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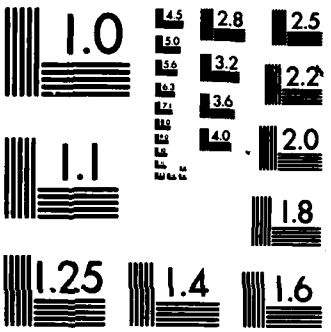

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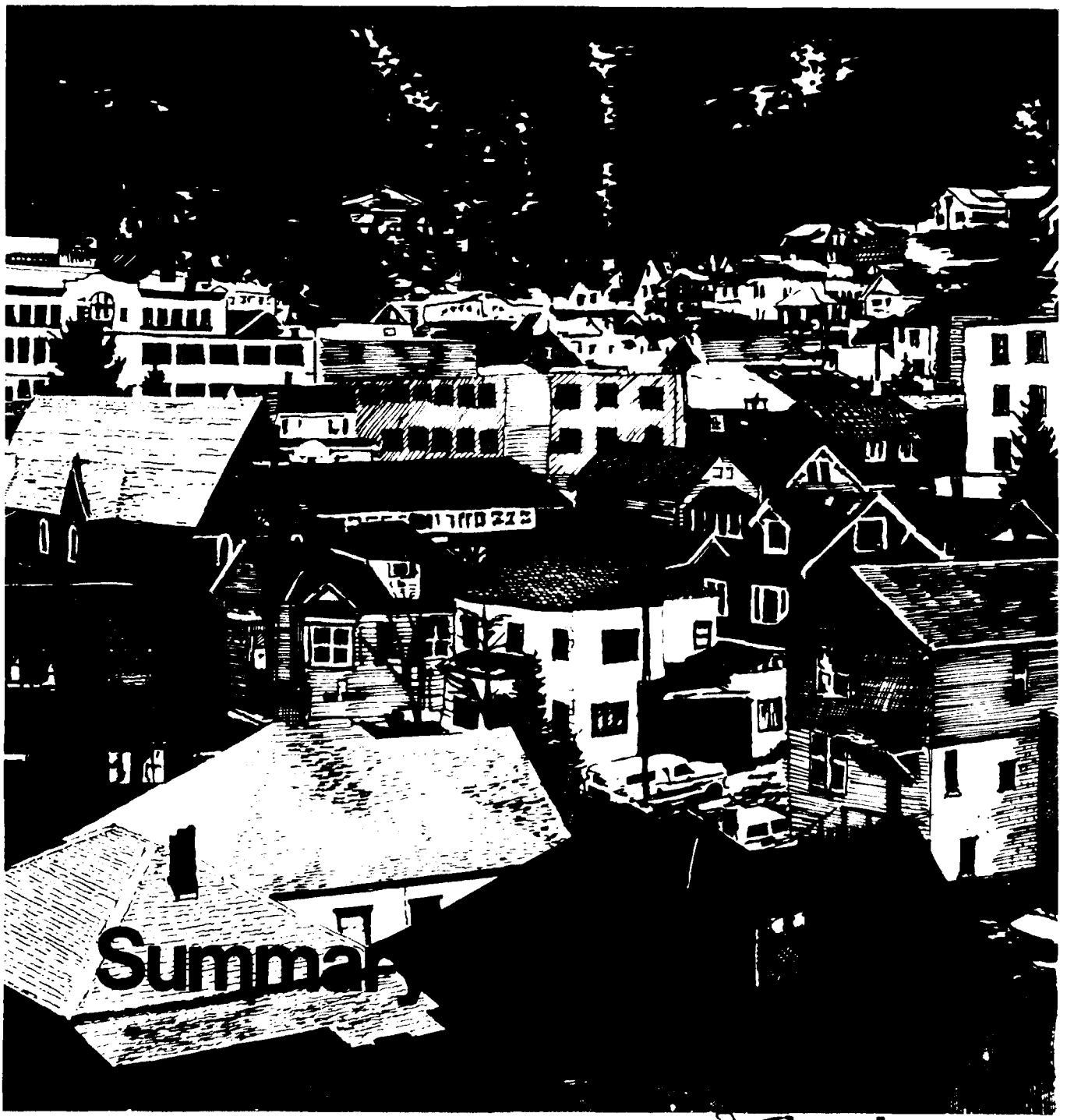

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The Fargo-Moorhead Urban Study was a cooperative Federal, State, and local planning effort aimed at developing viable solutions to water and related land resource problems, needs and concerns for 1980 to 2030.

The summary report contains a brief, non-technical overview. Readers desiring additional detailed information should review the appropriate technical appendixes.

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FARGO-MOORHEAD URBAN STUDY

SUMMARY REPORT

St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101-1479

MAY 1985

PREFACE

The Corps of Engineers Urban Study Program is designed to provide planning assistance to local interests in a variety of water and related land resource areas, including water supply, wastewater management, flood control, navigation, shoreline erosion, and recreation. In areas of traditional Corps responsibility (such as flood control), the Corps may implement and construct projects shown feasible in the urban study. In other areas (such as wastewater management), Corps involvement carries only through the planning stage when findings are turned over to local interests for incorporation into their broad comprehensive urban planning effort. Implementation is at the discretion of local interests in conjunction with appropriate State and Federal agencies.

The St. Paul District, Corps of Engineers sponsored the Fargo-Moorhead Urban Study as a cooperative effort between local, State, and Federal agencies. During the first stage, the 13-township study area was selected, major topics to be addressed were identified (water supply, water conservation, energy conservation, and flood control), and a "plan of study" was developed. The plan of study outlined the general approach the study would follow.

During stage 2, the major topics were broken down into explicit problem areas and a broad array of alternatives to resolve these problems were formulated. The cost effectiveness and the environmental/social impacts of the alternatives were examined to eliminate those which were not suitable or economically feasible.

This document summarizes the six technical appendixes produced during the Fargo-Moorhead Urban Study:

- Background Information Appendix
- Water Supply Appendix

- Water Conservation Appendix
- Flood Control Appendix
- Energy Conservation Appendix
- Fargo-Moorhead Water Resources Data Management System Appendix (FMWRDMS)

This summary report provides an overview of the urban study including:

- The study area
- How the study was conducted
- The study areas problem, needs, and concerns
- The final alternative solutions to these problems, needs, and concerns
- The findings and recommendations

This report is being distributed to all individuals, agencies, organizations, and special interest groups on the urban study's mailing list and to anyone else who requests a copy. Because of this broad distribution, the report is brief and written in non-technical terms. Readers desiring additional detailed information can review the appropriate technical appendix(es) listed above.

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FARGO-MOORHEAD URBAN STUDY
SUMMARY REPORT

INTRODUCTION

The Fargo-Moorhead Urban Study was a cooperative Federal, State, and local planning effort aimed at developing viable solutions to water and related land resource problems, needs, and concerns in the study area for the period 1980 to 2030.

The study was authorized by a resolution of the Committee on Public Works, U.S. Senate, 93rd Congress, 2nd session, adopted September 30, 1974.

The study area (figure 1) encompasses 13 townships in Cass County, North Dakota and Clay County, Minnesota. Major population centers in this area are Fargo, North Dakota and Moorhead, Minnesota. Study area boundaries were determined by distinguishing climatic, physical, biological, and socioeconomic characteristics that yielded common problems and goals.

The Fargo-Moorhead Metropolitan Council of Governments (MCOG), the study area's primary planning organization, was the focus of coordination with the Corps of Engineers. In addition, the general public and various Federal, State, regional, and local governmental agencies and commissions were involved in a number of ways, including representation on MCOG or its Water Resources Committee, participation in meetings, and consultations regarding baseline data, projections, problem identification, alternative development, social acceptability, and environmental impact assessment. This approach gave the urban study broad-based direction and support.

The Fargo-Moorhead Urban Study process consisted of two stages. Figure 2 shows the features of the two planning stages. Stage 1 concentrated primarily on the first step of the planning process - problem

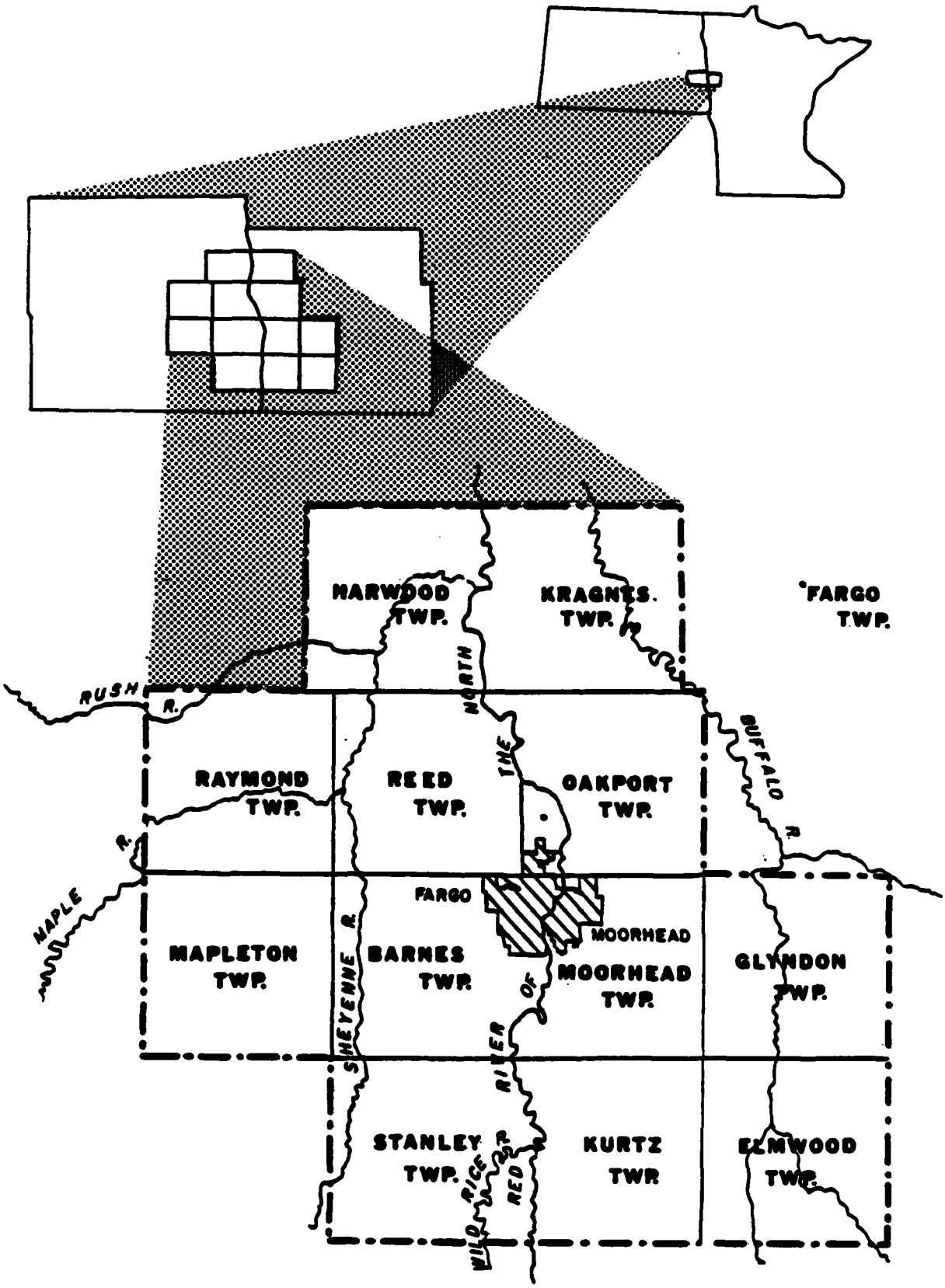


FIGURE 1
STUDY AREA

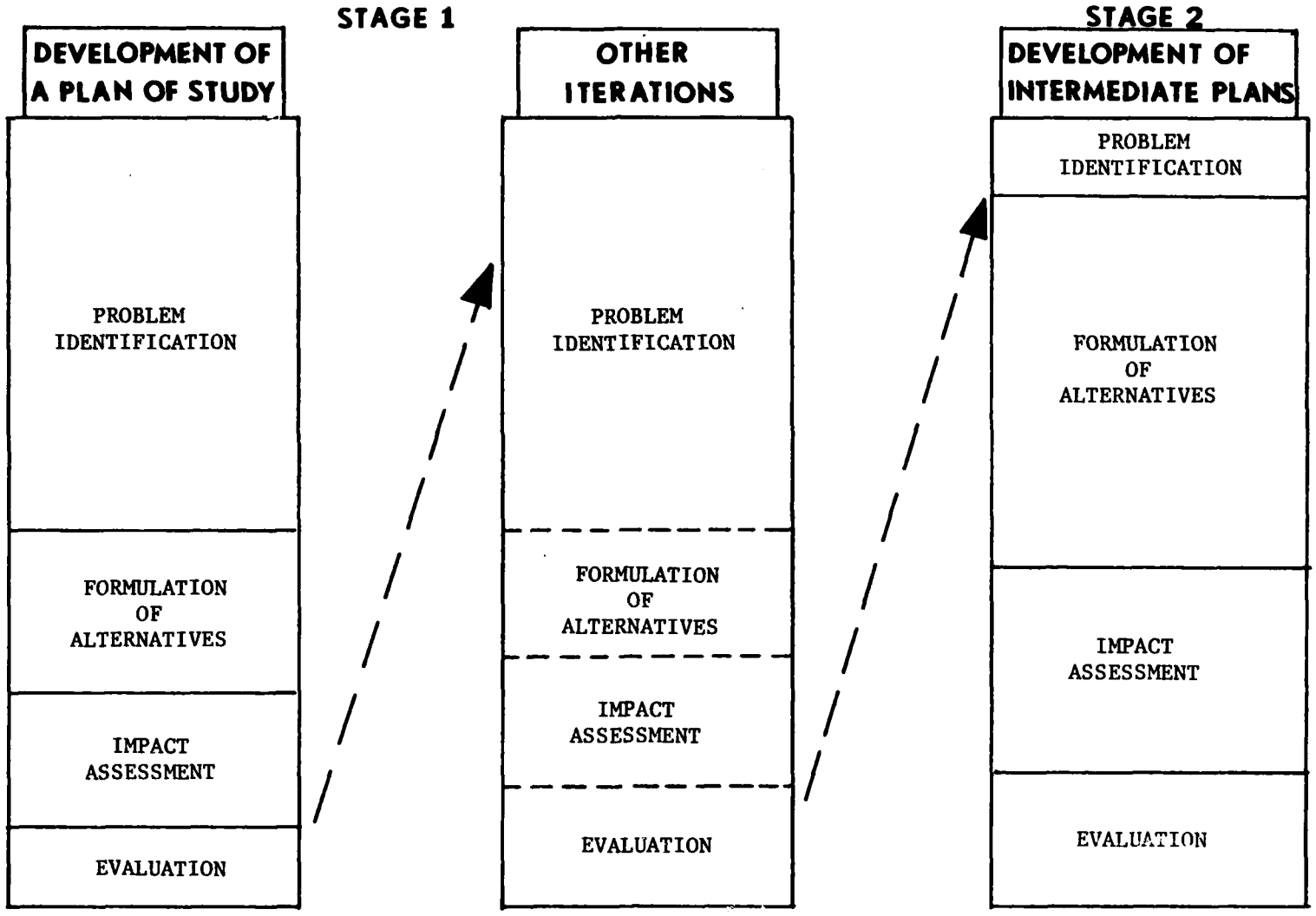


FIGURE 2
STUDY ORGANIZATION

identification; the emphasis in stage 2 was increasingly on alternative formulation, impact assessment, and alternative evaluation.

During these two stages, the four basic planning tasks were repeated a number of times. These four planning tasks were:

- o Problem identification
- o Formulation of alternatives
- o Assessment of impacts
- o Evaluation of alternatives

Successive iterations of these tasks reflect an increasing level of effort, detail, and refinement. In addition, these iterations provide an opportunity for incorporating additional information and broadening the scope of the urban study as it progresses.

Stage 1 of the urban study emphasized the identification of problems, concerns, and needs in the study area. It selected the study area boundaries and undertook a preliminary review and description of existing conditions. This first stage culminated in the urban study's econnaissance report which laid out the scope, objectives, and methodology of the study and identified the major problem areas that would be addressed, including flood control, water supply, water conservation, and energy conservation. The reconnaissance report served as a guide for all Federal, State, and local efforts throughout the remainder of the study.

Stage 2 of the study formulated specific alternatives, filled in any data deficiencies, and assessed and evaluated the impacts of these alternatives. Stage 2 also included continuing efforts at problem

identification in order to focus attention on specific concerns raised during the course of the study.

It should be noted that the two-stage planning process described above is a recent modification to the standard three-stage format followed for most Corps of Engineers feasibility studies. Since comprehensive planning for urban areas is primarily a local responsibility, the third stage of the planning process, during which detailed plans are developed, has been dropped from urban studies. The only exception to this is if stage 2 planning recommends continuation of Corps involvement for the purpose of flood control. The authority exists for the Corps to continue beyond stage 2 for the flood control element only. Planning beyond stage 2 for the other study elements is a local responsibility.

The following sections of this report summarize the work accomplished under the Fargo-Moorhead Urban Study.

WATER SUPPLY/WATER CONSERVATION

Introduction

As part of the Fargo-Moorhead Urban Study, the St. Paul District, Corps of Engineers, conducted a series of water supply/conservation investigations. Phase 1 of these investigations made preliminary demand projections and analyzed low-flow characteristics of area streams. Phase 2 investigated alternative approaches to future water supply for the Fargo-Moorhead study area. Phase 3 focused on water conservation. Each of these investigations is discussed below.

Low-Flow Analysis

The first phase of the water supply/conservation investigation focused on surface water resources. The objective of the analysis was to obtain a

statistical description of streamflows (water supply) and compare them with water demands to determine future supply needs.

Water demands for the study area were determined from information on water supply sources, wastewater systems, and past and present water withdrawals and discharges that were obtained from State agencies, representatives of communities, and major water users in the study area. Projected water demands and return flows for municipal, self-served industrial, irrigation, and livestock water uses in the area were developed on the basis of withdrawal and discharge records, population projections, and other pertinent information.

Streamflow statistics were based on output developed by the St. Paul District, Corps of Engineers from the Hydrologic Engineering Center is HEC-3 computer program. For two small streams, monthly streamflows were derived from regional correlations using the HEC-4 computer program. Partial duration analyses were performed on monthly streamflow data for several potential water supply points in the study area. The results were used to generate frequency curves for water supply, and these curves were compared with average annual water demands for actual year 1980 demands and projected demands.

These analyses determined that study area water demands for both 1980 and 2030 would exceed available surface water supplies, based on a 50-year recurrence interval drought. The total additional storage required to balance supplies and demands is in the range of 2,000 to 2,500 acre-feet for the year 2030 case and 1,000 to 1,200 acre-feet for 1980. The minimum in-stream flow requirements for the Red and Sheyenne Rivers account for large portions of the total storage needs -- generally 55 to 60 percent for the year 2030 and 20 to 40 percent for the year 1980.

Water Supply

The second phase of the water supply/conservation investigation for the Fargo-Moorhead Urban Study focused on future water supply needs in the study area and potential resource development to meet these needs.

In this phase, a fundamental distinction was made between the urban core communities of Fargo, Moorhead, West Fargo, and Dilworth and the remaining smaller study area communities. The smaller communities all rely on ground water and can meet projected future water needs with localized expansions of their water supply facilities. The water resources required for the smaller communities were included in the analysis of water supply alternatives for the urban core.

Using existing facilities and resources as a basis, the urban core communities were projected to require an additional 30.24 million gallons of water per day in the year 2030.

Of the five study area rivers investigated, the Red and Sheyenne Rivers were identified as logical future sources of part of the water supply for the urban core communities. Ground-water aquifers in the study area are also available for further development. In addition, the Sheyenne Delta Aquifer represents a very large potential water supply source near the study area.

The proposed Garrison Diversion would increase streamflows in the Red and Sheyenne Rivers. If fully implemented, the diversion would slightly decrease the cost of future water supply facilities required for the urban core communities. However, the cost ranking of long-term water supply alternatives would not be affected.

Of the water supply alternatives considered, the one that exhibited the best opportunity for future water supply facilities utilized interconnections between the urban core communities and would develop the

least costly sources of new water supply. Under this alternative, the four urban core communities would be interconnected to form a subregional water supply system. The alternative would also augment existing facilities with expanded development of the Kragnes, Moorhead, and Buffalo Aquifers, and construction of a larger Red River low-head dam.

Water Conservation

The last phase of the water supply/conservation investigation for the Fargo-Moorhead Urban Study concentrated on identifying those water conservation measures that would substantially reduce the need to develop future water supply facilities.

This study initially considered all possible methods of water conservation. These conservation measures were evaluated and selected measures were incorporated into the most cost-effective water supply plan developed in phase 2. The benefits of water conservation to study area communities include reductions in the costs associated with the water supply plan and savings in the energy bills of individual consumers. In addition, conservation save existing water resources, preserving supplies for future municipal growth.

The distinction between the urban core communities of Fargo, Moorhead, West Fargo, and Dilworth and the rural communities was retained in this phase of the study. Different conservation measures were proposed for each of the two groups after several screening criteria were applied. All communities were credited for existing conservation efforts, and any possible measures that duplicated existing efforts were eliminated from consideration. Conditions that may have impeded successful implementation of measures were mitigated in individual implementation plans. The conservation measures retained were applicable to water uses occurring in the study area, were capable of producing measurable reductions, were socially acceptable to the residents of the area, and had no significant adverse environmental impacts.

Principal economic benefits included reduced energy consumption from heating less hot water; savings from deferred, scaled-down, or eliminated capital improvements for water facilities; and reduced operation, maintenance, and replacement expenditures from treating and transporting less water. These benefits were offset somewhat by economic costs primarily for implementing the conservation measures.

The potential environmental and social impacts include increased water rates and reduced wastewater return flows. Potential increases in water rates would probably be the result of implementation of peak pricing for periods of heavy use. However, the size of this potential increase is site-specific and would need to be determined for each municipality by a separate rate study. Therefore, this effect is not presently quantifiable. Individual conservation measures produce minimal reductions in return flows.

The following measures were determined to produce a beneficial effect with no significant adverse environmental and social effects:

Measure	Urban core	Rural
Retrofit distribution and installation	x	x
Pricing	x	x
Retrofit distribution	x	x
Water-saving fixtures	x	x
Sprinkling ordinance	x	
Education	x	x

There are interactions between these measures because several measures affect the same water use or have some common methods of implementation. Therefore, when several conservation measures are combined the subsequent reduction is often less than the sum of the individual reductions. This is true for the economic benefits as well.

Based on evaluations of various combinations of measures, the following measures were identified as most cost-effective for the urban core and rural communities.

Measure	Urban core	Rural
Retrofit distribution and installation	x	x
Pricing	x	x
Education	x	
Sprinkling ordinance	x	

Implementation of the proposed measures for the urban core communities would reduce average annual demand by 13 percent. It would also have significant positive economic benefits for the urban core communities. These benefits are primarily due to energy savings and reduced supply costs. Energy savings, mostly from reduced hot water use, would amount to more than $924,000 annually over the study period. Reduced supply costs from postponed, scaled-down, or eliminated water and wastewater facilities would amount to more than $875,000 in annual savings. Major components of these savings include postponed water treatment and wastewater treatment plant expansions, reduced chemical treatment and power costs, and scaled-down aquifer development. In addition, the low-head dam and reservoir on the Red River would not need to be raised. Implementation costs -- mainly for retrofit devices and installation, rate studies, and educational material and distribution -- reduce total annual savings to $1,630,000.

Conservation would also reduce return flows from the urban core communities to area rivers by 2.29 mgd (3.55 cfs) in year 2030. However, this figure represents a reduction of less than 12 percent in the average return flows.

The proposed measures that offer the greatest benefits to the rural communities is retrofit distribution and installation and peak demand pricing during the season of heavy use.

These measures offer limited economic benefits. The savings in foregone supply costs would be minimal because fire flow requirements diminish the effect that conservation reductions have on the scale or timing of construction of these facilities. The net annual benefit is $30,100. In addition, the Cass Rural Water Users Association customers will have much more significant savings from reduced water bills although the impact of savings in water bills was not quantified. A potential social impact is the increase in water rates resulting from the implementation of the pricing measure.

The water supply/conservation plan for the study area is designed to meet the demands of the 50-year drought through the year 2030. Additional measures (measures not included in the integrated supply/conservation plan) can be used to extend the capability of water facilities to meet more severe droughts. Implementation of additional conservation measures as recommended by the Drought Emergency Plans will enable the communities to satisfy demands in more severe droughts than the 100-year event.

The smaller communities could particularly benefit from having an emergency plan in place. Presently many rural communities lack auxiliary pumps or wells, as well as enough storage to meet their full fire demand. Under these conditions, shortages occur more frequently and pose a greater problem.

In view of the substantial savings, the urban core communities should begin preliminary work toward subregional water supply facilities incorporating long-term conservation measures into their plans. Initial steps should lay the legal, fiscal, and administrative groundwork for these facilities, including interconnections between Fargo and West Fargo and between Moorhead and Dilworth. Subsequent work would involve

planning for the additional facilities required to serve Fargo and Moorhead jointly, as well as West Fargo and Dilworth.

It is also recommended that studies be conducted to assess the amount of with in-stream reservoir storage behind the low-head dam on the Red River.

URBAN FLOOD CONTROL

Introduction

As part of the Fargo-Moorhead Urban Study, the St. Paul District, Corps of Engineers, conducted a comprehensive investigation of the study area's flood problems. Flood control alternatives were identified, and the costs and benefits of providing flood control were developed to determine if economic feasibility exists. A detailed discussion of the flooding problems in the study area, alternative measures considered, and conclusions and recommendations is presented in the Flood Control Appendix.

Study Area

During the course of this investigation, 17 communities within the study area were identified as having potential flood damages from various flooding sources. The study area communities of West Fargo, Riverside, Horace, and Argusville, North Dakota, are being evaluated under other Corps studies and are, therefore, not included in this flood control investigation. The communities considered in the urban study and their flooding sources, as shown on figure 3, include: Fargo, Briarwood, Frontier, Prairie Rose, and North River, North Dakota, and Moorhead, Kragnes, and Rustad, Minnesota, from the Red River of the North; Brooktree Park, Rivertree Park, Harwood, and Reile's Acres, North Dakota, from the Sheyenne River; Sabin and Glyndon, Minnesota, from the Buffalo

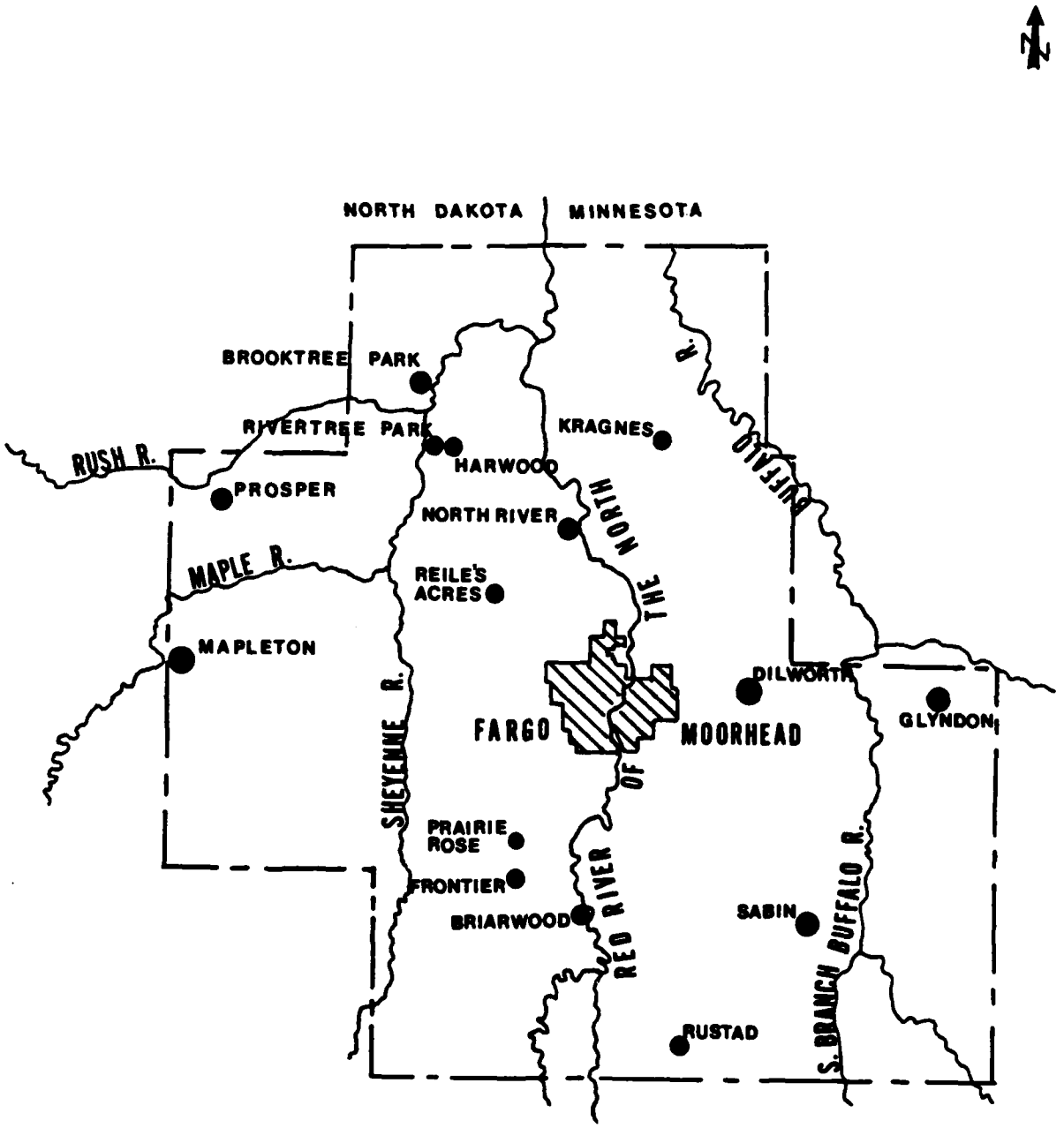


Figure 3

FARGO - MOORHEAD URBAN STUDY

FLOOD CONTROL STUDY AREA

River; Mapleton, North Dakota, from the Maple River; Prosper, North Dakota, from the Rush River; and Dilworth, Minnesota, from localized drainage ditch runoff.

Description of Existing Problems

The Red River of the North is the principal source of flooding within the city limits of Fargo and Moorhead. The channel capacity of the Red River of the North in the Fargo-Moorhead area is approximately 7,000 cfs. Flows exceeding this capacity can inundate residential and commercial properties in both cities and can damage municipal facilities such as streets, bridges, and sewer systems. In addition, portions of the urban study area are susceptible to overflows from the Sheyenne, Maple, Rush, and Buffalo Rivers and from numerous large county drainage ditches.

Over much of the area, floodwaters also frequently inundate rural areas during the spring snowmelt and after heavy summer rains with crops, farmsteads, and transportation facilities sustaining extensive damages. Although extensive flood damages occur to both urban and rural areas, the urban study focused only on urban flooding problems in the study area.

Present flood damages include both tangible and intangible losses. Tangible losses suffered during urban flooding include inundation damage to structures, utilities, and transportation facilities; flood fighting costs; business losses; increased expenses for normal operating and living during a flood; dislodged fuel storage tanks and pipelines; and flooding of sewage collection and treatment facilities. Intangible losses include threat to human life, human misery and potential health hazards from contaminated water and food supplies.

Under the limited flood protection presently available, tangible and intangible flood losses will continue on an increasing scale. Changes in the type and extent of flood damages would result from urban growth, community renewal programs, and land use shifts. Strict enforcement of

and more stringent regulations in local floodplain management programs would help reduce the growth of future flood losses.

The Corps of Engineers has constructed only one permanent levee in the study area. This levee is in the Island Park area of Fargo. Other levees in the study area provide some degree of partial protection but were not built to Corps of Engineers design standards nor do they contain provisions for interior drainage that meet Corps criteria for permanent protection.

Study Process

An initial analysis was conducted of Fargo, North Dakota, and Moorhead, Minnesota, and the 15 smaller communities identified in the urban study area to determine which of these communities experience significant flood problems. Field inspections were made at each of the communities to determine extent of development, elevations, and potential damage areas. Existing information was obtained from past floods to help determine which communities have been subject to flood damages. Based on this information, an initial screening process was performed. Communities that had no significant flood problems were eliminated from additional analysis. During this initial screening process, it was determined that the following communities did not have significant flood problems which could require or economically justify further consideration of a permanent flood control project: Rustad, Sabin, Glyndon, and Dilworth, Minnesota, and Prosper, North Dakota.

For the remaining communities in the study area, estimated average annual flood damages were developed. These figures were derived by developing and combining hydrologic, hydraulic, and damage curves relating flood elevation and discharge, discharge and frequency, and flood elevation and damages. The most notable work effort involved development of hydraulic and economic data for those communities directly flooded from the Red River of the North. An inventory was done of all structures in the

estimated 500-year floodplain of the Red River of the North within the corporate limits of Fargo, North Dakota, and Moorhead, Minnesota, as well as in the unincorporated areas upstream and downstream of these cities. Also included in the inventory were the communities of Reile's Acres, Prairie Rose, Frontier, Briarwood, and North River, North Dakota, and Kragnes, Minnesota. Information obtained included structure location, structure description, market value, and ground and first-floor elevations. This information was used to develop depth-damage relationships.

A hydraulic computer model was also developed for the Red River of the North within the study area to determine water surface profiles for existing conditions. The model was calibrated using historic flood profiles and discharges. Utilizing these computed water surface profiles, existing discharge frequency information, and depth damage relationships, average annual damages were computed for each of the remaining communities along the Red River of the North. Information for the communities subject to flooding from the Maple River and the Sheyenne River were also obtained. Reile's Acres, subject to flooding from the Sheyenne River, was included in the Red River of the North structure inventory. Information on flood damages from the Sheyenne River at Rivertree Park, Harwood, and Brooktree Park were updated from the report, "General Reevaluation and Environmental Impact Statement for Flood Control and Related Purposes, Sheyenne River, North Dakota," January 1984, by the U.S. Army Corps of Engineers, St. Paul District. Information necessary for development of annual damages at Mapleton, North Dakota, was obtained from a structure inventory survey and flood insurance study for the city of Mapleton dated July 2, 1981.

Based on these computed average annual flood damages, a second screening of communities was made. Because of insignificant annual damages, Kragnes, Minnesota, and Mapleton, Frontier, and Prairie Rose, North Dakota, were eliminated from further investigations.

Flood control alternatives were then developed for the remaining communities. These communities were Briarwood, Brooktree Park, Rivertree Park, Harwood, and Reile's Acres in North Dakota. Cost estimates were computed for each alternative; based on the average annual cost and the average annual damages prevented, a benefit/cost ratios were computed. This analysis determined that of the communities considered in detail, only Harwood and Rivertree Park have benefits exceeding the cost of providing flood protection.

Although the communities of Fargo and Moorhead have the potential to sustain substantial damages, it is not economically feasible to construct flood control alternatives in either community. There are also foundations problems in designing levees or flood walls along the Red River in these communities because of the close proximity of past development to the riverbanks. In addition to the foundation problems which exist, elevations are such that it would not be possible for any levee construction to tie into high ground.

Conclusions

Of the 17 communities evaluated during the Fargo-Moorhead Urban Study flood control investigation, it was determined that economic feasibility exists only at Rivertree Park and Harwood, North Dakota, which are located along the Sheyenne River near the confluence with the Red River of the North. These two communities are being recommended for more detailed studies under the Corps of Engineers Section 205 Small Project Program. Detailed results of the flood control investigation are available in the Flood Control Appendix.

ENERGY CONSERVATION

INTRODUCTION

The chain of events that led to the Fargo-Moorhead Urban Study addressing energy conservation began with the National Energy Conservation Policy Act, dated November 9, 1978. This law requires the Federal Government to be a pacesetter in energy conservation.

The Army plan was developed in response to this act and other administration and congressional actions. This plan declares that one of the Army's objectives is to participate in the national effort to conserve energy resources.

The St. Paul District, Corps of Engineers, coordinated with study area representatives and Corps higher authorities during the selection of energy conservation subjects that would fulfill the above stated objectives. Six subjects were originally suggested for inclusion in the urban study and further coordination narrowed this down to the following two subjects:

- Thermography
- Promotion of recycling

The following sections in this chapter briefly discuss the urban study's efforts in these two subject areas. A more detailed discussion of the results of the thermography and recycling studies are available in the Energy Conservation Appendix.

Thermography

Thermography is infrared photography that shows relative amounts of infrared radiation (heat) emitted and reflected by objects, much as normal photography shows relative amounts of visible light emitted or reflected.

Thermography is a popular tool for discerning energy (specifically heat) losses. Thermographic imagery shows bright ("hot") areas with greater heat losses and ("cool") areas with lesser heat losses. Because such visual imagery is relatively easy to understand and because many people find it interesting, thermography provides a captivating, instructive means to establish broader in-depth discussions of energy conservation topics.

As part of the Fargo-Moorhead urban study, ground-level thermography was conducted on over 1,600 residences in the 16 smaller communities and developments in the study area listed below (also see figure 4):

North Dakota		Minnesota
Argusville	Mapleton	Dilworth
Briarwood	North River	Glyndon
Brooktree Park	Prairie Rose	Kragnes
Frontier	Reile's Acres	Rustad
Harwood	Rivertree Park	Sabin
Horace		

In recent years, other sponsors had conducted aerial thermography for the larger municipalities (Fargo and Moorhead) and for some nearby communities (notably West Fargo and Riverside).

The videotaped ground-level thermographic images were available for public viewing at six community information centers. Volunteers from the

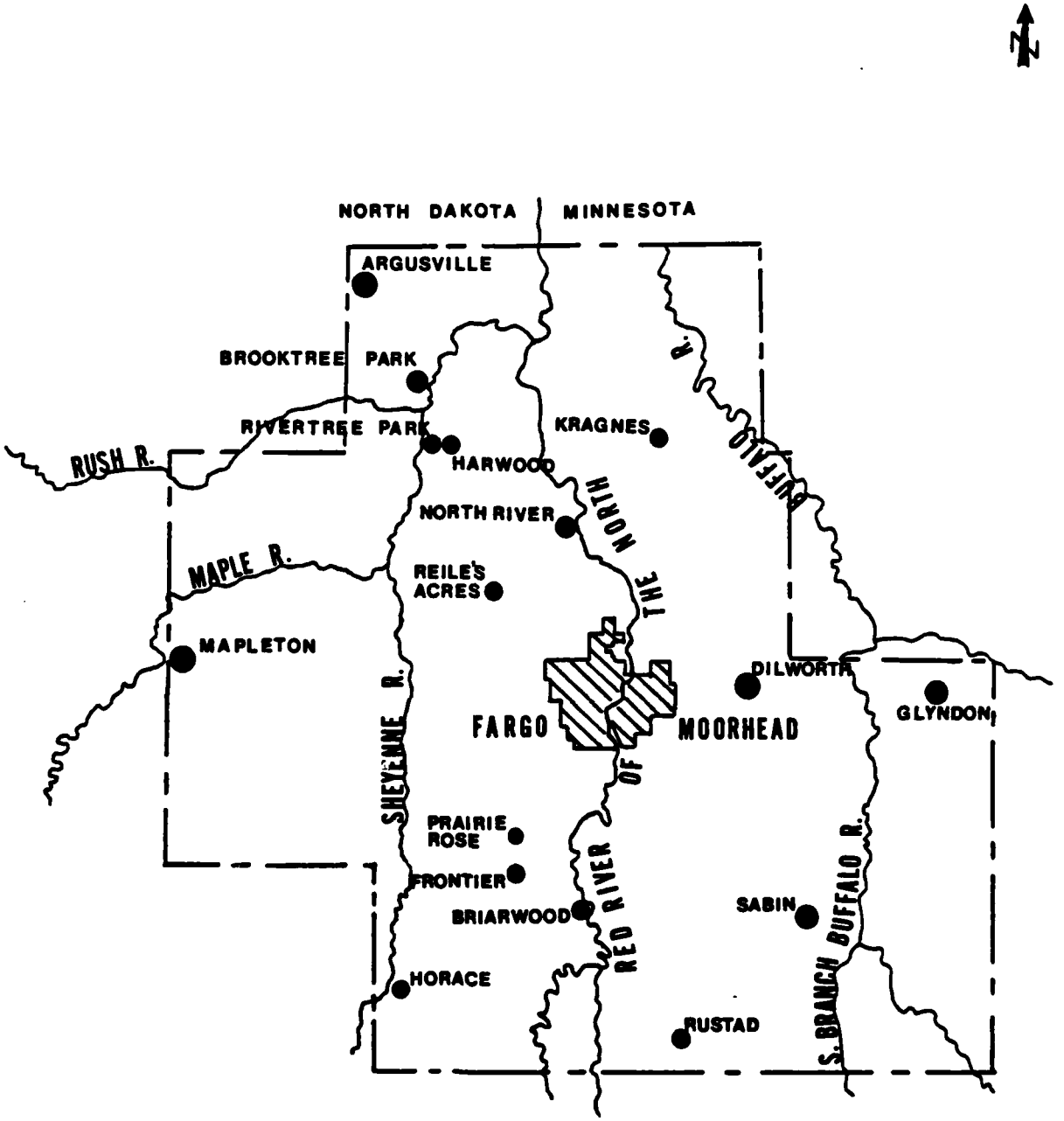


FIGURE 4
THERMOGRAPHY SURVEY STUDY AREA

study area were trained to operate videotape playback equipment and to interpret the thermograms for residents visiting the centers.

Visitation at the information centers was generally good, with estimates for the 16 communities ranging from 10 to 80 percent of the homeowners. Most visitors seemed to gain valuable information from the imagery and discussions with the interpreters. Visitors were often shocked to see the amount of apparent heat loss, and many expressed the intention to take steps to correct the problems revealed by the thermograms. Some visitors looked at the imagery merely to satisfy their curiosity, but even they left the information center more aware of their personal stake in energy conservation.

The thermography videotapes have subsequently been used at a local energy fair. The tapes are stored at North Dakota State University and are available for viewing through arrangements with the office of the cooperative extension service.

Recycling

The Fargo-Moorhead recycling project resulted from the growing concern among local governments regarding long-term solutions to the problem of municipal solid waste disposal. The urban study's energy conservation and water supply investigations had related concerns about possible effects of solid waste disposal. In particular, urban study involvement revolved around the concept of recycling reusable materials to save energy and to reduce the potential for contaminated leachate from landfills.

The purpose of the project was to develop and conduct a promotional campaign that would encourage residents and businesses in the Fargo-Moorhead area to recycle newspapers.

The newspaper recycling campaign was undertaken as a joint project between the cities of Fargo, North Dakota, and Moorhead, Minnesota, in cooperation with the Fargo-Moorhead Metropolitan Council of Governments (MCOG). A recycling committee consisting of appropriate officials from the two cities was established to oversee the project.

Audio Media, Inc., a marketing firm from Fargo, was awarded a contract to develop and implement a marketing program. Development of the program was based on a review of past and ongoing recycling efforts and an analysis of available marketing alternatives. Emphasis was placed on supplementing rather than duplicating ongoing recycling efforts in the private sector.

The recycling campaign was designed around the slogan "NO NEWS IN THE LANDFILL IS GOOD NEWS FOR FARGO-MOORHEAD!" Various media outlets were used, including television, radio, newspapers, billboards, and grocery bags. The newspaper recycling campaign was an outstanding success as the monthly volume of newspaper collected for recycling increased by an average of 446 percent during the campaign. This increase in volume translated into various short-term and long-term benefits, including savings in energy and transportation costs, extended life of area landfills, preservation of the environment and natural resources, increased public awareness, and favorable attitudes toward recycling.

Based on the positive results of the newspaper recycling campaign, it was concluded that the project was a success, and it was recommended that similar recycling campaigns continue to be implemented periodically in the future and that their scope be expanded to products other than newspapers if other recycling is determined economically feasible.

LEACHATE CONTAMINATION

From the early 1950's until 1981, the city of Fargo, North Dakota, had been disposing of its municipal solid waste in a 157-acre tract of land

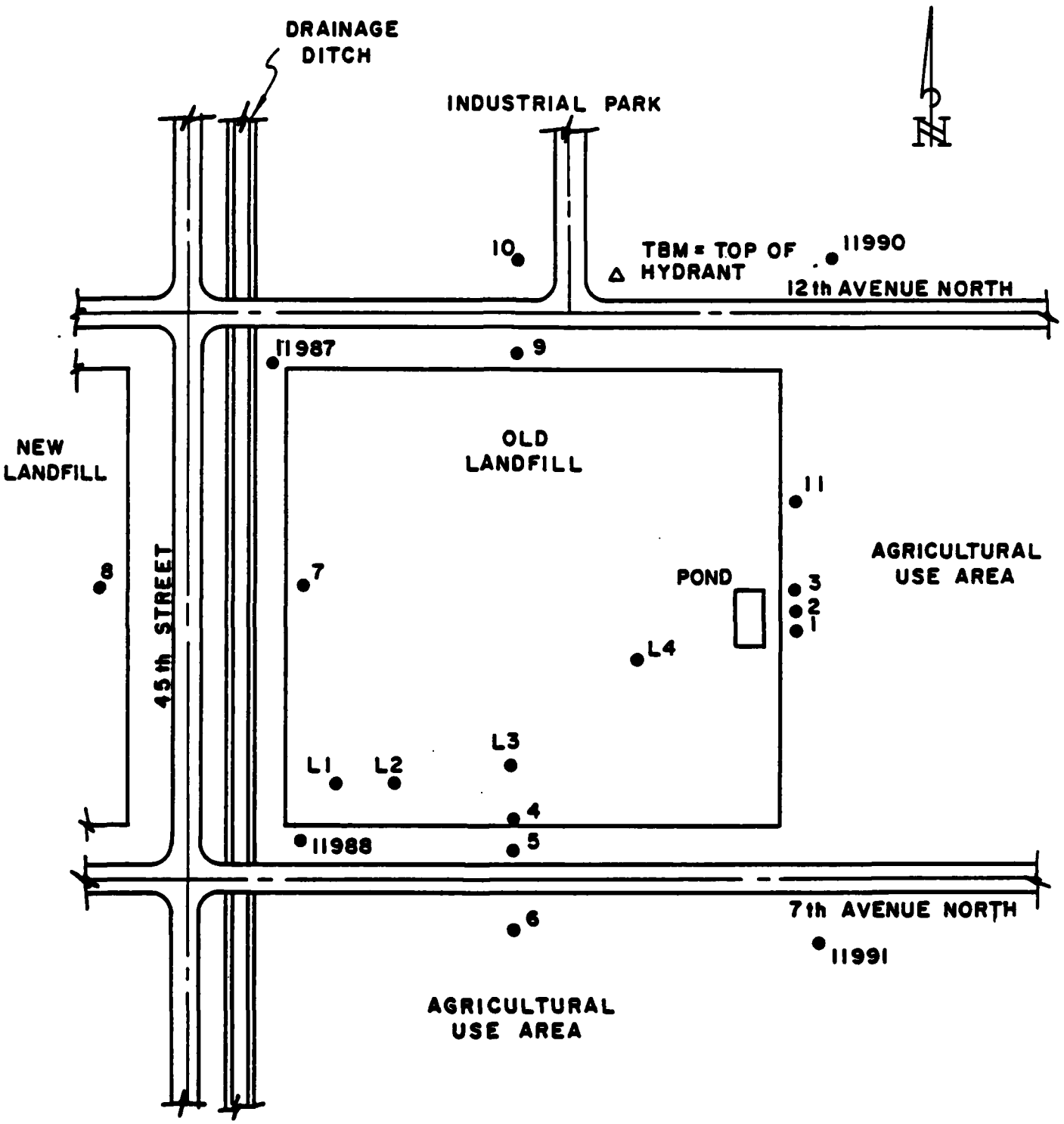
located northwest of the city in an industrial/agricultural area (see figure 5). In 1981, the city began using a 160-acre tract of land just west of and adjacent to the old Fargo sanitary landfill.

The old Fargo landfill, in general, consists of one 8-foot layer of refuse that is overlain by cover soil ranging in depth from 6 to 10 feet. The refuse is immediately underlain by a brown and gray mottled clay that separates the refuse from the silty sand layer 13 to 18 1/2 feet below the landfill surface. This silty sand layer is underlain by clay.

Recent pumping tests conducted by the North Dakota State Water Commission suggested that the new landfill as well as the west edge of the old Fargo landfill overlie the West Fargo Aquifer. This aquifer supplies water to the cities of West Fargo and Riverside, North Dakota. In addition, the Cass Rural Water Users Association services its customers in the North Dakota communities of Briarwood, Frontier, Mapleton, North River, and Reile's Acres with water also drawn from the West Fargo Aquifer. A study to determine alternative long-term uses for the old Fargo landfill was conducted by North Dakota State University for Fargo in the summer of 1981. Samples of leachate taken at that time showed potential for groundwater contamination by trace metals and other pollutants.

As a result of that study, the St. Paul District Corps of Engineers contracted with North Dakota State University in the fall of 1982, to further investigate the possibility of groundwater contamination due to leachate migration from the old Fargo landfill. The purpose of this study was to gather initial data to be used in the assessment of potential health hazards resulting from the contamination of subsurface water supplies.

The study involved monitoring of 15 observation wells located on and adjacent to the old landfill site to determine groundwater level fluctuations, groundwater conductivities, and groundwater temperatures. These data along with precipitation records were used to provide



LOCATION OF WELL SITES AT OLD FARGO LANDFILL

FIGURE 5

information on the quantity and movement of leachate at the old Fargo landfill. Chemical analysis of leachate samples by the North Dakota State Department of Health and North Dakota State University provided additional information on leachate quality.

Chemical analysis on groundwater samples indicated some degree of groundwater contamination in all wells except one, which was screened in clay at a depth of 100 feet. Wells completely in refuse showed severe contamination with dissolved solids. Wells that were screened at the silty sand layer showed evidence of severe contamination, with chloride, sodium, and sulfate ion concentrations particularly high.

Several wells show concentrations of selected trace metals in excess of safe drinking water standards. One well had concentrations of arsenic, cadmium, chromium, and lead in excess of safe limits. Groundwater samples from another well showed consistently high pH values.

Information from the North Dakota State Water Commission places the old Fargo landfill on the east edge of a cone of depression for a West Fargo municipal well. However, the landfill is separated from this aquifer by an underlying clay layer several tens of feet thick. The Corps-sponsored study uncovered no evidence to suggest that leachate movement poses a threat to this aquifer.

The Corps study also concluded that the shallow silty sand layer beneath the landfill appears to act as a separate groundwater system that does show evidence of contamination because of leachate migration. The areal extent of this contamination was not determined; further study would be needed to establish the existing and possible future extent and degree of contamination. At a minimum, shallow wells located in the immediate vicinity of the landfill should be monitored, and crops grown on or adjacent to the landfill should be examined for possible take-up of contaminants.

A more detailed discussion of the leachate investigation is available in the third volume of the Water Supply Appendix.

FARGO-MOORHEAD WATER RESOURCES DATA MANAGEMENT SYSTEM

The Fargo-Moorhead Water Resources Data Management System (FMWRDMS) was conceived in response to a request from State and local planning agencies for a computerized data system for the management of water resources in the study area. The St. Paul District, Corps of Engineers, through the Fargo-Moorhead Metropolitan Council of Governments, contracted with the North Dakota State University Department of Physics to design such a system. The FMWRDMS is the result of this effort.

The effort was conducted in two phases. Phase I consisted of surveying the various administrative and technical personnel in the State and local water resource planning agencies to determine what specific needs the system should fulfill. Also during phase I an inventory and assessment of the available historic records pertaining to water resources data such as meteorological, hydrological, water quality, water supply and water demand were undertaken to determine data gaps.

Phase II was designed to fulfill two primary objectives:

- To develop a comprehensive water resources data base from available historic records.

- To develop a computer-based interactive water resources data management system for storage, retrieval, updating, and manipulation of data including numerical, statistical, and graphical analysis pertinent to the needs of water resources management.

The fullfillment of the above objectives resulted in the following Phase II study reports:

Volume 1: FMWRDMS - A Computer Aided Tool for Regional Water Management

Volume 2: Regional Statistical Tables and Plots

Volume 3: Users Guide to FMWRDMS

Volume 4: Program Listings and Documentation

Volume 1 provides an overview of the FMWRDMS including an overview of the contents of the other three reports. Volume 2 contains a compilation of the 82 monthly statistical summary tables and 37 monthly statistical summary plots directly available in the system. These were generated using the comprehensive historic records stored off-line. An index of these tables and plots is available in appendix 2, 2a, and 2b of volume 2. All these tables and plots are also available for on-line viewing with the use of the appropriate command.

The Users Guide to FMWRDMS, the third volume of the study, describes the set-up, on-line manipulation, and back-up procedures of the system. Selected examples and applications, which are included in volume 3, provides a direct view of the operation of the system.

Volume 4 provides a complete listing with documentation of all the programs that were developed in this study. There are four types of programs: (1) on-line system programs, (2) set-up and back-up programs, (3) auxiliary programs, and (4) utility programs. The Users Guide (volume 3) provides instructions in the use of these programs.

The FMWRDMS is designed and implemented in two parts: (1) an on-line interactive database mode and (2) an off-line batch mode. The on-line database is manipulated with the use of commands designed to perform a variety of functions, including correlation analysis, statistical tables, and plots. The current on-line database has a 20-year historic record

period from 1963 to 1982. The system's design permits automatic updating for up to 10 additional years.

BANK STABILITY

Riverbank stability problems are common in the Red River Valley because of its geological history. The valley is the former lakebed of glacial Lake Agassiz where tens of feet of silt and clay were deposited. These deposits are extremely susceptible to slip-plane formation; and once shearing has occurred, the bond between the faces is weakened and subject to continued movement.

There are three sites along the Red River in Fargo, North Dakota that are threatened by riverbank slippages (figure 6). Included in these areas are several public facilities -- two Cass County-owned city-maintained cemeteries; buildings at Trollwood Park; and the Edgewood Golf Course clubhouse and adjoining pro-shop.

The St. Paul District originally examined the applicability of Section 14 of the 1946 Flood Control Act, as amended, which is the Corps authority for Emergency Streambank and Shoreline Protection of Public Works and Nonprofit Public Services. It was determined that Fargo's bank instability problems did not qualify for study under that authority. However, technical assistance and advice were available under the Fargo-Moorhead Urban Study in keeping with the goal of providing planning assistance to local interests.

The St. Paul District took soil samples and one boring to use in a geotechnical analysis of the problem. This analysis determined that, left undisturbed, riverbanks in this area, as in the rest of the Red River Valley, are near a state of equilibrium. Bank failures are common when the riverbanks are overloaded from placement of fill or buildings on top, or when nature upsets the status quo by eroding the toe of the bank. The later appears to be the major factor at the three problem areas

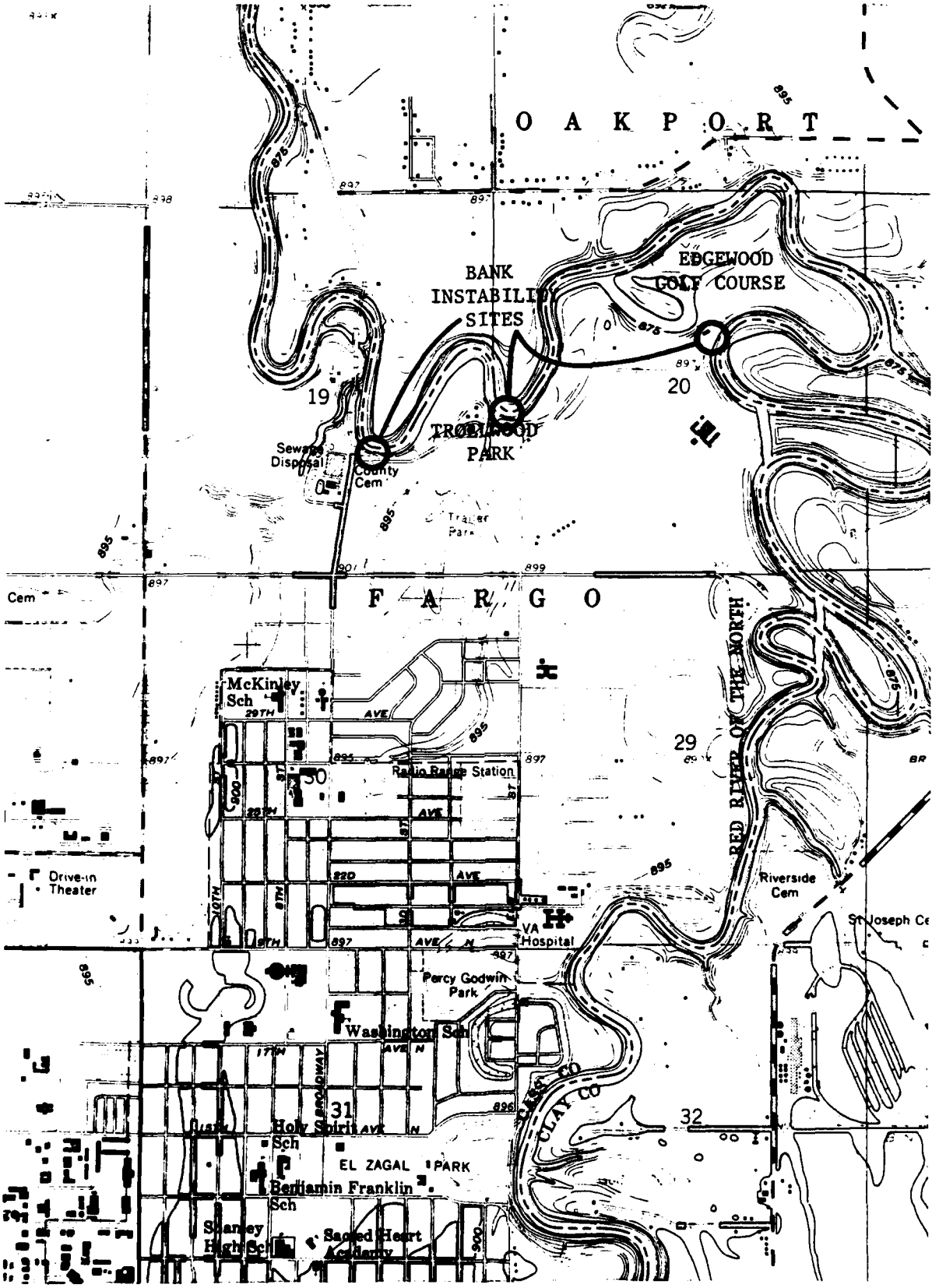


FIGURE 6
BANK STABILITY PROBLEM AREAS

examined during the urban study; every trouble spot is on the outside of a river bend where erosive forces are undercutting the riverbank.

Several alternative solutions to the problem are being considered by local officials:

1. Cutting new channels for the river away from the problem areas and using the excavated material to shore up the unstable banks.

2. Installing steel sheet piling at the toe of the bank to prevent its movement and shield it from further erosion.

3. Placing fill on the toe of the slide to counterbalance the "driving" weight of the soil high up the slope.

4. Constructing a low-head dam to back the river up against the toe as an alternate form of counterbalance.

5. Removing weight from the top of the bank which is the driving side of the slide.

6. Removing and replacing the soil.

7. Relocating the threatened graves and buildings.

These alternatives were examined by the St. Paul District on the basis of relative cost, reliability, practicability, environmental impacts, implementation factors, and local desires. It was recommended that alternative 7, which involves relocating threatened graves and buildings, is the most cost-effective, reliable solution. Implementation of this alternative, however, would require relocating numerous unmarked historic graves as well as moving the 50-year old, brick golf course clubhouse without incurring structural damage. Currently local officials have not selected a course of action, and the St. Paul District is continuing to

help identify possible Federal and State agencies that might be potential sources of funds or other assistance.

RECOMMENDATIONS

The Fargo-Moorhead Urban Study was a cooperative effort involving local, regional, State, and Federal agencies designed to provide comprehensive planning assistance to study area communities. Based on an assessment of the primary local concerns, the urban study focused on three topics -- flood control, water supply/conservation, and energy conservation. As the study progressed, it addressed other related needs as well.

The urban study's investigations are briefly discussed in this Summary Report. Details regarding the conduct, findings, and conclusions of those investigations are included in the respective technical appendixes.

Based on the results of those investigations, I recommend that:

Flood Control

o The communities of Harwood and Rivertree Park, North Dakota, consider requesting the Corps of Engineers to conduct detailed studies of flood damage reduction measures.

o All communities in the study area adopt/enforce sound floodplain management practices to minimize future flood damages.

o Hydrologic, hydraulic, and topographic information developed during the urban study be used by the Federal Emergency Management Agency (FEMA) to update existing flood insurance studies at Fargo and Moorhead to include a revised floodway through the urban area.

o Hydrologic, hydraulic, and topography information developed during the urban study be used by local communities (with assistance from

appropriate county, State, and Federal agencies) to prepare emergency flood fight plans, to design river crossings, and to determine in-stream storage capacities.

Water Supply/Conservation

o All communities in the study area immediately develop water conservation programs. For the urban core communities (Fargo, Moorhead, West Fargo, and Dilworth), these programs should include installing water-saving devices, revising existing pricing systems, conducting educational campaigns, and adopting sprinkling ordinances. For the rural communities, these programs should include installing water-saving devices and revising pricing systems. A water conservation program needs to be an integral part of each community's water supply planning.

o Urban core communities immediately begin implementing a subregional water supply/conservation system connecting the water supply systems of Fargo, West Fargo, Moorhead, and Dilworth. Initial efforts should include implementation of cost-sharing and integrated management.

o Urban core communities determine the amount of reservoir storage behind the existing low-head dam at Island Park (Fargo) on the Red River. If available storage is less than that required by the water supply/conservation plan, the communities need to assess alternative means of meeting the shortfall, including dredging, raising the dam, and off-stream storage.

o All communities in the study area immediately prepare drought emergency plans following the examples provided in the Water Conservation Appendix.

o Fargo continue to monitor shallow wells in the vicinity of the city's old landfill to track any migration of contaminated leachate, and crops grown on or adjacent to the landfill be examined for possible take-

up of contaminants. If monitoring suggests that leachate movement poses a potential threat to adjacent developments or farm lands or to underlying major aquifers, local officials should conduct additional studies to better assess the future areal extent and degree of leachate migration.

Energy Conservation

o Study area communities emphasize energy conservation through publicity and public awareness programs. Local government should take steps to motivate homeowners and businesses to adopt energy-conserving practices, including building codes, tax incentives, ground-level thermography surveys, and subsidized energy-efficiency inspections.

o Study area communities should encourage recycling to extend the life of existing sanitary landfills and to save energy.

Other

o The Metropolitan Council of Government (MCOG) should continue to maintain and update the Fargo-Moorhead Water Resource Data Management System. This system should be adapted for use on micro-computers to allow wider distribution and application by all agencies, firms, institutes, and individuals involved in water resources planning.

o The results of this urban study be incorporated into a local comprehensive urban planning being conducted by MCOG in conjunction with area communities to insure that the findings, conclusions, and recommendations of the urban study receive full consideration and are implemented as appropriate.

Edward G. Rapp
Colonel, Corps of Engineers
District Engineer

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