of the subbasin reports. It implies that unless the Corps has conducted public meetings, the public is ignorant. We don't believe this.

Jr.C1

Second paragraph - The Elm River Watershed Work Plan was prepared by the local sponsors with assistance by the U.S. Department of Agriculture, Soil Conservation Service in 1957, not 1972.

Third paragraph - Local sponsoring agencies have entered into working agreement. The plan has been carried out and the project is completed.

Page 25, First paragraph - The Elm River is classed as an intermittent stream. We don't believe channelization had anything to do with it. Rainfall, snowmelt runoff, etc., dictate streamflow. Channelization does not influence climate.

Page 34, Last paragraph - With only 0.1 percent of the area in forest, we expect the absence of habitat is the reason for the decline of the black bear rather than hunting and trapping. When was the black bear last reported in Traill County?

Rush River:

Page 13, Public Perception of Problems and Solutions - Same trite statement; however, the second paragraph almost contradicts it in that the Corps reports on a public hearing.

Sincerely,

Charles E. Mumma
Assistant State Conservationist (WR)

REVISED AUG 1980

STATES' CURRENT NORMALIZED PRICES FOR PRINCIPAL COMMODITIES: ISSUED OCTOBER 1979

State	Wheat all(1)	Rye(1)	Soybeans for beans	Corn for grain(1)	Oats(1)	Barley(1)	Flaxseed	Hay, all baled	Dry beans	Sugar beets(2)	Potatoes
Michigan	2.78	1.83	6.19	2.09	1.27	2.17	-	46.48	15.59	26.17	4.58
Wisconsin	2.62	1.96	6.03	2.13	1.13	1.66	-	43.05	-	-	4.40
Minnesota	2.99	2.13	6.13	2.02	1.12	1.91	5.92	45.14	13.41	22.37	3.09
Iowa	2.56	2.10	6.21	2.08	1.15	-	-	44.92	-	-	3.96
North Dakota	3.14	2.00	5.97	2.05	1.08	1.86	5.94	40.02	14.41	21.64	3.16
South Dakota	2.97	2.01	5.81	1.99	1.11	1.72	5.90	40.37	-	-	2.94

(1) Includes allowances for loans outstanding and purchases by the Government valued at average loan and purchase rate. Does not include price support payments.

(2) Does not include payment under the Sugar Act.

These have been revised - Please check the prices you used.

United States Department of the Interior
FISH AND WILDLIFE SERVICE
AREA OFFICE—NORTH DAKOTA
1500 CAPITOL AVENUE
P.O. BOX 1897
BISMARCK, NORTH DAKOTA 58501

SEP 2 5 1980

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

Re: Red River Mainstem (CE)

Dear Colonel Badger:

This letter provides U.S. Fish and Wildlife Service (FWS) comments on the Draft Reconnaissance Report recently compiled by the Gulf South Research Institute for the Turtle River Subbasin in Grand Forks and Nelson Counties, North Dakota.

As expressed in our comments on previous subbasin reports, our major concerns are associated with the woodland, grassland, wetland, riverine and riparian flood-plain habitats that still remain within this subbasin. Much of the woodland, grassland and wetland habitat in the eastern half of the subbasin has been converted to agricultural uses. We agree with the statements on pages 11, 22, 23 and 33 that these remaining grassland, woodland and wetland habitat types are significant and need to be protected, conserved and enhanced within the subbasin.

The report addressed four structural alternative measures that have been identified to date to meet the study's flood damage reduction objective. The report indicated, however, that only one of these measures has a favorable B/C ratio and appeared to be economically feasible. These measures and our comments relative to each are as follows:

Alternative 1 - Agricultural Levees

This alternative consists of the construction of levees along each side of the Turtle River for a distance of 35 miles upstream from its mouth to high ground.

Our main concern with this alternative is that the levees be constructed outside the riparian woodland corridor to minimize adverse impacts on riparian woodland, wetland and grassland habitats. Page 58 of the report states that moderate to maximum beneficial effects are anticipated for wildlife resources since the large setback of the levees away from these river channels would provide protection of the riparian belt and induce a reestablishment of the riparian community (woodland and/or brushland habitat) between the levees in these areas. We suspect, in many instances, this would only occur if these areas are "zoned" to prevent agricultural activities from being undertaken between the levees and the existing river channel. It is also stated on Page 58, that minimum beneficial recreation benefits would accrue from fishing activities in borrow areas that

would be created in order to construct the levees. We believe these borrow areas would only have a minimum fishery value. Instead, we would suggest that wetland areas be constructed in these borrow site locations as a mitigation feature for the project. The general design specifications for these wetland areas, however, should be coordinated with the FWS. This alternative did not have benefits that exceed costs. If this alternative is implemented, adverse environmental impacts are likely to range from moderate to very severe depending on the placement of agricultural levees.

Alternative 2 - Channel Modification (10 Percent Flood)

This alternative consists of 35 miles of channelization to the Turtle River. This alternative would provide the entire subbasin with a 10 percent flood protection and protect about 23,800 acres.

In our view, channelization projects constitute short-term, piecemeal and localized attempts to reduce flooding problems that disregard effective long-range solutions and place an added burden of floodwaters on people and property downstream. It is the FWS's belief that wetland drainage, both legal and illegal, is one of the principal causes for the increased frequency of flooding in the Red River Basin to date. In the past, stream modification alternatives in the Prairie Pothole Region of eastern North Dakota and western Minnesota facilitated the drainage of existing wetlands, in addition to those already drained in the project area. This alternative does not have benefits that exceed costs. If this alternative is implemented, adverse environmental impacts are likely to be very severe.

Alternative 3 - Combination Channel Modification and Diversion Channel (10 Percent Flood)

This alternative would improve 8 miles of the existing Turtle River channel to contain the 10 percent (10-year) flood and constructing a diversion channel to contain (in conjunction with the existing channel) the 10 percent flood. This alternative did not have benefits that exceed costs. Our comments are the same for this alternative as those provided previously for Alternative 2.

Alternative 4 - Farmstead Levees

We do not anticipate any adverse environmental impacts due to this alternative provided the dikes are not constructed through wetland areas and impacts to existing woodland vegetation are avoided to the extent possible.

Generally, we find the draft report to be a well written overview of the water and related land resources, problems and possible solutions to some of these problems within this subbasin of the Red River of the North. We suggest, however, that the following changes be made in the report:

* 1. Pages 14-15, third paragraph, under the heading "Public Perception of Problems and Solutions - We suggest this paragraph be changed to read as follows:

At that time, the primary problem was watershed flooding causing damage to crops, roads and bridges. Local sponsors also cited the need for water based recreation. The sponsoring districts stated a desire that recreational development be a goal for future watershed projects. Other water related needs of the subbasin are conservation of fish and wildlife and improvement of water quality. Soil Conservation Service (SCS) nonstructural improvements in the upper watershed will contribute towards meeting these needs. Nonstructural land treatment improvements should include, but not be limited to the following: (1) maintain existing riparian vegetation along the Turtle River and tributary stream to preserve existing wildlife habitat, help control wind and streambank erosion, retain the soil on the land and reduce the amount of sediment, nutrients and other pollutants entering the waterways; (2) maintain grassed waterways and eliminate stream channelization practices (straightening, deepening or widening), which provide only localized flood protection while moving floodwaters downstream for other areas to contend with; (3) establish vegetation windbreaks adjacent to tributary streams (greenbelts) and in other appropriate areas to reduce erosion and help to retain the soil on the land; (4) apply more cover crops and utilize minimum tillage practices to reduce erosion, the rate of snow melt and increase subsurface moisture; and (5) provide incentives to local landowners within the Turtle River Subbasin so that sound land-use practices will be implemented. Implementation of these alternatives will improve the water quality and enhance the fish and wildlife resources currently found in the Turtle River Upper Watershed.

*2. Page 20, first paragraph, second sentence, under the heading "Land Use" - We suggest this sentence be changed to read, "Most of the pasture is located in the western part of the subbasin".

*3. Page 22, first paragraph, third sentence - We suggest this sentence be changed to read, "Wetlands are not common in the eastern portion, where agricultural development is most prevalent".

*4. Page 26, fifth and seventh sentences - The "Murray River" should be changed to read "Marais River".

*5. Page 33, first paragraph, second sentence - We suggest this sentence be changed to read, "The rivers and lakes are important for recreation, water supply and fish and wildlife".

*6. Page 34, first paragraph, under the heading "Waterfowl Production Areas" - We suggest this paragraph be changed to read as follows:

Waterfowl Production Areas (WPA's) are wetland areas that the U.S. Fish and Wildlife Service (FWS) has either acquired through fee title, or obtained an easement interest in, to preserve valuable breeding, nesting and feeding habitat for migratory

waterfowl. These wetland areas are purchased, or an easement interest obtained, with funds received from the sale of migratory bird hunting and conservation stamps (Duck Stamps). These WPA's are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities, as well as providing valuable habitat for migratory waterfowl and many other forms of wildlife. FWS is responsible for the compatibility determinations (uses) and the issuance and denial of permits involving these lands. WPA's acquired in fee title are managed for optimum wildlife production, particularly waterfowl. On easement WPA's, the rights acquired are limited to the burning, draining and filling of wetland basins and right of access. All other property rights remain with the landowners. The approximate locations of the WPA's acquired in fee within the subbasin are shown in Figure IV. Total acreage of these WPA's, fee and easement, included in the subbasin are listed in Table 9.

*7. Page 36, Figure IV - Place "fee tracts" in parenthesis after the legend. We believe at least 11 WPA's should be identified by a dot in Figure IV. We have attached a copy of Figure IV indicating the approximate locations of these WPA's (Attachment 1).

*8. Page 38, first paragraph, fifth sentence, under the heading "Other Important Species" - We suggest this sentence be changed to read, "Wood ducks in North Dakota are commonly found along woody reaches of the Red River and its tributaries" (FWS 1980).

*9. Page 38, first paragraph, first sentence, under the heading "Rare and Unique Plants" - Remove "(no date)" and insert "(1976)".

*10. Page 38, first paragraph, under the heading "Natural Areas" - We suggest this paragraph be changed to read as follows:

Three natural areas are located within the subbasin (Figure IV). They include: (1) Oakville Prairie Biology Station (University of North Dakota) located 2 miles east of Emerado, North Dakota. This tract contains 800 acres of lowland and upland prairie; (2) Grand Forks County Prairie Chicken Range located 2½ miles north of Mekinock, North Dakota. This tract is comprised of a low prairie grassland type habitat which supports a small population of prairie chickens; and (3) Turtle River State Park located 1 mile northwest of Arvilla, North Dakota. This is a 475-acre woodland forest consisting of bur oak, green ash, American elm and basswood (Kantrud 1973).

*11. Page 47, last paragraph - We suggest the following sentences be added to this paragraph:

Additional nonstructural alternative study recommendations have been included in Section XI on pages 62-64 of this report. In particular, Study Recommendation Nos. 7, 10, 12 and 27 should be totally explored to reduce flooding throughout the Turtle River Subbasin.

* 12. Page 48, last paragraph, last sentence, under the heading "Adequacy of Existing Measures" - We recommend this sentence be changed to read, "Additional flood control measures be required to further reduce flood damages". It is recommended that non-structural alternatives be thoroughly explored and implemented prior to the implementation of structural alternatives.

* 13. Page 60, first paragraph, last sentence - We suggest this sentence be omitted from the report. It is doubtful, at best, to conclude that water quality will be appreciably improved after the channelization of 43 miles of the Turtle River. In the view of the FWS, water quality will be further degraded over the short and longrun scenarios resulting from this structural alternative.

14. Page 61, second paragraph, under the heading "Evaluation" - It is doubtful that riparian woodlands would expand, be created or be protected unless strict "zonation" be implemented and enforced. On page 58 it is stated, "Adverse effects would occur to land use (possible induced clearing) and to water quality as a result of increased turbidity from construction activities, but the effects would be minimum." This statement leads one to believe that levees would be constructed very near the river encroaching upon existing riparian woodlands.

* 15. Page 52 - Add "riparian woodlands" to Recommendation No. 2.

* 16. Page 64, Add Recommendation No. 27 - We suggest the following additional Study Need Recommendation be added:

The potential for land treament measures (e.g., erosion control measures such as cover crops, greenbelts, reduction of fall tillage, etc.) needs to be thoroughly investigated.

* 17. Page 65, Bibliography Citation No. 1 should read as follows:

Barker, William T., Gary Larson and Richard Williams. 1976. "Rare and Unique Plants of North Dakota". Department of Biology, Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota.

* 18. Page 68, Bibliography Citation No. 10 should read as follows:

_____. 1978. Terrestrial and Aquatic Resources Package for North Dakota Tributaries to the Red River of the North. Area Office, Bismarck, North Dakota.

* 19. Page 68, Bibliography Citation No. 11 should read as follows:

_____. 1980. Terrestrial Resources Package for Minnesota Tributaries to the Red River of the North. Ecological Services Office, St. Paul, Minnesota.

*20. Page 68, Bibliography include the following citation on this page:

_____. 1980. Personal communication, staff biologist, Bismarck Area Office, Bismarck, North Dakota.

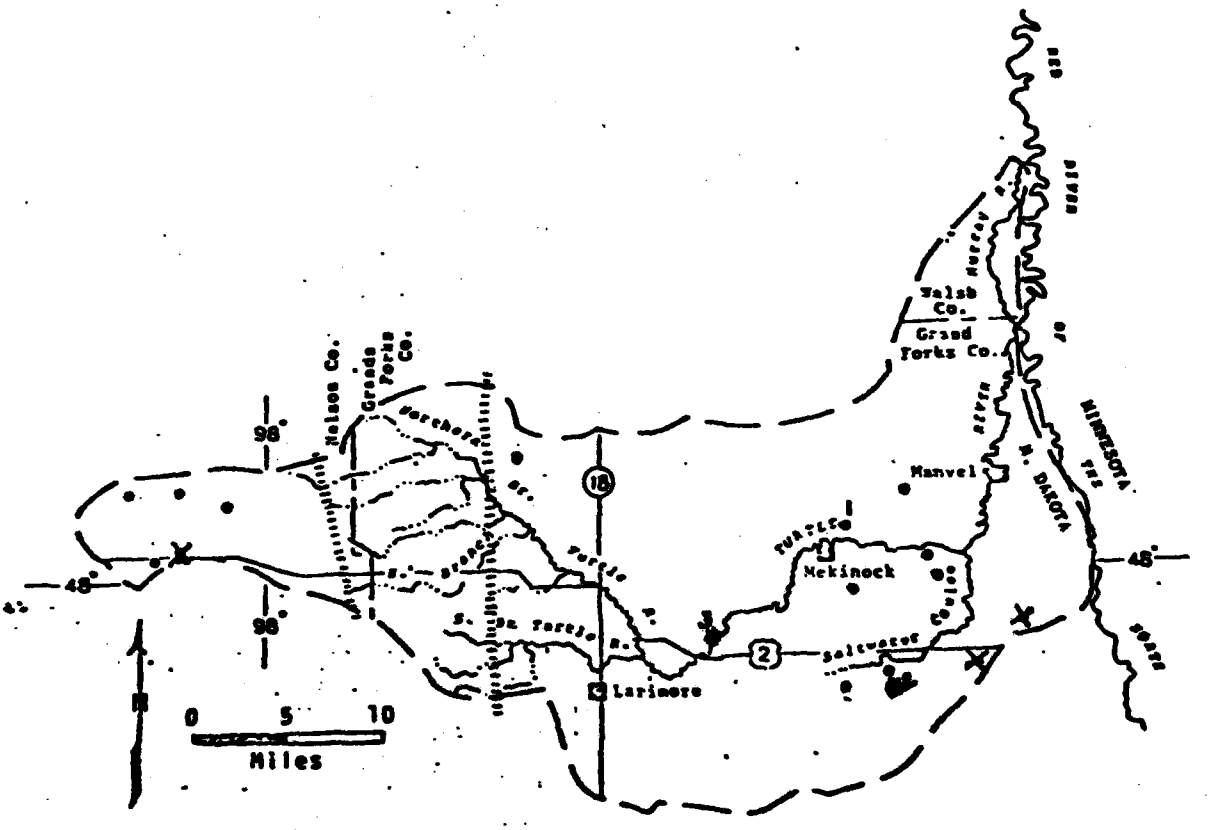
These comments have been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and other authorities mandating Department of the Interior concern for environmental values. They are also consistent with the intent of the National Environmental Policy Act of 1969.

The opportunity to review and comment on the Draft Reconnaissance Report of the Turtle River Subbasin is appreciated.

Sincerely yours,

for Gilbert E. Key
Area Manager

Attachment (1)



*SCIENTIFIC AND NATURAL AREAS

* 1-Grand Forks County Prairie Chicken Range
  2-Oakville Prairie Biology Station
  3-Turtle River State Park

•Waterfowl Production Areas (Fee Tracts)

*Exact locations and numbers of WPA's are on file at the U.S. Fish and Wildlife Service, Area Office, Bismarck. No copies of these maps have been published or released but can be reviewed at the above office.

Source: State Comprehensive Outdoor Recreation Plan, 1975; Kantrud, 1973; USFWS, 1980.

Figure IV. WATERFOWL PRODUCTION AREAS (Fee Tracts)

Incl 5

U.S. Army Corps of Engineers
North Central Division
Comments on the
Draft Turtle River Subbasin Report
(August 1980)

* 1. Figure I - The Turtle Basin should be shaded in on the upper vicinity map.

2. Page 53 - The relationships discussed in the first paragraph should be displayed in graphs. The paragraph should note whether the impacts of flood storage volume loss through levee construction were considered. If they were, the method should be described.

3. Figure II is a poor map. There needs to be a legend which clearly describes the patterning used to delineate the 100-year floodplain, marshy areas, etc.

* 4. Pages 45-47 and 54-55 - Incorporate the following thoughts into the explanation of nonstructural measures.

Nonstructural measures modify the susceptibility of land, people, and property to damage or losses. In addition they modify the impact of flooding upon people and communities. Nonstructural measures do not attempt to modify the behavior of floodwaters.

5. Page 49 - Add a discussion of the National Objectives (NED & EQ) as established by Principles and Standards.

6. Page 50 - The objectives are basically good but awkwardly written. Rewrite such as below.

Enhance the recreational opportunities in the Turtle River Subbasin for the benefit of the local people.

7. Pages 56-61 - The assessment and evaluation sections need to emphasize how each alternative meets or does not meet both study objectives and National Objectives.

8. Pages 9-10, Flood Damages - Since two types of flooding are identified - overbank and overland - this discussion of flooding should stipulate which type caused the majority of the flooding. Also, if due to rainfall (and not snowmelt) the amount of rainfall should be disclosed.

9. Pages 6-15, Problem Identification - It is difficult to criticize this approach, because some very good things were done - search of old reports, good writing, and good organization. The report presents a well-documented array of water-related problems. The shortcoming is that some material is very old and the persistence of the problems at that exact place and magnitude is questionable. To update the material, local experts and universities should have been consulted and an organized problem identification effort executed as part of the public participation program.

10. Page 16, Social Characteristics - The discussion of social characteristics should go beyond mere numbers and begin describing the social environment in terms of trends, quality of life, and specific problems. Newspapers are a good social record of communities. We suggest a diachronic analysis of newspaper contents. Add no later than Stage II.

11. Page 50, Planning Objectives - Should the study for this subbasin continue, more specific planning objectives must be formulated. Those for EQ should include specifics on problems identified on page 10 and resources discussed on pages 21-29. For example, be specific as to wetland location for preservation and potential reaches for habitat improvement.

12. Page 61, Evaluation - This section should be retitled "Recommendations" and include a definite statement whether to terminate or proceed. The present discussion simply is not clear. Finally, remember that the nonstructural analysis must be carried beyond Stage I.

SWC
STATE WATER COMMISSION
900 east boulevard
701-224-2750
bismarck 58505
north dakota

September 8, 1980

Col. William W. Badger, District Engineer
St. Paul District Corps of Engineers
1135 U.S. Post Office & Customhouse
St. Paul, MN 55101

RE: Red River Mainstem Study - SWC Project #1701

Dear Col. Badger:

This letter is to provide comments on the draft reports for the Goose, Turtle, Park, Elm, Rush, and Forest River Subbasin reports for the Red River of the North Reconnaissance Study. Although, the reports are satisfactory, it is recognized that they are specific to flood control problems. As stated previously, it is hoped that solutions for total water management can be addressed in the final basin report.

In reviewing the Goose River Subbasin Report, mention was found of the water supply problems experienced by the City of Mayville. Since lack of water by the city has been a significant problem for Mayville in recent years, it is believed that more emphasis should be placed on describing this problem. In addition, alternatives should be considered for improving Mayville's water supply. On page 49 of the report, there is discussion of flood control planning for the subbasin. Since the State Water Commission has authority in flood control planning, this agency should be included in the discussion. There appears to be an error on the map on page 51, in that it shows the subbasin to have 10 existing Corps of Engineers reservoirs. On page 52 of the report mention is made of the use of present drainage ditches for flood water storage. It is questioned whether or not this is practical and feasible.

* The Turtle River Subbasin Report contains an error on page 14, where it is stated that the Upper Turtle River Watershed Work Plan was published by the Minnesota Soil Conservation Service. As in the Goose River report, mention should be made that the StateWater Commission should also be involved in additional efforts in flood control planning. This is discussed on page 44 of the Turtle River report. In the formulation of alternative measures section, it should be mentioned that for alternatives 1, 2, and 3, that other agencies such as the State Water Commission or water management boards could be the implementing agency.

GOVERNOR ARTHUR A. LINK
Chairman
RICHARD P. GALLAGHER
Vice Chairman-Minot
ALVIN A. KRAMER
Minot
GORDON K. GRAY
Valley City
ARTHUR J. LANZ
Devils Lake
ARLENE WILHELM
Dickinson
MYRON JUST, EX-OFFICIO MEMBER
Comm. of Agriculture
VERNON FAHY
Secretary & State Engineer

In the Park River Subbasin Report, the water supply section states that the City of Grafton relies solely on the Park River for its water. This is not true, since the City of Grafton has recently completed a pipeline to the Red River. Again, the State Water Commission should be identified as an agency that has the authority for flood control planning for this river basin. A recent study of the flood problem at Grafton by the State Water Commission revealed that a snagging and clearing project on the Park River downstream from Grafton would reduce the flood damage in Grafton considerably. Consideration should be given to including snagging and clearing of the Park River in this vicinity as another structural alternative.

The irrigation section of the Elm River Subbasin Report states that very limited amounts of acreage in the basin are being irrigated. The identification of the Page aquifer and increased interest in irrigation has resulted in an increase in irrigation in the basin in recent years. In considering the systems that have been developed and the interest in developing additional systems, it can be stated that substantial amounts of acreage in the subbasin are being irrigated.

The Rush River Subbasin Report states that the subbasin includes portions of three water management districts. Although this may be true since legal descriptions are used to describe the water management districts, for the most part it is commonly accepted that all of the Rush River Subbasin is within the jurisdiction of the Rush River Water Management Board. Again, it must be stated that the State Water Commission has jurisdiction for flood control planning for the subbasin along with the other federal and local entities.

The water supply section of the Forest River Subbasin Report states that water supply in the subbasin is adequate. This is true from a quantity standpoint, although the City of Minto is in serious need of a new water supply dam, since their existing dam is damaged beyond repair. As stated before, mention of State Water Commission authority for flood control planning should be added to the report.

Oftentimes in the reports, GSRI is mentioned as a source for data. If this is updated data from other reports, the method for updating the data should be described. Data from the published county ground water reports could be used for ground water aquifer identification in the subbasin.

Sincerely,

David A. Sprynczynatyk, P.E.
Director of Engineering

DAS:smh

General Comments
Turtle River Subbasin Draft Report
(July 1980)

(These comments apply to the entire report and all subsequent subbasin documents)

1. Comments from Federal, State, and local agencies and a letter from the St. Paul District will be included in an appendix in each final subbasin and in the overall report. The format for the appendix will be:

a. Introduction - This section should stress:

(1) The importance of completing the study on time.

(2) That the purpose of the study is to advise other agencies and interests.

(3) The need for a selected review by various interests to provide complete and factual documentation.

(4) The use of the study as a building block for future water resource efforts.

(5) That cooperative efforts to evaluate results and develop solutions to remaing problems will be incorporated.

(6) A complete public involvement program when the study is finished.

b. The distribution list.

c. Copies of letters of comment.

Only comments that identify significant errors or need specific attention will be addressed in the final subbasin report. However, all comments incorporated should be identified with a marking system. The distribution list for the Turtle River Subbasin Report is given below:

Agencies receiving draft report	Date sent	Date comments received
Federal		
Soil Conservation Service	15 Aug 80	15 Aug 80
Fish and Wildlife Service	15 Aug 80	-
Corps of Engineers, North Central Div.	15 Aug 80	-
Corps of Engineers, St. Paul District	15 Aug 80	15 Aug 80
State		
North Dakota Game & Fish	15 Aug 80	-
North Dakota State Planning	15 Aug 80	-

Incl 2

Local

Red River Regional Planning Council	19 Aug 80	-
Grand Forks County Water Management District	19 Aug 80	-
Red River Joint Water Management Board	19 Aug 80	-

2. Care should be taken to ensure that similar data reported in the various draft reports is uniform and consistent. For example, in the climate sections temperatures are recorded in ranges, means, and averages.

3. The supporting information for alternatives including technical, economic, and environmental backup data should be provided (at least under separate cover).

4. All references by the same author and of the same year should be ranked (i.e., 1979a, 1979b, etc.) so that these references can be distinguished.

5. The evaluation section of each report is primarily the recommendations of the document. Generally only the alternatives which have a benefit-cost ratio greater than 1 are presented. Little attention is given to other less economically feasible alternatives that may be important in specific aspects of future flood damage reduction planning for the subbasin as well as the basin as a whole. Some of these alternatives may provide the necessary environmental or social conditions to warrant future attention. Therefore, this section should be expanded to provide the appropriate discussions.

6. The 1980 current normalized prices issued in October 1979 were revised in July 1980. Attached is a table showing the revised 1980 current normalized prices for principal commodities. Label all references to current normalized prices as "pre-revision" or "post-revision" as appropriate.

REVISED AUG 1980

STATES' CURRENT NORMALIZED PRICES FOR PRINCIPAL COMMODITIES: ISSUED OCTOBER 1979

State	Wheat all(1)	Rye(1)	Soybeans for beans	Corn for grain(1)	Oats(1)	Barley(1)	Flaxseed	Hay, all baled	Dry beans	Sugar beets(2)	Potato
Michigan	2.78	1.83	6.19	2.09	1.27	2.17	-	46.48	15.59	26.17	4.58
Wisconsin	2.62	1.96	6.03	2.13	1.13	1.66	-	43.05	-	-	4.40
Minnesota	2.99	2.13	6.13	2.02	1.12	1.91	5.92	45.14	13.41	22.37	3.09
Iowa	2.56	2.10	6.21	2.08	1.15	-	-	44.92	-	-	3.96
North Dakota	3.14	2.00	5.97	2.05	1.08	1.86	5.94	40.02	14.41	21.64	3.16
South Dakota	2.97	2.01	5.81	1.99	1.11	1.72	5.90	40.37	-	-	2.94

(1) Includes allowances for loans outstanding and purchases by the Government valued at average loan and purchase rate. Does not include price support payments.

(2) Does not include payment under the Sugar Act.

These have been revised - Please check the prices you used.

St. Paul District Corps of Engineers
Specific Comments on the
Draft Turtle River Subbasin Report
July 1980

*1. Page 3, paragraph 1 - Part of Walsh County is also in the subbasin. Also, no mention is made of Murray River.

*2. Page 4, Figure I - The Pembina Escarpment should be identified on the map. Also, there are references in the report to both Michigan and Michigan City. Highway maps refer to the community as Michigan, N.D. The text and map should be corrected and referenced accordingly.

3. Page 10, Table 1 - In other subbasin reports, damages for both 1975 and 1979 floods were compared. Why were data not presented for the 1975 flood?

*4. Page 12, Water Supply Problems - Where are the cities of Arville, Emerado, and Michigan City? These should be shown on the maps on pages 4, 8, 31, 36, 46, and 52. Also change "...is not always portable, ..." to "... is not always potable...".

5. Page 13, Irrigation - Does the high mineral content of water from acquifers affect irrigation practices in any way/ If so, this should be discussed.

6. Page 14, Table 2 - Michigan and Petersburg are not shown on any of the maps in the report. If a municipality is mentioned, it should be indicated on maps. Also, Mekinock is not listed as having wastewater treatment.

*7. Page 14, Public Perception of Problems and Solutions - The reason that the public perception of problems and solutions is not adequately defined is not simply because the Corps has not conducted public meetings in the area. It is doubtful if a few public meetings would have enabled these factors to be adequately defined. The social analysis which would yield this information is identified on page 64 of this report as an area needing further study. This sentence should be rewritten to reflect other limitations besides the lack of public meetings.

*8. Page 15 - Change sentence "... it is evident that residents of the Red River Basin consider flood control ..." to read "...it is evident that most residents of the Red River Basin consider flood control...". The original statement implies that this opinion is shared by all the residents of the basin. It is quite probable that some residents may think other water-related problems are more important, e.g., the farmer living in an upland area who has water supply problems.

*9. Page 16, Social Characteristics: In and out migration that is identified appear to be net migration. It should be so noted as net. If it is not net migration, then the net migration figures should be supplied.

*10. Page 16 - What is meant by "close knit?" Since this is an ambiguous term, an explanation would help understanding.

*11. Page 16, Social Characteristics, paragraph 2 - In the second sentence, it is stated that from 1970-1977, Michigan (not Michigan City) had a 26.8 percent increase in population. Because of the large increase, an explanation should be given.

*12. Page 16, Social Characteristics - Does the proximity of the Grand Forks urban area have any population affect? If so, it should be stated.

13. Page 17 and 20 - What is the correction factor used to convert figures to 1979 dollars? It would be helpful if it were included.

14. Page 18, top paragraph - Are these income figures for the subbasin or for counties which have portions of their area in the subbasin? Also, the distribution of income (such as percentage of population below the poverty level, etc.) should be included.

*15. Page 18, Agriculture, paragraph 1 - 79 + 11 = 90 percent. Please account for the remaining 10 percent. Also list acreages for the percentiles.

*16. Page 18, Agriculture, paragraph 2 - 39 + 24 + 31 = 94 percent. Please account for the remaining 6 percent.

17. Page 19 - In addition to the factors noted on yield per acre, harvested acres, and total production for particular crops, it would be helpful if gross income per acres for particular crops were included. This information would give a better understanding of the relative importance of each crop. One other factor that would aid understanding of flooding problems are the differences in susceptibilities of crops to flood damages. Some crops are not as seriously affected by a flood event as others. In addition, the differences in costs per acre to plant particular crops would aid understanding.

*18. Page 19, Manufacturing - It is stated that the 19 manufacturing establishments are primarily involved with processing agricultural products. It is assumed that the 9 listed in table 4 are the non-agricultural based industries. This should be made clearer. Also, list the number of persons employed in the agricultural based industries.

19. Page 20, Transportation, paragraph 1 - Niagara is not shown on any of the maps. Also maps should include Federal and interstate highways.

*20. Page 20, Land Use, paragraph 1 - 79 + 11 + 5 + 1.2 + 0.9 = 97.1 percent. The remaining 2.9 percent should be identified.

*21. Page 22, Biology Section - The paragraphs describing the vegetative communities are poorly written because of the shifting of verb tenses. A consistent use of the present tense would be preferred.

*22. Page 23, paragraph 2 - It is stated that deer population densities range from <0.5 to <1.5 per square mile. Is this for the basin as a whole or just forested areas, etc.? This should be clarified.

*23. Page 25, Table 5 - Why was Nelson County not included? Also it should be made clear whether the county totals are for the county as a whole or just for the portion of the counties in the subbasin.

*24. Page 27, paragraph 1 - It is stated that the average consumption rate for Larimore is 730,000,000 gallons annually. How much of this is for industrial use and how much is for general use? Also do any of the industries have their own wells or do they rely on municipal wells? Usage at Michigan (not Michigan City) should be included.

*25. Page 27, Water Quality, paragraph 1 - Why was data from "Brush Lake near Mercer," included? Brush Lake is not even located in the Red River Basin. What relationship might this data have to water quality needs is the Turtle River subbasin? These questions should be answered.

*26. Page 30, paragraph 2 - Change last sentence to read "There are no sites listed on or eligible for listing on the National Register of Historic Places at this time."

27. Page 32, Social Section - In addition to the information presented, a discussion of the social consequences or implications of flood events should be presented, particularly those concerning behavioral damages that may occur.

*28. Page 32, Cultural Section - Change last sentence to read "No sites are listed on the National Register of Historic Places, but a more systematic survey may locate other potentially eligible properties."

*29. Page 34, paragraph 1 - Data for table 8 was collected in 1964. The wetlands area probably has drastically changed in the past 16 years. This change should be noted.

*30. Page 37, Table 9 - Please include Walsh County.

*31. Page 37, Threatened or Endangered Species Section - This section should specify that the pugnose shiner, banded killifish and greater prairie chicken are considered threatened species only in North Dakota and are not listed Federally as threatened or endangered.

*32. Page 38, Rare or Unique Plants Section - This section should specify that the carex prarisa is considered unique only in North Dakota. It should also discuss that the reason for this species' limited occurence in North Dakota is because it is on the limits of its natural distribution.

*33. Page 39, last paragraph - Why is a large reliance on military employment considered as the "biggest obstacle" to economic growth and development? Please clarify.

*34. Page 41, Table 12a - (Flood damages, 1980, crip), 17,200 should be 117,200.

*35. Page 42, paragraph 4 - Why is this paragraph included? Earlier in the report, it was stated that there are no urban damages to be considered.

*36. Page 47, paragraph 1 - Floodplain regulation listings should be available at local or regional planning agencies.

*37. Page 49, Planning Objectives Section - The second paragraph seems to be too strongly stated. The following rewrite is suggested:

> "The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin from the information that was available. On the basis of this analysis of the problems, needs, and desires that could be identified, the following planning objectives were established."

38. Page 55 - Most of the nonstructural measures listed would be effective with respect to reducing urban damages, which were stated to be minimal for this subbasin. How effective would they be in helping lower rural damages?

*39. Page 58-60, Channel Modifications - The assumption that water quality would improve in the long run as a result of channelization is not valid. In fact, on page 11, it is reported that previous channel improvements have contributed to the degradation of water quality in the subbasin. The references to increased water quality as a result of channelization should be deleted.

*40. Page 61, Evaluation Section, paragraph 1 - See general comment #3.

41. Page 64 - It should be noted in each subbasin report that the probability of institutional and social boundaries being the same as subbasin boundaries is remote, at best. Since this boundary-overlap exists, integrated basin-wide social and institutional analyses are desirable.

42. Bibligraphy Appendix - See general comment #4.

*43. Page 9, Flood Damages, paragraph 3 - Change second sentence to read, "The 1979 flood event was the second largest flood recorded and rural damages sustained were more than five times greater than the average annual damage figure for the subbasin."

*44. Page 14, paragraph 3, third line - Change "...1969 by the Minnesota Soil Conservation..." to "North Dakota Soil Conservation...".