CHAPTER IV
MAJOR ELEMENTS OF A COMPREHENSIVE
WATERSHED PLANNING PROGRAM

The following outline sets forth the major necessary work elements of a pro-
posed comprehensive watershed planning study of the Fox River basin in south-
eastern Wisconsin. The outline has been prepared for the purpose of establishing
a generalized work program appropriate to meet the specific needs of the Fox
River basin and to provide fair and practical solutions to the problems of the
basin as cited previously in this Prospectus.

The outline is based upon the following assumptions:

1. That the ultimate purpose of a watershed planning study of the Fox River
basin is to assist in the abatement of the water-related problems of the
basin and in the preservation and enhancement of the resource base by
developing a workable plan to guide the staged development of multi-pur-
pose water-related facilities and related resource conservation and man-
agement programs for the Fox River basin. In addition, the study shall
provide, insofar as possible, planning and engineering data which can
contribute to local planning programs and to broader regional resource
planning programs.

2. That the study must be comprehensive in both functional scope and in
geographic area, fully recognizing the interrelationship of the water and
land use problems of the basin as well as the need to consider the waters-
shed as a rational planning unit.

3. That the study will utilize the latest planning and engineering techniques
and seek to achieve a comprehensive, coordinated plan for the entire basin.

4. That the task of establishing a comprehensive watershed planning pro-
gram, the collection and analysis of basic data under such a program,
the formulation of improvement plans, and plan implementation all re-
quire close and continuing cooperation among the various levels and agen-
cies of government concerned with, and involved in, the land and water
use problems of the watershed.

It is intended that the study present and evaluate alternative water-related facil-
ity plans and accompanying development patterns. Evaluation of the alternative
plans should be based upon a comprehensive assessment of effects on the natural
resource base and on the total environment as well as on the overall costs of
developing and operating the combined water-related facilities and accompan-
ing development patterns.
While sufficiently detailed to permit the development of initial cost estimates and time schedules, the outline is not intended to be a detailed study design. It is sufficiently general to permit latitude in the selection of specific procedures and techniques as the study proceeds. It is intended that full use be made of all existing and available surveys, reports, and other data pertinent to the study. Additional data collection activities should be conducted only as necessary to develop essential original data currently unavailable or to supplement or update existing data.

A. STUDY ORGANIZATION AND DETAILED STUDY DESIGN

Before beginning actual work, the study must be designed in sufficient detail to assure maximum coordination between participants, the efficient use of funds and personnel, and the ultimate combination of work elements into a sound, comprehensive plan. In order to accomplish this, it is necessary to begin the watershed study with the design of an organizational fabric which sets forth very clearly the detailed work procedures, staff assignments and requirements, and time schedules. Initial effort expended in study design will result in a greatly increased efficiency in the planning program.

B. COLLECTION OF BASIC PLANNING AND ENGINEERING DATA

1. Maps

Essential to any consideration of watershed planning is a knowledge of the topographic and cultural features of the watershed, and such knowledge can only be adequately based upon topographic and cadastral maps of the required scale and accuracy. Information will be required on such natural features as relief, watershed boundaries, areas subject to inundation, and locations of streams, lakes, and wetlands as well as on such man-made features as real property boundary lines, highways, railroads, and principal buildings.

a. General base maps

General base maps of the watershed will be required to provide a medium for recording and presenting in graphic form the results of the planning studies as well as the natural and man-made features of the watershed.

Regional base maps have been prepared by the SEWRPC and are available for the study. These maps portray each county in the Region at four scales: 1:24000, 1:48000, 1:62500, and 1:96000 and can be assembled by mosaic processes to cover the watershed as a unit. These base maps can be expanded or reduced in scale for use in various phases of the study and will show, among
other information: all major lakes, streams, and watercourse lines; all railroads, streets, and highways; all township range and section lines and all civil division lines. These maps are compiled to National Map Accuracy Standards utilizing the Wisconsin State Plane Coordinate System Grid (South Zone) as the map projection.

Large scale topographic and/or planimetric maps and cadastral maps of their respective jurisdiction are available from certain of the municipalities within the basin, and large scale topographic maps of Waukesha are available from the Waukesha County Park and Planning Commission.

b. Aerial Photographs

Current aerial photography at appropriate scales will be required to provide detailed planimetric data, as a basic source for land use data and as a data source for the necessary updating of all base maps.

New aerial photography of the entire planning Region was obtained by the SEWRPC in April of 1963, and these aerial photographs are available for the study at scales of 1:4800 and 1:24000.

c. Flood hazard and land reservation maps

As the study efforts reach a more precise and definitive stage, maps providing detailed information on property boundary lines and topography to a much greater degree of accuracy and precision than furnished by the general base maps will be required. The degree of accuracy which can be attained in such plan implementation activities as flood plain regulation depends upon the accuracy and scale of available detailed planning maps. Therefore, such maps will have to be available at a scale of 1 inch equals 200 feet, with a vertical contour interval of five feet. In order to properly correlate topographic and cadastral (property boundary) map data, such maps should be based upon a monumented control survey network which relates the U. S. Public Land Survey System to the State Plane Coordinate System. These maps will be required only along such reaches of the major stream channels as the ultimate plan may indicate as requiring land use controls for flood plain reservation or as requiring the reservation of land for the ultimate construction of drainage and flood control facilities. These maps will provide a basis for the preparation of local plans and plan implementation devices.
The flooding pictured in these two scenes occurred in the Kenosha County community of Silver Lake in 1961 and 1962, respectively, as the result of a normal spring snow melt in the Fox River basin and do not represent the severe flood conditions possible under unusual weather and runoff conditions. The possible damage to private and public property and the attendant public health hazard from such flooding are apparent. Changing land use in the watershed is generally intensifying flood dangers. Before reasonable plans can be drawn to abate flooding, it is necessary to collect and analyze a great deal of engineering data on land use, soils, rainfall, the physical dimensions and capacities of waterways, and the expected frequencies of flooding. Such analysis must include all upstream tributary areas as well as all downstream areas producing a backwater effect.

2. Surface Water Data Inventory - Hydrologic and Hydraulic Investigations

Essential to effective water use and land use planning, as well as to effective drainage and flood control engineering, is data on water quantity, particularly on the flood potential of streams. Basic data on the hydrologic and hydraulic characteristics of the Fox River will, therefore, have to be gathered. These data should include historic flood data and stream flow measurements, including information on low flows as well as peak discharges from which flood magnitudes, expected frequencies, stage-discharge relationships, flood profiles, velocities, and expected sustained average and low flows can be derived. Rainfall frequency-intensity-duration data should be collected and correlated to historic flood data and streamflow measurements. A physical inventory of the major stream channels will be necessary to determine existing flow capacities and should include data on culverts and bridges, including heights of underclearance, number and width of spans, and deck and guard rail elevations above stream bed; dams and encroachments, including heights and overflow sections; historic high water marks; and stream profiles and cross sections showing the main channel and its relationship to the natural flood plains. Data on damages from past floods will have to be collected including specific information on fatalities and personal injuries, if any, on property damage and the cause and nature of the damage and on areas of particularly high damage.
Streamflow and lake level information within the basin is incomplete and generally represents a short time range. The only long-term record of streamflow has been obtained at Wilmot where water levels have been read twice daily since 1939. A partial record of lake levels has been obtained at Browns Lake and Eagle Lake in Racine County and Silver Lake in Kenosha County. A network of surface water gaging devices, including one water-stage recorder, two staff gages, and eight crest gages, was established along the main stem of the Fox River in 1962 by the SEWRPC in cooperation with local municipalities in the basin. Because of the short period of record of most of the hydrographic stations in the basin, methods of synthesizing streamflow records will probably have to be utilized in the watershed planning study.

3. Ground Water Basic Data Studies

In view of the degree of dependency of the basin water users upon ground water, the geology, hydrology, and use of the ground water supplies must be established as a basis for projecting future water needs and foreseeing future water problems. Because most lake levels and practically all nonflood streamflow is maintained by ground water discharges, it is vitally necessary to determine the quantitative relationships between ground waters and surface waters. In order to accomplish these objectives, a ground water study should include determination of: the location of recharge areas; the hydraulics of aquifers within the basin, including permeability, transmissibility, and specific capacities; trends in ground water pumpage; trends in ground water levels as related to precipitation, pumpage, lake levels, streamflow and wetland existence; and ground water conditions, such as the Milwaukee and Chicago drawdown cones, which are limited, not by the Fox River drainage basin areas, but primarily by the boundaries of the larger artesian water basin comprising parts of southeastern Wisconsin and northeastern Illinois.

The ground water studies will be performed to the degree of intensity necessary in a basin-wide comprehensive approach, and the studies will not involve consideration of extremely localized problems which do not pertain to the surface drainage basin or the ground water reservoirs. Although the study will be based primarily upon existing data, considerable effort will have to be expended in the assembly of data from various sources. Field work will be required to verify and update existing data and to collect additional information. Additional well-drilling or extensive field testing of aquifers will not be required.
4. Water Quality Investigations

The value of water is tied directly to its quality. Because of differing economic and esthetic limitations, the concept of "suitable" water changes considerably from one type of use to another. It is, therefore, necessary to establish a generalized but comprehensive understanding of the quality of water in the Fox River basin in order to determine the suitability for all general kinds of use, including domestic and industrial water supply, agriculture, recreation, and the dilution and assimilation of wastes.

The SEWRPC is presently conducting a regional surface water quality study. This study includes the periodic collection and analysis of surface water from each of 28 stations on the Fox River and its major tributaries. The analyses include determination of standard parameters of physical, chemical, and bacteriological quality; and the results of this study will be available for application in the watershed planning work. In addition, certain state agencies have in the past performed pollution surveys of the Fox River and major tributaries, including physical, chemical, bacteriological, and biological analyses. The existing data should prove adequate for an assessment of the quality of stream water in the Fox River basin for watershed planning purposes.

A data collection program will, however, be required to determine the quality of lake waters. The Wisconsin Conservation Department has sampled and analyzed lake waters for certain selected physical and chemical characteristics, but additional data will be needed to determine the extent of pollution and fertilization of the basin's lakes.

Existing information should prove adequate for a summary appraisal of ground water quality.

5. Water Use Inventory

An investigation will be required of the various kinds of water use and of the intensities of water use, relating both to water quality and land use. Decennial (1950 and 1960) and current consumption rates will be established for ground water and surface water—and to the extent practicable, for precipitation—in terms of land use requirements. It will be necessary to establish not only the withdrawal demand for water, but also to determine, to the extent reasonable, the demand for water as a commodity in recreation, wildlife preservation, and in the dilution of wastes.

6. Soils Capabilities Investigation

Detailed soil capability information, including type and depth of major
horizons, depth to bedrock, depth to water table, permeability and run-off characteristics, susceptibility to erosion, suitability for reservoir sites, terraces and diversion structures, and for sewage disposal systems and foundations, will be required.

An operational soil capabilities study (standard soil survey) of the entire Region is presently being performed by the SEWRPC in cooperation with the S.C.S., and will be available for application in the watershed planning work.

7. Land Use Inventory

Since land use is an important determinant of water use and the time and rate at which storm water runoff occurs, a land use inventory of the watershed will be required as an integral part of the basin study. Such an inventory must determine the existing and proposed amount, type, intensity, and spatial distribution of all land use, including agricultural and recreational, and be adequate to establish historic patterns and trends. Generalized data should be included, in addition to use, on land and improvement values and for currently undeveloped land, physical characteristics of the site, valuation, and availability of utilities and community facilities. The inventory should also include data on existing local land use plans and development policies.

The results of the regional land use and of the local planning inventories being conducted by the SEWRPC will be available for the planning work.

Additional land use data will be available from such organizations as the Wisconsin Conservation Department and the Waukesha County Park and Planning Commission.

8. Economic and Population Base Study

It will be necessary to inventory and analyze the socio-economic factors which underlie the increasing demand for the basin's natural resources and which are accentuating the accompanying problems of flooding, falling ground water levels, and water pollution. Such a study will include the mapping of trends in population and economic activity and a correlation of these trends with the supply and suitability of the basin's resources.

Population and economic basic studies of the Region have been completed by SEWRPC and will be available for application in the watershed planning work.
9. Fish, Game, Park, and Recreation Study

A comprehensive approach to the problems of the watershed will require the collection of data on fish, game, park and other open space resources. Basic water-related surveys should include collection of data on species of fish, food chains, habitat analysis, basin configurations and shore types, and on habitat destruction. Any reservoir sites having recreational potential should be located. Data should be collected on the present use of water-related recreational facilities, such as beaches and launching ramps. Data on existing and potential game and other wildlife values will need to be collected and present habitat consisting of wetlands, waterways, lakes, and uplands inventoried. An inventory of existing and potential park and open space facilities will be required to appraise the recreational values of proposed changes in the flow regimen. A standard forest inventory and forest utilization and development study should also be included in a basic inventory of the resource base.

Results of the regional existing and potential park and open space inventory being conducted by the SEWRPC will be available for the planning work as will additional resource data from the Wisconsin Conservation Department.

10. Inventory of Public Utility Facilities

An inventory of the existing and proposed public utility facilities within the watershed, including sanitary sewerage, water supply, and urban storm water drainage facilities, together with existing and possible future service areas, will be required to determine urban land use capabilities and possible future effects upon the basin's hydrography.

An existing public utilities inventory has been completed by the SEWRPC and will be available for application in the watershed planning work.

11. Survey of Existing Water Law

A survey of the present legal framework of public and private water rights affecting general water management planning and project engineering design will be required. This should include an inventory of the existing powers and responsibilities of the various levels of government involved in resources management and the structure of public and private water rights which must necessarily be considered in the formulation of water management plans. Effort should be concentrated upon those aspects of common, statutory, and case law which apply specifically to the problems and potential developments in the Fox River basin.
C. PLANNING OPERATIONS

1. Technical Analysis of Water Resource Problems, Characteristics and Capabilities

A careful and detailed analysis of the hydrologic and hydraulic data collected will be required and should include identification of the extent of existing and probable future flood hazards by the preparation of overflow maps, an analysis of the character of the flooding—velocities, time of concentration, duration and causative factors. Noteworthy historic floods in the basin and in the Region surrounding the basin should be analyzed and related to the probable flood hazard and to rainfall intensity—duration—frequency data. Data on past flood damages will have to be analyzed and related to probable future flood frequencies and stages. General deterioration of the stream through erosion, sedimentation, debris and rubbish accumulation should be analyzed. Probable average and sustained low flow data should be analyzed and related to both water quality and potential consumption rates by various land use categories. The probable sustained yield of the ground water reservoirs should be established. The quality of the basin's lakes should be analyzed in terms of current and foreseeable impact of urbanization and recreation.

This work, of central importance to the planning operations, will have to be carried out as an integral part of the study program.

2. Analysis of Population Growth Trends and Resource Requirements

A careful and detailed analysis of the human activities within the watershed as these affect the water resources will be required. Such analyses should include an analysis of the economic and population structure and trends within the watershed and preparation of future population and economic growth levels; the establishment of future resource requirements based upon the estimated future population and economic growth levels; and the probable spatial distribution of these future requirements based upon an analysis of existing local development plans and policies and upon an analysis of soil and water capabilities and the capacities of public utility facilities to support such development. This phase of the work will be critical since the effect of future development and changing land uses are particularly important on smaller watersheds. Future development patterns will have to be analyzed to determine their effects upon demands for water recreation facilities; increasing municipal, industrial, and agricultural water supply and waste disposal needs; and continuing encroachment on flood plains, stream channels, and lake sides.

With respect to recreational resources, the fish, game, and other related
wildlife needs should be correlated with other land and water requirements within the basin; and the potential needs for the development of modification of natural units, such as stream habitat development, wetland restoration, scenic wayside units, dam sites for recreational reservoirs, and others, should be analyzed and liability-benefit ratios in the public interest established. A recreational demand analysis of the basin should consider the preservation of scenic areas; historic sites; natural fauna and flora; potential swimming, boating, fishing, hunting, picnicking, and camping areas in relation to the demand generated both within the Region and the Chicago metropolitan area to the south as well as to the resource base itself.

3. Adoption of Design Criteria and Standards

There are certain planning and engineering criteria and guides that are applicable in determining solutions to water resource problems that will have to be agreed upon by all parties concerned within the watershed if any cooperatively adopted plans and plan implementation measures are to be evolved.

The selection of floods--maximum known flood, standard project flood, regional flood, maximum probable flood, or design flood--to be used for regulatory purposes will have to be decided upon. This selection is one of public policy and is dependent on many nonengineering as well as engineering considerations and will require agreement among the various levels and units of government involved. Similarly, common design criteria, methods, and devices for channel improvements and reservoir

Man affects the flow regimes of a natural stream system, not only through changing land use, but also through changing stream channel capacities. Such changes may drastically affect historic flood plains. Basin-wide drainage and flood control measures must take into consideration existing drainage ways, such as this large canal in Racine County which drains the abandoned Hoge Air Force Base. Moreover, the elevations and capacities of farm waterways and urban storm drains must be adjusted to the ultimate design hydraulic grade line of the receiving channels if the drainage facilities are to function properly.
construction, as well as for urban storm water drainage systems relating to the main channel, will have to be agreed upon among the various agencies of government involved. Agreement must be reached on exact measures for augmenting low streamflow for the carriage and disposal of wastes. It may become necessary to agree on the most beneficial uses of lake waters or of certain zones within lakes. Pollution will have to be defined; and standards for surface and ground water quality, based upon the existing and potential water and land uses by channel reach, will have to be established and agreed upon. Again, such classification is dependent upon many nonengineering as well as engineering considerations and is, therefore, a matter of public law and policy. Finally, acceptable cost-benefit ratios for any public works improvements necessary to develop the water resources of the basin, such as channel improvements, protective levees and upstream dams and holding reservoirs, will have to be developed and agreed upon.

The adoption of such criteria and standards by all parties concerned is extremely important since these criteria and standards will be used as a basis for the determination of the adequacy of existing water-related facilities, as a basis for plan preparation and as a basis for determining the relative urgency among various needs. The consideration and adoption of any and all of these and other criteria and standards will, therefore, have to be preceded by appropriate studies.

All levels and agencies of government concerned will have to participate in this phase of the planning work, and it will be particularly important that the criteria and standards adopted meet the requirements of such Federal agencies as the Soil Conservation Service and the Corps of Engineers which might be asked to participate in the plan implementation.


The ultimate purpose of the proposed work will be the preparation and presentation of a number of feasible alternative watershed plans for public evaluation and choice of a final plan for implementation. Watershed plans may include proposals for erosion and sedimentation control, flood protection, urban and rural drainage facilities, streamflow augmentation, water quality protection, pollution abatement, conservation and recreation facilities, flood plain protection and stream channel stabilization and beautification, ground water recharge and conservation, land use zoning, water management facilities, and the improvement and maintenance of fish and wildlife habitat. Each alternate plan must be quantitatively tested to establish the ability of the flood control-channel and sewerage facilities to carry their respective loadings within adopted standards.
Any single plan for specific water management facilities and engineering structures carries with it far-reaching decisions and effects on general land and water use patterns, allocation of resources, public investment policies, and broad community "benefits" and "costs." Decisions regarding such broad matters should not be made by technical planners or engineers alone. Such decisions properly belong in the realm of public policy-making through officials and citizens utilizing democratic processes.

If, therefore, an adopted watershed plan is to represent and include more than merely technical planning and engineering decisions, then the related physical, economic, social, and legal effects of alternative watershed plans must be analyzed and presented in understandable form to watershed officials and citizens for their study and evaluation. This should be done through a preliminary report describing the correlative effects and broad "benefits" and "costs" of alternative plans.

A preliminary report adequate for plan selection and public policy-making purposes should include, in addition to feasible alternative plans, statements providing information on the following important points:

a. The purpose of the watershed program and the resultant preliminary report as an instrument for public decision making.

b. Clear statements of watershed problems revealed by surveys and studies.

c. The role and effects of public capital investment and resource allocation decisions in watershed development.

d. Positive and negative general effects of watershed growth on variables, such as resource use rates, resource qualities, public overhead costs, environmental amenities, and required levels of public controls.

e. Description of the general structure of water law as a design and decision-making framework and consideration of how it relates to the plan.

f. Description of cost-benefit concepts used in evaluating the watershed plans.

g. Critical decisions that need to be made in the watershed in the light of the total problem.

5. Selection of Final Plan
One plan should be chosen, after public hearings, as the final plan for the long-range development of the watershed and, through cooperative adoption by all levels and agencies of government involved, become the basic reference for future urban development patterns, soil and water management, public investment in public works, and detailed drainage and sewerage design within the watershed. The published report should include a clear graphic and written description of the general plan and the reasons for its selection.

6. Administrative - Financial Analysis

An administrative and financial study will be required to suggest practical organizational and financial arrangements under which the selected watershed plan and its related water management structures can be constructed and operated. The study should analyze the fiscal capacities of local units of government, identify Federal and State financial and technical assistance for watershed projects, and recommend an organizational structure and financial procedures for implementation of the watershed plan.

7. Preparation of Precise Plans and Plan Effectuation Devices

The primary objective of the planning studies is to motivate specific action toward the solution of the most pressing watershed problems. While a plan setting forth the general location and characteristics of proposed water management facilities is necessary as a statement of mutually agreed upon long-range objectives, it is, however, quite ineffective as a sound basis for plan implementation through land reservation and for extending technical planning assistance and advice to local governments.

With respect to the drainage and flood control problem, the application of such flood abatement devices as flood plain regulation, flood forecasting, temporary and permanent evacuation, open space reservation, flood proofing, urban redevelopment, warning signs, tax adjustments, and development policies as well as the proper design of local storm drainage facilities, all require the preparation of precise and definitive plans. These precise plans should set forth the ultimate development of each major stream channel of regional significance so that both present and possible future floodways and flood plains can be delineated and flood hazard maps prepared. In the case of drainage and flood control facilities, such plans should set forth proposals as to centerline location of channel improvements; location and extent of reservoir sites, floodways and restrictive zones; waterway openings required; channel bottom elevations and elevations of hydraulic gradients at low, average, and peak discharge rates.
If ground water recharge facilities are recommended in the plan, the sites, design features, and methods of operation must be carefully detailed. The proposal of a well-spacing and management program to enable maximum sustained withdrawals of ground water would require also that precise details be spelled out. As pollution generally has a traceable source, suggestions for remedial measures should include plans or devices of sufficient precision to enable cost determinations.

Finally, upland soil and water conservation measures necessary for the protection and efficient management of the land and water resources above any proposed improvement works shall be recommended in sufficient detail to provide a sound basis for conservation action programs; and plans shall be prepared for each water area, recommending the best land and water use in terms of the public interest and the protection of the resource base.

D. TIME SCHEDULE

An estimated time schedule for the accomplishment of the major elements of the study is shown on Figure 3, page 39. This schedule is subject to revision upon detailed study design but represents the best estimate possible in the absence of such a design. Study organization and cost estimates are predicated upon the recommended time schedule, which identifies all of the major work elements.
TIMING OF MAJOR WORK ELEMENTS OF THE PLANNING PROGRAM FOR THE FOX RIVER WATERSHED

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