COMMUNITY ASSISTANCE PLANNING REPORT NO. 185

A PLAN FOR THE CREATION OF AN AUTOMATED MAPPING AND PARCEL-BASED LAND INFORMATION SYSTEM FOR KENOSHA COUNTY

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NUMBER 185

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Prepared by the

Southeastern Wisconsin Regional Planning Commission
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August 1990

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August 1, 1990

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Kenosha County Courthouse
912 - 56th Street
Kenosha, Wisconsin 53140

Mr. John R. Collins
Kenosha County Executive
Kenosha County Courthouse
912 - 56th Street
Kenosha, Wisconsin 53140

Ladies and Gentlemen:

On March 20, 1990, the Kenosha County Board of Supervisors adopted a resolution requesting that the Southeastern Wisconsin Regional Planning Commission convene an advisory committee to examine the feasibility of developing an automated mapping and parcel-based land information system within the County. The resolution was subsequently approved by the Kenosha County Executive. Acting in response to this request, the Regional Planning Commission created an Advisory Committee composed of knowledgeable and concerned representatives of various county departments, the City of Kenosha, the Kenosha Unified School District, and the public and private utilities operating within the County. This report sets forth the findings and recommendations of that Committee.

Based upon careful review of pertinent information, the Advisory Committee concluded that the needs of the various Kenosha County departments, the local units of government concerned, and the public and private utilities operating in Kenosha County would best be served by the development over time of a decentralized land information system. Under this type of system, individual users would be responsible for analyzing their own needs, developing the necessary data files, and acquiring computer hardware and software. All concerned, however, would share a common digital mapping base and parcel identification system, thereby permitting the ready exchange of data among the decentralized data banks.

Accordingly, it is the recommendation of the Advisory Committee that Kenosha County undertake the creation of the common digital mapping base and, upon completion, maintain that base in a current condition. This common digital mapping base would provide an automated mapping capability suitable for the development by individual county departments, local units of government, and public and private utilities of a wide variety of automated applications, such as land ownership and title recordation systems, real property assessment and taxation systems, public and private utility inventory and management systems, environmental inventory and management systems, and zoning and other code monitoring and enforcement systems. The development over time of these and other applications and their shared use of the common digital mapping base can be expected to result in the efficient evolution of a fully integrated, effective, parcel-based land information system in Kenosha County.

This report sets forth a set of specifications for the development of a countywide digital mapping base, provides an estimate of the cost of creating such a mapping base for the County, and proposes a practical means of funding the creation of the mapping base. The Advisory Committee unanimously recommended that the Kenosha County Board favorably consider the recommendations set forth in this report.

Sincerely,

Kurt W. Bauer
Executive Director

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Chapter I

INTRODUCTION

BACKGROUND

On March 20, 1990, the Kenosha County Board of Supervisors adopted a resolution asking the Southeastern Wisconsin Regional Planning Commission to convene an advisory committee to analyze the feasibility of modernizing land records within the County by developing an automated mapping and land information system. This resolution was subsequently approved by the Kenosha County Executive. A copy of the adopted resolution is provided in Appendix A.

PURPOSE OF THE REPORT

The basic purpose of this report is to explore and document the need for the development of an automated mapping and land information system within Kenosha County. The report is intended to provide sufficient information to permit the Kenosha County Board of Supervisors, the Kenosha County Executive, the affected Kenosha County departments, the concerned local units of government, and the public and private utilities to consider the benefits and costs of creating such a system, and thereby to determine the desirability of proceeding with its implementation. To this end, the report is intended to accomplish the following purposes:

1. To provide county and local officials, utility managers, and concerned citizens with a basic understanding of the components of an automated mapping and land records system and the manner in which these components must be assembled to provide a conceptually and technically sound operational system.

2. To identify and briefly describe existing automated mapping and land information systems whose operation pertains to all or portions of Kenosha County.

3. To examine the advantages and disadvantages of different organizational arrangements for the development of an automated mapping and land information system for Kenosha County, including, particularly, cooperative intergovernmental organizational arrangements between and among the affected units of government.

4. To identify those technical issues which, in the case of a shared, multi-user, automated mapping and land records system, would need to be resolved before a shared system could be developed.

5. To estimate the time and resource requirements for implementing an automated mapping and land records system for Kenosha County.

6. To recommend a course of action.

ADVISORY COMMITTEE STRUCTURE

To provide a proper forum for the preparation of the report and for seeking agreement on the course of action to be recommended, an advisory committee was created. That committee included knowledgeable representatives of the County and City of Kenosha, certain local units of government within Kenosha County, and the Kenosha Unified School District. A roster of the advisory committee is reproduced on the inside front cover of this report.

The purpose of the Advisory Committee was to place the knowledge and experience of the committee members at the disposal of the study and to actively involve the various interests in the study. The Committee carefully reviewed and approved the findings and recommendations of this report.

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Chapter II

AUTOMATED MAPPING AND LAND INFORMATION SYSTEMS: AN OVERVIEW

INTRODUCTION

For more than a decade now, there has been growing interest in the United States in land information systems. This interest ranges from a relatively narrow concern about the need to modernize land title recordation systems to a relatively broad concern about the need to create entirely new land-related data banks for multipurpose applications. This growing interest has involved many disciplines, ranging from surveyors, abstractors, assessors, and attorneys concerned with the fiscal and legal administration of real property to planners, engineers, public utility managers, public administrators, and elected officials concerned with resource management and community development. Much of the interest was initially centered on the use of electronic computers for the storage, manipulation, and retrieval of land-related information and, more recently, for the use of computer-assisted graphics collection and display hardware for the reproduction of the data in mapped as well as tabular form.

As interest in the area of land data systems has grown, the topic has become increasingly prominent as a subject of professional papers, reports, conferences, and the meeting programs of various professional organizations. Accordingly, a body of professional literature on the subject of automated mapping and land information systems has begun to coalesce and accumulate. Over this same time frame, an increasing number of local units of government and private utilities have undertaken the creation of automated mapping and land information systems—including several systems that currently cover all or parts of Kenosha County. This chapter presents a summary of pertinent literature in the area of automated mapping and land information systems, and identifies and briefly describes currently operating automated mapping and land information systems whose operation pertains to all or portions of Kenosha County.

NATIONAL RESEARCH COUNCIL STUDIES

In 1979, the National Research Council convened a Panel on a Multipurpose Cadastre to review the status of cadastral activities at the federal, state, and local governmental levels and in the private sector and to review a number of demonstration projects that had been undertaken at various locations. This action was taken by that Council in response to the growing interest in land data systems and to the perceived increasing need for land-related information by all levels of government and by the private sector. In 1980, a report was issued, the principal finding of which was that:

> There is a critical need for a better land-information system in the United States to improve land-conveyance procedures, furnish a basis for equitable taxation, and provide much needed information for resource management and environmental planning.[1]

The report set forth the concept of the multipurpose cadastre as a basis for a dynamic public process that could effectively collect, maintain, and disseminate land-related information. It identified the land resource-related problems faced by public and private organizations and outlined the basic structure of a multipurpose cadastre that could help to remedy those problems. However, the report did not address how governments, especially local governments, could carry out the recommendations made in the report.

To address the questions left unanswered by its 1980 report, the National Research Council prepared a second report which set forth a set of recommended procedures and standards for the design and implementation of a multipur-

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[1] *National Research Council, Assembly of Mathematical and Physical Sciences, Committee on Geodesy, Panel on a Multipurpose Cadastre, Need for a Multipurpose Cadastre, National Academy Press, Washington, D. C., 1980.*

pose cadastre.[2] It was the intent of this report to assist the local units of government wishing to pursue the development of cadastral records systems for their own jurisdictions, and also the many other regional, state, and federal agencies, as well as private businesses, whose participation will be needed for the development over time of true multipurpose land information systems.

The procedural model put forth by the Panel identified the basic components of a modern land information system as: 1) a spatial reference framework consisting of monumented geometric control points; 2) a series of accurate, large-scale topographic base maps; 3) a cadastral overlay to the base maps that delineates all cadastral—that is, real property ownership—parcels; 4) a cadastral parcel numbering scheme that provides for unique identification of each cadastral parcel; and 5) a series of compatible registers of interests in, and data about, the land parcels keyed to the parcel identifier. It is important to note, in this regard, that the creation of such land information systems requires as a foundation a means of spatial reference for the data. An adequate geometric framework for such spatial reference must, if it is to serve even the narrowest purposes of a land information system, permit identification of land areas by coordinates down to the individual ownership parcel level. A geometric framework of adequate accuracy and precision to permit system operation at the highly disaggregated parcel level is the most demanding specification possible, but, once achieved, permits ready aggregation of information from the more intensive and detailed level to the more extensive and general level as may be necessary.

The local mapping and survey control network recommended by the Southeastern Wisconsin Regional Planning Commission since 1964—which is described in greater detail in Chapter III of this report—provides two of the five basic components of a modern land information system as set forth by the Panel, namely: 1) the required spatial reference framework, and 2) the required accurate large-scale topographic base maps; and facilitates the creation of the third component, a cadastral map overlay. The spatial reference framework is provided by the relocation, monumentation, and placement on the State Plane Coordinate System of the U. S. Public Land Survey corners. The Commission-recommended topographic maps provide the base maps specified by the Panel. In addition, by placing the U. S. Public Land Survey corners on the State Plane Coordinate System, the Commission-recommended system provides the basis for the ready and economical preparation of accurate cadastral—that is, real property boundary line—overlays to the topographic base maps, since all real property boundary descriptions in Wisconsin are, by law, tied to these corners. Less obvious, but of equal importance, is the fact that the Commission-recommended survey control network ties these real property boundary descriptions to the State Plane Coordinate System and, in turn, to latitude and longitude, thereby facilitating the precise correlation of real property boundary lines and earth science data—a necessary condition to the creation of a modern, automated, land information system.

It is important to note in this regard that the Commission-recommended local mapping and survey control network program was one of a select few local land information system modernization efforts described by the Panel in its reports, and therefore put forth as a system for emulation across the nation.

It is also important to note—particularly within the context of the development of this report—that both National Research Council reports determined that for much of the United States, the county presented the most logical locus for the development of multipurpose land information systems.

WISCONSIN LAND RECORDS COMMITTEE

Within Wisconsin there has also been growing interest in land information systems and land records modernization. In 1985, then Governor Anthony Earl appointed the Wisconsin Land Records Committee, a group representing state, regional, and local governmental interests, private utilities, and other private businesses that utilize local maps and land records. Over a

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[2]*National Research Council, Assembly of Mathematical and Physical Sciences, Committee on Geodesy, Panel on a Multipurpose Cadastre, Procedures and Standards for a Multipurpose Cadastre, National Academy Press, Washington, D. C., 1983.*

period of two years, this group issued 13 reports on various aspects of automated mapping and land records modernization, and a final report that summarized the more important findings of the Committee's deliberations.[3]

Like the National Research Council Panel, the Wisconsin Land Records Committee determined a need for continued efforts directed at land records modernization, and recognized the contribution that could be made by computer technology in certain aspects of this modernization process. The Committee determined that the costs to develop modernized land records systems would not be trivial, but that these costs would be reasonable, nonetheless, in view of the sums already being expended for current outdated and inefficient land information management practices. The Committee recognized, correctly, that the ultimate costs of land records modernization would be borne by citizens in the form of tax bills and utility bills, and accordingly recommended that various levels of government, private utilities, and other private businesses involved in the use of land information make every effort to jointly develop and use automated systems to minimize their total societal costs.

The Committee recognized that its recommendation for the development of shared approaches to land information systems modernization would create new organizational and institutional strains that would be as demanding in their solutions as the technical issues involved in the creation of new, automated land information systems. The Committee accordingly recommended that the educational and coordinative aspects of land records modernization receive as much attention as the technical issues.

The deliberations of the Committee and its published reports reaffirmed the validity of the procedural model advanced by the National Research Council Panel for the development of modern, automated, land information systems and, as did the National Research Council reports, highlighted the Commission-recommended local mapping and survey control network program as a basis for the development of modern, automated, land information systems.

Also, like the National Research Council Panel, the Wisconsin Land Records Committee recognized that there is a central role to be played by counties in the land records modernization process. Although the Committee chose not to precisely define that role, preferring instead to have individual counties make that determination, at the minimum, a coordinative role was seen as necessary in view of the records maintenance functions given to the counties by the state constitution and state statutes.

WISCONSIN LAND INFORMATION PROGRAM

Among the final recommendations of the Wisconsin Land Records Committee was a proposal for the creation of a Wisconsin Land Information Program overseen by a state level board that would provide a focal point for land records modernization issues and efforts within Wisconsin. During 1989, the Wisconsin Legislature enacted legislation creating the Wisconsin Land Information Program. The legislation was signed into law by Governor Tommy Thompson, and late in 1989, the Wisconsin Land Information Board began to meet following the appointment of the Board members by the Governor. Voting members of the Board are defined by statute as follows:

1. The Secretary of the Department of Administration, the Secretary of the Department of Agriculture, Trade and Consumer Protection, the Secretary of the Department of Natural Resources, and the Secretary of the Department of Transportation, or their designees.

2. Four representatives from county and municipal government appointed by the Governor to six-year terms, including at least one member of a county board of supervisors, at least one member of a city council or village board, and at least one person who is a county officer active in land information management.

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[3] *Wisconsin Land Records Committee, Final Report of the Wisconsin Land Records Committee, Modernizing Wisconsin's Land Records, University of Wisconsin-Madison, Center for Land Information Studies, Madison, Wisconsin, 1987.*

3. Four representatives chosen from public utilities and private businesses appointed by the Governor to six-year terms, including at least one public utility representative and at least one representative of a professional land information organization.

4. The State Cartographer.

In addition, the State Historic Preservation Officer, the Secretary of the Department of Revenue, the State Geologist, or their designees; a representative of a regional planning commission who is selected by the Board; a county employee active in land information management who is selected by the Board; and representatives of state and federal agencies active in land information management who are selected by the Board shall serve as nonvoting, advisory members of the Board.

As set forth in the legislation, the duties of the board will include:

1. The provision of technical assistance and advice to state agencies and local units of government with land information responsibilities.

2. The preparation of guidelines and standards to coordinate the modernization of land records and land information systems.

3. The creation and administration of a grant program for local units of government to assist in the development of modernized land records systems.

In its initial meetings, the Board identified the creation of a grants program to provide a source of partial funding for land records modernization as one of its high-priority issues and took steps to encourage the passage of a bill in the State Legislature that would provide such a funding mechanism. This bill was passed by both houses of the Legislature in March and April 1990. The Governor signed the legislation into law in April 1990.

ALTERNATIVE TYPES OF OPERATIONAL COMPUTER SYSTEMS AVAILABLE FOR THE DEVELOPMENT OF AN AUTOMATED MAPPING AND LAND INFORMATION SYSTEM

The professional literature currently categorizes operational automated mapping and land information systems into three general types: strictly automated mapping or computer-assisted drafting (CAD) systems; automated mapping-facilities management (AM-FM) systems; and geographic information systems (GIS). The distinction between these types of systems is somewhat artificial and stems from marketplace segmentation strategies adopted by vendors of computer hardware and software. Nevertheless, as long as it is recognized that operational systems comprise a continuum and that many systems will resist being neatly categorized as one or another of the three general types of systems, the tripartite division is a useful one for discussion purposes.

The computer hardware components comprising these three types of systems usually provide no basis for categorization, and the different systems are virtually identical in a physical sense. Computer software available for operating the different system types generally provides a basis for distinguishing between CAD systems on the one hand and the AM-FM and GIS systems on the other; but the differences between the software utilized to operate AM-FM systems and GIS systems is often less clear. Indeed, a number of proprietary software products currently purport to support either type of operation equally well.

Functionally, the CAD systems are perhaps the easiest of the three to categorize since they tend to be almost exclusively automated mapping systems with little or no capability for the management of associated land records. Both AM-FM and GIS systems possess automated mapping and records management capabilities, although the distinction between the two as often as not is a function of the type of associated land information managed by the system rather than of any pronounced functional difference between system components. Typically, systems categorized as AM-FM systems are found where the predominant function is to manage information associated with networks: for example, water distribution systems, sanitary sewerage systems, telephone systems, and electric power and natural gas distribution systems. GIS systems are usually systems that manage information associated with areas: real property parcels, administrative districts, land use polygons, and soil mapping units. While these distinctions between predominant functions of AM-FM and GIS systems are helpful in a taxonomic sense, in practice these distinctions

are often more apparent than real as virtually all currently available AM-FM software systems—while they may, in fact, be designed for optimal operation in network data analysis environments—are capable of analyzing polygon data. Likewise, virtually all currently popular GIS software is capable of performing network data analysis functions.

CURRENTLY OPERATING AUTOMATED MAPPING AND LAND RECORDS SYSTEMS PERTAINING TO ALL OR PARTS OF KENOSHA COUNTY

It was previously noted in this chapter that there are several automated mapping and land information systems already in existence whose areas of operation cover all or portions of Kenosha County. Since one of the primary purposes of this report is to determine the feasibility of some type of shared or joint operation of a countywide automated mapping and land information system, these existing systems are identified and their operations briefly described below.

The different map coordinate systems utilized by the different automated mapping operations in the Kenosha area represent an issue of central importance in any consideration of cooperative mapping efforts, and of the transfer of existing digital map information between the existing automated mapping sites. Therefore, the map coordinate system or systems utilized and the horizontal map datum upon which the coordinate system is based are identified for each operation.

The universe of all map coordinate systems is rather large, although currently, only two such systems are in regular use in the Kenosha area: the State Plane Coordinate System and the Universal Transverse Mercator (UTM) coordinate system. Both of these systems are based upon the North American Datum of 1927 (NAD-27) which is, in turn, derived from the Clarke 1866 mapping spheroid. Since both the State Plane Coordinate System and the UTM coordinate system are based upon NAD-27, it is possible, albeit computationally tedious, to translate with mathematical precision from one of these coordinate systems to the other. It is, in an analogous fashion, further possible to move with mathematical precision between either of these two systems and any other map coordinate system derived from NAD-27, although again, the procedure is tedious.

Recently, the National Geodetic Survey of the National Oceanic and Atmospheric Administration, U. S. Department of Commerce—the federal government agency responsible for the maintenance of the nation's geodetic control system—has begun to move all federal mapping activity from the Clarke 1866 mapping spheroid onto the Global Reference System of 1980 (GRS 80), a newly defined mapping spheroid. As part of this transfer, an entirely new horizontal datum, NAD-83, has been developed for use with GRS 80. Any precise conversion between NAD-27 and NAD-83 requires recomputation utilizing the original control survey field measurements. The implications for the conversion from NAD-27 to NAD-83 of the type of control network and related large-scale planimetric mapping typically prepared by local units of government and utilities are therefore both technically severe and operationally costly. A similar situation exists for large-scale topographic mapping with the proposed replacement of the National Geodetic Vertical Datum of 1929 (NGVD 29) by NGVD 87 which has been developed for use with GRS 80 and NAD-83. Importantly, the replacement of NAD-27 and NGVD 29 with NAD-83 and NGVD 87 will be costly, while offering no improvement in map accuracy or precision for locally oriented large-scale mapping operations.

Southeastern Wisconsin Regional Planning Commission

The Southeastern Wisconsin Regional Planning Commission installed CALMA hardware and software in 1976 to begin conversion to digital format of its land use and natural resource inventory data. Since then, the Commission has converted its analog land use inventories for 1963, 1970, and 1975 for its 2,689-square-mile planning area, has completed digital land use inventory updates for 1980 and 1985 for the entire planning area, and has digitized operational soil surveys for about 2,500 square miles, or about 93 percent, of its planning area. Kenosha County lies completely within the Commission's planning area. The primary Commission system products are land use maps, interpretive soil maps, summary areal extent statistics prepared in support of long-range planning activities, and "camera ready" artwork

prepared for the printing of thematic maps appearing in published reports. The Commission utilizes the State Plane Coordinate System, NAD-27, for its digital mapping activities.

In 1984 and 1985, the Commission, in cooperation with Kenosha County and the State of Wisconsin, undertook a demonstration project in the Town of Randall and the Village of Twin Lakes in Kenosha County to determine the feasibility of building a multipurpose, automated, land information system utilizing then-current computer hardware and software technology. The demonstration project covered an area of about 24 square miles containing urban, suburban, and rural land use development patterns, and resulted in the preparation of digital map overlays of real property boundary lines, right-of-way easement lines, hydrography, structure outlines, existing land use, soil mapping units, zoning districts, floodplain limits, and shoreland boundary areas.[4] Kenosha County had already began a program in 1980 to implement the Commission-recommended local mapping and survey control system throughout the County. The large-scale topographic base maps previously produced for the project area under this countywide program—which was completed throughout the County in 1988—provided the source for the digitization of most of the planimetric map features captured—surface water and stream channels; the pavement edges of public streets and highways; and structure outlines. The positions of these features had been determined by photogrammetric methods during the original preparation of the topographic maps, and therefore appeared on the finished maps. These maps also provided a precise base for the subsequent delineation of floodplain limits and shoreland boundary districts prior to their digitization. Recorded subdivision plats, certified survey maps, abbreviated legal descriptions, recorded easement descriptions, plats of right-of-way locations, and surveyors' field notes were used to locate real property boundary lines and real property boundary line-related information, such as easement and right-of-way lines, on maps prior to digitization. The real property boundary lines were constructed on the maps in the same way a land surveyor would construct those lines in the field. This was made possible by the framework of control provided by the known locations of the U. S. Public Land Survey corners on the State Plane Coordinate System and the attendant known grid lengths and grid bearings of all quarter-section lines.

Following the demonstration project, Kenosha County contracted with the Commission for the preparation of equivalent digital map files in adjoining portions of the County. Currently, this automated mapping conversion effort, including the research and delineation of real property boundary lines on correct map bases, has been completed or is underway for an area of about 112 square miles, including the original 24-square-mile demonstration area. Accordingly, about 40 percent of the area of the County already has, or is in the process of acquiring, a basic automated mapping and land information system capability. These 112 square miles contain approximately 17,000 real property ownership parcels, or about 30 percent of all such parcels in the County.

The experience gained by the Commission in more than a decade of automated land use and natural resource mapping provided a valuable base upon which to evaluate the available hardware and software products when, in 1986, the Commission reached a decision to acquire new computer hardware and software for its automated mapping operation. In 1987, a completely new automated mapping system was installed comprised of DELTAMAP software running on Hewlett-Packard and Calcomp hardware. The enhanced operational capability provided by this new system allowed the Commission staff to begin taking steps in 1988 to convert its large-scale and intermediate-scale base mapping operations from analog to digital format.

State of Wisconsin

Two agencies of state government currently possess and use automated mapping systems:

[4]*SEWRPC Technical Report No. 30, The Development of an Automated Mapping and Land Information System: A Demonstration Project for the Town of Randall, Kenosha County, 1985.*

the Department of Transportation and the Department of Natural Resources.

The Department of Transportation installed INTERGRAPH hardware and software in 1982. This system is used primarily for maintaining and updating the Department's official State Highway Map and the Department's statewide series of county highway maps. Some of the map data for these two programs were created by optical scanning of color separation plates that had been used for color map printing. The system is also used for project mapping in support of highway construction and improvement projects. The map data for this activity are usually acquired through direct digitization from stereoscopic models. All of the Department of Transportation's digital mapping currently utilizes the State Plane Coordinate System, NAD-27, although the Department is in the process of shifting its mapping datum to NAD-83.

The Department of Natural Resources began building a digital map data collection system in 1980. This system has been, in effect, custom built by Department staff who have configured purchased hardware components and written their own computer software. The system is used primarily in support of Department land acquisition, improvement, and management projects, but was used to create, and currently maintains, a statewide inventory of wetlands. The Department of Natural Resources has not chosen a standard coordinate system for its digital mapping, and, although it utilizes the UTM coordinate system, NAD-27, for some projects, it also utilizes the State Plane Coordinate System, NAD-27, for some projects and local coordinate systems on occasion. The Department possesses computer software translation capability between UTM and State Plane coordinates. The Department of Natural Resources is in the process of evaluating whether or not to shift its mapping datum to NAD-83.

Recently, both the Department of Transportation and the Department of Natural Resources began to use the proprietary software ARC/INFO to develop network and polygon map data analysis capability, while continuing to maintain their automated mapping functions on the originally acquired systems. The Department of Transportation has acquired the software and is running it on Digital Equipment Corporation (DEC) hardware which it recently installed for that purpose. The Department of Natural Resources is running the software in a "time share" mode on the University of Wisconsin's DEC system, and has recently utilized this system to develop a statewide analysis—including a state map prepared by computer-assisted methods—of groundwater contamination susceptibility.

Wisconsin Electric Power Company and Wisconsin Natural Gas Company

The Wisconsin Electric Power Company (WEPCo) and the Wisconsin Natural Gas Company (WNG), both subsidiaries of Wisconsin Energy Corporation, have jointly developed a digital mapping base upon which to map their respective electric and gas service networks. This effort was initiated in 1979 with the installation of INTERGRAPH hardware and software at WEPCo. The majority of Kenosha County lies within the service territory of WEPCo and WNG. Small portions of western Kenosha County receive electric power service from Wisconsin Power & Light Company and natural gas service from Wisconsin Southern Gas Company. WEPCo and WNG completed the development of digital map coverage for the portion of Kenosha County lying within their service territories prior to 1985.

Throughout much of the Southeastern Wisconsin Region, WEPCo and WNG utilized data from large-scale topographic mapping and control survey projects prepared to Commission-recommended specifications to establish their spatial reference framework. These data were acquired in State Plane Coordinate System, NAD-27, format and converted by WEPCo and WNG to the UTM coordinate system, NAD-27, which the two companies continue to utilize for their digital mapping activity.

Both WEPCo and WNG have recently begun to transfer a portion of their automated mapping capability to IBM hardware and software in order to utilize the digital maps created on the INTERGRAPH system for the mapping of nongraphic attribute data stored on the Corporations' corporate data base which is maintained on IBM equipment.

Digital Map Data Exchange Issues

The use of different hardware and software systems by the various governmental units and private utilities that currently maintain digital mapping capability in Kenosha County may affect the ability to exchange digital map data

between different automated mapping sites and systems. Commercial software products are available that will provide for the "translation" of digital map data between different proprietary automated mapping systems. The use of different map coordinate systems, however, does not affect the ability to exchange digital map data provided that the different map coordinate systems have been developed on the same horizontal datum. The use of mathematically unrelated horizontal datums, however, does pose potential problems for the exchange of digital map data. Simply stated, the relative mapped position of geographic features can be expected to differ between maps prepared on mathematically unrelated datums. This situation can be expected to adversely affect—at least at higher required levels of precision—the correct integration of digital map data between sites using NAD-27 and NAD-83.

SUMMARY

For more than a decade, there has been growing interest in the United States in land information systems. This interest ranges from a relatively narrow concern about the need to modernize land title recordation systems to a relatively broad concern about the need to create entirely new land-related data banks for multipurpose applications. This growing interest has involved many disciplines, ranging from surveyors, abstractors, assessors, and attorneys concerned with the fiscal and legal administration of real property to planners, engineers, public utility managers, public administrators, and elected officials concerned with resource management and community development. Much of the interest was initially centered on the use of electronic computers for the storage, manipulation, and retrieval of land-related information, and, more recently, for the use of computer-assisted graphics collection and display hardware for the reproduction of the data in mapped as well as tabular form.

In 1979, the National Research Council convened a Panel on a Multipurpose Cadastre to review the status of cadastral activities at the federal, state, and local governmental levels and in the private sector. This action was taken by that Council in response to the growing interest in land data systems and to the perceived ever-increasing need for land-related information by all levels of government and by the private sector. In 1980, the Panel issued a report, the principal finding of which was that there is a critical need to modernize the land information systems of the United States and to improve land conveyance procedures, to furnish a basis for equitable taxation, and to provide much-needed information for resource management and environmental planning.

The report set forth the concept of the multipurpose cadastre as a basis for a dynamic public process that could effectively collect, maintain, and disseminate land-related information; however, the report did not address how governments, especially local governments, could carry out the recommendations made in the report. To address the questions left unanswered by its 1980 report, the National Research Council prepared a second report, issued in 1983, which set forth a set of recommended procedures and standards for the design and implementation of a multipurpose cadastre. It was the intent of this report to assist local units of government in the development of cadastral records systems for their own jurisdictions, and also the many other regional, state, and federal agencies, as well as private businesses, whose participation will be needed for the development over time of true multipurpose land information systems.

These two reports provide a conceptually sound model for the development of automated mapping and land information systems, and have come to be regarded in some circles as de facto standards for land records modernization. The procedural model put forth by the Panel identified the basic components of a modern land information system as: 1) a spatial reference framework consisting of monumented geometric control points; 2) a series of accurate, large-scale topographic base maps; 3) a cadastral overlay to the base maps that delineates all cadastral—that is, real property ownership—parcels; 4) a cadastral parcel numbering scheme that provides for unique identification of each cadastral parcel; and 5) a series of compatible registers of interests in, and data about, the land parcels keyed to the parcel identifier. The local mapping and survey control network recommended by the Southeastern Wisconsin Regional Planning Commission since 1964 provides two of the five basic components of a modern land information system as set forth by the Panel, namely: 1) the required spatial reference framework, and 2) the required accurate large-scale topographic base

maps; and facilitates the creation of the third component, a cadastral map overlay. Less obvious, but of equal importance, is the fact that the Commission-recommended survey control network provides a mechanism for relating real property boundary descriptions to the State Plane Coordinate System and, in turn, to latitude and longitude, thereby facilitating the precise correlation of real property boundary lines and earth science data—a condition necessary for the creation of a modern, automated land information system.

The Commission-recommended local mapping and survey control network program was one of a select few local land information system modernization efforts described by the Panel in its reports, and therefore put forth as a system for emulation across the nation. It is also important to note—particularly within the context of the development of this report—that both National Research Council reports determined that for much of the United States, the county presented the most logical locus for the development of multipurpose land information systems.

In 1985, then Governor Anthony Earl appointed the Wisconsin Land Records Committee, a group representing state, regional, and local governmental interests, private utilities, and other private businesses, to examine land records modernization issues in Wisconsin. This group issued 13 reports on various aspects of automated mapping and land records modernization and a final report that summarized the more important findings of the Committee's deliberations. Like the National Research Council Panel, the Wisconsin Land Records Committee determined a need for continued efforts directed at land records modernization.

The Committee determined that the costs to develop modernized land records systems would not be trivial, but that the costs would be reasonable in view of the sums already being expended for current outdated and inefficient land information management practices, and further suggested that various levels of government, private utilities, and other private businesses involved in the use of land information make every effort to jointly develop and use automated systems in order to minimize their total societal costs, recognizing, as they did, that the ultimate costs of land records modernization would be borne by the State's citizens in the form of tax bills and utility bills.

The Committee recognized that its recommendation for the development of shared approaches to land information systems modernization would create new organizational and institutional strains that would be fully as demanding in their solution as the technical issues involved in the creation of new, automated land information systems. Accordingly, the Committee recommended that the educational and coordinative aspects of land records modernization receive as much attention as the technical issues.

The deliberations of the Committee and its published reports reaffirmed the validity of the procedural model advanced by the National Research Council Panel for the development of modern, automated land information systems and, as did the National Research Council reports, called attention to the Commission-recommended local mapping and survey control network program as a basis for the development of modern, automated land information systems. Finally, as did the National Research Council Panel, the Wisconsin Land Records Committee recognized that there is a central role to be played by counties in the land records modernization process.

Among the final recommendations of the Wisconsin Land Records Committee was a proposal for the creation of a Wisconsin Land Information Program overseen by a state level board that would provide a focal point for land records modernization issues and efforts within Wisconsin. During 1989, the Wisconsin Legislature enacted legislation creating the Wisconsin Land Information Program. The legislation was signed by Governor Tommy Thompson, and late in 1989, the Wisconsin Land Information Board began to meet following the appointment of the board members by the Governor.

As set forth in the legislation, the duties of the board will include: the provision of technical assistance and advice to state agencies and local units of government with land information responsibilities; the preparation of guidelines and standards to coordinate the modernization of land records and land information systems; and the creation and administration of a grant program for local units of government to assist in the development of modernized land records systems.

Three general types of automated mapping and land information system operational structures are currently recognized: strictly automated mapping or computer-assisted drafting (CAD) systems; automated mapping/facilities management (AM-FM) systems; and geographic information systems (GIS). Although the distinctions between the types are not always clear, the CAD systems are perhaps the easiest of the three to categorize since they tend to be almost exclusively automated mapping systems with little or no capability for the management of associated land records.

Both AM-FM and GIS systems possess automated mapping and records management capabilities, although the distinction between the two systems is quite often a function of the type of associated land information managed by the system rather than of any pronounced functional difference between the two system types. Typically, systems categorized as AM-FM systems are found in situations where the predominant function is to manage information associated with networks: for example, water distribution systems, sanitary sewerage systems, telephone systems, and electric power and natural gas distribution systems. GIS systems are usually systems that manage information associated with areas: real property parcels, administrative districts, land use polygons, and soil mapping units.

There are a number of automated mapping and land information systems already in existence whose areas of operation include all or portions of Kenosha County. Several of these systems—those of the Southeastern Wisconsin Regional Planning Commission, and the Wisconsin Electric Power Company and Wisconsin Natural Gas Company—have been functional for a decade or more and have developed extensive digital map holdings. These systems currently utilize a variety of proprietary computer hardware and software products in their operation, and are using several different map coordinate systems, not all of which are mathematically relatable to each other. The use of different proprietary products may affect the ability to exchange digital map data between different automated mapping sites and systems, as commercial software products are available that can "translate" digital map data between different proprietary automated mapping systems. The use of mathematically unrelated map coordinate systems, however, can be expected to adversely affect—at least at higher required levels of precision—the correct integration of digital map data between sites using mathematically unrelated map coordinate systems.

Chapter III

COMPONENTS OF AN AUTOMATED MAPPING AND LAND INFORMATION SYSTEM

INTRODUCTION

This chapter provides a description of the major elements of a multi-purpose cadastre—or parcel-based land information system—and discusses such a cadastre within the more general context of geographic information systems. Since the development of a multipurpose cadastre generally assumes that the relevant land-related information will be transformed into a computer-readable format, this chapter also provides a description of the process whereby land-related information stored in the form of maps and aerial photographs is converted into a form whereby it can be manipulated by computer. This process is commonly referred to as "digitization." Finally, the chapter describes remonumenting and base mapping efforts previously carried out in the Region and in Kenosha County, which provide the essential base for the establishment of an automated mapping and land information system.

THE CADASTRE AS PART OF A LARGER SYSTEM OF LAND INFORMATION

A cadastre may be defined as a record of interests in land, encompassing both the nature and extent of these interests. Historically, cadastres have been created and maintained for the purpose of taxing these interests, and evidence of the existence of cadastres goes back through hundreds of years of human civilization. It is possible to develop an automated version of a cadastre defined in this more narrow, historical sense; and, in fact, the development of such single-purpose cadastres has been advanced on the premise that the development of more complex multipurpose cadastres and land information systems ought to begin with the development of single-purpose cadastres relating only to the value of real property as a basis for taxation, and perhaps the registration of land ownership, being extended later in an evolutionary manner to other applications.

Thus, the development of a more narrowly defined cadastre can be considered a preliminary step in the development of a broader land-related information system. Additional information subsequently incorporated into such a system may include data on land use; certain natural characteristics of the land such as soil and geologic conditions; natural hazards such as flooding and shoreline erosion; environmentally sensitive areas such as woodlands and wetlands; permits; public and private infrastructure systems; and selected social and economic data, to name just a few. These broader land information systems are considered to contain, in addition to the information considered to be part of a single-purpose cadastre, all types of land-related information both cultural and natural.

ELEMENTS OF A MULTIPURPOSE CADASTRE

A multipurpose cadastre can be conceptualized as a public, operationally and administratively integrated, land-related information system which provides continuous, readily available, and comprehensive information at the ownership parcel level. The Panel on a Multipurpose Cadastre of the National Research Council has proposed the procedural model shown in Figure 1 for the development of multipurpose cadastres. This model consists of the following five basic elements: 1) a geographic reference frame consisting of a geodetic survey network; 2) a series of current, accurate, large-scale base maps properly related to the geographic reference frame; 3) a cadastral map overlay delineating all cadastral parcels which is also properly related to the geographic reference frame; 4) a unique identifying number assigned to each parcel; and 5) a series of registers, or land data files, each including a parcel index for purposes of information retrieval and cross referencing with information in other land data files.

Additional elements in the form of maps and records of land-related information can be readily added to the base over time.

Geodetic Reference Framework

A reference frame—or survey control network—consisting of a system of survey monuments having geodetically based coordinates, is neces-

sary for defining the relative spatial location of all land-related data, and as such comprises the first component for a multipurpose cadastre. In the United States, two different, and heretofore largely uncoordinated, systems of survey control have evolved. One of these two systems, the State Plane Coordinate System, is founded in the science of measurement and is intended to be utilized as a basis for the collection of earth science data and the preparation of earth science maps, such as topographic, geologic, soils, and hydrographic maps. The other of these two systems—the U. S. Public Land Survey System—is founded in the principles of property law, as well as in the science of measurement, and is utilized for the collection of cadastral data and the preparation of cadastral maps, such as real property boundary line maps.

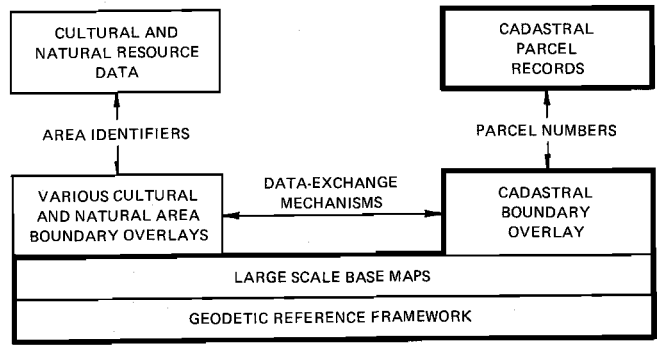
U. S. Public Land Survey System: For most of the United States, the federal government has provided the basic survey control system for cadastral mapping in the form of the U. S. Public Land Survey System. Under regulations imposed by the Congress, the U. S. Public Land Survey System has been extended into 30 of the 50 states, including Wisconsin.

This system is founded in the best features of the English common law of boundaries, superimposing on that body of law systematic land survey procedures under which the original public domain is surveyed, monumented, and platted before patents are issued; legal descriptions are by reference to a plat; lines actually run and marked on the ground control boundaries; adjoiners are respected; and the body of law in effect at the time of the issuing of the deed is controlling, and forever a part of, the deed. Unlike scientific surveys, which are made for the collection of information and can be amended to meet improved standards or changing conditions, the original government land survey in an area cannot be legally ignored, repudiated, altered, or corrected as long as it controls rights vested in lands affected.

The U. S. Public Land Survey System is one of the finest systems ever devised for describing and marking land. It provides a basis for a clear, unambiguous title to land, together with the physical means by which that title can be related to the land it describes. The system is ingenious, being simple and easy to comprehend and administer; and without it, the nation would unquestionably have been poorer. The "rectangular" land survey system, however, has one serious flaw. Its use requires the perpetuation of monuments set by the original government surveyors, the positions of which are not precisely related to the surface of the earth through a scientifically established map projection.

Figure 1

COMPONENTS OF A MULTIPURPOSE CADASTRE



The basic elements of a multipurpose cadastre (in heavy outline) provide a ready framework for the incorporation of additional land related information in the form of maps and records.

Source: National Research Council and SEWRPC.

State Plane Coordinate System: A strictly scientific control survey system designed to provide the basic control for all federal—and most private—topographic and other earth science mapping operations exists separately from the U. S. Public Land Survey System in the triangulation and traverse stations established by the National Geodetic Survey (formerly U. S. Coast and Geodetic Survey). The triangulation and traverse stations established by this agency comprise a nationwide network connecting thousands of monumented points whose geodetic positions, expressed in terms of latitude and longitude, are known. In order to make the National Geodetic Survey control network more readily available for local use, the U. S. Coast and Geodetic Survey devised the State Plane Coordinate System in 1933. This system transforms the spherical coordinates—latitudes and longitudes—of the stations established in the national geodetic survey into rectangular coordinates—eastings and northings—on a plane surface. This plane surface is mathematically related to the spheroid on which the spherical coordinates of latitude and longitude have been determined. The mutual relationship, which makes it practicable to pass with mathematical precision from a spherical to a plane coordinate

system, makes it also practicable to utilize the precise scientific data of the National Geodetic Survey control network for the reference and control of local surveying and mapping operations. A limitation on such uses, however, is imposed by the relatively widespread location of the basic triangulation and traverse stations and the difficulties often encountered in the recovery and use of these stations.

Large-Scale Base Maps

To satisfy the growing need for an integrated, land-related information base, a system capable of handling a variety of information ranging from such earth science-related data as flood hazard boundary line locations, to such cadastral-related data as real property boundary line locations, is required. It is also mandatory that field work, data resolution, and information presentation be consistent with the most detailed level of land-related decision-making, that of the individual proprietary parcel. These requirements call for base maps at scales significantly larger than those generally available in the United States as the second component of a multipurpose cadastre. These maps should be topographic maps showing in their correct location and orientation the principal natural and cultural features of the area concerned and the elevation and configuration of the surface of the earth.

Cadastral Overlay

The third component of a multipurpose cadastre is the cadastral overlay. Preparation of the cadastral overlay requires identifying and delineating the most fundamental unit of land—a cadastral parcel. This unit of land becomes the basic building block for maintaining real property boundary line-related information, including information on rights and interests. A cadastral parcel is, therefore, an unambiguously and uniquely defined unit of land within which rights and interests are legally recognized and for which there is a unique and complete group of rights. The primary type of interest, for this definition, is land ownership associated with that set of rights and interests that may be acquired and transferred.

Parcel Number

The fourth component of a multipurpose cadastre is the parcel identifier, defined as a code for recognizing, selecting, identifying, and arranging information to facilitate storage and retrieval of parcel records. It may also be used for spatial referencing of information and as a means for referring to a particular parcel in lieu of a full legal description. There is general agreement that the identifier system used should provide for the assignment of a unique code to each parcel, should be easily understandable and usable to the general public—or at least to that segment of the public that may have cause to use the system, should be capable of serving a variety of different uses, and should be reasonably permanent.

Land Information Files

The fifth and last component of a multipurpose cadastre consists of the land information files, or land data files, which contain facts about the land parcel in question and are related to the cadastral map through the parcel identifier. The various types of information that may be compiled about the land are potentially voluminous, and may include information about both natural and cultural—that is, man-made—features of the parcel. Perhaps the most familiar land information files are those of local land-title records systems and tax assessment and collection records systems.

CONVERSION OF GRAPHIC DATA INTO A COMPUTER COMPATIBLE FORMAT

Much of the current interest in the modernization of land data systems has been centered on the use of electronic computers for the storage, manipulation, and retrieval of the data and, more recently, the use of computer-assisted graphic collection and display hardware for the reproduction of the data in mapped as well as tabular form. Nongraphic land information—parcel identification numbers, legal descriptions, and assessment information, for example—can be entered into a computer through standard "key punch" data entry procedures. Land information that has traditionally been maintained in the form of maps—such as real property boundary lines—however, must be converted into a numeric, or digital, format before it can be entered into a computer. This is most often accomplished by a device, sometimes itself computer controlled, called a "digitizer," and the process by which the conversion is completed is often identified as "board digitizing."

A digitizer, therefore, is a machine system which transforms mapped information into a computer-readable form to facilitate information manipula-

tion and display. A digitizer is usually comprised of the following hardware components:

1. A controller, which is often a small to medium size computer.

2. An on-line data storage device.

3. An operator work station, which consists of a keyboard for entering commands and nongraphic data into the system and a graphic display screen or screens for viewing collected information.

4. A digitizing board or tablet which allows for determining the accurate relative location of a point identified on the surface of the board using a device—a cursor—which is able to move freely over the surface of the board.

Additional equipment may include a printer, a computer tape unit, and graphic production devices called "plotters." Each component can vary greatly in size and capability depending on the operating requirements of the particular system.

The transformation of mapped information into computer-readable information requires maps which are related to some system of geometric control and which have at least two or three points for which an x-y coordinate pair can be determined. The coordinate system utilized can vary from an arbitrary scale unique to the base map to some more universal system such as the State Plane Coordinate System. Once the base map has been placed on the digitizer board, the known coordinates of the map are entered into the digitizer and located on the base map with the cursor. When this operation is complete the map is said to be "scaled," and positions of other points on the map can be established based upon their relative positions to the known points.

Each line on the map is defined as a series of connected points. The cursor is used to identify each point, which is then assigned an x-y coordinate pair based on the position of the point relative to the known base points used to scale the maps. Each map line is then stored in the system as a series of x-y coordinates. Each line or segment can be stored separately or combined with other segments to form closed polygons with defined attributes and measurable areas.

Base map accuracy is an important consideration when digitizing. A digitizing system does not improve the accuracy of a base map but only replicates the map features, including errors and discrepancies. While the board digitizing procedure just described is the most common technique for conversion of map data into digital form, several other techniques have been developed which work well in certain specialized situations or with certain specific types of map information. These are optical scanning, direct digitizing from stereoscopic models, and coordinate geometry entry.

An optical scanning system is a machine system that is much like a board digitizing system in its physical arrangement. It merely substitutes an optical scanning device for the digitizing board or tablet. In operation, the document to be converted to digital form is mounted on a large drum that rotates at high speed under an optical device that scans the drum and "reads" the document. While these devices are capable of converting documents to digital form more rapidly than can board digitizing, they have typically required quite complex software to perform editing and categorizing of the converted data. For anything other than very simple maps, these devices have yet to supplant board digitizing.

Direct digitizing from stereoscopic models is relatively more recent in origin than either board digitizing or optical scanning, but is, however, based upon long-established photogrammetric engineering procedures. In a direct, stereoscopic digitizing system, the digitizing board or tablet that would be present in a board digitizing system is replaced by a stereoscopic map compilation machine. Stereoscopic aerial photography acquired for map compilation purposes can be used to establish a stereoscopic model in the traditional manner, but rather than utilizing the model to prepare an analog map manuscript for subsequent board digitization, the operator optically "digitizes" map features directly from the model, thereby producing the digital map files directly.

An additional means of converting map information into maps is coordinate geometry entry, sometimes referred to as "precision digitizing." In coordinate geometry entry, there is no analog device present in the machine system for the conversion of map documents to digital maps. All of the information needed to construct a map

is key entered and the map is constructed utilizing plane geometry relationships and formulae contained in highly specialized computer software. Conversion of map data by coordinate geometry is exceedingly tedious and is generally used only for relatively small project areas, or for areas where the quality and precision of the data available warrant the additional effort of this procedure. Of all the currently available methods of data entry, however, coordinate geometry procedures are the only procedures that do not result in a loss of precision and are the only conversion procedures that produce digital map data that are truly scale independent.

Once the initial map data are transformed into digital form with the digitizer, a variety of manipulations become possible. Data mapped at one scale can be reproduced at different scales, provided that the accuracy limitations of the original maps are recognized in any enlargement, as opposed to reduction, in scale. Graphic base files collected from different sources can be merged and reproduced at a uniform scale. Data for special study areas can be identified, reproduced, and measured; and information on the base maps can be identified in such a manner that only selected portions of that information are reproduced at a time.

EXISTING FRAMEWORK FOR THE DEVELOPMENT OF MULTIPURPOSE CADASTRES WITHIN SOUTHEASTERN WISCONSIN

It should be noted that the first three elements of the procedural model for the creation of a multipurpose cadastre as proposed by the National Research Council have long been embodied in the Regional Planning Commission's recommended large-scale base mapping program. Recognizing the importance of good large-scale maps and attendant survey control to sound community development and redevelopment, the Commission has, for almost three decades, encouraged the preparation of large-scale topographic and cadastral maps within its 2,689-square-mile Planning Region. These maps are based on a unique system of survey control that combines the best features of the U. S. Public Land Survey System and State Plane Coordinate System. The large-scale maps and attendant control survey system, where they already exist, provide, in a highly cost-effective manner, the technical foundation for the creation of multipurpose cadastres within the Region. Because of their critical and central importance to the implementation of a multipurpose cadastre, these three elements—the geodetic reference frame, large-scale base maps, and the cadastral overlays—are discussed in greater detail in the following sections.

A Composite System for the Geodetic Reference Framework

From the preceding brief discussion of the U. S. Public Land Survey and State Plane Coordinate Systems, it is apparent that two essentially unrelated control survey systems have been established in the United States by the federal government. One of these—the U. S. Public Land Survey System—is founded in the legal principles of real property description and location and was designed primarily to provide a basis for the accurate location and conveyance of ownership rights in land. The other—the State Plane Coordinate System—is founded in the science of geodesy and was designed primarily to provide a basis for earth science mapping operations and for the conduct of high-precision scientific and engineering surveys over large areas of the earth's surface. Both systems have severe inherent limitations for use as a geographic framework for a local land data system. By combining these two separate survey systems into one integrated system, however, an ideal system for the geometric control required for land data systems is created.[1] This ideal system includes the relocation and monumentation of all U. S. Public Land Survey section and quarter-section corners, including the centers of sections, within the geographic area for which the land data system is to be created, and the utilization of these corners as stations in second order traverse and level nets, both nets being tied to the National Geodetic Datum. The traverse net establishes the precise geographic positions of the U. S. Public Land Survey corners in the form of state plane coordinates, while the level net establishes the precise elevation above mean sea level of the monuments marking the corners.

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[1] *See K. W. Bauer, "Geometric Framework for Land Data Systems," Journal of the Surveying and Mapping Division, Proceedings of the American Society of Civil Engineers, Volume 107, Number SU1, November 1981.*

Such a system of survey control has at least the following three advantages as a geographic framework for a multipurpose cadastre:

1. It provides an accurate system of control for the collection and coordination of cadastral data, since the boundaries of the original government land subdivision form the basis for all subsequent property divisions and boundaries. As all subsequent legal descriptions and plats must be tied to the U. S. Public Land Survey System, accurate reestablishment and monumentation of the quarter-section lines and corners permits the ready compilation of accurate property boundary line data and the ready maintenance of these data in current form over time. These data can be readily and accurately updated and extended since, in Wisconsin, all new land subdivisions must by law be tied to corners established in the U. S. Public Land Survey, and since the accuracy of the surveys for these subdivisions can be readily controlled by state and local land subdivision regulations. The recommended survey control system thus fully meets the needs of a narrowly defined cadastre for the fiscal and legal administration of real property, yet this cadastre can be developed readily and soundly into a multipurpose land data system.

2. It provides a common system of control for the collection and mapping of both cadastral and earth science data. By relocating the U. S. Public Land Survey corners and accurately placing them on the State Plane Coordinate System, it becomes possible to accurately correlate real property boundary line information with earth science data. This placement of property boundary and earth science data on a common datum is absolutely essential to the sound development of any multipurpose land data system. Yet such a common control datum is rarely used. The establishment of state plane coordinates for the U. S. Public Land Survey corners permits the correlation with mathematical precision of data supplied by aerial and other forms of earth science mapping with property boundary line data compiled through the usual land surveying methods. Only through such a common geometric control system can all of the information required for a multipurpose land data system be accurately collected for, and correlated in, the system.

3. It permits lines and areas entered into the data base—whether these lines represent the limits of land to be reserved for future public uses, the limits of land to be taken for immediate public use, the limits of districts to which public regulations are to be applied, or the location and alignment of proposed new property boundary lines or of proposed constructed works—to be accurately and precisely reproduced upon the ground.

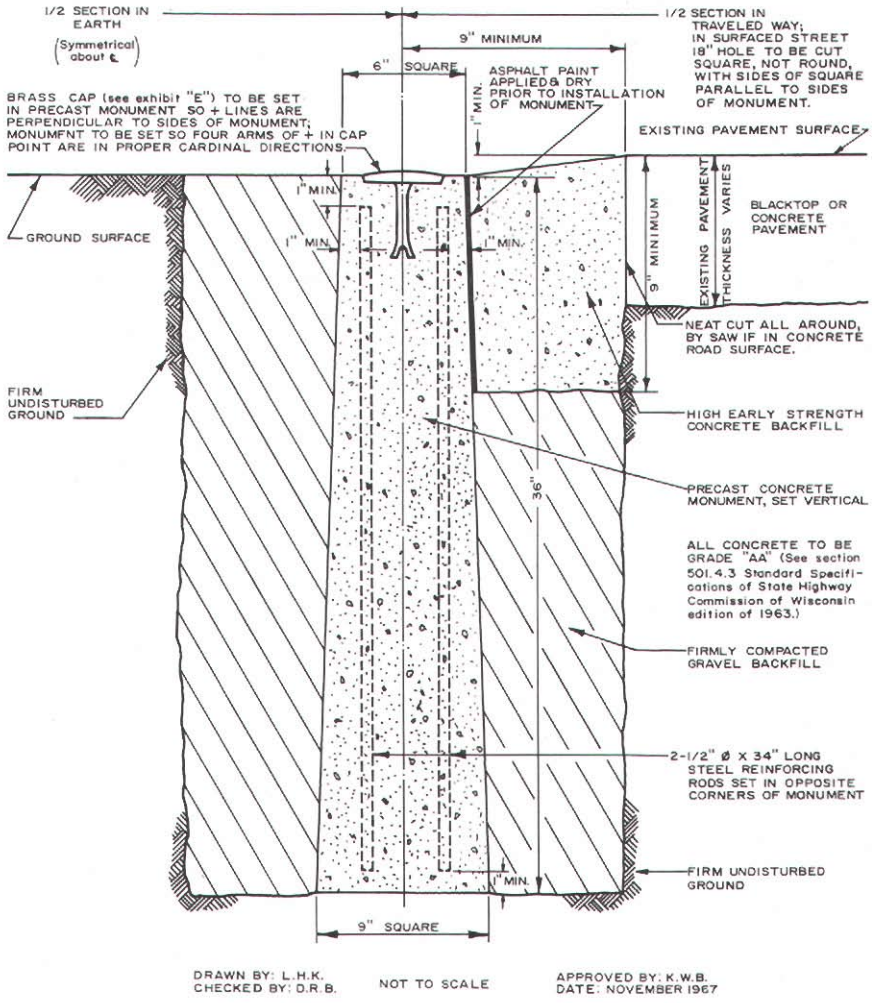
Commission Specifications for Geometric Framework and Base Maps

As already noted, the Regional Planning Commission has, since 1961, promoted the preparation of large-scale topographic and cadastral base maps based upon a control survey system which combines the U. S. Public Land Survey and State Plane Coordinate Systems. The maps and attendant control survey system, in addition to providing essential municipal planning and engineering tools, were intended to provide the foundation for the eventual development of automated, multipurpose cadastres within the Planning Region. Since the Commission-specified topographic base maps and survey control system are already in place throughout Kenosha County and Commission-specified cadastral maps have been prepared for a significant portion of Kenosha County, a description of those specifications herein is warranted.

Specifications for Relocation, Monumentation, and Coordination of U. S. Public Land Survey Corners: The Commission specifications governing the creation of the necessary survey control network requires the relocation of all U. S. Public Land Survey corners in the areas to be mapped, and the marking of the relocated corners by reinforced concrete monuments, having engraved bronze caps imbedded in the tops (see Figures 2 and 3). The bronze caps are inscribed with the corner notation—quarter section, town, and range. The monuments placed are referenced by ties to at least four witness marks. The specifications require that the survey engineer and land surveyor provide a dossier on each control station established in order to permit its ready recovery and use. The dossier sheets provide for each station a sketch showing the monument erected in relation to the salient

Figure 2

DETAIL OF MONUMENT INSTALLATION FOR SURVEY CONTROL STATIONS



Source: SEWRPC.

features of the immediate vicinity, all witness monuments together with ties, the state plane coordinates of the corner, its U. S. Public Land Survey description, the elevation of the monument, and the location of appurtenant reference benchmarks referred to National Geodetic Vertical Datum of 1929 (see Figure 4). These dossier sheets are recorded with the County Surveyor as well as with the Commission, and are thereby readily available to all land surveyors and public works engineers operating in the area mapped.

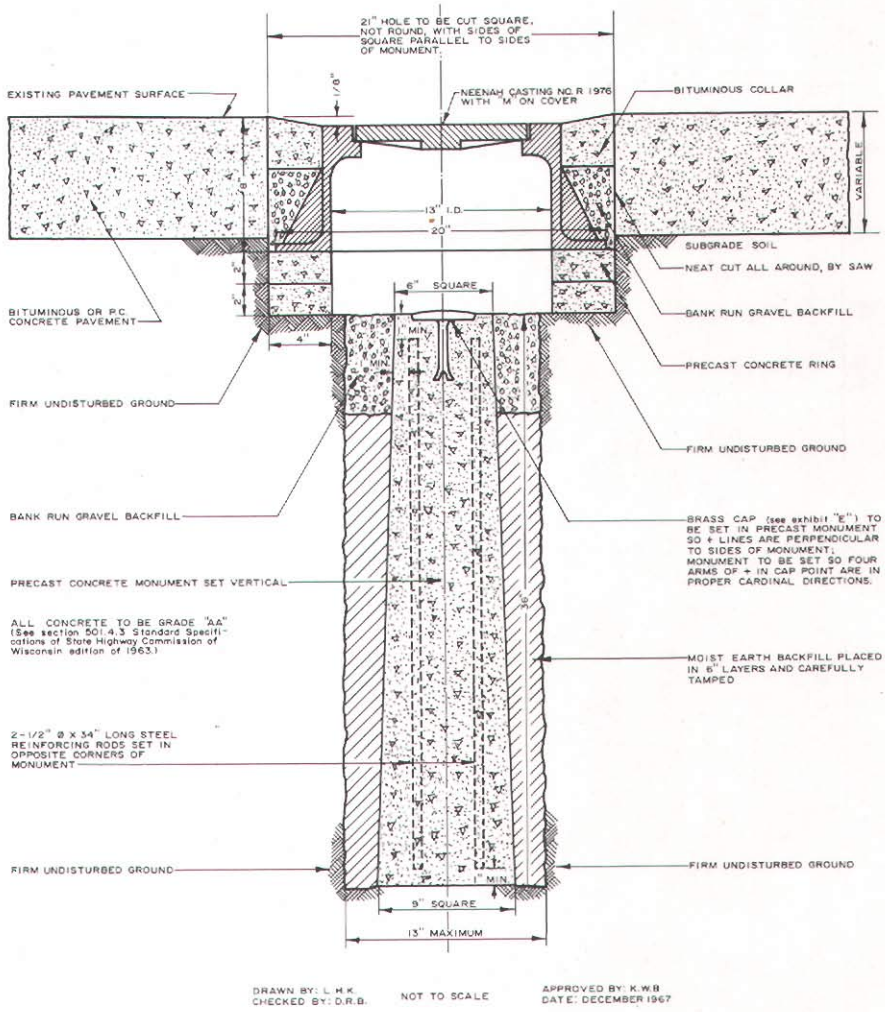
The specifications require the control survey data to be summarized by means of a control survey summary diagram showing the exact grid and ground lengths and grid bearings of the exterior boundaries of each U. S. Public Land Survey quarter section; the area of each quarter section; all monuments erected; the number of degrees, minutes, and seconds in the interior angles of each quarter section; the state plane coordinates of all quarter-section corners together with their Public Land Survey System identification; the benchmark elevations of all monuments set; and the basic National Geodetic Survey control stations utilized to tie the Public Land Survey corners to the horizontal geodetic control datum, together with the coordinates of these stations. The angle between geodetic and grid bearing is noted, as is the combination sea-level and scale-reduction factor (see Figure 5).

All the work necessary to execute the control surveys and provide the finished topographic maps described below has been done in southeastern Wisconsin on a negotiated contract basis with an experienced photogrammetric and control survey engineer. In this regard, it was considered essential to retain a photogrammetric and control survey engineer familiar with higher order field methods and procedures and with the attendant geodetic survey computations and adjustments, and whose crews were properly equipped with state-of-the-art survey instruments. Electronic distance-measuring equipment was employed in the work, as well as optically reading theodolites and appurtenant traverse equipment, automatic levels, and precision level rods. Indeed, the control survey system used is made economically feasible only through the application of these relatively recently developed instruments, particularly the electronic distance-measuring devices.

Although the specifications governing the work make the photogrammetric engineer responsible for overall supervision and control of the mapping work, as well as for the quality of the finished maps, they require that the actual relocation of the Public Land Survey corners be done by a local land surveyor employed as a subcontractor by the photogrammetric engineer or as a contractor by the Commission directly. The specifications thereby recognize that this portion of the work requires expert knowledge of local survey custom and boundary and title law, as well as the assembly and careful analysis of all authoritative survey information—such as title documents and attendant legal descriptions, land subdivision plats and certified survey maps, survey records, and, of cardinal importance, records on existing land survey monumentation and land occupation—in order to arrive at the best possible determination of the location of the land survey corners. In the areas mapped, the land survey portion of the control survey work requires a very high degree of professional competence, as almost all of the Public Land Survey corners fall under the federal definition of either obliterated or lost corners. The importance of this phase of the work and its impact on real property boundaries throughout the community can hardly be overemphasized.

Figure 3

DETAIL OF ALTERNATIVE CONTROL SURVEY MONUMENT INSTALLATION IN SURFACE TRAVELED WAY OF STREETS AND HIGHWAYS

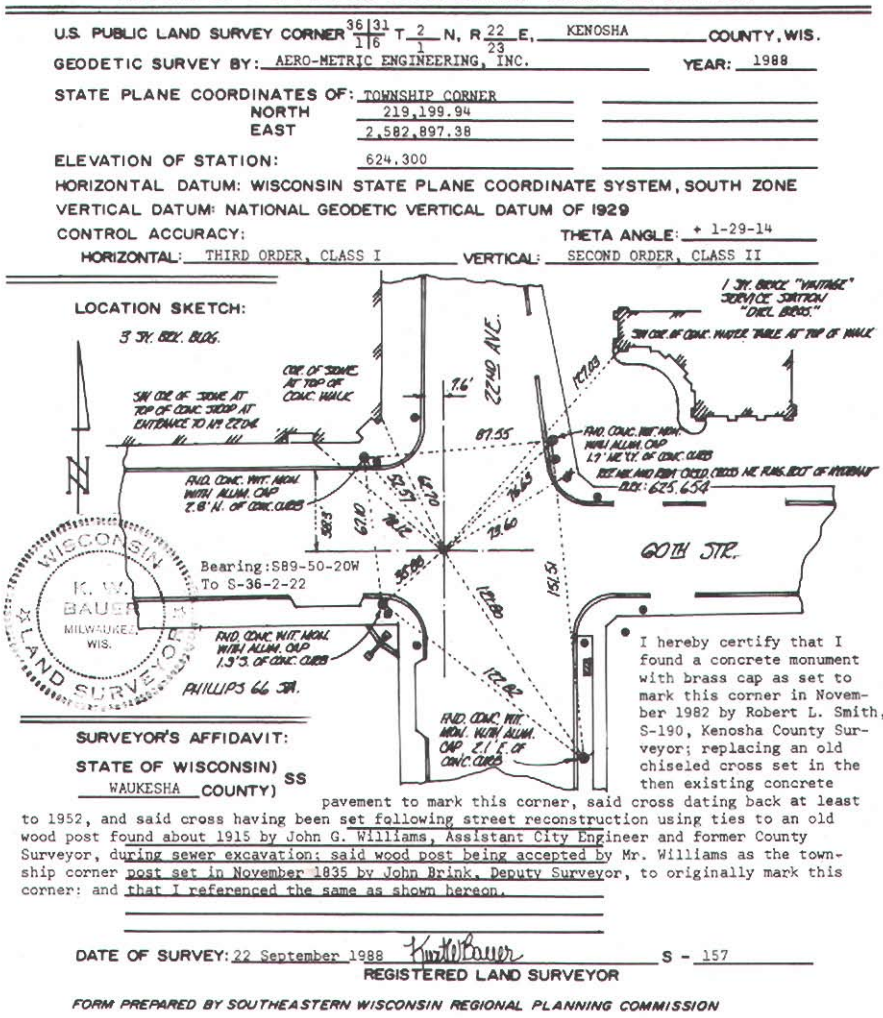


Source: SEWRPC.

Specifications for Topographic Mapping: The specifications provide for the completion of finished topographic maps that can serve as the base maps for the preparation of a multipurpose cadastre by accurately recording the basic geography of the area mapped. In addition to showing the usual contour information, spot elevations, planimetric and hydrographic detail, and coordinate grid ticks, the maps show, in their correct position and orientation, all U. S. Public Land Survey quarter-section lines and corners established in the control surveys (see Figure 6). The specifications require that all state plane coordinate grid lines and tick marks and all horizontal survey control stations be plotted to within 1/100 inch of the true position as expressed by the coordinates for the control survey stations. The specifications further require that the planimetric features and contours shown on the maps conform to National Map Accuracy Standards. Thus, 90 percent of all well-defined planimetric features must be plotted to within 1/30 inch of their true positions, and no such features may be off by more than 1/20 inch. Ninety percent of the elevations indicated by the solid-line contours must be within one-half contour interval of the true elevation, and no such elevation may be off by more than one contour interval. A combination sea level and

Figure 4

A TYPICAL U. S. PUBLIC LAND SURVEY CONTROL STATION DOSSIER SHEET



RECORD OF U.S. PUBLIC LAND SURVEY CONTROL STATION

U.S. PUBLIC LAND SURVEY CORNER 36|31 / 1|6 T. 2 / 1 N, R. 22 / 23 E, KENOSHA COUNTY, WIS.

GEODETIC SURVEY BY: AERO-METRIC ENGINEERING, INC. YEAR: 1988

STATE PLANE COORDINATES OF: TOWNSHIP CORNER

NORTH 219,199.94

EAST 2,582,897.38

ELEVATION OF STATION: 624.300

HORIZONTAL DATUM: WISCONSIN STATE PLANE COORDINATE SYSTEM, SOUTH ZONE

VERTICAL DATUM: NATIONAL GEODETIC VERTICAL DATUM OF 1929

CONTROL ACCURACY: THETA ANGLE: + 1-29-14

HORIZONTAL: THIRD ORDER, CLASS I VERTICAL: SECOND ORDER, CLASS II

LOCATION SKETCH:

3 TR. BRK. BLDG.

CNR. OF SIDWK. AT TOP OF CONC. WALK

SW CNR OF SIDWK AT TOP OF CONC. STEP AT ENTRANCE TO NO. 22 DR.

FND. CONC. WIT. MON. WITH ALUM. CAP 2.8' N. OF CONC. CURB

FND. CONC. WIT. MON. WITH ALUM. CAP 1.9'S. OF CONC. CURB

PHILLIPS 66 SIGN

Bearing: S89-50-20W To S-36-2-22

22ND AVE.

7.6'

87.55

FND. CONC. MON. WITH ALUM. CAP 1.9' NE'LY OF CONC. CURB

REF. NAIL AND BRASS WASHER ON NE FACE OF HYDRANT ELEV.: 625.654

60TH STR.

I hereby certify that I found a concrete monument with brass cap as set to mark this corner in November 1982 by Robert L. Smith, S-190, Kenosha County Surveyor; replacing an old chiseled cross set in the then existing concrete pavement to mark this corner, said cross dating back at least to 1952, and said cross having been set following street reconstruction using ties to an old wood post found about 1915 by John G. Williams, Assistant City Engineer and former County Surveyor, during sewer excavation; said wood post being accepted by Mr. Williams as the township corner post set in November 1835 by John Brink, Deputy Surveyor, to originally mark this corner: and that I referenced the same as shown hereon.

SURVEYOR'S AFFIDAVIT:

STATE OF WISCONSIN) SS

WAUKESHA COUNTY)

DATE OF SURVEY: 22 September 1988 Kurt W. Bauer S - 157

REGISTERED LAND SURVEYOR

FORM PREPARED BY SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Source: SEWRPC.

scale-reduction factor, and the angle between geodetic and grid bearing, are noted on each map sheet, as is the equation between any local datum and mean sea level.

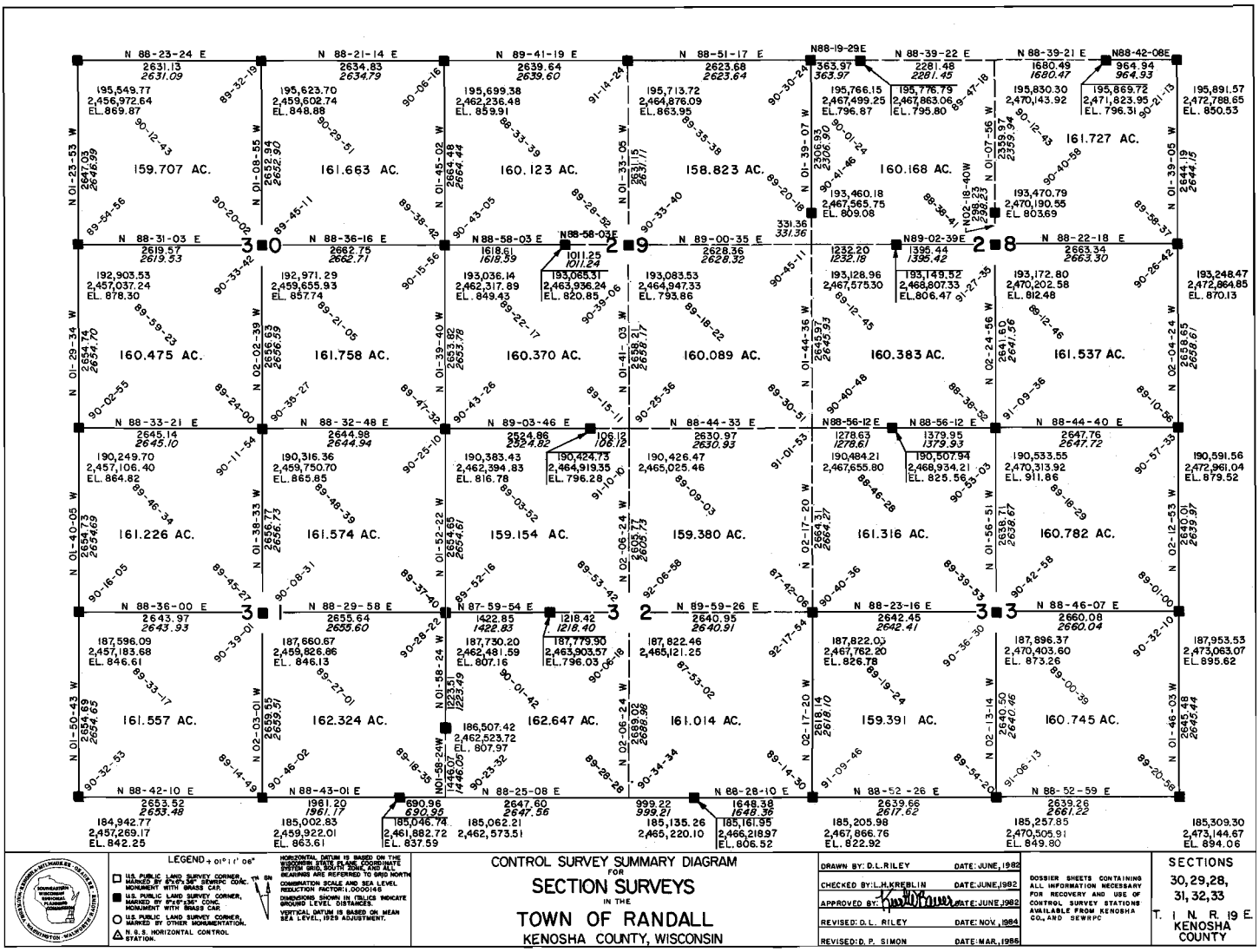
Specifications for Cadastral Mapping: The Commission's specifications visualize the preparation of real property boundary line maps, complementing the topographic maps, by the local units of government concerned utilizing resident engineering and planning staffs or consultants. The property boundary line maps are compiled at a scale matching that of the topographic maps, each map sheet covering, like the topographic maps, a U. S. Public Land Survey section or quarter section.

As the topographic maps are being compiled, the Commission specifications require that the photogrammetric engineer provide cadastral base sheets. These sheets consist of reproducible duplicates of the partially completed topographic maps showing, in addition to the state plane coordinate grid, the U. S. Public Land Survey section and quarter-section lines and corners in their correct position and orientation, together with the attendant ground lengths and grid bearings, and such salient planimetric detail and hydrographic features as may be helpful in the subsequent plotting of real property boundary lines, including railway tracks, electric power transmission lines, principal structures, wetlands, and such hydrographic features as streams and lakes.

Utilizing recorded subdivision plats, certified survey maps, and legal descriptions, all real property boundary lines, including street right-of-way lines and major utility easement lines, are then constructed on the base sheets working within the framework of control provided by the ground lengths and grid bearings of the U. S. Public Land Survey quarter-section lines. The property boundary lines are constructed in a manner that parallels the location of these lines on the surface of the earth following land surveying practice in the State of Wisconsin. The specifications require that all real property boundary lines be plotted within 1/30 inch of their true position based on analysis of all authoritative information available. Dimensions are shown for all platted areas as shown on the recorded subdivision plats. Wisconsin Statutes have long required that such plats be prepared to an accuracy of 1 part in 3,000, as compared to the accuracy of 1 part in 10,000 required by the specifications for the basic survey control network. Any overlaps or gaps between adjoining property boundary lines, as indicated by the constructions and plotting of those lines, are noted on the cadastral maps.

Figure 5

A TYPICAL CONTROL SURVEY SUMMARY DIAGRAM



Source: SEWRPC.

Finally, a cadastral parcel identification number is added.

The property boundary line maps thus show the ground length and grid bearing of all quarter-section lines; the state plane coordinates of all quarter-section corners; the monuments marking these corners; the recorded dimensions of all street lines, alley lines, and boundaries of public property; recorded street widths; platted lot dimensions; and a parcel identification number. In unplatted areas, real property boundaries are shown by scale alone. Railway tracks, electric power transmission lines, principal structures, fences, wetlands, lakes, streams, and drainage ditches are also shown (see Figure 7). As previously noted, these boundary line maps can be readily and accurately updated and extended as new land subdivision plats and certified map surveys, utilizing the survey control, are made and recorded.

Status of Survey Control, Large-Scale Topographic Base Mapping, and Cadastral Mapping in Kenosha County

As previously noted, the Commission has long recognized the importance of good large-scale maps to the proper administration of local

government functions, and has encouraged counties, cities, and villages within the Region to prepare such maps. As shown on Map 1, all of Kenosha County has had large-scale topographic maps prepared to Commission-recommended standards, including the relocation, monumentation, and placement on the State Plane Coordinate System of the U. S. Public Land Survey corners. This area totals about 278 square miles. A total of 1,203 U. S. Public Land Survey corners have been relocated, monumented, and coordinated as part of this base mapping effort. Cadastral maps have been prepared, or are currently being prepared, to Commission-recommended standards for about 112 square miles, or about 40 percent of the area of Kenosha County. These cadastral maps contain about 17,000 real property parcels, or about 30 percent of the real property parcels in the County. Therefore, a significant portion of the initial effort necessary to begin the development of a countywide automated mapping and land information system has already been accomplished.

SUMMARY

A multipurpose cadastre can be conceptualized as a public, operationally and administratively integrated, parcel-based land information system which provides for continuous, readily available, and comprehensive land-related information at the parcel level. The National Research Council has proposed that multipurpose cadastres consist of the following five elements: 1) a geographic reference frame consisting of a geodetic network; 2) a series of current, accurate, large-scale topographic base maps properly related to the geographic reference frame; 3) a cadastral map overlay delineating all cadastral parcels, which is also properly related to the geographic reference frame; 4) a unique identifying number assigned to each parcel; and 5) a series of registers, or land data files, each including a parcel index for purposes of information retrieval and cross-referencing with information in other land data files.

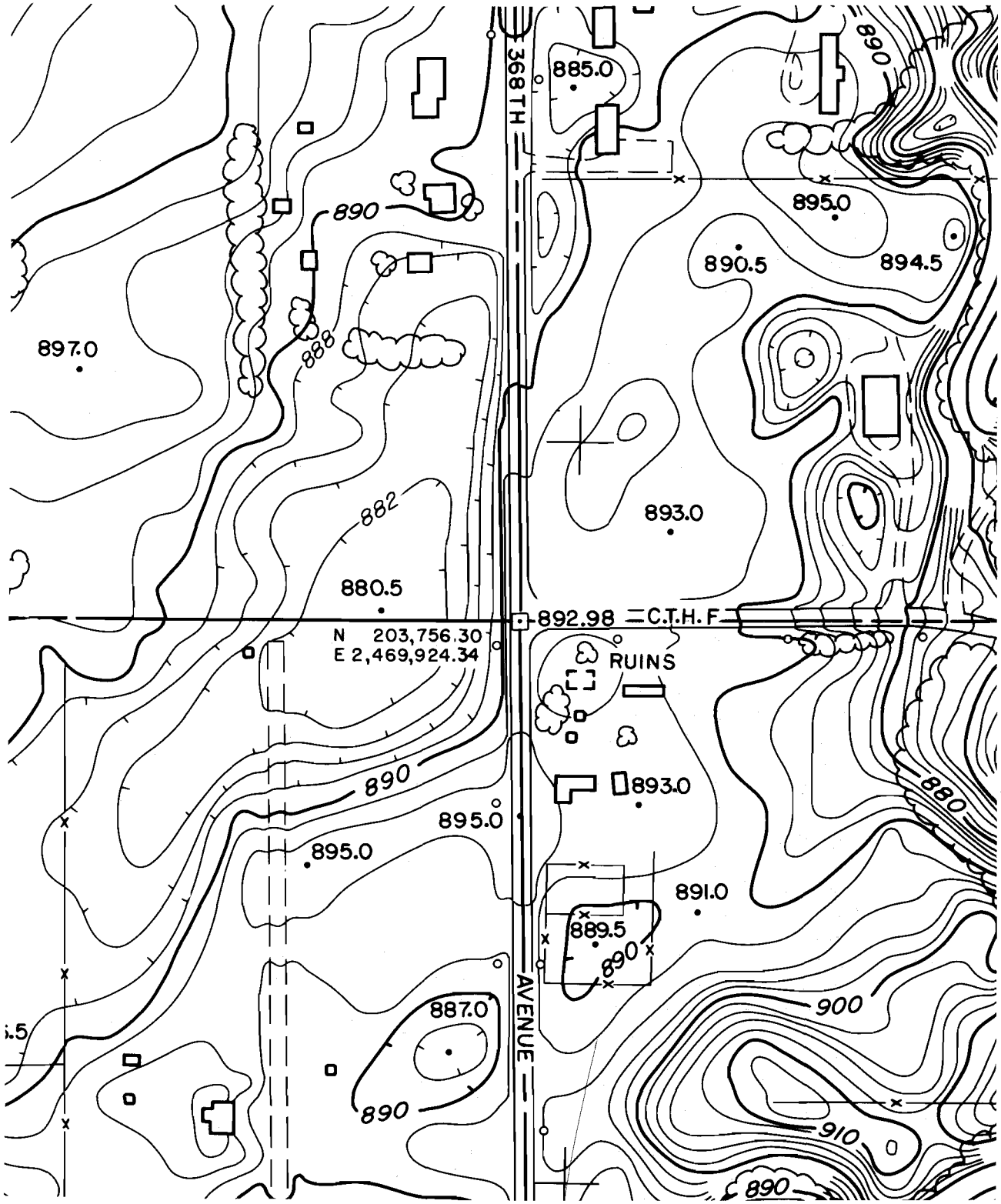
The first three elements of the procedural model for the creation of a multipurpose cadastre as proposed by the National Research Council have long been embodied in the Regional Planning Commission's recommended large-scale base mapping and attendant survey control program. Recognizing the importance of good large-scale maps and attendant survey control to sound community development and redevelopment, the Commission has for almost three decades encouraged the preparation of large-scale topographic and cadastral maps within its 2,689-square-mile Planning Region. These maps are based on a unique system of survey control that combines the best features of the U. S. Public Land Survey System and State Plane Coordinate System. The large-scale maps and attendant control survey system, where they already exist within the Region, provide in a highly cost-effective manner the technical foundation for the creation of multipurpose cadastres within the Region, providing the first two of the five elements of such a cadastre, and a part of the third element.

Large-scale topographic maps have been prepared to Commission-recommended standards for all of Kenosha County. A total of 1,203 U. S. Public Land Survey corners in the County have been relocated, monumented, and coordinated, representing 100 percent of all such corner remonumentation needed in the County. Cadastral maps have been or are being prepared to Commission-recommended standards for about 112 square miles, or about 40 percent, of the County. Therefore, a significant portion of the initial effort necessary to begin the development of a countywide automated mapping and land information system has already been accomplished.

Much of the information that would be incorporated within a multipurpose cadastre or an automated mapping and land information system has traditionally been stored in the form of maps. Conversion of map information into a digital format where it can be manipulated and operated upon by a computer requires the use of a device called a digitizer. Alternatively, certain forms of specialized data conversion procedures such as optical scanning, direct digitizing from stereoscopic models, or coordinate geometry entry can be utilized. Once the initial map data are transformed into numeric form, a variety of manipulations become possible. Data mapped at one scale can be reproduced at different scales, provided that the accuracy limitations of the original maps are recognized in any enlargement, as opposed to reduction, in scale. Graphic base files collected from different sources can be merged and reproduced at a uniform scale. Data for special study areas can be identified, reproduced, and measured; and information on base maps can be identified in such a manner that only selected portions of that information are reproduced at a time.

Figure 6

A PORTION OF A TYPICAL LARGE-SCALE TOPOGRAPHIC MAP PREPARED IN ACCORDANCE WITH THE COMMISSION'S RECOMMENDED SPECIFICATIONS

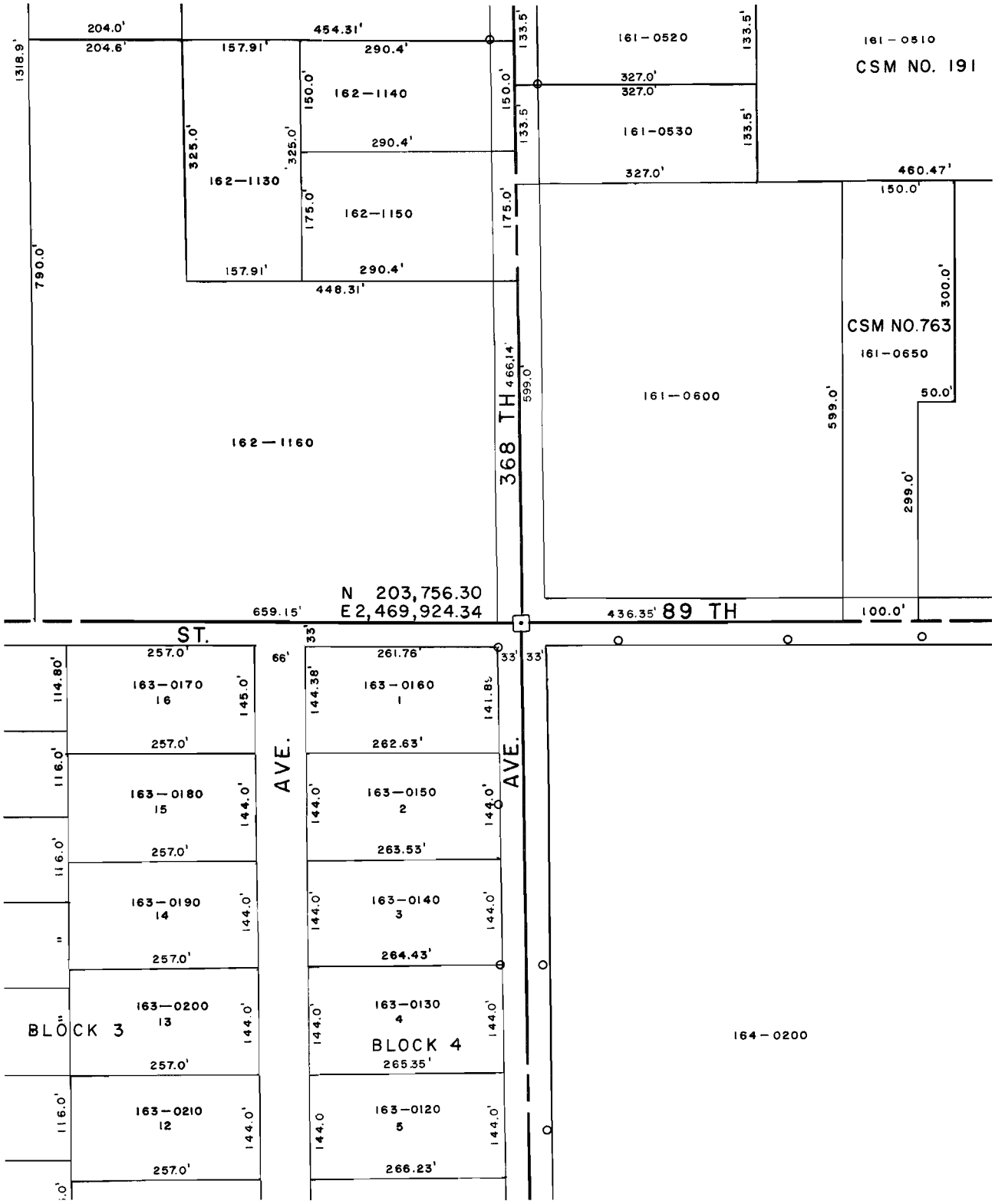


Shown here at drafted scale (1 inch equals 200 feet) is a portion of the topographic map prepared for Section 16 in the Town of Randall, Kenosha County. The figure is roughly centered on the center of the section and encompasses an area of approximately 50 acres, or about 8 percent of the area covered by the full map. A cadastral map of the same area is shown in Figure 7.

Source: SEWRPC.

Figure 7

A PORTION OF A TYPICAL CADASTRAL MAP PREPARED IN ACCORDANCE WITH THE COMMISSION'S RECOMMENDED SPECIFICATIONS

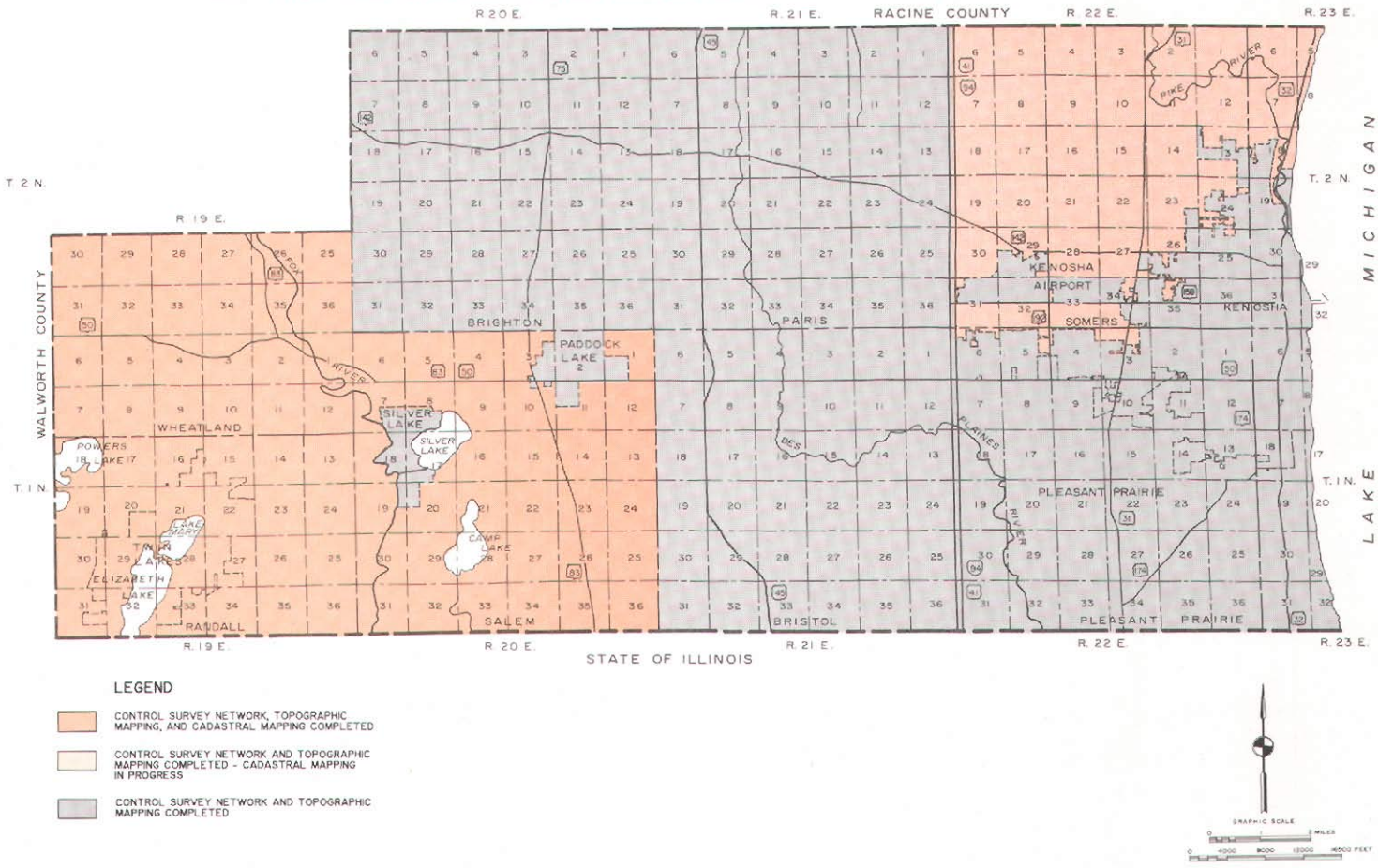


Shown here at drafted scale (1 inch equals 200 feet) is a portion of the cadastral map prepared for Section 16 in the Town of Randall, Kenosha County. The figure is roughly centered on the center of the section and encompasses an area of approximately 50 acres, or about 8 percent of the area covered by the full map. A topographic map of the same area is shown in Figure 6.

Source: SEWRPC.

Map 1

STATUS OF CONTROL SURVEY NETWORK, LARGE-SCALE TOPOGRAPHIC MAPPING, AND CADASTRAL MAPPING IN KENOSHA COUNTY, WISCONSIN: 1990



Source: SEWRPC.

Chapter IV

CREATION OF AN AUTOMATED MAPPING AND LAND INFORMATION SYSTEM FOR KENOSHA COUNTY

INTRODUCTION

Previous chapters of this report have presented an overview of the current status of automated mapping and land information system capability within Kenosha County, and have identified the National Research Council model for the creation of automated cadastres as the recommended model for the development of a multipurpose, multiuser, automated mapping and land information system in Kenosha County. The components of a multipurpose automated mapping and land information system have been identified, and the status of implementation of the first three of those elements—the establishment of a geometric framework in the form of a monumented survey control network, the preparation of a series of large-scale, topographic base maps, and the compilation of cadastral maps—within Kenosha County has been reported. The status of the digital conversion of these components has also been reported. This chapter sets forth a recommendation for the completion of the presently ongoing cadastral mapping and the digital conversion effort as the initial steps in the development of a countywide automated mapping and land information system; sets forth recommended standards for use in the creation of a countywide automated mapping and land information system; and provides cost estimates for the digital conversion of the survey control network, the large-scale topographic base maps, and the cadastral map overlays in those areas of Kenosha County not already covered by these map and map-related elements in digital form.

RECOMMENDED STANDARDS FOR AN AUTOMATED MAPPING AND LAND INFORMATION SYSTEM IN KENOSHA COUNTY

When discussing the design of an automated mapping and land information system, it has usually been assumed that the "system" is the computer hardware and software and that the "system" is physically centralized—that is, a single hardware configuration upon which reside all of the digital maps and associated land information of all system users. Users of this type of system operate in terminal fashion from the central computer. For many years, this type of operation was dictated at least in part by the available computer technology. Recent advances in computer hardware and software technology—particularly as they pertain to decreasing unit costs for computational and mass data storage capability, to networking between the hardware of different vendors, and to translation capability of digital map data between some different proprietary software products—now permit a different type of "system" to be specified—that is, one in which the system users share digital maps and an agreed-upon set of map-related information, but maintain their own separate—or distributed—computing capability.

If the centralized system concept is discarded, then a number of issues that have in the past been impediments to the development of shared automated mapping and land information systems are no longer pertinent. These are the organizational structure and the cost allocation among participants of a centralized operation, and the maintenance of data security on "proprietary" files in a centralized operating environment.

More importantly, perhaps, the ability to replace the centralized operating concept with a distributed operating concept permits discussion to be focused on the true system components of an automated mapping and land information system. In a distributed operating environment, the "system" is not hardware and software, but an agreed-upon set of procedures and specifications for the production and maintenance of a basic set of digital maps and map-related information, and an agreed-upon set of procedures and specifications for the interchange of these data between system users. It must be stressed that no amount of state-of-the-art computer technology can compensate for the absence of a robust set of specifications and standards for those elements that will be used in common.

The following recommended standards for an automated mapping and land information system for Kenosha County assume that initially only a selected set of elements—namely, a survey

control network, large-scale topographic base maps, and a cadastral map overlay with parcel identifiers—would be developed for joint use. Discussions held over the past several years among local operators of automated mapping systems indicate that these elements in the aggregate represent a set of map feature information common to most of the users. The provision of a common set of map information in this manner would provide a base sufficient to support a wide variety of uses, including county and local government and utility preliminary site engineering, outside plant and utility network mapping, the design and construction of public and private works, planning and zoning administration, vehicle routing, and emergency services provision, among others. It is assumed that these more specialized applications would be developed by the users either singly or in small groups as may be appropriate or necessary, rather than being jointly developed.

System Accuracy

The issue of map accuracy in a multiuser environment has been the subject of intense debate among the local mapping organizations, particularly as this issue may affect the allocation of the costs of shared development among the various participants in a multiuser system. In spite of past discussion, however, the ramifications of this issue are still not fully understood or appreciated by all participants in the dialogue. Debate, unfortunately, has focused on the relative cost of various levels of accuracy and how those costs might be allocated rather than on the true issue, which is the level of accuracy required to support a true multipurpose, multiuser system of digital map resources. If the agreed-upon system is incapable of supporting the needs of the most demanding of the users, the development of multiple systems is inevitable and the creation of a multipurpose, multiuser system cannot, by definition, occur.

In this regard, the recommended standards for a joint automated mapping and land information system as set forth herein are based upon the Commission-recommended standards for the development of survey control networks and local large-scale mapping programs. These Commission programs already represent formally adopted or de facto standards for much of southeastern Wisconsin, including Kenosha County. In addition, these programs have been subjected to critical review by knowledgeable professionals who have judged them to be both conceptually and procedurally sound.

The large-scale mapping and survey control programs have been in use for more than 25 years in manual mapping environments, and within the most recent decade have been successfully transported to digital mapping environments. They therefore represent successfully "field tested" standards and specifications. The maps and attendant survey control have been demonstrated to support a wide variety of operations to necessary levels of accuracy in both the public and private sectors, and are, therefore, ideally suited to a multipurpose, multiuser environment.

Map Projection System

It is recommended that the State Plane Coordinate System, North American Datum of 1927, be used as the map projection system for a countywide automated mapping and land information system. This system is already the system of choice of much of the local mapping community, and a great deal of effort and expense has been expended in its establishment and maintenance. Those organizations operating in the local area that have chosen to use the Universal Transverse Mercator (UTM) system have, in fact, converted much of their existing basic map information to the UTM system from the State Plane Coordinate System. The methodology for the precise conversion process between the two map projection systems already exists—as long as both coordinate systems are based upon NAD-27—for these organizations, and they can continue to "load data" in this manner if they so choose.

The map projection grid should be constructed inside computer memory through key entry procedures. This requirement, if combined with the key entry of all survey control network data, will produce a map projection that is essentially independent of map scale. Constructed in this manner, the map projection will be able to accept and accurately reference not only digitized data from mapped sources at any scale, but also numeric data derived from direct field measurements. This capability is as important as it is subtle, given the increasing availability and affordability of field devices, such as "total stations."

Survey Control Network and
Large-Scale Topographic Base Mapping

It has been previously noted in this report that the Commission-recommended survey control network and large-scale topographic base maps already exist throughout Kenosha County, and that, where this system exists, it is already being utilized by units of government and certain utilities in both digital and analog mapping. Even though this work has been completed throughout the County and no additional work on these elements of a countywide automated mapping and land information system will be necessary, the procedures and specifications for this work are set forth in the interest of completeness.

Control Surveys: The horizontal control survey work undertaken in Kenosha County included the recovery or relocation and monumentation of 1,203 U. S. Public Land Survey corners, including section and one-quarter-section corners, centers of sections, and correction corners. Having recovered, or relocated, and monumented these corners, high-order control survey traverses were run which utilized and incorporated all of the monumented corners as stations to determine the coordinates of the corners and the lengths and bearings of all quarter-section lines. Coordinates of the corners on the Wisconsin Coordinate System, South Zone, were computed, and sufficient survey connections were made to basic National Geodetic Survey (NGS) control stations of the NGS control net to permit the proper checks and adjustments to be made both in the traverse lengths and bearings and in the coordinate values of the monumented U. S. Public Land Survey corners. The accuracy of the horizontal control surveys conformed to the specifications for NGS Third-Order Class I accuracy for traverse.

The vertical control survey work was based upon National Geodetic Vertical Datum, 1929 Adjustment, as established by the NGS. Closed level circuits were run as necessary to establish permanent bench marks in the mapped area. All level circuits met or exceeded specifications for NGS Second-Order, Class II accuracy and were adjusted for closure by NGS methods. Elevations were determined for the monuments marking the section and quarter-section corners throughout the mapped area, and these monuments serve as permanent bench marks, each monument being supplemented by at least one reference bench mark.

Large-Scale Topographic Maps: Large-scale topographic base maps have been prepared to National Map Accuracy Standards at a scale of 1:2,400 (one inch equals 200 feet) for all of Kenosha County. Use of these standards ensures that all map projection grid lines, horizontal control stations, section corners, and quarter-section corners are plotted on finished maps to within 1/100 of an inch of their true position at the stated scale of 1:2,400. Ninety percent of all well-defined planimetric features are plotted to within 1/30 of an inch of their true coordinate position. No point may be more than 1/20 of an inch from its true coordinate position. Ninety percent of the elevations determined from the solid-line contours of the map have an accuracy with respect to true elevation of one-half the contour interval. No elevation so determined may be in error by more than a contour interval.

The large-scale topographic maps contain the following map information:

1. Hypsography by contour lines having a vertical interval of two feet.

2. All planimetric detail, such as pavements, curbs, walks, trails, railways, power lines, buildings, fences, wooded areas, dams, piers, dock walls, culverts and culvert head walls, bridges and bridge wing walls, retaining walls, airport runways and taxiways, and other identifiable features on the aerial photography from which the maps are compiled.

3. All hydrographic features, such as marshes, lakes, streams, watercourses, and drainage ditches.

4. All section and quarter-section lines and U. S. Public Land Survey corners in their correct position and orientation, together with their exact grid lengths and bearings.

5. Such lettering as may be secured from available maps of the area or as may be furnished by the participating organizations relative to the names of salient geographic features. The names of all state and county trunk highways, public streets, and major streams and lakes are shown on the maps.

Digital Map Features Obtained from Large-Scale Topographic Base Maps

The large-scale topographic base maps prepared throughout Kenosha County provide the source for the digitization of surface water and stream channels, for the digitization of the pavement edges of public streets and highways, and for the digitization of structure outlines. The topographic maps show principal structures that existed as of the date of the aerial photography flown for the photogrammetric compilation of the topographic base maps. Plats of foundation surveys prepared by registered land surveyors showing additional principal buildings constructed since the date of the aerial photography are used to carry this record forward. It should be noted in this regard, however, that the conduct of a foundation survey has been required by county ordinance only since May 7, 1983; therefore, these records are not necessarily complete for the period prior to that date. Where information on structure demolitions is available, it is also utilized, and the appropriate structure outlines deleted from the maps.

Cadastral Mapping Specifications

Much of what has been historically identified as cadastral mapping in southeastern Wisconsin cannot be mathematically related to the surface of the earth, and therefore does not meet the definition of a map. These "cadastral maps" are more properly identified as cadastral diagrams and are manifestly unsuited to be digitized as the cadastral layer of an automated mapping and land information system where one of the stated intents is the ability to accurately correlate real property boundary line information with earth science information, such as floodplain boundaries. To meet the rigorous requirements of a modern land information system, it is usually necessary that the real property boundary line maps be recompiled on the map projection system established for the land information system utilizing a permanently monumented survey control network as the mechanism for this recompilation. As previously reported, cadastral maps are currently being recompiled in this manner in Kenosha County.

These cadastral maps cover one U. S. Public Land Survey section at a scale of 1:2,400. The maps utilize the Wisconsin State Plane Coordinate System as the map projection and show all section and quarter-section lines and corners together with their grid and ground level lengths and grid bearings, all in their correct position and orientation. The State Plane Coordinate grid is plotted to within 1/100 of an inch of its true position, and each U. S. Public Land Survey section and quarter-section corner is likewise plotted to within 1/100 of an inch of its true position as expressed by the State Plane Coordinate values for the corner. Ninety percent of all well-defined planimetric features plotted on the maps as an aid in the delineation of real property boundaries, such as the threads of major streams and watercourses, fence lines, pavements, and principal buildings, are plotted to within 1/30 of an inch of their true positions. Real property boundary lines are plotted to within 1/40 of an inch of their true positions.

Determination of the location of real property boundary lines is based upon the examination and interpretation of all recorded subdivision plats and certified survey maps within the area to be mapped; legal descriptions, and where available, plats of all public utility easements in the area to be mapped; copies of legal descriptions and, where available, plats of all street right-of-way openings, reservations, or dedications in the area to be mapped; and abbreviated legal descriptions maintained as part of the tax assessment records of the County Assessor for all real property boundaries in the area to be mapped not included within recorded subdivision plats or certified survey maps. The Assessor's abbreviated legal descriptions for individual ownership parcels are derived from the most recently recorded deed transaction in the records of the county Register of Deeds.

Based upon review and interpretation of these materials, the cadastral maps show, all in their correct position and orientation, all real property boundary lines, all street right-of-way lines, and all major cross-country public and utility easement lines. These lines are graphically constructed in a manner which parallels the location of the lines on the surface of the earth following land surveying practice in the State of Wisconsin.

It is recognized that the recorded dimensions and orientation of real property boundaries plotted in this manner may not always agree with the horizontal control survey data also shown on the maps, since most property descriptions were written using field survey data obtained prior to the relocation of section and quarter-section corners and completion of the

horizontal control network tied to the Wisconsin State Plane Coordinate System. Further, the required survey accuracy for property boundary descriptions for land subdivisions, as defined in Chapter 236 of the Wisconsin Statutes and generally adhered to in other property boundary surveys, is 1 part in 3,000, as compared with the Second-Order accuracy of 1 part in 10,000 for the horizontal control surveys. As a result, overlapping or separated property boundary descriptions may be expected to exist. The property boundary line maps record all dimensions as contained in the official records of the county Register of Deeds, and wherever an overlap or gap of 2.5 feet or more exists, such overlap or gap is shown as a mapped line. Overlaps or gaps of less than 2.5 feet are evident only from an examination of the recorded property line dimensions.

For areas covered by recorded subdivision plats and certified survey maps, the following map annotation is provided:

1. Subdivision name or certified survey map number.
2. Block and lot numbers.
3. Street names.
4. Street, alley, and other public way right-of-way widths to the highest degree of accuracy permitted by the data source.
5. Recorded lot dimensions to the highest degree of accuracy permitted by the data source.
6. Easement right-of-way widths to the highest degree of accuracy permitted by the data source together with the purpose of the easement.
7. Kenosha County parcel identification numbers.

For all properties other than those contained in a recorded subdivision plat or certified survey map, the following map annotation is provided:

1. Street names.
2. Street, alley, and other public way right-of-way widths to the highest degree of accuracy permitted by the data source.
3. Recorded property dimensions to the highest degree of accuracy permitted by the data source.
4. Easement right-of-way widths to the highest degree of accuracy permitted by the data source together with the purpose of the easement.
5. Kenosha County parcel identification numbers.

Digital Map Features
Obtained from Cadastral Maps

As cadastral maps are being finished in Kenosha County, they are being digitized. All line features are digitized directly from the cadastral maps. Textual information, including, importantly, the parcel identification number, is key entered from the cadastral maps and placed by the digitizing system in its appropriate location on the digital maps.

Parcel Identification Numbers

The parcel identification number provides the link between the cadastral maps, which show the location of a particular parcel, and the records, either computer-readable or traditional paper records, that contain information about the parcel. Two parcel identification schemes are utilized in Kenosha County, both maintained by the Kenosha County Assessor's office for the keeping of records concerning the assessment of property for tax purposes. One of these schemes is used throughout Kenosha County excepting the City of Kenosha. The second scheme is used in the City of Kenosha only. Both schemes are directly relatable through modest computer programming effort to the Wisconsin Department of Revenue scheme recommended for use throughout the State. Both the schemes in use in Kenosha County are of a type known as "location identifier" and utilize the basic framework of the U. S. Public Land Survey System in the assignment of the parcel number. These schemes are illustrated in Figure 8.

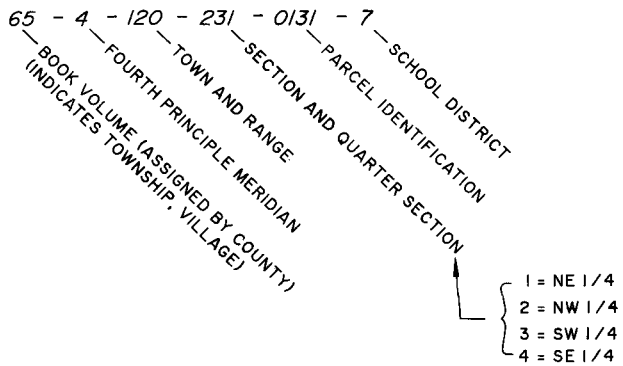
Property Ownership and Assessment Records

The property ownership and assessment records maintained by the County Assessor's office already exist as computer-readable files. These files contain such information as an abbreviated legal description, owner's name and mailing address, property address, acreage of the property, and assessed value of the land and any improvements to that land. These records can be

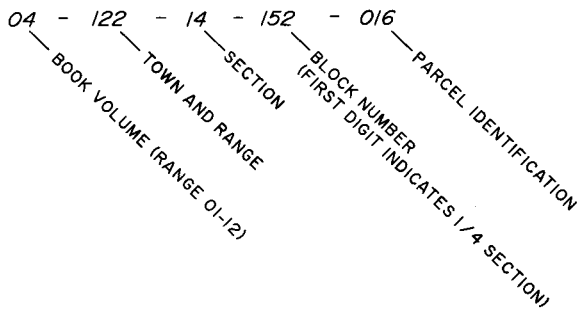
Figure 8

KENOSHA COUNTY PARCEL NUMBERING SYSTEM

AN EXAMPLE OF A COUNTY PARCEL IDENTIFIER:



AN EXAMPLE OF A CITY PARCEL IDENTIFIER:



Source: Kenosha County Assessor's Office.

integrated into the automated mapping and land information system in Kenosha County in a straightforward manner utilizing the previously described parcel identification numbering scheme which is common to both the maps and the records. The only operational step required for this integration is the establishment of proper programming access to the existing computer files of assessment records for the purpose of "reading" them.

Soil Units

Digital soil unit maps of Kenosha County already exist for all of Kenosha County through the efforts of the Southeastern Wisconsin Regional Planning Commission. A detailed operational soil survey for all of southeastern Wisconsin was conducted by the U. S. Soil Conservation Service in 1963 under contract to the Regional Planning Commission. The soil survey conducted in southeastern Wisconsin departed from the standard soil survey conducted in other areas of the State and United States in one important respect—namely, the type of aerial photography used as a base map for the field operation. The work specifications prepared by the Commission required that the boundaries of all soil mapping units be identified on prints of then current (1963) Commission aerial photographs. These photographs consisted of ratioed and rectified enlargements at a scale of one inch equals 1,320 feet of Commission one inch equals 6,000 feet scale high-altitude photographic negatives. Each field sheet base map covered six U. S. Public Land Survey sections. The specifications also required that the Commission be furnished with reproducible half-tone positives of the field sheets on dimensionally stable base material at a scale of one inch equals 2,000 feet. The reproducible positives were to be suitable for the preparation of clear blue-line or black-line prints by diazo process, and were to show clearly the soil mapping units with delineations and identifying symbols so that the prints could be used in conjunction with a published Commission report on the soils of southeastern Wisconsin. The specifications further required that finished photo maps be prepared to accompany the published soil surveys at a scale of one inch equals 1,320 feet, also using the negatives of current photography provided by the Commission. Key planimetric features, such as major highways, railroads, streams, and lakes, were to be identified on the finished photo maps, as were all U. S. Public Land Survey township, range, and section lines.

These base mapping specifications for the soils mapping program in southeastern Wisconsin were unique in that the normal U. S. Soil Conservation Service practice up to that time had been to prepare controlled photomosaics for the soil mapping. The revised base mapping procedure required by the Commission, consisting of the preparation of ratioed and rectified enlargements to eliminate all distortion except that due to relief, provided instead "photo maps" on which distances and areas could subsequently be accurately scaled and measured. Such distances and areas cannot be reliably obtained on controlled photomosaics.

Soil mapping unit boundaries were digitized from the 1 inch equals 1,320 feet scale photo maps for use in the project, this scale photo print being more convenient for the digitizer operators to scale and interpret. Because the salient features of the U. S. Public Land Survey System

had been previously marked on these photos, they were readily scaled for digitization using the previously computed state plane coordinates for the section and quarter-section corners. Because the digital soil unit maps prepared by the Regional Planning Commission utilized the same geometric reference framework as that specified for the Kenosha County automated mapping and land information system, they are already "integrated" with the other land information being incorporated into that system. It is only necessary to copy them.

Land Use

The digital land use information utilized in the ongoing development of the Kenosha County automated mapping and land information system consists of previously digitized land use maps prepared by the Southeastern Wisconsin Regional Planning Commission. The Commission's land use inventory incorporates the statutorily defined wetlands originally identified by the Wisconsin Department of Natural Resources as part of a statewide inventory of these areas. The digital land use maps had been originally digitized from interpreted 1 inch equals 400 feet scale ratioed and rectified prints of aerial photography flown for this purpose by the Commission in 1975. The ratioing and rectification of the photographs was controlled to the U. S. Public Land Survey System corners as those corners had been coordinated with the State Plane Coordinate System. The digitized land use maps were subsequently updated using aerial photography flown in 1980 and again in 1985. These maps are scheduled to be updated to 1990 conditions by the Commission utilizing new aerial photography already flown for this purpose during the spring of 1990. Because the digital land use maps prepared by the Regional Planning Commission—like the digital soil unit maps—utilized the same geometric reference framework as did the Kenosha County automated mapping and land information system, they—like the digital soil unit maps—are already "integrated" with the other land information in the system. It is only necessary to copy them.

The aerial photo enlargements upon which the land uses were originally delineated had been ratioed and rectified to provide, in effect, "photo maps" upon which distances and areas could subsequently be accurately scaled and measured. Some distortion due to relief, however, still exists in aerial photographs after ratioing and rectification. Accordingly, the cadastral maps are used to establish "ground truth" for the land use maps. Where discrepancies are noted between right-of-way and land/water boundary lines on the land use and cadastral maps, they are resolved in favor of the positions recorded on the cadastral map and adjoining land use lines are adjusted accordingly. The land use inventory is rechecked and reviewed and, in some cases, changed on the basis of the cadastral map information, which was not available when the original land use interpretations were made.

Zoning Districts

The digital zoning district map overlays are being prepared from source maps compiled for this purpose by the staff of the County Planning and Development Department. It has been determined by examining the zoning district boundary maps currently maintained by the Department that a majority of the lines necessary to identify zoning district boundaries are being digitized as part of either the cadastral maps or the land use maps. Therefore, a digital zoning district map overlay is prepared by "copying" appropriate line segments from the cadastral and land use maps, digitizing any additional line segments needed.

Flood Hazard Areas and Shoreland Areas

The digitization of surface water and stream channels was discussed in a preceding section of this chapter. Two additional water-related areas which often occur in conjunction with one another and which have implications for zoning administration—floodland and shoreland areas—are also being digitized as part of the creation of an automated mapping and land information system. Throughout Kenosha County, the limits of the floodlands and of the shoreland areas have already been delineated on the large-scale topographic base maps and are being digitized from these source materials.

Digital Graphic Data Exchange

In order to exchange digital map data between two or more physically separated automated mapping and land information systems, one of two conditions must exist. Either the systems must have compatible data structures for the storage of digital map data or an interchange mechanism between the two systems must be provided. It has been noted in this report that the existing automated mapping and land information systems in the Kenosha area are of several different proprietary types; therefore, before digital map data can be shared, agreement must

be reached between the various organizations concerning the manner in which digital map data may be exchanged. Intergraph automated mapping software is currently the single most prevalent type of automated mapping software used in the Southeastern Wisconsin Region, and the majority of the non-Intergraph systems have acquired the necessary computer software to translate some information from Intergraph data structures to their own proprietary software systems. Accordingly, the most expedient manner in which to establish digital map data exchange would involve the use of Intergraph data exchange mechanisms.

It is recommended, therefore, that Intergraph Standard Interchange Format (ISIF) be utilized as the standard digital map data exchange mechanism for the Kenosha County automated mapping community. It should be noted that this recommendation is not equivalent to recommending the purchase of Intergraph automated mapping systems, nor should it be interpreted to preclude the direct transfer of Intergraph files between two Intergraph sites running compatible versions of the Intergraph software when such direct transfer could be accomplished more efficiently than through the use of ISIF.

It should be noted that ISIF is "batch-oriented," meaning that it is used to load entire files of digital map information. Therefore, to update digital map files involving a transfer of files between two different vendor sets of hardware and software, it is necessary to reload the entire affected file rather than to load only the revisions. "Transaction-oriented" file update capability, or the ability to load only the revisions to a file, is a less well-developed capability and may be relatively easy or relatively difficult between different vendor sets of hardware and software, depending upon the similarity or dissimilarity of the internal architecture of the involved systems. As a practical matter, transaction-oriented capability may be available only through custom computer programming, or through the acquisition of the same hardware and software by the different operators involved.

In this regard, it should also be noted that the use of ISIF as the recommended standard for digital map data exchange will pose some problems for operations using IBM mainframe computers to operate automated mapping systems. IBM mainframe systems utilize digital map data storage models that differ from the models used by most other vendors, and translation between IBM models and non-IBM models is not a trivial programming task. This issue has not been addressed in the commercial market to the extent that digital graphic data exchange between other systems has been. The efficient and effective exchange of digital map data between IBM and non-IBM sites, therefore, may well require the use of an alternative graphic data exchange mechanism such as the Initial Graphic Exchange Standard (IGES) or some other mechanism that is more "generic" than ISIF.

Finally, it should be noted that this recommendation is intended to apply to map feature elements, or "geometry," rather than to data that may relate to map features. The National Research Council model, proposed in preceding chapters of this report as the model to guide the creation of the recommended automated mapping system for Kenosha County, utilizes the parcel identifier as a "key" to link location, or geometry, of features on maps to nongeometric information about the feature. The transfer of files of nongeometric, or attribute, data can be accomplished using existing procedures for the transfer of character data between different computer systems.

ESTIMATED COSTS FOR COMPLETION OF AN AUTOMATED MAPPING AND LAND INFORMATION SYSTEM FOR KENOSHA COUNTY

Compilation of real property boundary line maps, board digitization of these maps and selected map features from previously completed analog topographic maps, and integration of these features with other map and map-related information as described in the preceding sections of this chapter is currently being carried out for Kenosha County on a contract basis by the Regional Planning Commission at a cost of $20 per real estate parcel. The total project cost for completing the necessary cadastral mapping in Kenosha County and for completing the described basic automated mapping and land information system for the County, as set forth in the preceding sections of this chapter and as summarized in Table 1, is about $800,000 based upon an estimate of 40,000 real estate parcels remaining to be mapped. This cost is exclusive of any hardware or software needed to manipulate digital map data. It represents, however, one

Table 1

ESTIMATED COSTS FOR THE COMPLETION OF THE DESCRIBED AUTOMATED MAPPING AND LAND INFORMATION SYSTEM FOR KENOSHA COUNTY

Compilation of Real Property Boundary Line Maps for Approximately 40,000 Real Property Parcels	$400,000
Board Digitization of Real Property Boundary Line Maps for Approximately 40,000 Real Property Parcels	200,000
Board Digitization of Structure Outlines, Pavement Edges, Water Features, Floodplain Boundaries, and Shoreland Boundaries and Creation of Zoning District, Land Use, and Soil Unit Digital Map Overlays Associated with Approximately 40,000 Real Property Parcels	200,000
Total	$800,000

Source: SEWRPC.

of the most important components of a modernized, automated land information system for Kenosha County.

Of the total amount required to complete the already initiated system of maps and digital files, $400,000, or about 50 percent, would be necessary to complete the preparation of correctly compiled cadastral maps for the remainder of the County; $200,000, or about 25 percent, would be necessary to complete the digitization of these cadastral maps; and $200,000, or about 25 percent, would be necessary to complete the digitization of the remaining map information and the integration of the various digitized map files.

ESTIMATED ANNUAL MAINTENANCE COST OF AN AUTOMATED MAPPING AND LAND INFORMATION SYSTEM FOR KENOSHA COUNTY

A yearly maintenance cost for the preservation and maintenance of the survey control network is already being budgeted by Kenosha County. In recent years, this amount has been about $20,000 per year. This cost is a currently budgeted amount and does not represent a "new" cost associated with the completion of the described system. Section 59.635(8) of the Wisconsin Statutes envisions that the County Surveyor will maintain about 5 percent of the U. S. Public Land Survey corners within the County each year. In Kenosha County, this would require the County Surveyor to visit about 60 of the 1,203 corners within the County each year to inspect the monument installations and to replace as may be necessary witness monuments and ties to such monuments. At an estimated $35 per corner, this inspection would cost about $2,000 per year. Experience indicates that the visits may be expected to find about 1 percent of the corner monuments—or about 12 per year—and the attendant reference bench marks to have been damaged or destroyed. This necessitates replacement—at a cost of about $200 per corner, or about $2,400 per year. In addition, the horizontal and vertical survey control for the disturbed monuments must be checked, at a cost of about $1,100 per corner, or about $13,200 per year. Thus, the total cost of the survey control network maintenance may be expected to approximate $17,600 per year.

It should also be noted that it will occasionally be necessary for Kenosha County to revise the topographic mapping that forms an integral part of the described system. This type of update is required by construction that changes the physical land- and cityscape, and should be reflected in the planimetric and hypsometric data that are shown on the maps. The area of topographic mapping requiring updating will vary over time with the rate of public and private development in the County. From 1963 to 1985 land has been converted from rural to urban use within Kenosha County at an average

rate of about 0.6 square mile per year. Thus, it may be expected that, on the average, about one square mile of revised topographic mapping would need to be obtained annually, at a cost of $3,000 to $5,000 per square mile—depending upon such factors as density of development and size of the project area. It should again be noted that Kenosha County is already in the process of obtaining revised topographic mapping on an as-needed basis, taking into account major developments, highway improvements, and drainage and flood control changes. Again, these costs do not represent new costs associated with completion of the described system, but rather represent costs that are already being expended on a yearly basis by Kenosha County.

Maintaining the currentness of the information already digitized is costing about $10,000 per year in Kenosha County. As ever larger quantities of digital map files and related information are created, this amount may be expected to increase. It is estimated that the yearly maintenance cost of the described digital map files will total $30,000 at completion.

In summary, then, total annual maintenance costs for the described system would be on the order of $55,000 to $80,000 upon completion. Of this amount, about $20,000 annually would be used for survey control network maintenance; a range of $5,000 to $30,000 annually, depending upon the rate of change in the County, would be used to obtain revised topographic mapping; and about $30,000 would be used to revise the cadastral maps and related digital map files.

RECOMMENDED ORGANIZATIONAL ARRANGEMENT

The needs of the various Kenosha County departments and local units of government in Kenosha County would probably best be served by the use of a decentralized operating arrangement. Under this type of an arrangement, individual county departments and local units of government would be responsible for analyzing their own needs, developing the necessary computer base data files, and acquiring their own computer hardware and software. All would agree to share a common digital mapping base and parcel identification system. Because of fundamental changes that have occurred over the past several years in computer-assisted mapping technology, it is now doubtful that a system organized around a multiuser model would ever be physically centralized. Accordingly, the historically divisive issue that pertained to management structure and cost allocation among participants in a centralized system need no longer be germane. Instead, under the decentralized operating arrangement herein recommended, independent data processing units communicating either over networks or by transportation of data using a medium, such as magnetic tape, would exist. In this type of organizational structure, the system is provided by an agreed-upon set of digital mapping standards and specifications, and the common use of a single set of digital maps.

Under this type of decentralized operating arrangement, one-time costs to the County for hardware, software, and staff training may be expected to range from $250,000 to $500,000. Assuming that all participants in this type of multiuser system would possess their own hardware and software systems, costs toward the higher end of this range would be required for the purchase of a more traditional minicomputer-based system. Costs on the lower end of this range could be expected for the acquisition of a networked work station-based system. This type of decentralized operating arrangement would provide the greatest degree of operational independence to the county departments and to the communities within the County. It would also provide the County with the opportunity to evaluate a wide variety of hardware and software systems.

The Kenosha County Board of Supervisors, in a resolution adopted on March 20, 1990, designated the Office of Planning and Development as the County Land Information Office. It is recommended that this designation remain in place, and that the County Planning and Development Department continue to serve as the County Land Information Office. Under this arrangement, the Land Information Office would be responsible for completing and maintaining the computerized digital mapping base and parcel numbering system for use by all county departments and communities within the County. The various departments and communities utilizing their own hardware and software systems would link pertinent data files to the parcel identifiers, thereby creating a unified parcel-based land information system. The range of data that can in this way be linked to

specific geographic location, collated, analyzed, summarized, and tabulated in various ways is extremely broad. Such data could range from information on land ownership, land use, and assessed valuation to public and private utility facility inventory and management data, environmental inventory and management data, and planning and zoning data; to code monitoring and enforcement data; and to emergency and service delivery vehicle routing systems.

The provision of a single integrated system of survey control and topographic maps and digital planimetric and cadastral map elements will be extremely useful in many aspects of property tax assessment and property tax collection, county and municipal planning and zoning, and public works engineering, as well as in private development and redevelopment. The resulting maps and survey control are useful to attorneys; appraisers and assessors; land surveyors; civil engineers in private practice; utility corporations; and particularly governmental agencies, such as city and village planning and engineering departments, county and state highway departments, and county and municipal park departments.

The topographic maps, for example, permit drainage areas to be precisely defined and measured, and alternative route locations for various types of public works facilities to be defined and evaluated. These maps also permit the distances between existing cultural and topographic features and between such features and existing and proposed property boundary lines and proposed public and private works construction to be accurately scaled, profiles drawn, and grade lines established and computed. Importantly, the attendant survey control network permits lines drawn on maps to be accurately reproduced in the field when planned land use development and supporting public works projects reach the construction stage, or when public land use controls, such as zoning and official mapping, require precise enforcement.

The survey control network also permits the maps to be readily and economically updated, since by law all public works-related surveys should be, and all land surveys must be, tied to the U. S. Public Land Survey System. The survey control network facilitates the conduct of land and engineering surveys whether made for public or private purposes. Most importantly, the maps provide in a convenient, coordinated form the basic information needed to define environmental and developmental problems, and to investigate alternative solutions to such problems without further costly field surveys.

The maps and survey control networks are extremely useful, if not absolutely essential, to sound public works system and facility planning, design, and construction layout, and in the preparation of "as built" records. The maps and control network facilitate the planning, design, and construction of streets and highways, sanitary sewers, water supply facilities, stormwater management and flood control facilities, and stream and lakeshore erosion control facilities. The maps are also useful in commercial and industrial building and site development; in land subdivision design and development; and in the day-to-day administration of zoning, land subdivision, and certified survey plat review activities. The maps are absolutely essential to the accurate delineation of flood hazard and shoreland zoning boundaries.

The survey control network also facilitates the development of good land title and survey records in that it permits the ready, yet accurate, reference of land boundaries to both the U. S. Public Land Survey System and the State Plane Coordinate System, thereby relating all land ownership descriptions to known points of beginning and to a common bearing base. Importantly, the maps and survey control network provide a technically sound and rigorous foundation for the evolution of increasingly more powerful automated land records functions and activities.

PUBLIC FUNDING SOURCES

Since 1980, Kenosha County has used general revenues derived from the property tax to fund the survey control and mapping program required to create a parcel-based land information system. As of July 1990, the Wisconsin Statutes provide for the creation in each county of the State of a Land Information Office. If such an Office is created, the Statutes further provide that from July 1, 1990, through June 30, 1991, the County can retain $2.00 of a newly increased $4.00 per document recording fee for all eligible documents recorded with the County Register of Deeds. Thereafter, for a period of five years, the County can retain $4.00 of a $6.00 per document recording fee. The monies so retained must be

used for land records modernization. In addition, the County is eligible to apply to the Wisconsin Land Information Board for state grants in partial support of such modernization. After an initial two-year period, the County must, in order to continue to retain the monies and continue to be eligible for state grants, have a Wisconsin Land Information Board approved plan for land records modernization within the County.

From 1985 through 1989, the number of eligible documents recorded in the office of the Kenosha County Register of Deeds ranged from a low of about 16,700 in 1985 to a high of about 23,900 in 1987. Assuming an average of about 20,000 eligible documents recorded per year, the County may expect to receive about $40,000 for land records modernization in the period from July 1, 1990, through June 30, 1991, and then about $80,000 per year thereafter for five years. Thus, a total of about $440,000 will be available over a six-year period for land records modernization exclusive of any state grants.

SUMMARY

The development and common use of a parcel-based automated system would be a major step toward the elimination over time of redundancy, and would forestall the development of new, partially redundant operations. Past discussions within the County concerning shared system development tended to focus on the need to use a single, centralized computer system. Recent advances in computer hardware and software technology—particularly as they pertain to decreasing unit costs for computational and mass data storage capability, to networking between the hardware of different vendors, and to translation of digital map data between different proprietary software products—now permit a different type of "system" to be specified—that is, one in which the system users share digital maps and an agreed-upon set of map-related information, but maintain their own separate—or distributed—computing capability. The ability to replace the centralized operating concept with a distributed operating concept permits discussion to be focused on the true system components of an automated mapping and land information system. In a distributed operating environment, the "system" is not hardware and software, but an agreed-upon set of procedures and specifications for the production and maintenance of a basic set of digital maps and map-related information and an agreed-upon set of procedures and specifications for the interchange of this data between system users. It must be stressed that no amount of state-of-the-art computer technology can compensate for the absence of a robust set of specifications and standards for those elements that will be used in common.

The standards recommended herein for an automated mapping and land information system for Kenosha County assume that initially only a selected set of elements—namely, a survey control network, large-scale planimetric and topographic base maps, and a cadastral map overlay—would be developed for joint use. These elements, if properly designed, should, in the aggregate, provide map feature information meeting the needs of all users. The development of a single digital mapping base prepared to a sufficiently precise set of specifications is of central importance to the coordination of future digital mapping efforts in Kenosha County. Unless prudent action is taken in the initial implementation effort, the future ability of participants to exchange digital map data without extensive and expensive "refitting" will be jeopardized, and a portion of the advantages inherent in moving to a digital mapping environment will be lost. Indeed, it is the anticipated ability to be able to transfer digital map data, such as utility system data, between installations that is perceived as one of the major benefits of a shared, digital mapping system.

The Commission-recommended survey control network and large-scale topographic base maps already exist throughout Kenosha County, and are being utilized by some county departments and some utilities in automated mapping efforts. Indeed, the survey control network and associated topographic and cadastral base mapping represent, in effect, a County Board-sanctioned standard. Accordingly, the completion of this program in the remainder of Kenosha County should be pursued, and it should be considered the standard for common use.

It is accordingly recommended that the preparation of new cadastral maps and the digitization of real property boundary lines be completed within the County, complementing the completed topographic maps, all based upon the geometric framework already in place in the form of the remonumented U. S. Public Land

Survey System and related geodetic control network. The cadastral maps, like the topographic maps, cover one U. S. Public Land Survey section at a scale of 1:2,400. The maps utilize the Wisconsin State Plane Coordinate System, North American Datum of 1927, as the map projection and show all section and quarter-section lines and corners, together with their grid and ground level lengths and grid bearings, all in their correct position and orientation. Determination of the location of real property boundary lines is based upon the examination and interpretation of all recorded subdivision plats and certified survey maps within the area to be mapped; legal descriptions, and where available, plats of all public utility easements in the area to be mapped; copies of legal descriptions and, where available, plats of all street right-of-way openings, reservations, or dedications in the area to be mapped; and legal descriptions contained in the most recently recorded deed transaction in the records of the County Register of Deeds for all real property boundaries in the area to be mapped not included within the recorded subdivision plats or certified survey maps.

The completion of the described automated mapping and land information system is estimated to cost $800,000. Continuing maintenance costs would total approximately $55,000 to $80,000 per year upon completion of the system depending upon the rate of yearly change in the County.

This estimated system implementation cost of $800,000 does not include any hardware or software costs for the individual installations that would use the common set of digital maps. The funding of individual operating hardware and software systems and the expenses of their operation would be the responsibility of each individual participant.

It is recommended that the Kenosha County Planning and Development Office, acting as the County Land Information Office, be assigned the responsibility of creating and maintaining the digital maps comprising the shared system. It should be pointed out that the County is already carrying out this development function and that the costs entailed are not, therefore, "new" costs.

The Advisory Committee determined that the best alternative would be for Kenosha County to create a decentralized land information system based upon a common set of digital maps and parcel identifiers. Implementation of this system would consist of the continued development and use of the common digital map files and a set of specifications and conventions of the exchange of digital map information. In this manner, existing operating systems would concentrate on their individual applications, and new operating systems would be spared the expense of having to create an automated mapping base wholly or partially duplicative of existing systems. Future costs of developing redundant capability would be avoided, and the need for assessing these costs against area residents through taxes, user fees, and utility rate payments would be reduced or eliminated. This recommendation is consistent with national studies of land records modernization issues which have concluded that counties are the best agencies to assume lead roles in this area because of the responsibilities assigned to them by the State Constitutions and State Statutes for the keeping of basic records and information about the land.

Acquisition by the County of computer hardware and software sufficient for its own use of the digital mapping files is estimated to cost from $250,000 to $500,000. Under the recommendations made by the Advisory Committee, the County would need to acquire only sufficient capacity to support its own day-to-day operations. Since the recommendations assume a distributed, rather than a centralized, operating scheme, each unit of government and utility would acquire and maintain its own operating system.

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Chapter V

RECOMMENDATIONS AND CONCLUSIONS

On March 20, 1990, the Kenosha County Board of Supervisors adopted a resolution requesting the Southeastern Wisconsin Regional Planning Commission to convene an Advisory Committee to analyze the feasibility and cost-effectiveness of modernizing land records within the County by developing an automated mapping and land information system. The resolution was subsequently approved by the Kenosha County Executive. Acting in response to this request, the Regional Planning Commission created an Advisory Committee composed of county and city departmental officials and representatives of the Kenosha Unified School District and of public and private utilities to guide the conduct of the requested study and the preparation of this report setting forth the findings and recommendations of the study.

The Committee reviewed the pertinent conclusions of recent research efforts in the area of land records modernization, including, most importantly, the reports of the National Research Council Panel on a Multipurpose Cadastre and the reports of the Wisconsin Land Records Committee. The Committee also reviewed the efforts and accomplishments of those existing automated mapping and land records systems whose operations cover all or portions of Kenosha County.

The Advisory Committee concluded that a modernized land records system in Kenosha County could best be created by provision of a single automated mapping base for the entire County. This single mapping base would be prepared to a set of specifications sufficient to meet the most stringent of accuracy and map feature content requirements of all of the users concerned. These specifications are set forth in Chapter IV of this report. Each organization using the automated base would provide its own operating environment—that is, computer hardware and software. Only the digital maps and parcel identification system would be shared. This basic system would provide an automated mapping capability suitable for the development by individual operators of a wide variety of applications such as land ownership and title recordation systems, real property assessment and taxation systems, public and private utility inventory and management systems, environmental inventory and management systems, zoning and other code monitoring and enforcement systems, and emergency and service vehicle response and routing systems.

GENERAL RECOMMENDATIONS

It is recommended by the Advisory Committee that Kenosha County undertake the creation of an automated digital map base suitable for the creation within the County of a fully coordinated parcel-based land information system. More specifically, it is recommended that Kenosha County undertake the responsibility for providing the basic system of U. S. Public Land Survey corner monumentation, attendant horizontal and vertical control surveys, digital planimetric and topographic maps, digital cadastral map overlays, and parcel identifiers that together constitute the basic automated mapping system; and that—once the system is completed—the County undertake the responsibility of maintaining the system in a current condition. It is the belief of the Advisory Committee that the County represents the most logical locus for this activity.

The Kenosha County Automated and Land Information System would be centered in the County Office of Planning and Development, and the Director of Planning and Development would function as the executive officer of the system. The Office of Planning and Development would continue to serve as the County Board-designated Land Information Office. The Director of Planning and Development would—during the period that would be necessary to create the system—prepare a yearly budget for the creation of the system; secure the appropriate funding from the County Board and other funding organizations; and administer the funds, once obtained.

The assignment of parcel identification numbers to newly created real property parcels is currently carried out in the County Assessor's office. It is recommended that the parcel identification number assignment and the tax lister's function be transferred from the County Assessor's office to the County Land Information office.

The Register of Deeds office currently is responsible for the processing of real property-related documents, and the County Surveyor's office maintains files on certain land-related information such as the location of the U. S. Public Land Survey monuments. The maintenance and revision of the real property boundary lines on the digital cadastral maps, utilizing data provided by the Register of Deeds office and the County Surveyor, are functions that are currently being carried out by the County Office of Planning and Development. Since none of these functions represent new functions that would be added as a result of the creation of an automated mapping and land information system, it should not be necessary for the County to retain additional staff to perform these functions.

It is also recommended that the Advisory Committee convened to oversee the preparation of this report continue to function as an oversight committee as the recommendations set forth herein are implemented over the next several years. In this regard, the Advisory Committee would be expected to provide general direction to the implementation effort and to serve as a coordinating body as the automated mapping user group begins to expand in Kenosha County.

FUNDING RECOMMENDATIONS

The Advisory Committee recommended that the completion of the automated mapping and land information system described herein be carried out over a three-year time frame. This timing was considered critical by the Kenosha Water Utility, which is proposing to proceed with automation of its sewer and water utility records. That automation should be accomplished using the county mapping system herein recommended.

As indicated in the preceding chapter, the completion of the recommended automated mapping base for Kenosha County is estimated to cost $800,000. Because the private utilities represented on the Advisory Committee stated a reluctance to participate financially in the implementation of the recommended system, in order to move forward in a timely manner in carrying out the work outlined in this report the Advisory Committee recommended that the implementation of the system be funded in the public sector. Accordingly, this Advisory Committee recommended that the necessary funding support be provided as set forth in Table 2. Of the approximately $800,000 needed to carry out the specified work over a three-year period, it is recommended by the Advisory Committee that $300,000, or $100,000 per year, be obtained by applying for grants from the Wisconsin Land Information Board. In addition, it is estimated that Kenosha County will receive a total of $200,000—$40,000 in the first year and $80,000 in each of the two succeeding years—as a result of recently enacted State legislation that raised the recording fees of eligible real property-related documents. Of the remaining $300,000 required to complete the recommended system over a three-year period, it is proposed that Kenosha County and the Kenosha Water Utility each provide $150,000, or $50,000 per year, toward completion costs.

The $50,000 per year proposed to be obtained from the Kenosha Water Utility represents "new" funding; the $50,000 per year proposed to be obtained from Kenosha County does not represent new funding, but rather approximates a continuation of Kenosha County's historical level of funding for the ongoing development of digital mapping capability.

The Advisory Committee strongly recommends that the recommended work be carried out in a three-year time frame in order to allow the Kenosha Water Utility to move ahead with its present plans to automate its infrastructure records. The Committee also strongly recommends that the County make a grant application to the Wisconsin Land Information Board as soon as is practical in partial support of the work outlined herein, and that the County aggressively pursue the acquisition of a grant in the amount of $100,000 per year for three years as proposed by the Committee.

In the event that Kenosha County does not receive the recommended state grant in whole or in part, then it will be necessary to increase the time frame for the work. One possible alternative funding plan under this alternative is set forth in Table 3. Under this less desirable alternative, it is assumed that, owing to the time delay, the Kenosha Water Utility would not participate in the funding.

Acquisition by Kenosha County of computer hardware and software sufficient for use by the

Table 2

PROPOSED ALLOCATION OF ESTIMATED YEARLY AND THREE-YEAR TOTAL COSTS FOR THE CREATION OF AN AUTOMATED MAPPING BASE FOR KENOSHA COUNTY

Funding Source	Yearly Costs			Total Three-Year Costs
	First Year	Second Year	Third Year	
Wisconsin Land Information Board Grant	$100,000	$100,000	$100,000	$300,000
Document Recording Fee Increase	40,000	80,000	80,000	200,000
Kenosha County	50,000	50,000	50,000	150,000
Kenosha Water Utility	50,000	50,000	50,000	150,000
Total	$240,000	$280,000	$280,000	$800,000

Source: SEWRPC.

Table 3

POSSIBLE ALTERNATIVE ALLOCATION OF ESTIMATED YEARLY AND SIX-YEAR TOTAL COSTS FOR THE CREATION OF AN AUTOMATED MAPPING BASE FOR KENOSHA COUNTY

Funding Source	Yearly Costs						Total Six-Year Costs
	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Year	
Document Recording Fee Increase	$ 40,000	$ 80,000	$ 80,000	$ 80,000	$ 80,000	$ 80,000	$440,000
Kenosha County	60,000	60,000	60,000	60,000	60,000	60,000	360,000
Total	$100,000	$140,000	$140,000	$140,000	$140,000	$140,000	$800,000

Source: SEWRPC.

various departments—including at least the County Planning and Development office, the County Assessor's office, the County Register of Deeds office, and the County Highway Department—of the digital map files would cost from $250,000 to $500,000, depending upon the type and capacity of the chosen equipment, the number of departments involved, the applications involved, and the time frame chosen for implementation. This amount is in addition to the $800,000 needed to complete the recommended automated mapping base. It should be noted that under the recommendations made by the Advisory Committee, the various county departments would need to acquire only sufficient capacity to support their own day-to-day operations. Since the recommendations assume a distributed, rather than a centralized, operating scheme, the County would have no need to provide the additional computational and storage capacity that would otherwise be necessary in a centralized system.

CONCLUDING STATEMENT

The Advisory Committee has herein outlined the effort needed to create a parcel-based digital mapping base which could be used by all county departments, by local communities, and by public and private utilities to cooperatively create a shared, modern, land information system within the County. The Committee has recommended specifications for the technical work involved, along with an organizational structure for the conduct of that work. The Committee recommends that the automated mapping and land information system herein outlined be undertaken at the earliest possible date and that the organization structure be as recommended in this report.

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APPENDICES

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Kenosha County

BOARD OF SUPERVISORS

RESOLUTION NO. 205

Subject: Feasibility Study for a Kenosha County Automated Mapping and Land Information System			
Original ☒	Corrected ☐	2nd Correction ☐	Resubmitted ☐
Date Submitted: March 20, 1990		Date Resubmitted:	
Submitted By: Land Use Committee			
Fiscal Note Attached ☐		Legal Note Attached ☐	
Prepared By: George E. Melcher Dir., Planning & Development		Signature:	

WHEREAS, Kenosha County, through the Office of Planning and Development, has, since 1985, been creating digital cadastral map overlay files, maintained topographic base map files, and overseen maintenance of the U.S. public land survey corners located in the county, which activities would serve as a foundation to an automated mapping and land information system, and

WHEREAS, since this project was begun in the Department of Planning and Development, other county departments, such as the Assessor, Emergency Services, Highway Department, Information Systems/Data Processing, Register of Deeds, and Sheriff's Department, have indicated that an automated mapping and land information system could be of benefit to their respective departments, and

WHEREAS, other units of government, along with private and public utilities, have also indicated a need for an Automated Mapping and Land Information System, and

WHEREAS, if a feasibility study was undertaken by Kenosha County, this study could define the benefits of an Automated Mapping and Land Information System, along with estimated costs and potential funding sources, for all county departments, other units of government, along with public and private utilities, and

WHEREAS, the Wisconsin Legislature, in 1989, enacted legislation creating the Wisconsin Land Information Program and further created the Wisconsin Land Information Board, and

WHEREAS, the duties of the Wisconsin Land Information Board will be to provide technical assistance to local governmental units and prepare guidelines to coordinate the modernization of land records and land information systems, along with the creation and administration of a grant program for local units of government to assist in the development of modernized land records systems, and

WHEREAS, legislation is currently pending, which would establish funding for the grant program for local units of government; and, if Kenosha County is to participate in any grant program, a feasibility study would have to be undertaken and submitted to the Wisconsin Land Information Board for approval prior to applying for any grant funds, and

WHEREAS, the Southeastern Wisconsin Regional Planning Commission has prepared similar feasibility studies for other municipalities and has indicated a willingness to prepare a feasibility study for Kenosha County at no cost to Kenosha County other than costs associated with printing a report documenting the findings of a feasibility study, and

WHEREAS, funds do exist in the 1990 Planning and Development adopted budget, which would cover said publication costs,

NOW, THEREFORE, BE IT RESOLVED, that Kenosha County request the Southeastern Wisconsin Regional Planning Commission to prepare a feasibility study for a Kenosha County Automated Mapping and Land Information System.

BE IT FURTHER RESOLVED, that the Kenosha County Office of Planning and Development continue to serve as the lead county department responsible for this program and the preparation of said study; and that for the purposes of dealing with the Wisconsin Land Information Program and the Wisconsin Land Information Board, the Kenosha County Office of Planning and Development be designated as Kenosha County's Land Information Office until such time as the feasibility study may deem otherwise.

BE IT FURTHER RESOLVED, that the Southeastern Wisconsin Regional Planning Commission, with direction from the Kenosha County Executive and assisted by the Office of Planning and Development, be requested to create an advisory committee composed of representatives of affected county departments and other local units of government within Kenosha County, along with private and public utilities, to guide in the preparation of this study, which will present its findings and recommendations in the form of a published Southeastern Wisconsin Regional Planning Commission Community Assistance Planning Report.

BE IT FURTHER RESOLVED, that the report when completed shall be forwarded to the Kenosha County Board of Supervisors, through the Kenosha County Land Use Committee, for review and adoption.

Approved by:

James L. Fonk

Stanley Kerkman
Stanley Kerkman

Fred C. Schmalfeldt
Fred C. Schmalfeldt

Richard Lindgren
Richard Lindgren

Geoffrey Wheeler
Geoffrey Wheeler

LAND USE COMMITTEE

ADOPTED ☑ DEFEATED ☐ REFERRED ☐
ADOPTED AS AMENDED ☐ WITHDRAWN ☐
ATTESTED TO BY:

Eugene A. Bilitt 3-22-90
CHAIRMAN - COUNTY BOARD

Nancy Principe 3/22/90
COUNTY CLERK