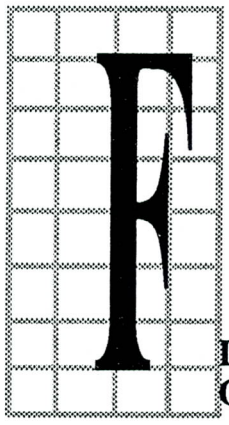

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

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Redlands, California 92373

Geographic Information System
CONCEPTUAL DESIGN

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Flood Control District of Maricopa County

Geographic Information System
Conceptual Design

March 1991

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Figures and Tables

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Appendixes

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Introduction

1.0

1.1 Preface

This report presents a conceptual design for the Geographic Information System of the Maricopa County Flood Control District. It represents the final task in a ten step process focused on charting the four components of the District's GIS: database, user applications, organization/management, and hardware/software. Prior to and during this conceptual design process, the District made considerable progress in accomplishing goals related to organization/management and hardware/software purchase and installation. Thus, while providing an overall framework and context for the District's GIS, the conceptual design highlights database and applications components to be addressed by the District.

1.2 Contents

This report is organized into nine sections including this Introduction. They are:

- **Section 2, Project Methodology:** outlines the activities that make up the user needs assessment process, and describes the methodology applied to the data inventory and analysis efforts.

- **Section 3, User Needs Assessment:** describes the overall organization of the District and the principal responsibilities and GIS-related tasks performed by each participating division.

- **Section 4, Data Inventory and Analysis:** provides a description of the data items inventoried, classifies these data according to category, identifies sources of the data, and summarizes data use by division and branch.

- **Section 5, Conceptual GIS Database Design:** discusses the geographic database model, then builds from this model to define the components and layers of the District GIS database. The section also discusses methods for data collection, automation, and maintenance.

- **Section 6, GIS Application Concepts:** describes a set of operational views of the GIS, as it will be employed by various types of system users within the District. Each application is defined in terms of the functions it will perform, the data it will use and generate, the types of map and report products it will produce, and the organizations which will use it.

- **Section 7, Existing and Planned GIS Hardware/ Software System:** describes the District's current and anticipated hardware/software environment to support the proposed database and application concepts.

- **Section 8, System Management, Staffing, and Training Recommendations:** addresses other components which must be considered in developing an operational geographic information system for the District. The section discusses the staff positions, training requirements, and organizational structure for system operation.

- **Section 9, Implementation Strategy:** presents an implementation strategy which can be used by the District to initially organize and guide its GIS development and to direct ongoing management and development of the system. The strategy addresses the GIS components of database, applications,

and systems in terms of the tasks required to implement the components, their priorities and schedule, and associated cost estimates.

The report also contains appendixes which provide supplemental information. Appendix A provides a summary of the user needs asssessment interviews. Appendix B provides a data assessment form for each data item collected from the District during the interview process.

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Project Methodology

2.0

2.1 Project Orientation and Seminar

A seminar on GIS technology and the conceptual design process was conducted with the Flood Control District on March 27, 1990. The purpose of the seminar was to introduce participating District personnel to basic GIS concepts, show examples of GIS applications in local government, and provide an orientation to the conceptual design process. The topics addressed in the seminar included

- Basic concepts of geographic information management;
- Potential benefits to the District of increased efficiency in operations and public services from a geographic information system;
- Capabilities of the ARC/INFO geographic information system; and
- The needs assessment process and methods for data collection, interviewing, data analysis, and conceptual design methodology.

2.2 User Needs Interviews

Interviews were conducted between March 26 and 29, 1990, with representatives from separate branches of six District divisions including Administration, Construction and Operations, Engineering, Hydrology, Land Management, and Planning and Project Management. During these interviews, the principal functions and tasks of each branch were identified. Interviewees were asked to describe the detailed steps and procedures for performing each task, including the data used and produced during the task and interactions with other branches, divisions, or agencies. Potential applications of the GIS to support the tasks were discussed. Additionally, samples of the maps and data used or produced by the participating branches were collected. A summary of the interviews is presented in Appendix A.

2.3 Data Inventory and Analysis

The geographic data items collected during the interview process were inventoried and categorized for further analysis. This inventory classified the data according to its database category, geographic theme, format, scale, and extent of geographic coverage. The common name of the data, responsible division and branch, data source, basemap, and other pertinent characteristics were also recorded. A complete description of the data inventory and analysis is presented in Section 4.

2.4 GIS Database Design

The GIS database concept for the District builds upon a geographic database model in which data are organized into various basic types (basemap control, land records, infrastructure/transportation, area, and environmental). Data samples which were collected and analyzed in Tasks 2, 3, and 4 are organized according to this data model, then subcategorized into map layers and associated attribute data. Relationships between map layers and the various attribute data which further describe them are identified. For each type of data, methods for data collection, automation, and maintenance are then described.

2.5 GIS Application Concepts

The development of GIS application concepts involves interpreting the step-by-step functions of various prospective GIS users, then coupling functions involving similar types of procedures to define how sets of users will interact with the GIS database and software to perform analyses and/or create products. For each group of related functions, a flow diagram of procedural operations is prepared, indicating when and what types of data may be retrieved, what type or types of software procedures will be invoked, what new data or products are created, and when and how updates to the GIS database are carried out. Relationships between and among modules for data are also considered in the application module concepts.

Each module is intended to provide the conceptual basis for further design and programming of the applications for the respective groupings of functions and tasks.

2.6 Other Design Issues and GIS Implementation Plan

Design issues and options are discussed relevant to developing an appropriate organizational structure for system development and operation. Considerations for establishing and maintaining the suitable hardware/software system for system operation are also addressed. Finally, an implementation strategy is outlined, which takes into consideration the considerable progress already made by the District in the areas of organization/management and system development. Steps remaining to be completed are addressed as a series of work tasks, with recommendations made for who should be responsible to carry out these tasks.

2.7 Reporting and Review Cycle

The results of the above activities were initially documented in a series of three Technical Memoranda. The first addressed the results of the user needs assessment and data analysis, the second presented data base, applications, and systems design concepts, and the third introduced an implementation strategy. Each memorandum was submitted to the District for review. Comments received were incorporated into this final document.

User Needs Assessment

3.0

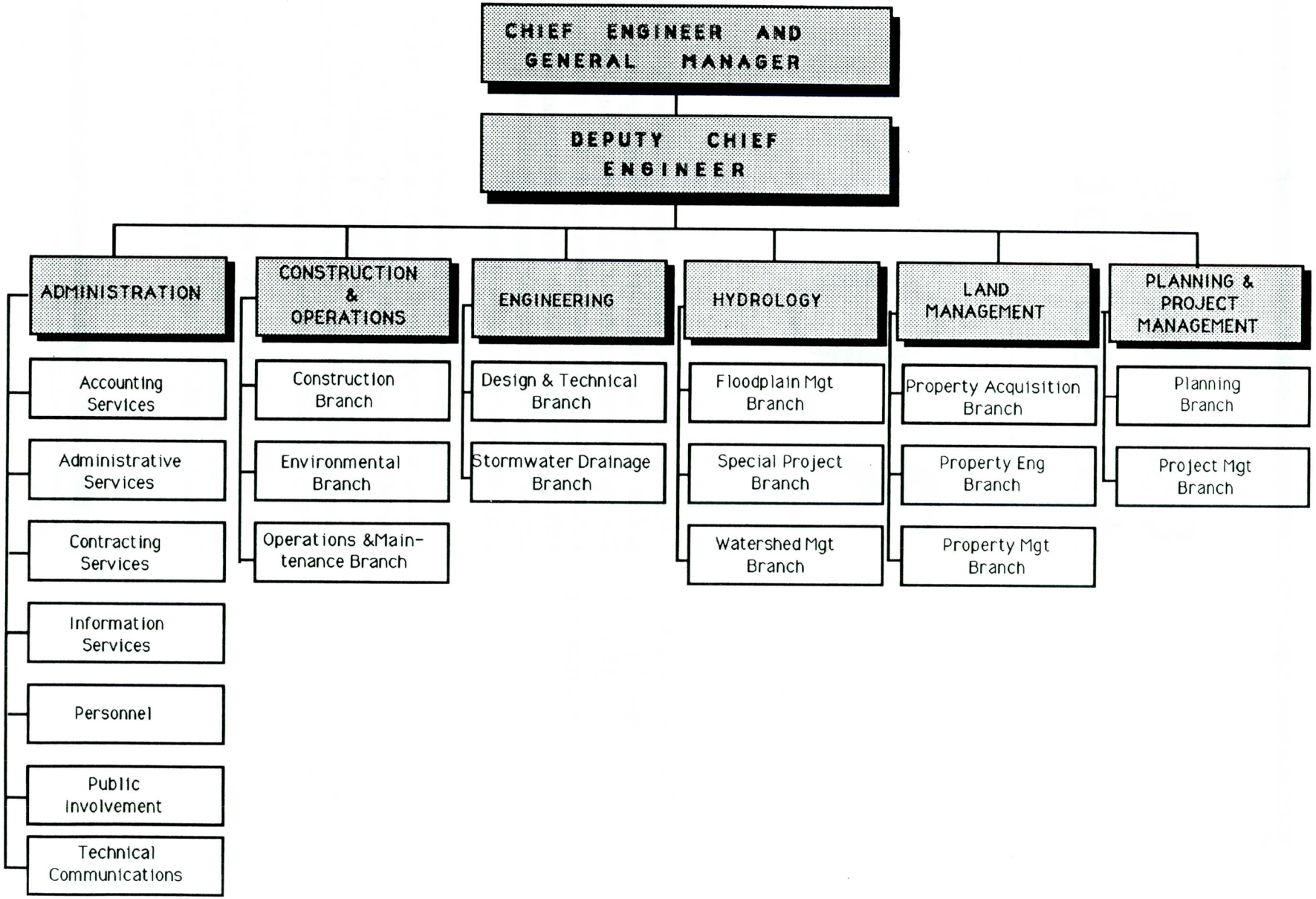
3.1 Overview of Flood Control District Organization

The Flood Control District is principally responsible for identifying and mitigating floodplain hazards and drainage problems in Maricopa County. The main functions of the District include the planning, design, construction, and maintenance of flood control projects. Other major responsibilities involve hydrological analyses of areas of concern within the District and acquisition and management of properties affected by District projects.

Cooperation between divisions and branches of the District is required for successful completion of District projects. The District is organized into six divisions, each composed of supporting branches. The Division Chiefs report to the Chief Engineer and General Manager, and to the Deputy Chief Engineer. A current organizational chart for the District is shown in **Figure 3-1**.

Close coordination between the Flood Control District and federal, state, and local agencies is required for many of the District's basic functions. The principal agencies that the District exchanges

Figure 3-1
Maricopa County
Flood Control District
Organization Chart



information with and which could potentially contribute data to the GIS include

- Arizona Department of Transportation
- Arizona Game and Fish Department
- City of Phoenix
- County Assessor
- County Planning and Zoning Department
- Maricopa County Highway Department
- Soil Conservation Service
- U.S Army Corps of Engineers
- Various Consulting and Engineering Companies

3.2 Functions and GIS-Related Tasks of the Divisions

This section summarizes the structure and main functions of each of the Flood Control District divisions. The specific tasks that the divisions perform which could potentially be supported by the GIS are also defined and described. These task descriptions were developed as a result of the user needs interview process and are not intended to be a comprehensive inventory of all work performed by a particular division.

Administration Division

The Administration Division is organized into seven branches, of which only the Information Systems Branch/GIS Section was interviewed in the user needs assessment. The Information Systems Branch is responsible for managing and operating all computer systems owned by the District. The Branch coordinates all GIS, computerized drafting, programming, and computer system support activities within the District. The GIS Section performs all GIS-related functions for the District.

Division tasks that could potentially be supported by the GIS:

1. **Map floodplain delineations.** The GIS Section maps floodplain delineations to support the Hydrology Division. This includes drafting cross-section lines onto topographic maps, drafting floodplain boundaries that result from the output of the HEC-2 model, and digitizing those boundaries using AutoCAD.

The resulting digital maps are overlaid with the 1"=1200' zoning basemap for use at the public counters.

2. **Map land ownership and project boundaries.** This task is performed to support the Land Management Division which provides the GIS Section with legal description maps for individual parcels on separate sheets of paper. The GIS Section edgematches the information and prepares a digital map of the entire project area using AutoCAD.

3. **Prepare maps for public information.** This task is performed to support the Public Information Branch of the Administration Division. The maps are produced using AutoCAD or Intergraph and may include location maps and various types of flyers, brochures, and other presentation graphics.

4. **Draft schematic diagrams for flow-path models.** This task is performed to support the Hydrology Division. The GIS Section drafts subbasins and concentration point symbols showing the connectivity of all elements in the flow model.

5. **Map soils.** This task is performed to support the Hydrology Division. Watershed boundaries are overlaid with soil maps to create Watershed Soil Maps.

Construction and Operations Division

The Construction and Operations Division is organized into three branches: Construction, Environmental, and Operations and Maintenance. The Division is responsible for all aspects of the construction of District projects, including construction management, engineering inspections, surveying, and operation and maintenance of all District facilities and property. In addition, the Division is responsible for erosion control, aesthetic treatment of District properties through vegetative means, and hazardous materials monitoring and maintenance.

Division tasks that could potentially be supported by the GIS:

1. **Maintain District projects and facilities,** including dams, bridges, fences, underground facilities, electrical lines, and vegetation.

2. **Produce maps required by NPDES** for industrial and stormwater drainage. Maps include all tributaries of U.S. waters, drainage basins, location of outfalls, and monitoring locations.

3. **Maintain vegetation, wildlife, and soils inventory** for all project areas. This task is part of the Division's general function of maintaining vegetative erosion control improvements to District properties.

4. **Conduct environmental review** of District projects to identify potential impacts on Superfund sites, landfill sites, archaeological sites, and endangered/threatened species.

Engineering Division

The Engineering Division is organized into two branches: Design and Technical Review, and Stormwater Drainage. The Stormwater Drainage Branch was interviewed to assess data requirements and potential GIS applications. The Stormwater Drainage Branch is responsible for development review, administration of and compliance with drainage regulations, and coordination with other agencies regarding drainage.

Division tasks that could potentially be supported by the GIS:

1. **Review permit applications** for compliance with drainage regulations. This task includes reviewing both conceptual and detailed site plans submitted by the applicant, inspecting sites (if necessary), and approving or denying a permit.

2. **Issue drainage clearances.**

3. **Inspect sites for compliance** with drainage regulations.

4. **Respond to drainage inquiries** and complaints.

Hydrology Division

The Hydrology Division is organized into three branches: Floodplain Management, Special Projects, and Watershed Management. The main responsibilities of the Division are to conduct hydrology projects and coordinate efforts with other District divisions and outside agencies, identify and quantify flood hazards, manage the real-time flood monitoring system, create watershed modeling scenarios for project development, and provide District project support.

Division tasks that could potentially be supported by the GIS:

1. **Delineate floodplains.** This task includes flying aerial photography of the study area and generating a contour map through photogrammetric means, generating floodplain lines using the HEC-2 model, and drafting floodplain boundaries onto the Floodplain Zoning Maps. The data are distributed to the Federal Emergency Management Administration (FEMA) for use in compiling the Flood Insurance Rate Maps (FIRM).

2. **Regulate floodplain development.** The Floodplain Management Branch issues Floodplain Use Permits and inspects construction sites for compliance with floodplain use regulations.

3. **Provide project design support** to the Engineering Division.

4. **Manage the real-time flood warning system.** The Special Projects Branch coordinates with Civil Defense for emergency response and evacuations, dispatches crews to handle problems in the field, and coordinates with other jurisdictions on flood-related matters. The Branch is currently using a PC-based system with ALERT software to monitor flood levels in real time at gauging stations. Part of this system is a three-dimensional physical model of topography and drainage features equipped with light bulbs to alert staff when rainfall is beginning at any of the gauging stations.

5. **Prepare dam break analysis.** The Special Projects Branch uses the DAMBRK program to model and predict the results of dam breaks and prepare dam break inundation maps.

6. **Review hydrology projects.** Hydrology projects are reviewed by Special Projects for special considerations regarding flood hazards.

7. **Perform hydrologic and hydraulic modeling studies** to identify flood hazards using watershed, soils, rainfall, land use, topographic, and vegetation data. The HEC-1 model is used to perform surface-water modeling.

8. **Provide project support** to the Planning and Project Management Division on hydrology aspects of Area Drainage Master Studies (ADMS). This includes providing hydrologic data for cost/benefit studies of District projects.

9. **Review projects** of other jurisdictions to collect data on existing and proposed development.

Land Management Division

The Land Management Division is organized into three branches: Property Acquisition, Property Engineering, and Property Management. The Division is responsible for the acquisition and management of District properties required for flood control projects. This includes identification of properties for acquisition; coordination of agreements with contractors, property owners, and other agencies; and management of real property legal issues.

Division tasks that could potentially be supported by the GIS:

1. **Map project boundaries.** Project limits are obtained from the Engineering Division.

2. **Identify parcels** affected by a project. This is done as a preliminary step in determining the ownership of affected parcels and the amount of land that must be acquired by the District.

3. **Prepare detailed maps** and legal descriptions of individual parcels affected by a project based on preliminary reconnaissance.

4. **Determine land acquisition needs.** The final determination is based on an accurate field survey.

5. **Manage District properties.** This includes maintaining basic information about properties, managing lease agreements, and disposing of improvements.

Planning and Project Management Division

The Planning and Project Management Division is organized into two branches: Planning, and Project Management. The primary responsibilities of the Division are to plan, implement, and manage local and federal agency flood control projects.

Division tasks that could potentially be supported by the GIS:

1. **Identify flood control projects** for the District. This includes flooding and drainage problems associated with development or proposed development. Projects are prioritized based on a comprehensive analysis of the economic impacts of a project.

2. **Compile and analyze data** to support Area Drainage Master Studies (ADMS).

3. **Coordinate** with various federal, state, and local agencies on flood control projects.

4. **Compile background data** for use in project implementation. This includes maps of all existing utility lines, easements, rights-of-way, and so forth, that are potential obstacles to construction. Most of this information is provided by outside agencies and utility companies.

5. **Analyze information** collected from other agencies to determine the locations of existing facilities and the impacts they will have on project planning and implementation.

6. **Manage and store project records.** Project records include construction drawings, maps, reports, legal descriptions, and calculations.

Data Inventory and Analysis

4.0

4.1 Overview

During the user interviews, samples of maps and data used or produced by the interviewees were collected, in order to get an idea of the types of data that are currently being used by the District. A total of sixty (60) data samples were collected, inventoried, and analyzed as part of the user needs assessment. These data do not represent a comprehensive inventory of all District data; only the data samples presented to or discussed with ESRI® staff during the user interviews are included here. However, the inventory does represent the primary geographic data sources that could potentially be used with or included in the District's GIS.

The data were classified according to the general data category they belong to, the primary geographic features they relate to, and other characteristics such as format, source agency, geographic coverage, frequency of use, and so forth. A form was completed for each data sample and entered into a computer database for analysis. The

information contained in the following subsections summarizes the results of the data inventory and analysis carried out under Task 3 of the GIS Conceptual Design Study.

4.2 Data Categories

In order to understand the full range of data requirements identified in the user needs assessment, it is useful to conceptualize the data elements in aggregate terms (i.e., as *categories* of data). For the purposes of this study, the data identified during the interview process can be described as belonging to one of the following five general categories: 1) basemap, 2) land records, 3) infrastructure, 4) administrative areas, and 5) environmental. These categories are further broken down into twenty more specific *data sets* which describe the theme or geographic feature to which the data relate. Examples of two data sets that belong to the "environmental" category are "floodplains" and "soils." Data sets may consist of both map and tabular data elements and are used as the basis for analyzing the data requirements of District GIS users. The general categories of data and corresponding data sets are described below.

Basemap

Data in the basemap category provide geodetic control and spatial referencing for all other map data in the GIS. Basemap data include benchmarks, survey control points, and commonly used basemap features such as topographic contours, buildings, and cultural features. The basemap category includes the following three data sets:

Geodetic Control includes survey control points and monumentation that is used to provide spatial referencing on maps used by the District. The township/range/section grid system is also considered part of the geodetic control data set.

Topography includes topographic contours, elevation points, and slope categories.

Planimetric Features includes building footprints, structures, parking areas, improvements, and miscellaneous cultural features.

Land Records

The land records category includes all data related to land parcels, property ownership, assessor's data, and other parcel-specific data records such as permit applications. This category consists of the following three data sets:

Property Ownership data include parcel boundaries, easements, rights-of-way, survey data, assessor's data, legal descriptions, title reports, etc. The property ownership data set is one of the most important and commonly used data sets in the District.

Project Boundaries data include the location or boundaries of District projects and facilities, and project-specific information contained in project files such as inspection reports, cost information, and so forth.

Permits/Applications include drainage permit applications, floodplain use permits, and environmental permit sites. Related data records contained in permit files or tabular databases are also part of this data set.

Infrastructure

The infrastructure category includes all data related to highways, roads, streets, utility lines, and District facilities. This category includes the following two data sets:

Roads/Streets data include general highway maps used for reference, detailed street maps, and address range information which is associated with street segments. Road-related facilities, such as traffic lights, are also included in this data set.

Facilities/Utilities data include maps and maintenance records related to water, sewer, gas, telephone, electrical and cable TV lines, and related facilities. This type of information is often maintained by outside agencies or utility companies. This data set also includes maps and records related to District facilities and structures including dams, bridges, fences, and underground facilities.

Administrative Areas

This category includes data related to administrative zones which are used to delineate political jurisdictions or planning areas. Administrative areas map data may include political boundaries, utility service districts, statistical areas, and zoning boundaries. The following two data sets are required by the District:

Political Boundaries include Federal- and State-owned lands, and municipal boundaries. Up-to-date information regarding boundaries of incorporated areas and annexed areas is very important to District functions for determining jurisdictional responsibilities.

Zoning information includes maps, zoning classifications, and regulations regarding the permitted use of individual properties. Zoning is used to determine the future land use and development potential of an area for drainage studies.

Environmental

The environmental category includes the greatest number of data sets used by the District. Environmental data include information related to the natural and cultural environments such as hydrology, soils, land use/land cover, hazardous waste sites, and archaeological sites. This category contains the following ten data sets:

Hydrology/Drainage includes data related to rivers, streams, drainage features, watersheds, and drainage basins. This includes the flow paths, concentration points, and discharge data used in hydrological modeling.

Floodplains include maps and data related to the flood channel, floodway line, SPF floodplain limits, 100- and 500-year floodplains, and FIRM floodplains.

Rainfall includes rainfall data in the form of isopluvial maps and related tabular data.

Soils data include soil classification maps, hydrologic soil groups, soil codes, and descriptions.

Land Use/Land Cover data include existing land use, land cover, and vegetation. Land use/land cover data are used to determine the

extent of existing development and types of land cover for surface water modeling.

Wildlife includes maps and data related to native species of wildlife and threatened/endangered species.

Monitoring Stations include the locations of stream gauges and environmental monitoring points. Historical monitoring data maintained in tabular databases are also included in this data set.

Waste Discharge Points include outfall locations, industrial sites, dairy and agricultural sites, and irrigation canal discharge points.

Landfills/Hazardous Waste Sites include maps and data related to landfills and waste facilities.

Historic/Archaeological Sites include historic buildings, structures, and Native American sites.

4.3 Data Requirements by Division/Branch

Data requirements identified by individuals during the user interviews include both information used routinely in performance of tasks and applications, as well as information not currently available or in usable form which is desired for project work. The level of detail provided about individual data sources, both existing and desired, varied considerably during the interview process. In some cases, information on data used/desired was provided at a detailed level, but in most cases, data sources and needs were described in general terms. For this reason, the data requirements of users are summarized by the *data sets* defined above.

The specific data sets required by individual divisions and branches of the District are shown as a matrix in **Figure 4-1**. This matrix is useful for summarizing the data needs of each branch, and also for determining which data sets are most commonly used by the District as a whole. This information should be used to prioritize the development of data sets for inclusion in the District GIS.

Figure 4-1

Data Required by Division/Branch

	Basemap			Land Records			Infra-structure		Admin-istrative Areas		Environmental									
	Geodetic Control	Topography	Planimetric Features	Property Ownership	Project Boundaries	Permits/Applications	Roads/Streets	Facilities/Utilities	Political Boundaries	Zoning	Hydrology/Drainage	Floodplains	Rainfall	Soils	Land Use/Land Cover	Wildlife	Monitoring Stations	Waste Discharge Points	Landfills/Hazardous Waste Sites	Historic/Archeological Sites
Administration Division																				
GIS Section	●	●	●	●	●		●	●	●	●	●	●		●					●	
Construction and Operations Division																				
Environmental Branch	●					●	●		●		●		●	●	●	●	●	●	●	●
Operations and Maintenance Branch	●			●	●		●	●												
Engineering Division																				
Stormwater Drainage Branch	●	●		●		●	●		●	●	●	●	●	●	●					
Hydrology Division																				
Floodplain Management Branch	●	●		●		●	●				●	●			●				●	
Special Projects Branch	●	●	●				●				●	●	●	●	●		●			
Watershed Management Branch	●	●	●	●		●	●			●	●	●	●	●	●					
Land Management Division																				
Property Engineering Branch	●			●	●		●		●		●	●			●					
Planning and Project Management Div.																				
Planning Branch	●	●	●	●	●		●				●	●	●	●	●					
Project Management Branch	●	●	●	●	●		●	●							●					

Fig. 4-1 Div./Branch

As can be seen in the matrix, some data sets are required by most or all of the District branches, such as geodetic control, topography, property ownership, roads/streets, hydrology/drainage, floodplains, and land use/land cover. These universal data sets should be considered priority layers for development in the GIS. Other data sets are required by only a few District branches, such as wildlife, monitoring stations, waste discharge points, and historic/ archaeological sites. The District should carefully evaluate which data sets will provide the most immediate benefits and utility when planning schedules and resources for database development.

4.4 Data Characteristics

In order to determine the suitability of data sources for use in developing layers for the District GIS, selected characteristics of the data sources were recorded in the data inventory. These characteristics provide useful information about the data source such as the common name used to describe it, the general data category it belongs to, the primary geographic feature it relates to, the source agency, format, basemap used, scale, and geographic coverage. The utility of each of these characteristics for evaluating the data sources is described below.

Name: Common name or title of data source given by interviewee. A particular map or data source is often called different names within the same organization. One goal of the data inventory is to standardize the name used so that all parties are talking about the same data source.

Category: Data sources are classified according to the general data categories described in Section 4.1. These categories are useful for conceptually organizing the data for the purpose of database design.

Data Set: The data set is the primary geographic feature or theme that the data source relates to, such as "floodplains" or "property ownership." Twenty data sets used by the District were identified during the user needs assessment, and are described in Section 4.1. Data sets are used as a basis for defining the layers that will be included in the database design.

Source: Source refers to the originating source of the data, including both in-house divisions and outside agencies. Knowledge about the map source (i.e., what are the original materials from which the map is compiled) helps define map accuracy and reliability.

Format: Data sources are classified according to the physical formats they are in. The current format of data is essential for planning automation procedures. Data formats include maps, imagery (e.g., aerial photographs), plans (e.g., detailed construction drawings), tabular data, graphs, schematic diagrams, and text.

Scale: Map scale provides an indication of the resolution and level of detail of a map. The scale of input is a very important consideration in the physical design of data layers for automation in a GIS.

Geographic Coverage: Identifies the geographic extent of coverage of a data source (e.g., the entire County, a watershed, or a project location). Geographic coverage provides information on the availability and completeness of data for a given area.

Data source characteristics are summarized in **Tables 4-1** through **4-5**. Individual data sources are listed in separate tables by general data category, and are sorted alphabetically by the primary data set to which each source is related.

4.5 Data Inventory Evaluation and Conclusions

The following summary observations can be made about the Flood Control District data inventory:

- A total of sixty (60) data samples were inventoried and analyzed during the user needs assessment. The first step was to classify the samples according to five general data *categories* which describe the broad class of geographic features to which the data relate. These categories are basemap, land records, infrastructure, administrative areas, and environmental. Three (3) of the data sources in the inventory were categorized as basemap data, fourteen (14) as land records, seventeen (17) as infrastructure, two (2) as administrative areas, and twenty-four (24) as

Table 4-1
BASEMAP CATEGORY

NAME	DATA SET	SOURCE	FORMAT	BASE MAP	SCALE	GEOGRAPHIC COVERAGE
Aerial Photography	Planimetric Features	Consultant	Imagery	N/A	Varies	Project areas or as contracted
Topographic Map	Topography	City of Phoenix	Map	Quarter Section Map	1"=100'	City of Phoenix
USGS 7.5' Quad Sheet	Topography	U.S. Geological Survey (USGS)	Map	N/A	1:24000	United States

Table 4-2
LAND RECORDS CATEGORY

NAME	DATA SET	SOURCE	FORMAT	BASE MAP	SCALE	GEOGRAPHIC COVERAGE
Strip Map	Property Ownership	Land Management Division	Map	Unknown	Varies	Project areas
Property Location Map	Property Ownership	Land Management Division	Map	N/A	varies (1"=1750',	Project areas
Project Display Map	Project Boundaries	Land Management Division	Map	Aerial photos	Varies	Project areas
Section Plat Map	Property Ownership	County Assessor's Office	Map	Quarter Section Map	Varies (1"=400')	Project areas
Parcel Legal Description Map	Property Ownership	County Assessor's Office	Map	N/A	1"=100', 1"=200'	Project areas
Project Index Map	Project Boundaries	Land Management Division	Map	N/A	Varies (1"=8000')	Project areas
Plat Map	Property Ownership	Developer/Consultant	Map	N/A	Varies (1"=400')	Developed areas
Project Location Map	Project Boundaries	Planning and Project Management Division	Map	Street map	Varies	Project areas
Permit Application Sites	Permits/Applications	Hydrology Division	Map	Phoenix Metropolitan	Approx. 1"=4 mile	Maricopa County
Quarter Section Map	Property Ownership	City of Phoenix Engineering Department	Map	N/A	1"=100'	City of Phoenix
Brochures and Publications	Project Boundaries	Administration Division/Public Involvement Branch	Map/Text	Street Map	Varies	Project areas
Detail Plan	Property Ownership	Land Management Division	Plan	Corps of Engineers Detail Plan	Varies (1"=40')	Corps of Engineers project areas
Floodplain Use Permit/Variance Applications	Permits/Applications	Hydrology Division	Tabular	N/A	N/A	Maricopa County
Assessor's Data	Property Ownership	County Assessor's Office	Tabular	N/A	N/A	Maricopa County

Table 4-3
INFRASTRUCTURE CATEGORY

NAME	DATA SET	SOURCE	FORMAT	BASE MAP	SCALE	GEOGRAPHIC COVERAGE
Blue Stake Reference Maps	Facilities/Utilities	Engineering Division	Map	Quarter Section Map	1"=100'	Project areas
Storm Drain Map	Facilities/Utilities	City of Phoenix	Map	Quarter Section Map	1"=100'	Project areas
Phoenix Metropolitan Street Atlas	Roads/Streets	Wide World of Maps	Map	N/A	Approx. 1"=4 miles	Phoenix metropolitan area
Maricopa County Highway Map 1990	Roads/Streets	Maricopa County Highway Department	Map	N/A	Approx. 1"=4 mile	Maricopa County
Buried Facility Map	Facilities/Utilities	Mountain Bell	Map	Parcel basemap	1"=100'	Maricopa County
Highway Construction Map	Roads/Streets	Planning and Project Management Division	Map	Topographic map	1"=400'	Project areas
General Highway Map of Maricopa County	Roads/Streets	Arizona DOT	Map	Arizona DOT	Approx. 1"=2 miles	Maricopa County
Electric Distribution Map	Facilities/Utilities	Arizona Public Service Company	Map	Parcel basemap	1"=100'	Maricopa County
Water Distribution Map	Facilities/Utilities	City of Phoenix Water & Sewers Department	Map	Quarter Section Map	1"=100'	City of Phoenix
Cable Television System Map	Facilities/Utilities	American Cable Television, Inc.	Map	Parcel basemap	1"=100'	Cable TV service area
Gas Distribution Map	Facilities/Utilities	Arizona Public Service Company	Map	Parcel basemap	1"=100'	Gas service area
Sewer Facilities Map	Facilities/Utilities	City of Phoenix Water & Sewers Department	Map	N/A	1"=100'	City of Phoenix
Construction Plans	Facilities/Utilities	Engineering Division	Plan	N/A	Large	Project areas
Plan and Profile	Facilities/Utilities	City of Phoenix	Plan	N/A	Varies	Project areas
Grading and Drainage Plan	Facilities/Utilities	Developer/Consultant	Plan	N/A	Varies (1"=40')	Project areas
Highway Plan and Profile	Roads/Streets	Arizona DOT	Plan	Aerial photos	1"=400' horizontal	Project areas
Operations and Maintenance Responsibilities Chart	Facilities/Utilities	Construction and Operations Division	Tabular	N/A	N/A	Maricopa County

Table 4-4
ADMINISTRATIVE AREA CATEGORY

NAME	DATA SET	SOURCE	FORMAT	BASE MAP	SCALE	GEOGRAPHIC COVERAGE
City Limits Sheet	Political Boundaries	County Highway Department	Map	County Highway Map	?	Maricopa County
Zoning Map	Zoning	County Department of Planning and Zoning	Map	County Parcel Map	Medium	Developed areas

Table 4-5
ENVIRONMENTAL CATEGORY

NAME	DATA SET	SOURCE	FORMAT	BASE MAP	SCALE	GEOGRAPHIC COVERAGE
Flood Hydrograph	Hydrology/Drainage	Hydrology Division	Graph	N/A	N/A	Maricopa County
Flood Profile	Floodplains	Hydrology Division	Graph	N/A	N/A	Maricopa County
Floodplain Index Map	Floodplains	Administration Division/GIS Section	Map	County Basemap	Small	Maricopa County
Arizona Hydrology Map	Hydrology/Drainage	Hydrology Division	Map	State map	Small	Arizona
Telemetered Gauge Locations	Hydrology/Drainage	Hydrology Division	Map	?	Not to scale	Maricopa County
Dam Break Inundation Map	Hydrology/Drainage	Hydrology Division	Map	USGS quad sheet	1:24000	Dam locations
Flood Insurance Rate Map (FIRM)	Floodplains	Federal Emergency Management Agency (FEMA)	Map	Unknown	1:24000	Maricopa County
Floodplain Delineation Map	Floodplains	Hydrology Division	Map	Planning and Zoning parcel map	Varies (1"=1200')	Maricopa County
Flood Insurance Study Work Map	Floodplains	Hydrology Division	Map	Topographic basemap	1"=400'	Drainage study areas
Solid Waste Landfill Sites Map	Landfills/Hazardous Waste Sites	Hydrology Division	Map	County basemap	Small	Maricopa County
Watershed Boundary Map	Hydrology/Drainage	Hydrology Division	Map	USGS quad sheet	1:24000	Drainage study areas
Precipitation Map	Rainfall	National Oceanic & Atmospheric Admin. (NOAA)	Map	County basemap	Small	Maricopa County
Watershed Soils Map	Soils	Hydrology Division	Map	Soil Conservation Service Map	1:24000	Maricopa County
Groundwater Contamination Map	Hydrology/Drainage	Construction and Operations Division	Map	N/A	Small	Phoenix and vicinity
Land Use Map	Land Use/Land Cover	Construction and Operations Division	Map	County Watershed Map	Small	Individual river basin
Threatened and Polluted River Reaches	Hydrology/Drainage	Construction and Operations Division	Map	County Watershed Map	Small	Individual river basin
Channel Cross-Section Map	Hydrology/Drainage	Planning and Project Management Division	Map	Unknown	Unknown	Project areas
Soil Conservation Service Maps	Soils	Soil Conservation Service (SCS)	Map	N/A	1:24000	United States

Table 4-5
ENVIRONMENTAL CATEGORY

NAME	DATA SET	SOURCE	FORMAT	BASE MAP	SCALE	GEOGRAPHIC COVERAGE
County Hydrology Map	Hydrology/Drainage	Administration Division/GIS Section	Map	N/A	Small	Maricopa County
Area Drainage Management Study (ADMS)	Hydrology/Drainage	Hydrology Division	Map/Text	N/A	Small	Approx. 200 sq. mi. of Maricopa County
Flow Model Schematic	Hydrology/Drainage	Hydrology Division	Schematic Diagram	N/A	N/A	Drainage study areas
Precipitation Data	Rainfall	Hydrology Division	Tabular	N/A	N/A	Maricopa County
HEC-1 Model Data	Hydrology/Drainage	Hydrology Division	Tabular	N/A	N/A	Drainage study areas
HEC-2 Model Data	Floodplains	Hydrology Division	Tabular	N/A	N/A	Drainage study areas

environmental. This classification scheme is useful for conceptually organizing the data for the purpose of database design.

- The general data categories were broken down into twenty (20) specific *data sets* for the purpose of analyzing the data requirements of District divisions and branches. A data set is a group of related data elements that provides information about a common geographic feature or theme, such as "topography" or "roads." Data sets are used as a basis for defining layers that will be included in the District's GIS. Some data sets were found to be universally required by District divisions, such as geodetic control, property ownership, roads/streets, hydrology/drainage, floodplains, and land use/land cover. Other data sets are required by only a few District branches, such as wildlife, monitoring stations, waste discharge points, and historic/archaeological sites. The District should carefully evaluate which data sets will provide the most immediate benefits and utility when planning schedules and resources for database development.

- Over 50% of the data used by the District is generated in-house, with the majority of that coming from the Hydrology Division. Other sources of data include other County departments, the City of Phoenix, the State of Arizona, the Federal government, utility companies, developers, private consultants, and private map vendors. The accuracy and reliability of any data source are determined by the originating agency, and should be major considerations in identifying sources of data for GIS automation.

- The data samples collected during the user interviews include a wide variety of physical formats. Maps make up the largest group, by far, with forty-five (45) data sources, or 75% of the total inventory. The maps include a wide variety of map types and scales, ranging from small-scale statewide maps to very detailed site-specific maps. One (1) data source, aerial photography, is classified as imagery. Eight (8) data sources fall into the plans category, including various types of site plans, detailed construction drawings, and plan and profile drawings. Three (3) sources of tabular data were identified, including property

ownership data from the Assessor's office and hydrologic data used for modeling. Three (3) data sources were classified as "other," including various types of graphs, schematic diagrams, and text. **Table 4-6** shows the number of data sources that fall into each format classification by general data category.

- Many of the maps created by the District use other maps as a base to which the user adds additional information. The update and maintenance of these maps, then, also requires upkeep of the basemaps. One advantage of the GIS is that it will allow the District to maintain and update basemap information separately from other map information, which can then be overlaid to produce desired products. The basemaps used by the District vary considerably in scale and content, depending on their application. Some of the more commonly used basemaps include USGS quad sheets, large-scale topographic maps, County street maps, quarter section maps with parcels, and aerial photographs.

- The maps used by the District range in scale from statewide general reference maps (small scale) to very detailed plans of individual projects (large scale). Two general scales are used most commonly by District divisions. Much of the District's data was related to or overlaid with USGS 7.5' quad sheets at 1:24,000. Another commonly used scale was in the range of 1"=100' to 1"=400' (1:1200 to 1:4800) for more detailed information related to topography, floodplains, property ownership, and existing utilities. These two general scales should be considered as the primary input scales for the GIS.

- The geographic coverage of maps and data sets used by the District range from complete coverage of the entire United States to limited coverage of specific study areas. It will be desirable to have complete coverage of Maricopa County for some general data layers in the GIS, such as topography, hydrologic features, and roads. Other information in the GIS, such as existing utilities and zoning, may only be relevant for the developed areas of the County or specific project locations. The required extent of data coverage should be evaluated in designing the database and determining sources of data for the GIS.

Table 4-6

Data Sources Classified by Format and Data Category

	Map	Imagery	Plan	Tabular	Other	TOTALS
Basemap	2	1				3
Land Records	11		1	2		14
Infrastructure	12		4	1		17
Administrative Areas	2					2
Environmental	18		3		3	24
TOTALS	45	1	8	3	3	60

565/k

Conceptual GIS Database Design

5.0

5.1 Geographic Database Model

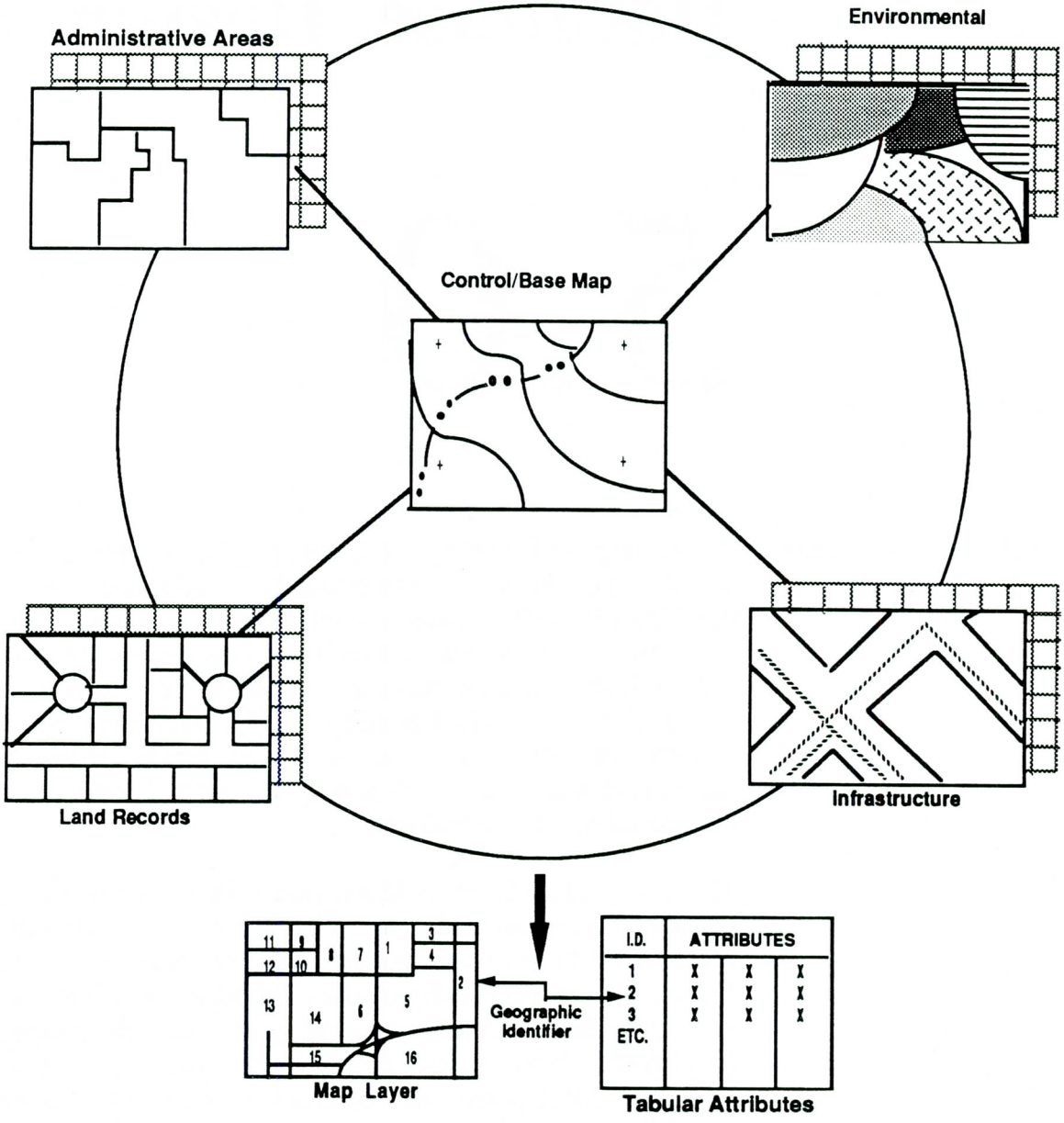
One of the primary concepts of the District GIS conceptual design is the "shared database." The shared database implies that various divisions with different responsibilities may have common data needs. For example, users within each division of the District use property ownership data. It is not necessary for each division to store, manage, and update this data independently. Rather, the opportunity exists for all to electronically access the same data in a shared database, in which the data are periodically updated and its accuracy maintained by a designated user.

The concept of the District GIS database is derived from an integrated geographic database model shown in **Figure 5-1**. In this model, all users share data resources from a common database. The model is a database design tool which provides a logical structure for organizing geographic data into five fundamental types. For each data type, map (spatial) and tabular (attribute) components are defined. The five geographic data types include: basemap/control data, land records data, infrastructure data, administrative areas data, and environmental data.

FIGURE 5-1

GEOGRAPHIC DATABASE MODEL

Shared Database Concept



MAP LAYER AND TABULAR ATTRIBUTES LINKED BY GEOGRAPHIC IDENTIFIER

1. **Basemap/Control Map and Tabular Data**—A basemap with survey control points provides the basic spatial reference tool for registering all other map layers to a common set of coordinates. Control tabular data include descriptions of the control points and references to surveys from which they were created.

2. **Land Records Map and Tabular Data**—Land records, or parcel map data, provide the basic drawing of parcels, including land subdivision and land ownership. Parcel tabular data include a variety of data sets about the individual parcels or activities pertaining to them, such as the owner name and address, and value of land. Map and tabular parcel data are referenced to one another by geographic identifiers such as site address or assessor parcel number.

3. **Infrastructure Map and Tabular Data**—This category includes road and other transportation networks, as well as utility networks such as water and sewer. Transportation map data include street segments and intersections which comprise the street network. Railroads and other forms of transportation networks can also be included in this data type. Transportation tabular data include various data sets about streets, intersections, and street-related facilities and activities, such as pavement type, number of lanes, accident locations, etc. Facilities map data display the location and connectivity of network types of facilities, such as water lines, sewer lines, and electrical lines. Facilities tabular data include characteristics of the facility segments and devices, such as pipe diameter, volume of flow, and so forth, as well as indexes to related engineering drawings and plans.

4. **Administrative Areas Map and Tabular Data**—Area map data define the boundaries of various administrative, enumerative, service, and statistical analysis areas (such as census tracts and traffic analysis zones). Area tabular data include a variety of data sets about the areas, such as the number of households, annual household income, and so forth. Sometimes these tabular data are the result of aggregating parcel tabular data for all of the individual sites within the selected area or areas of interest.

5. **Environmental Map and Tabular Data**—Environmental maps typically include features of the natural environment such as soils, geology, hydrology, and vegetation, as well as some features of the man-made environment such as park sites or designated open spaces. Environmental tabular data describe characteristics of the mapped features, such as soil type, permeability, and erodibility.

Each of the data types within the model include multiple map layers and attributes. As illustrated in the lower portion of **Figure 5-1**, tabular attributes are linked to their corresponding map layers by geographic identifiers, also called "keys."

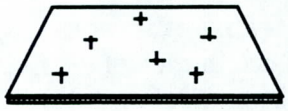
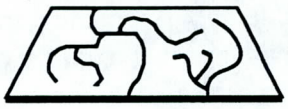
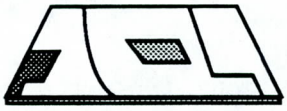
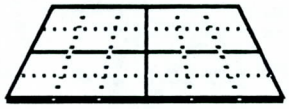
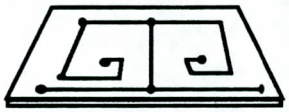
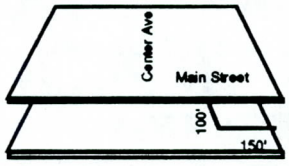
Spatial data deal with location, shape, and relationships among features. The three basic or "primitive" forms of spatial data are points, lines, and polygons, as shown in **Figure 5-2**. The primitive data are combined to represent a map or set of maps. Relationships (e.g., adjacency, connectivity) between features on the map are explicitly stored in the GIS. That is, the connection of one line segment to another, or which polygon is next to another, is stored as information in the spatial database. This information imparts "intelligence" to the spatial data, enabling it to be used for analysis as well as display.

In some cases, more than one map feature may be displayed in a layer, as in the case of a network (line and polygon) or link (line and point) layer, as shown in **Figure 5-2**. The objective of a network layer is to provide the capability to display attributes attached to both polygons and the lines that compose them. A link layer allows concurrent display of attributes associated with both line and points.

Attribute stores are groups of related descriptive data elements, generally stored in tabular files. Descriptive data are derived from forms and tables, reports, counts and measures, and include words, numbers, and alphanumeric characters. The data elements contained in a given attribute store describe map features or activities related to map features. These data elements are the basic units of the attribute or descriptive portion of the database. Individual data elements are often dealt with as a set, or attribute store.

Figure 5-2

Map Layer Types

Map Features Represented as...	*Layer Type*	*Examples*
Points • Single coordinate pair • No length or area	**Point Layer** 	Wells Utility Poles Monitoring Stations
Lines • String of coordinates with beginning & end points • Has length but no area	**Line Layer** 	Roads Streams Bus Routes
Polygons • String of coordinates with same beginning & end point • Has length and area	**Polygon Layer** 	Land Parcels Zoning Boundaries Zip Code Zones
Polygons and Lines • Attributes attached to polygons • Attributes attached to lines	**Network Layer** 	Census Tracts/Blocks Township/Range/Section
Lines and Points • Attributes attached to lines • Attributes attached to points	**Link Layer** 	Streets/Intersections Water Lines/Hydrants Sewer Lines/Manholes
Text and Symbols	**Annotation Layer**  Level 1 Level 2	Street Names Parcel Dimensions

Descriptive information can also appear on a digital map layer in the form of words, numbers, shades, or symbols. These data are typically stored for graphic display as separate annotation layers, as shown in **Figure 5-2.**

5.2 GIS Database Components

The following sections describe recommended map layers to be included in each of the five data model components of the District GIS database. Each map layer is described and displayed in diagrams in terms of its features and format. Feature identifiers and related attribute stores are also discussed. Recommendations and considerations pertaining to the automation and maintenance of attribute and map data are described. Regardless of the type of data to be automated, a variety of general implementation considerations need to be addressed. A general discussion of automation issues pertaining to attribute data and map data thus precedes the discussion of database creation and maintenance by data type.

For attribute data, important considerations for database development include file content, file linkages, and file development and maintenance responsibilities. Some of these determinations are intuitive. As such, they become most relevant to address during the detailed database design activities which precede actual implementation. Some questions which must be addressed include

- how to determine the best available data source(s);
- how to organize selected data to eliminate redundancies;
- how should related files be structured and linked together;
- what standards for data structure and format are needed; and
- how will files be initially developed and maintained.

For map layer data, key considerations for implementation include source data quality, content and preparation requirements, input methods, storage requirements, maintenance demands, and standards for format, scale, and accuracy. As with attribute data, determining the best sources and eliminating redundancies are important questions to address. Appropriate techniques for preparing map data for automation depend upon the type of data being automated. Options for data storage and maintenance also depend upon the type of data

and its usage demands. Maintenance factors to be considered include the required frequency of update and use, opportunities for transactional data update, and the identification of agencies responsible for data input and update.

The creation of the District geographic database will involve the conversion of map and tabular data, currently in both automated and manual formats. Establishment of standard data formats will be needed prior to initiation of the conversion process. After initial data conversion establishes various data layers and attribute stores, data loading, further updates, additions, and maintenance can occur within the operation of Application Modules, as described in Section 6. Application modules support sets of related functions and tasks using common geographic data management software procedures in combination with the shared GIS database.

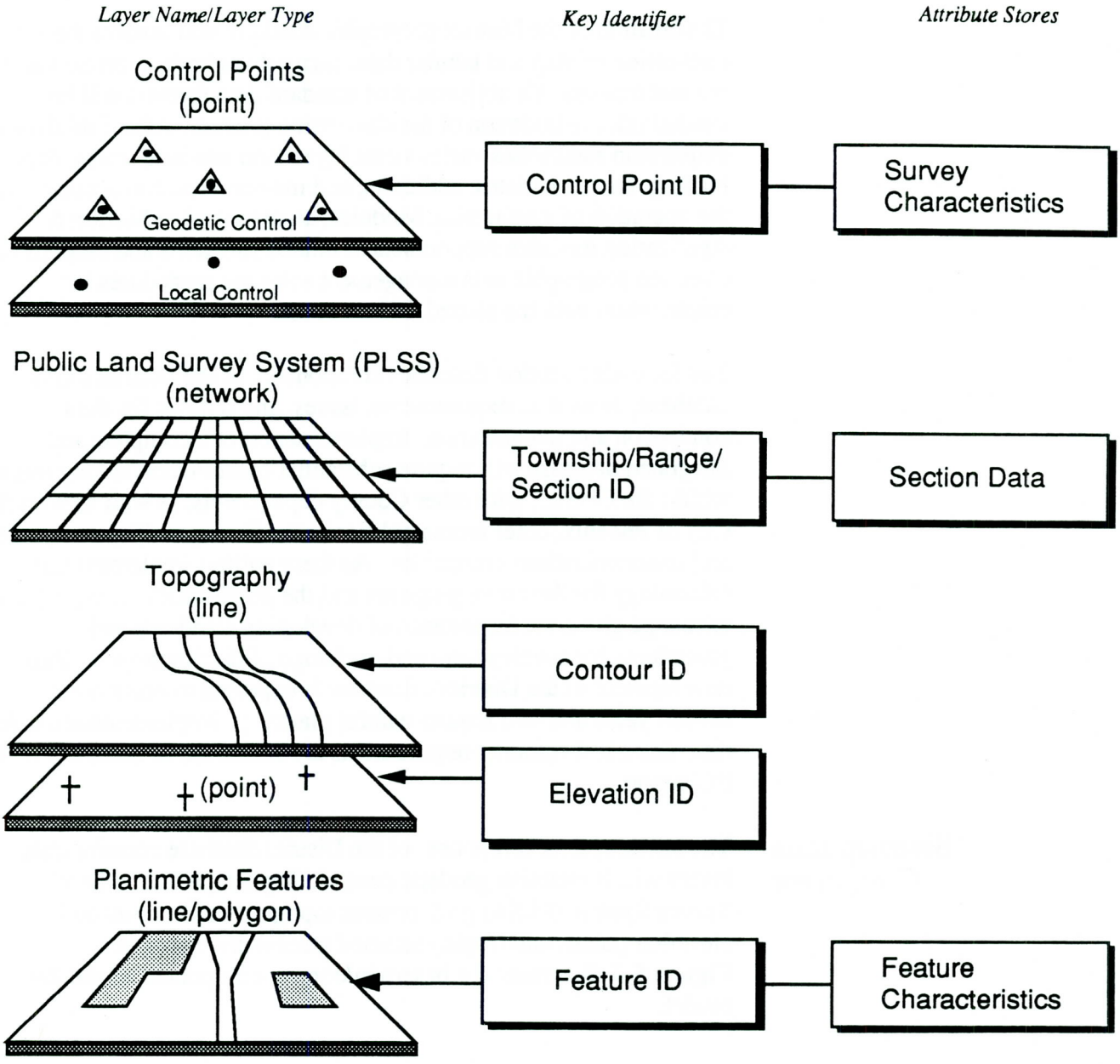
The following section describes components of the District's GIS database, as well as requirements, issues, and options for data conversion and maintenance. Implementation of a complete and integrated database will require substantial coordination among users within the District, with other County departments, as well as with the City of Phoenix, other municipalities in the County, utility companies, and communications companies. As these entities implement GIS technology for their own purposes and the possibilities for digital data exchange grow, the importance of developing standards and procedures for development and exchange of data increases. Full development of the District's database is expected to occur over several years and will require careful planning. Implementation tasks, time lines, and resource requirements are addressed in Section 9.0 of this report.

Basemap Data Component

The basemap data component of the District database contains data layers which establish geodetic control, display the Public Land Survey System (PLSS) grid, present topographic contours and elevation points, and display selected planimetric features. **Figure 5-3** illustrates the basemap/control component of the data model.

Figure 5-3

BASEMAP/CONTROL DATA COMPONENT



The geodetic control layer provides registration and spatial referencing for all other map layers of the District database. It is particularly important for layers such as land records and infrastructure, for which high accuracy is needed in daily use of the data. However, geodetic control is also potentially desirable for converting the environmental map layers, and is indirectly used in building the administrative areas map layers of the database. Attribute stores contain survey characteristics such as control point values, survey type, order, and date.

The first step in creating the basemap control layer is to organize and standardize available digital and tabular control point data. Control point data, in conjunction with existing digital files of Public Land Survey Systems (PLSS) data, is appropriate for building the County-wide control layer. Conversion of existing and available control data should then precede the conversion of other layers. Over time as development activities produce new control, the layer may be enhanced.

The Public Land Survey Systems grid is stored as network data (line and polygon) to enable symbolizing of township, range, and section lines. These data are used in mapping display and analysis by most divisions in the District. Attribute stores may contain, for example, data related to section corner monumentation.

The topographic layer contains information related to topographic contour lines and elevation points taken from USGS topographic maps or project-specific topographic maps. This layer relies on the geodetic control layer for spatial accuracy and registration.

Existing sources of topographic map data, including USGS topographic maps and project area-specific topographic maps generated through air photo interpretation, can be employed in building topographic map layer(s). A County-wide topographic layer can be developed by scanning or digitizing USGS quads, and another topographic layer containing more accurate, detailed contours can be built on a project by project basis. USGS DEM (Digital Elevation Model) files can be used to supply elevation point data.

The planimetric data layer may include, for example, building footprints, structures, parking areas, and improvements. Attribute stores provide tabular information about planimetric features—for example, type of structure, size, and year constructed. The planimetric features layer may be created and updated as individual projects require, using aerial photography containing proper control for accurate registration.

The loading, update, and maintenance of the basemap/control data can occur through the Data Entry and Maintenance Module, which is described in Section 4.2. Maintenance of the basemap/control layers may involve adding supplementary data based upon new project requirements.

Land Records Data Component

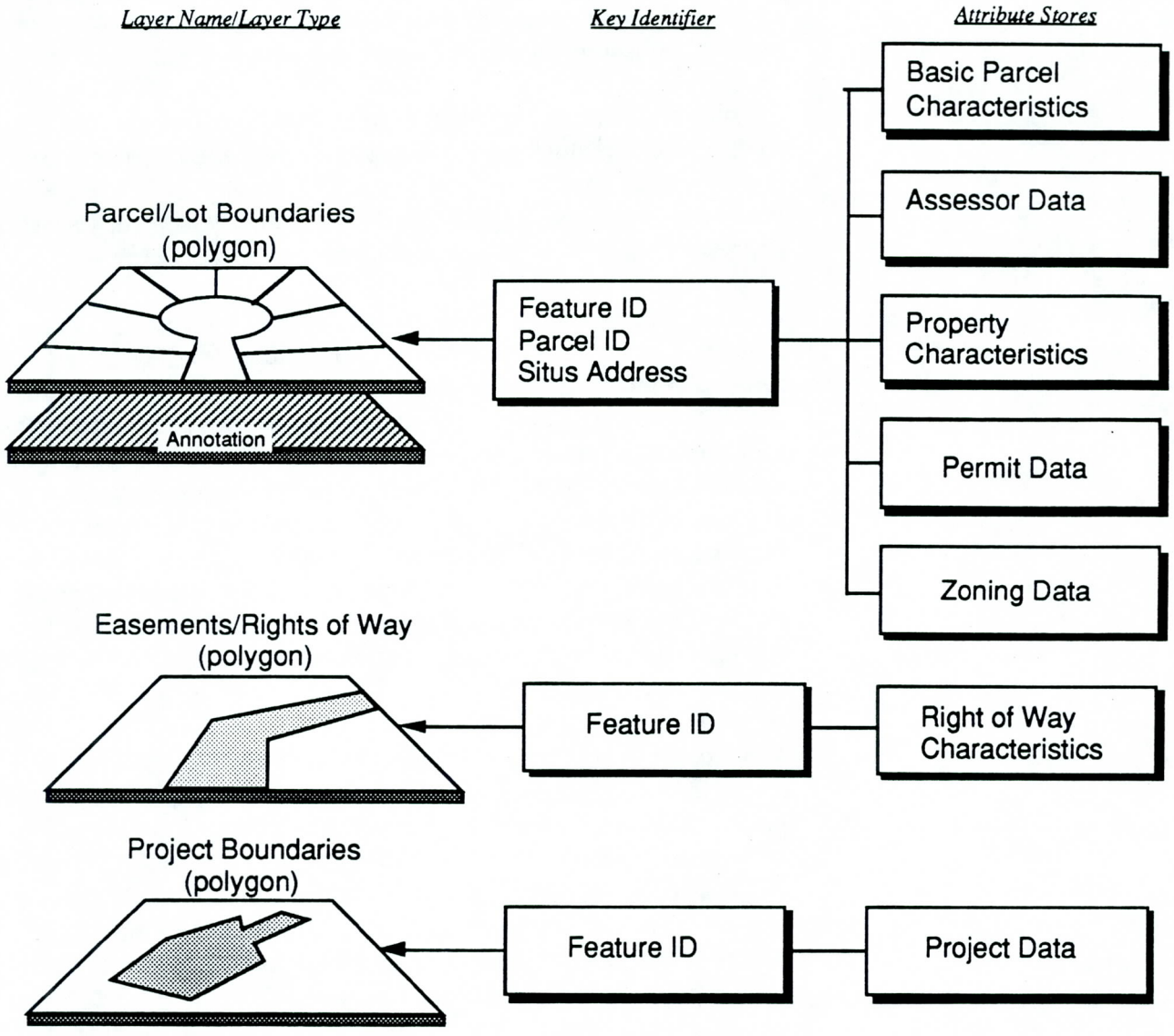
The land records database component consists of map layers depicting the recorded descriptions of lot and parcel boundaries, as well as easements, rights of way, and project boundaries as defined through District project activities. As such, three primary layers are identified for this database component: 1) parcel and lot boundaries, 2) easements and rights-of-way, and 3) project boundaries. **Figure 5-4** illustrates the land records component of the data model.

The parcel/lot boundaries layer displays legal lot and parcel boundaries in polygon format. In addition to the unique feature identifier assigned during automation, key identifiers may include the assessor parcel number and situs address. Several diverse attribute stores provide descriptive information for this layer, including basic parcel characteristics, assessor parcel data, property characteristics, existing permit data, and zoning characteristics data. An annotation layer accompanies the parcel/lot boundaries layer and displays such information as parcel number, lot dimensions, street names, and other text commonly shown on parcel maps as required by District users.

The easements/rights-of-way layer consists of public land ownership data in polygon format. A feature identifier links map features to attribute stores containing public ownership and right-of-way characteristics data.

Figure 5-4

LAND RECORDS DATA COMPONENT



The project boundaries layer of the land records component is proposed to contain mapped project boundaries resulting from projects being carried out within divisions of the District. These boundaries, to be stored in polygon format, are linked via a feature identifier to attribute stores which contain project-related data such as project type, status, and components. An index to construction drawings and other physical project records may also be contained in the attribute store.

Possible methods for creating the parcel map layer include 1) digitizing directly from existing parcel maps and/or other source documents, 2) coordinate geometry (COGO) entry, or 3) using a combination of digitizing and coordinate geometry methods to enter lot and parcel boundaries, and rectifying these to available imagery.

Existing property ownership map data, such as the Assessor's parcel map, may be used in creating parcel boundaries, easements, and rights-of-way. The project boundaries layer may be digitized using data from several sources, including the Assessor's map and the Land Management Division's property location, project index, and project location maps. Update of the land records map layers may occur through COGO entry of property boundaries using the Property Management Module. This procedure can be used to replace existing digitized parcel data with the more accurate COGO-generated data as it becomes available. Update of the land parcel layer may also be accomplished through digitizing of parcel updates using the Data Entry and Maintenance Module.

Much of the District's land records attribute data are currently maintained in INGRES. Use of these data in GIS requires a Relational Database Interface (RDBI), to link the primary parcel attribute file (Polygon Attribute Table, or PAT) in ARC/INFO, to the INGRES database maintained on the MV 40000. Other attribute data may be created and updated via transactions using the Property Management Module (for basic parcel characteristics, assessor data, and property characteristics), the Permit and Inspection Module (for permit and zoning data), and the Environmental Analysis and Modeling, and Facilities Planning and Management Modules (for project data). For the most part, parcel attributes will be maintained in INGRES, so any transactional updates which occur through GIS

modules will use the RDBI to access and update files in INGRES. Existing permit files may also be automated on an as-needed basis.

Infrastructure Data Component

The infrastructure component of the database consists of layers and attribute stores related to transportation and other network facilities. Seven layers are identified for inclusion in this data component: 1) street centerlines, 2) storm drainage facilities, 3) water distribution facilities, 4) sewer facilities, 5) electrical networks, 6) gas distribution system, and 7) communication networks. High priority layers include street centerlines and storm drainage facilities. Other layers are considered potential future layers, which may be automated as needed. **Figure 5-5** illustrates the layers and associated attribute stores proposed to comprise the infrastructure data component.

The street centerline layer is comprised of lines and points, with feature identifiers of street segment ID, street name/address range, and intersection ID. The attribute store associated with this layer includes street characteristics such as street name, direction, and functional classification. An annotation layer contains street names and other street-related text required for display purposes.

Automated sources of street centerline data, such as the Maricopa Highway Department's digital centerline file, or TIGER files available from the US Census Bureau can serve as the District's initial centerline layer. Existing manual map sources, such as the Arizona DOT's General Highway Map for the County, or the County Highway Department's commercially available Maricopa County Highway Map 1990 may be used to update and verify the digital file. An advantage of using the TIGER files is that they contain address ranges for each street segment, thus allowing the process termed "address matching" to be used, which assigns points to site addresses in a given range. These points can then be used as surrogate parcels to which parcel attributes could be attached, prior to automation of the parcel/lot boundaries map layer.

Figure 5-5

INFRASTRUCTURE DATA COMPONENT

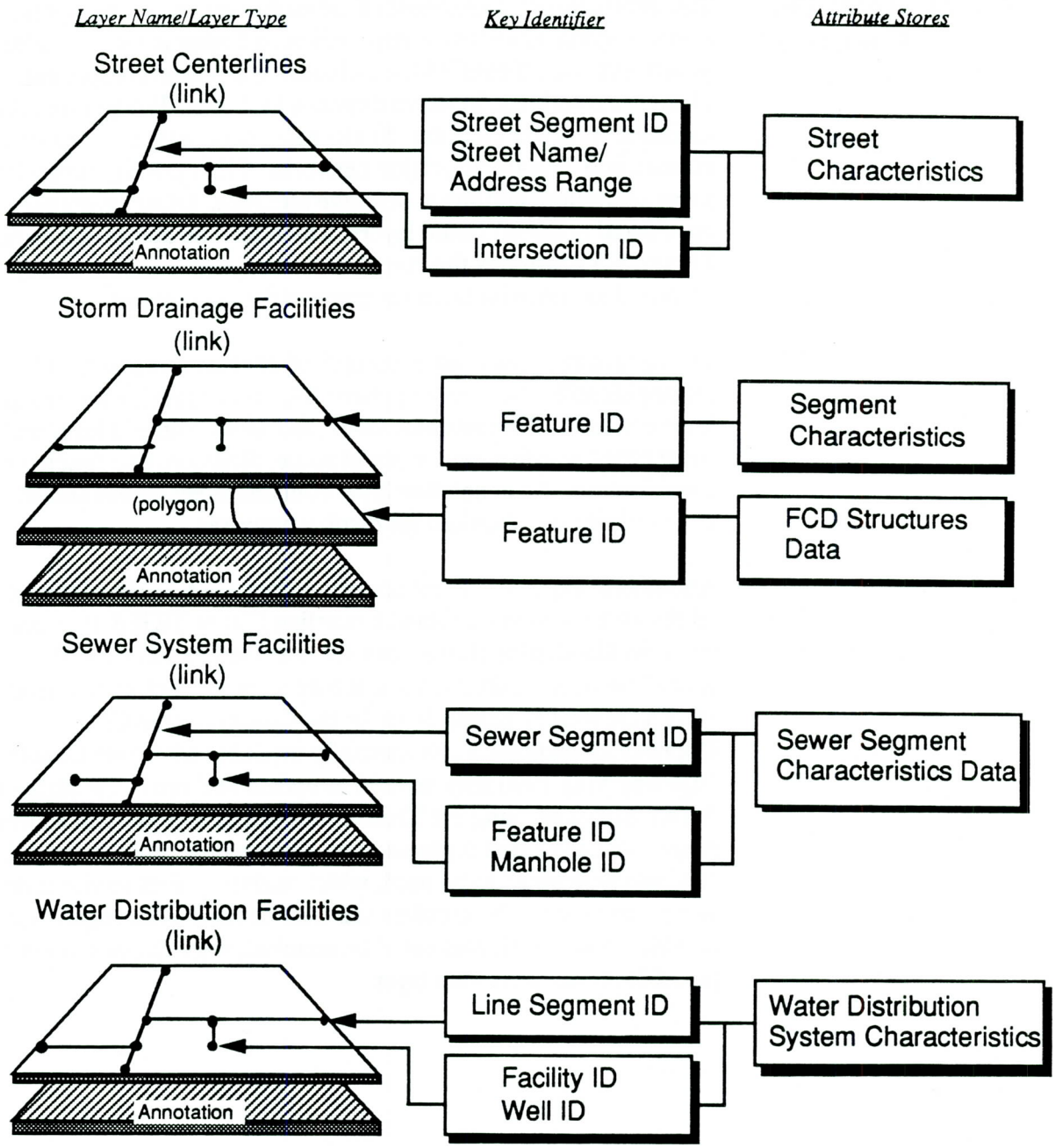
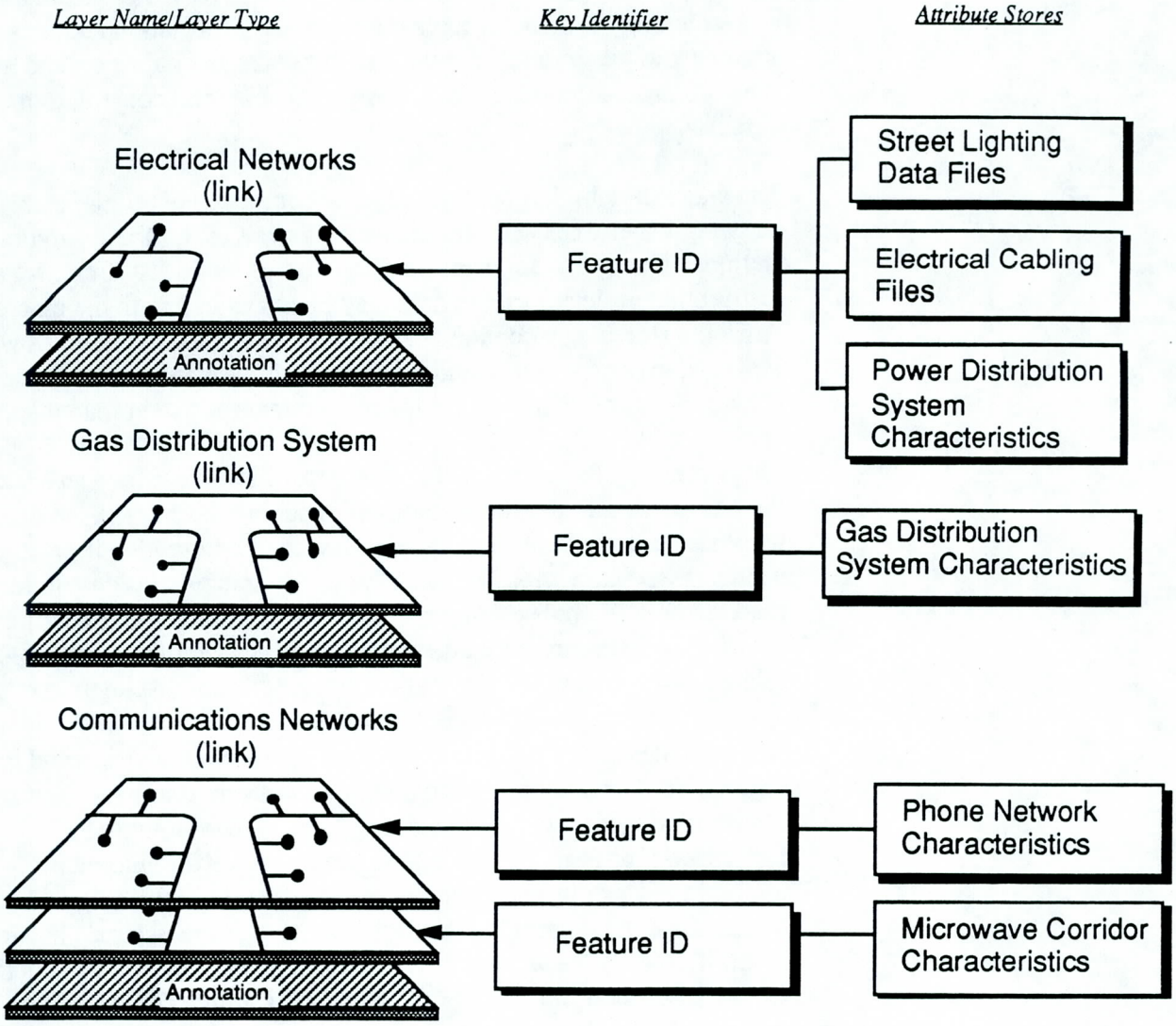


Figure 5-5 (continued)

INFRASTRUCTURE DATA COMPONENT



Storm drainage features are contained in link and polygon layers. The storm drainage network is displayed as a link layer where drainage is conveyed via pipe or narrow open channel (e.g., within cities), and is shown as a polygon layer where conveyance involves large channels and structures. Attribute stores may contain information about segments in the drainage network such as size and capacity, and about flood control structures such as design capacity and construction details.

The water distribution facilities layer is comprised of a link layer showing water lines and facilities such as valves, hydrants, and pump stations. Using line segment, facility, and/or well identifiers, water distribution system attribute data may be associated with the map data. Attribute stores may contain characteristics such as pipe size, flow rates and volumes, and maintenance records. An annotation layer provides water facility names and related text for use in map displays.

Similarly, map features data for sewer facilities, electrical networks, the gas distribution system, communication networks, and the cable television network are stored as link layers. Feature identifiers are used to associate various types of system characteristics data to the map feature. An index relating CAD drawings and/or engineering drawings to infrastructure layers may also be developed. Facility-related text are stored in annotation layers for map display purposes.

Source materials available through the Engineering Division and the City of Phoenix can be used in creating the storm drainage, water distribution, and sewer facilities map layers. The Blue Stake Reference Maps can provide an important source for automating underground facility locations. The buried facility map created by Mountain Bell can provide the basis for the communications network layer. Cable TV network map data, currently maintained by American Cable Television, Inc., can provide the map source for this layer. The Arizona Public Service Company, which maintains maps of gas and electrical distribution facilities, can provide the basic data sources for these layers. Tabular data associated with maintenance and repair of District-owned facilities are currently maintained in digital form and may be converted for use in the GIS.

Maintenance of the storm drainage map layer and attribute data can be accomplished through the Facilities Planning and Management Module. Maintenance of other infrastructure layers can be accomplished through the Data Entry and Maintenance Module.

Administrative Areas Data Component

The administrative areas data component, as illustrated in **Figure 5-6**, includes political boundaries and zoning area map layers. Both of these layers are stored in polygon format, and employ feature or area identifiers linking the map data to related attribute files.

The political boundaries layer includes incorporated area boundaries and annexation boundaries. Attribute files for the political boundaries map layer include jurisdictional characteristics such as name, incorporation date, population, and size, as well as annexation data.

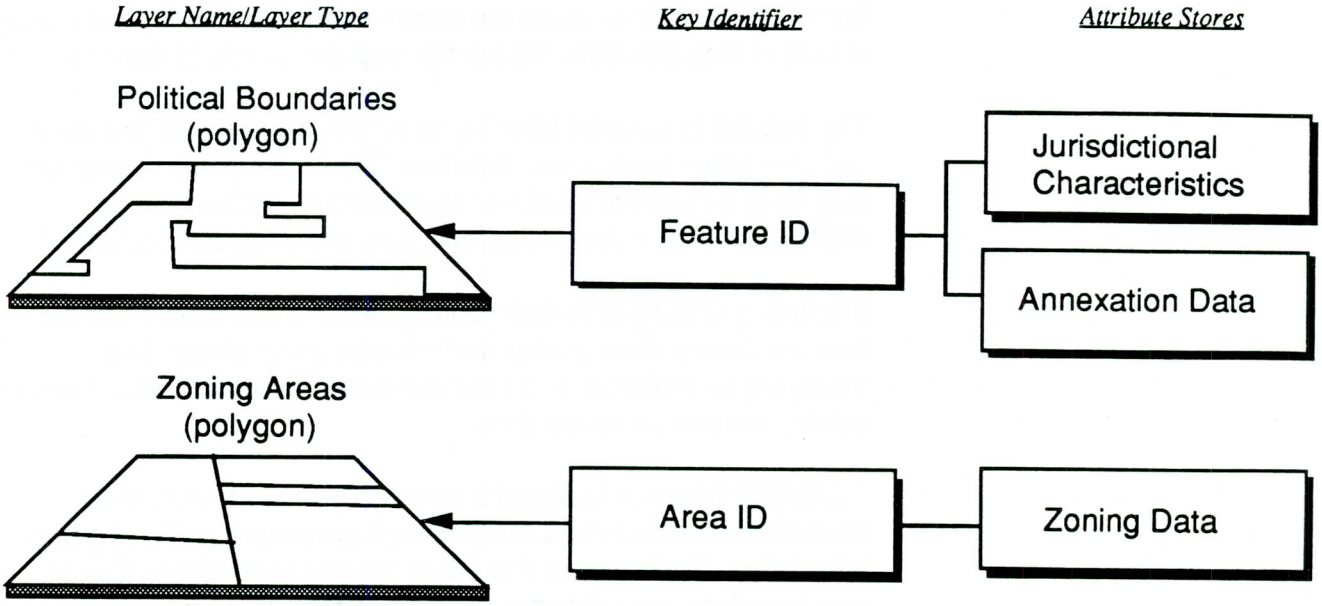
The zoning area layer includes zoning designations taken from the existing County Zoning Map, and related zoning tabular data indicating zone district, and other attributes of each district such as lot, height, and setback restrictions.

Administrative areas boundaries commonly coincide with street centerlines, certain natural features such as streams, and land parcel boundaries. To the extent that this is the case in Maricopa County, area boundaries map data may be derived from these map layers using GIS software procedures. This eliminates redundant digitizing and provides for proper registration between the area layers and other layers. Alternately, area boundaries can be digitized from existing map sources, including the County Highway Department's City Limits Sheet, and the Zoning Map maintained by the County Department of Planning and Zoning.

While some updates to political boundaries and related tabular data may occur through the Property Management Module and some updates to zoning data may occur through the Permit and Inspection Module, most updates to administrative areas boundaries can be accomplished through the Data Entry and Maintenance Module.

Figure 5-6

ADMINISTRATIVE AREAS DATA COMPONENT



Environmental Data Component

The environmental data component consists of thirteen map layers, including: 1) hydrology/drainage, 2) floodplain boundaries, 3) precipitation, 4) soils, 5) slope, 6) land use, 7) natural/cultural features, 8) environmental monitoring sites, 9) waste discharge sites, 10) solid/hazardous waste facilities, 11) surficial geology, 12) depth to groundwater, and 13) groundwater contamination areas. The various layers proposed to comprise the environmental data component of the data model are displayed in **Figure 5-7**.

Hydrology/drainage is comprised of a line layer for streams and rivers, and a network layer for watersheds/sub-watersheds and water bodies. Designing the watershed layer as a network layer allows watershed boundaries to be distinguished from sub-watershed boundaries by displaying them in a different line symbology. Key identifiers associated with these map layers include stream segment IDs, water body names, and watershed IDs. Tabular data associated with stream segments may include physical characteristics such as stream order, channel width and depth, side slopes, substrate, degree of roughness, and riparian habitat. It may also include water quality standards data. Watershed or drainage basin tabular data may consist of attributes such as drainage area size, land use composition, stream miles, status of drainage studies, etc. Water body attributes may include type, size, depth, and ownership.

Conversion of the USGS DLG hydrography data into GIS format can serve as an initial, small-scale County-wide coverage for the hydrology/drainage layer. A more detailed, positionally accurate layer can be developed over time by digitizing USGS quads, or by using source materials employed in developing the County Hydrology Map.

The floodplain boundaries map layer will be prepared in polygon format, using various existing floodplain map sources. Feature identifiers are employed as keys to access flood hazard zone type data, floodway limits, flood elevation data, and flood records data. The Flood Insurance Study Work maps should be considered for use in automating the floodplain map layer. Floodplain boundaries can be digitized or possibly converted from CAD to GIS format. The Data Entry and Maintenance Module can be used in maintaining the floodplain boundaries map layer and associated attribute data.

Figure 5-7

ENVIRONMENTAL DATA COMPONENT

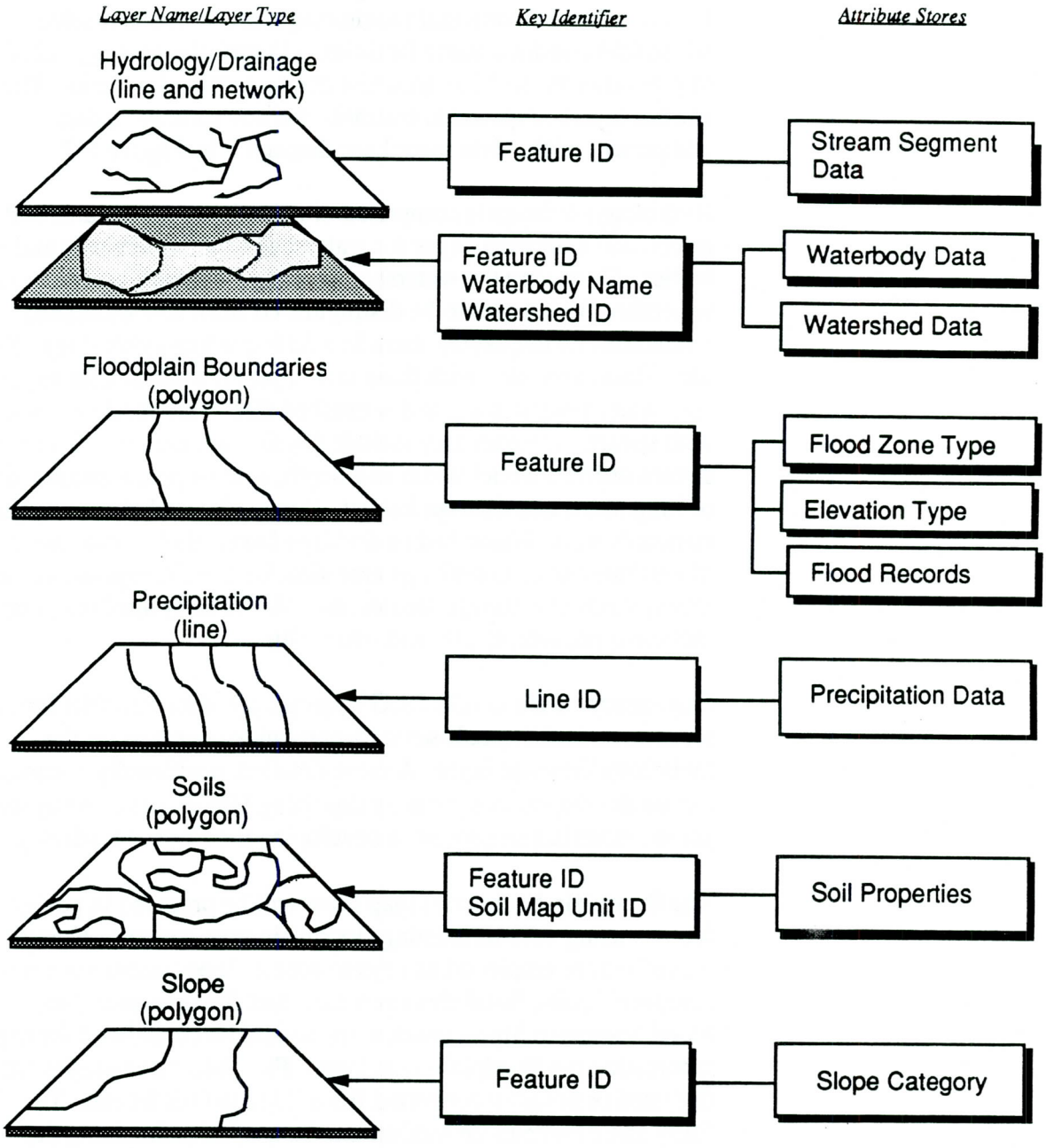


Figure 5-7 (continued)

ENVIRONMENTAL DATA COMPONENT

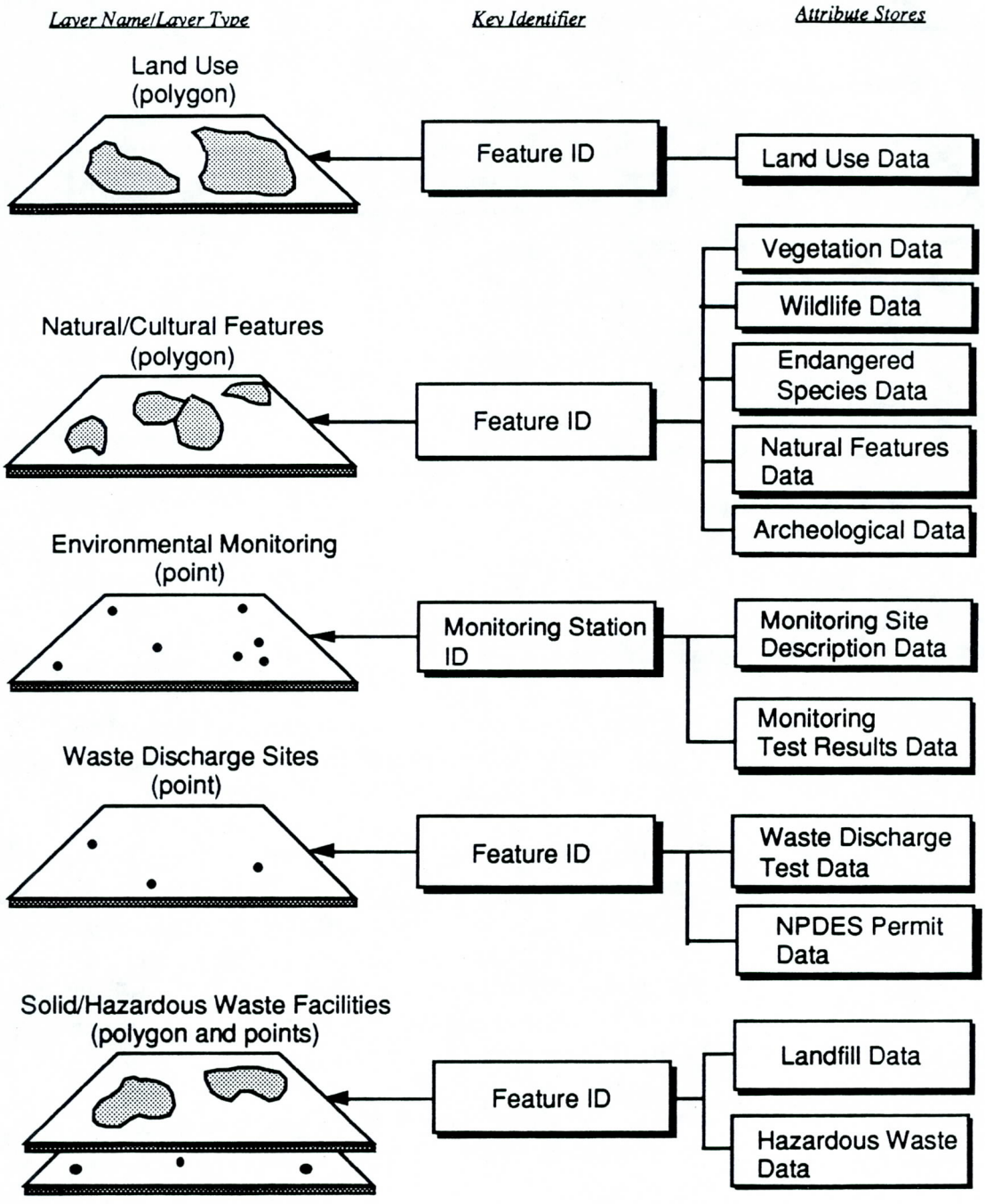
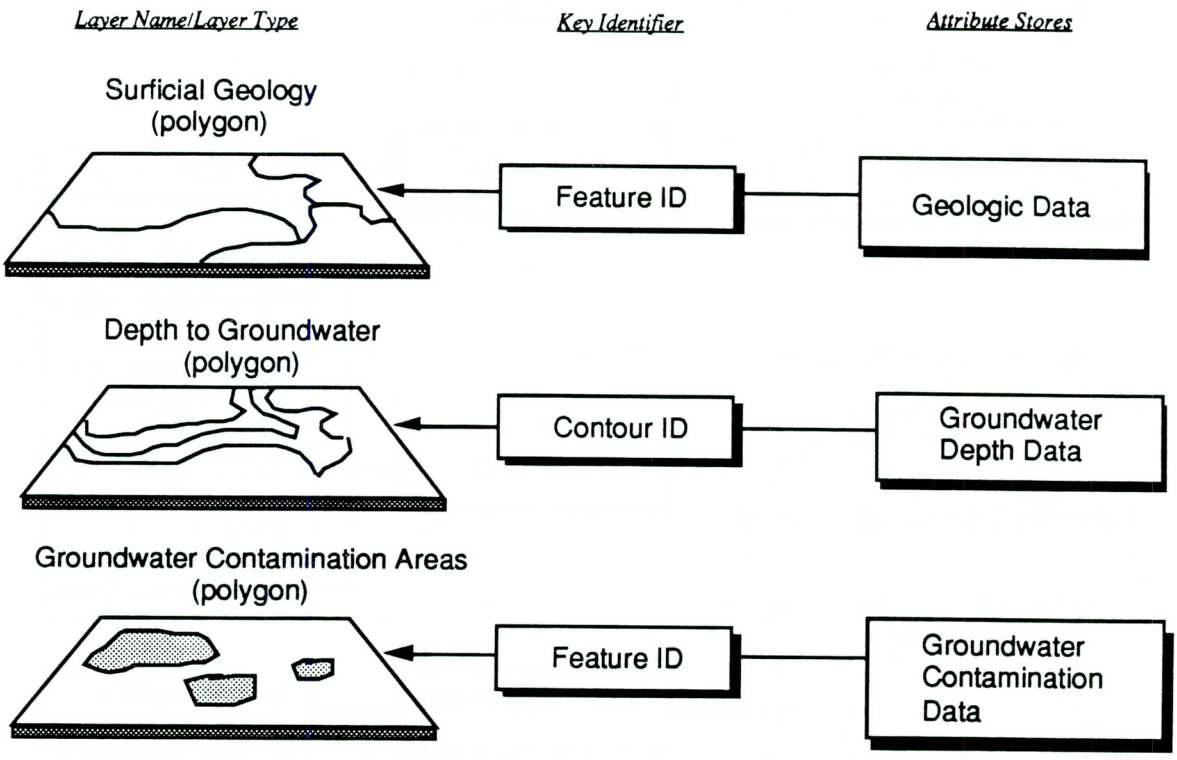


Figure 5-7 (continued)

ENVIRONMENTAL DATA COMPONENT



The precipitation map layer may be prepared in line format, using line IDs to link map features to precipitation records available from the Hydrology Division and NOAA, respectively.

The soils, slope, and land use map layers will be prepared in polygon format. These layers employ feature IDs (and soil mapping unit ID if available for the soils layer) to link map and tabular data sets. Attribute data for the soils layer may include such items as soil name, type, erodibility factor, and permeability factor. Attribute data for the slope layer will include slope category, typically given in ranges. Land use attributes will contain land use type.

Environmental map layers of soils, geology, slope, and natural/cultural features, should be commonly formatted for

conversion. These map layers would be drafted in an integrated manner for the automation process. The use of map integration techniques for creating these layers can reduce the number of maps to be automated, as well as reduce the possibility of data mismatches which commonly result from independent drafting of individual source maps. These layers are relatively static and infrequently require update.

The natural/cultural features layer is a network layer to allow for varying line symbology according to data type (i.e., wildlife areas versus archaeological areas). Several attribute data stores are associated with the natural/cultural features map layer including vegetation data, wildlife data, endangered species data, natural features data, and archaeological data.

The layer depicting environmental monitoring/gauging sites is designed as a point layer. These points may represent locations along streams, within water bodies, or below ground (wells). Monitoring/gauging station identifiers will be used to link specific stations with monitoring data. Attribute stores associated with monitoring data may contain site characteristics such as site number, latitude/longitude, type of station, equipment, and sampling frequency. Field and laboratory measurements and test results are also stored as attributes to this layer.

The waste discharge sites layer will depict discharge sites in point format. Attribute stores containing waste discharge data and NPDES permit data (permittee name, address, permit requirements) will be made accessible via unique feature identifiers.

The solid and hazardous waste facilities layer will display facility sites within the County in polygon format. Attribute stores containing landfill data and hazardous waste data will be accessible via unique feature identifiers.

Subsurface environmental factors of surficial geology, depth to groundwater, and known areas of groundwater contamination are depicted as polygon layers. Feature identifiers link the map layers to attribute stores of geologic data (e.g., strata type, composition, and

depth), depth to groundwater data, and groundwater contamination data (e.g., type, concentration, depth of contaminant).

Source materials used to prepare the Telemetered Gauge Locations Map, Groundwater Contamination Map, Threatened and Polluted River Reaches Map, Area Drainage Management Study Maps, Land Use Map, Solid Waste Landfill Sites Map, and Precipitation Map should be used to develop the environmental monitoring, waste discharge sites, solid/hazardous waste facilities, groundwater, and precipitation layers. This will require a process of collecting and evaluating source materials, rectifying data to the control layers, and redrafting the information onto manuscripts for automation. The Data Entry and Maintenance Module can be employed as needed in maintaining these layers.

GIS Application Concepts

6.0

6.1 Overview of Application Concepts

This section defines a series of functional components or application module concepts for the District GIS. Application module concepts represent how divisions, branches, and other user agencies can view and interact with the system. More specifically, application modules provide the framework for defining what the GIS must accomplish, from a system operation standpoint, in order to support the performance geographically related tasks carried out by the District.

Building upon the user needs and data evaluation findings which resulted from Tasks 2, 3, and 4, seven GIS applications have been defined to provide the breadth of system functionality articulated by District interviewees. These GIS applications are:

1) Data Entry and Maintenance Module
2) Environmental Analysis and Modeling Module
3) Facilities Planning and Management Module
4) Permit and Inspection Module
5) Public Inquiry Module
6) Flood Hazard Analysis and Modeling Module
7) Property Management Module

Each module is defined to support one or more geographically related functions now carried out by District divisions. The description of each module includes the following information:

- The functions of the application module
- The data it will use and generate
- The types of map and report products it will produce
- The organizations which will use it
- The dependencies among modules for data

Figure 6-1 provides an overview illustration of proposed module use by divisions and branches within the District. A summary of module roles in data update is displayed in **Figure 6-2.**

An integral part of application module development will be the Relational Database Interface (RDBI) linking the ARC/INFO® database with the INGRES databases on the DG. **Figure 6-3** illustrates the RDBI concept. Property-related and other attributes are being developed and used with INGRES SQL for query, update, and reporting. GIS application modules will require access to these databases for purposes of spatial query, display, and analysis. In addition, it is possible that some attribute transactional update functions may occur within the application modules. SQL commands may be invoked in an ARC/INFO application module session to query, manipulate, or update the INGRES databases through the RDBI.

6.2 Application Module Descriptions

Data Entry and Maintenance Module

The Data Entry and Maintenance Module consists of a database and set of software procedures for the maintenance of the basemap/control, land records, infrastructure, administrative areas, and environmental data layers of the District database. The primary purpose of this

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Figure 6-1

Proposed Use of Application Modules

Division	Application Module: Data Entry and Maintenance	Environmental Analysis & Modeling	Facilities Planning & Management	Permit and Inspection	Public Inquiry	Fld. Hazard Analysis & Modeling	Property Management
Administration							
GIS Section	●				●	●	●
Const. & Opers.							
Environmental		●			●		
Operations/Mtc.			●		●		
Engineering							
Stormwater Drainage				●	●		
Hydrology							
Floodplain Mgt.				●	●		
Special Projects		●			●	●	
Watershed Mgt.		●			●		
Land Mgt.							
Property Eng.	●			●	●		●
Property Mgt.					●		●
Plng & Proj Mgt.							
Planning		●	●		●		
Project Mgt.			●		●		

Figure 6-2

Application Module Roles in Data Update

Data		Application Module: Data Entry and Maintenance	Environmental Analysis & Modeling	Facilities Planning & Management	Permit and Inspection	Public Inquiry	Fld. Hazard Analysis & Modeling	Property Management
Map	**Basemap**							
Map	Geodetic Control	●						
Map	PLSS	●						
Map	Topography	●						
Map	Planimetric	●						
Tabular	Survey Characs.	●						
Tabular	Section Data	●						
Tabular	Planim. Features	●						
Map	**Land Records**							
Map	Parcel/Lot Bnds.	●						●
Map	Easements/ROW	●						●
Map	Project Bndries.	●						
Tabular	Parcel Characs.							●
Tabular	Assessor Data							●
Tabular	Prop. Characs.							●
Tabular	Permit Data				●			
Tabular	Zoning Data				●			
Tabular	ROW Data							
Tabular	Project Data		●	●				●
Map	**Infrastructure**							
Map	All Facilities Map Data	●		●				
Tabular	All Facilities Tabular Data	●		●				

Figure 6-2

(continued)

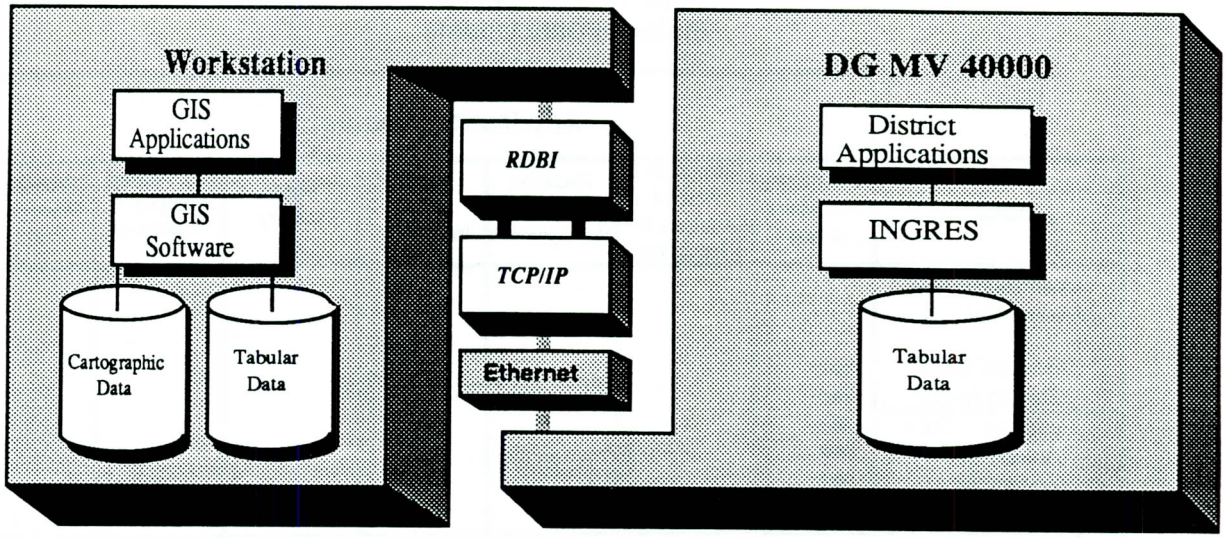
Application Module
Roles in Data Update

Data		Application Module: Data Entry and Maintenance	Environmental Analysis & Modeling	Facilities Planning & Management	Permit and Inspection	Public Inquiry	Fld. Hazard Analysis & Modeling	Property Management
Map	**Administrative Areas Data**							
Map	Political Bnds.	●						
Map	Zoning Areas	●			●			
Tabular	Jurisdict. Data	●						
Tabular	Annex. Data	●						
Tabular	Zoning Data	●			●			
Map	**Environmental**							
Map	Hydro/Drainage	●						
Map	Floodplain Bnds.	●						
Map	Precipitation	●						
Map	Soils	●						
Map	Slope	●						
Map	Land Use	●						
Map	Nat/Cult. Ftrs.	●						
Map	Env'l. Monitoring		●					
Map	Waste Dischg Sts.		●					
Map	Sol/Haz Facils.	●						
Map	Surficial Geology	●						
Map	Depth To Grwtr	●						
Map	Grwtr Contam	●						
Tabular	Hydro/Drainage	●					●	
Tabular	Floodplains		●					
Tabular	Precipitation	●						
Tabular	Soils	●						
Tabular	Slope	●						
Tabular	Land Use	●						
Tabular	Nat/Cult. Ftrs.	●						
Tabular	Env'l. Monitoring		●					
Tabular	Waste Dischg Sts		●					
Tabular	Sol/Haz Facils.	●						
Tabular	Surficial Geology	●						
Tabular	Depth To Grwtr	●						
Tabular	Grwtr Contam	●						

565/1

Figure 6-3

RDBI Concept



application module is to provide a set of automated procedures for the continued update of map layers. Attribute update will, in some cases, be performed on a transactional basis through other application modules (e.g., update of permit attributes of the parcel layer may occur on a transactional basis through the Permit and Inspection Module). Attribute update will also continue to occur independently, however, in INGRES-based files on the DG (which are related to the GIS on an as-needed basis via RDBI). Where attributes are not updated transactionally, update can occur through the Data Entry and Maintenance Module.

This module will also support the generation of standard map products. The module will draw upon the control, land records, infrastructure, environmental, and administrative areas data components in both creating and maintaining various maps. Varying combinations of data layers and attributes will be graphically overlaid to produce commonly-used or standard map products. Map products generated through this module might include, for example, floodplain delineation/parcel maps, watershed soils maps, NPDES permit/drainage maps, and land use maps.

The following software capabilities will be employed in the Data Entry and Maintenance Module:

- Attribute data entry, editing, update, management, and reporting for map features maintained by the module.
- Spatial data entry and management procedures, including digitizing, drafting, coordinate geometry (traverse entry), electronic survey data entry, digital data conversion, spatial data update, and storage/management of spatial data.
- Spatial and attribute query capabilities.
- Transformation/projection, edgematch, mapjoin, and other spatial/attribute data editing procedures.
- Scale change, graphic superimposition, and other spatial data preparation and display procedures.

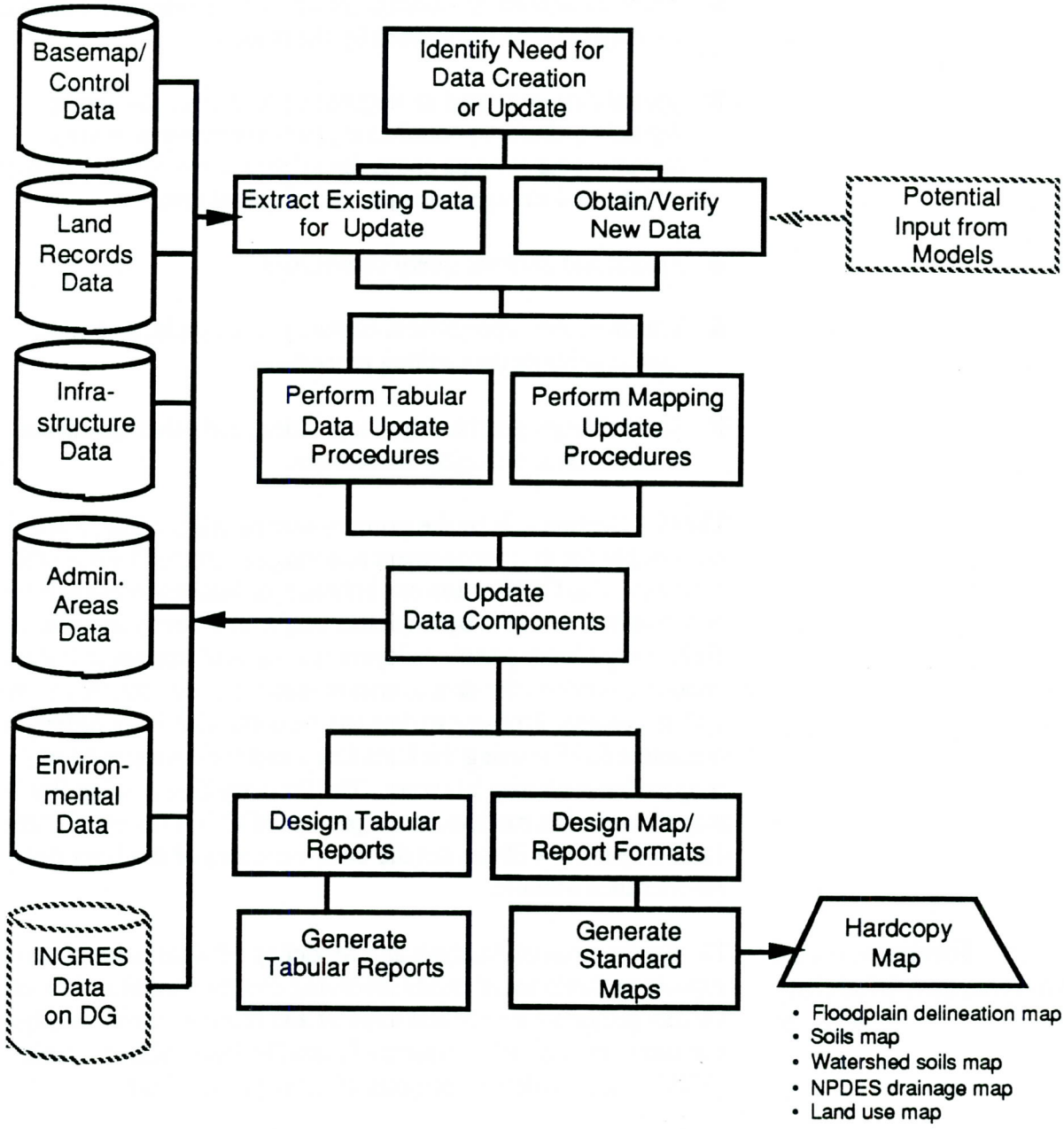
The GIS Section will be the primary user of this module, since it is responsible for the management and integrity of the District GIS database. The GIS Section can enhance its database management and maintenance functions by implementing a map library system. A digital map library partitions layers into units of manageable size, imposing order on the data to ensure spatial fit and accuracy in the data update process. Updates to data can be controlled in an orderly and consistent fashion using the Data Entry and Maintenance Module in conjunction with map librarian. The Property Engineering Branch may also use this module, in the process of COGO entry of parcel data. **Figure 6-4** illustrates the basic concepts of the Data Entry and Maintenance Module.

Environmental Analysis and Modeling Module

The Environmental Analysis and Modeling Module is designed to support multiple users' needs involving environmental review of District projects for potential impacts and hazards, project analyses pertaining to hydrology aspects of Area Drainage Master Studies (ADMS), and review of projects of other jurisdictions.

Figure 6-4

Data Entry and Maintenance Module Concept



Demands for the use of this module may emerge as a result of project or facility planning activities initiated within the Property Management, or Facilities Planning and Management modules. **Figure 6-5** graphically depicts the concept of the Environmental Analysis and Modeling Module.

Once needs for data analysis and/or modeling have been identified, the module will draw upon basemap control, land records, infrastructure, administrative areas, and environmental data in accumulating needed data for analysis. In performing analytical and/or modeling procedures, the module may obtain input from various modeling tools used by District offices. Module procedures will then result in the update of project and inventory data, the development of recommendations, or the generation of map and/or tabular products. Software procedures which will be employed in this module include

- Tabular data manipulation, update and retrieval including the capabilities to: 1) extract land use, cultural features, flood and hydrologic data to analyze impacts of proposed projects; 2) retrieve property characteristics and Assessor property valuation data for given floodplain areas to use in analyzing cost impacts of projects; and 3) aggregate hydrology information by selected keys or areas for use in reporting.

- Modeling the impacts of proposed projects on existing environmental and land use features and constraints.

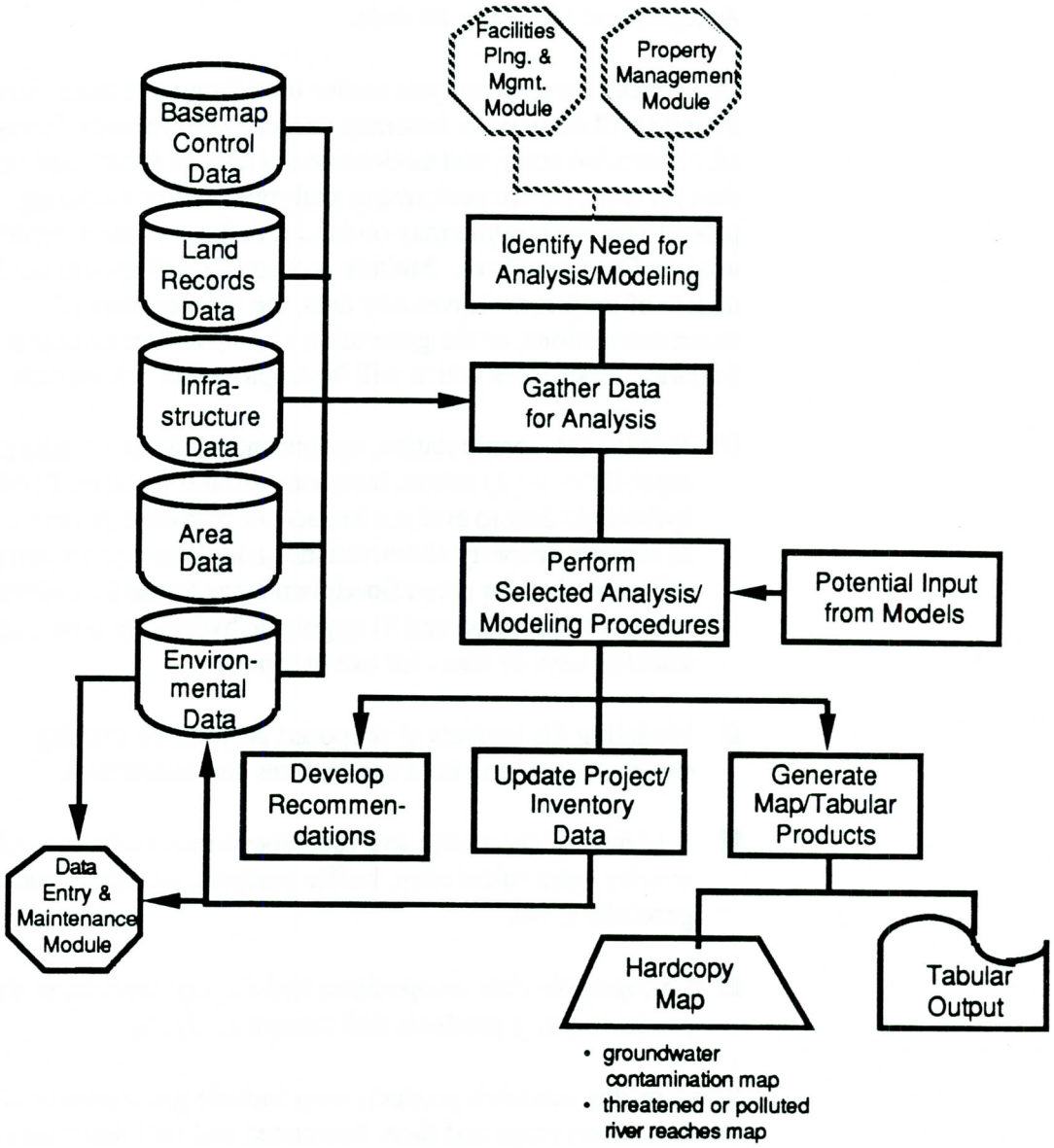
- A variety of geometric analysis procedures, including polygon overlay, area calculation, buffer analysis, proximal analysis, geocoding, etc.

- Cartographic data composition and display procedures for producing map products and custom analyses.

Some of this module's products may include groundwater contamination maps and data, threatened and polluted rivers maps, and specialized maps or reports displaying results of environmental analyses.

Figure 6-5

Environmental Analysis & Modeling Module Concept



Several branches can use the Environmental Analysis and Modeling Module. The Planning, Environmental, and Special Projects Branches can employ the module in a range of environmental analysis and project review activities. The Watershed Management Branch can use the module in Area Drainage Master Studies, and in hydrologic and hydraulic modeling studies.

Facilities Planning and Management Module

The Facilities Planning and Management Module supports activities involving two tracks: the planning, design, and construction of new facilities, and the ongoing inspection and maintenance functions pertaining to existing facilities. **Figure 6-6** illustrates the Facilities Planning and Management Module concept.

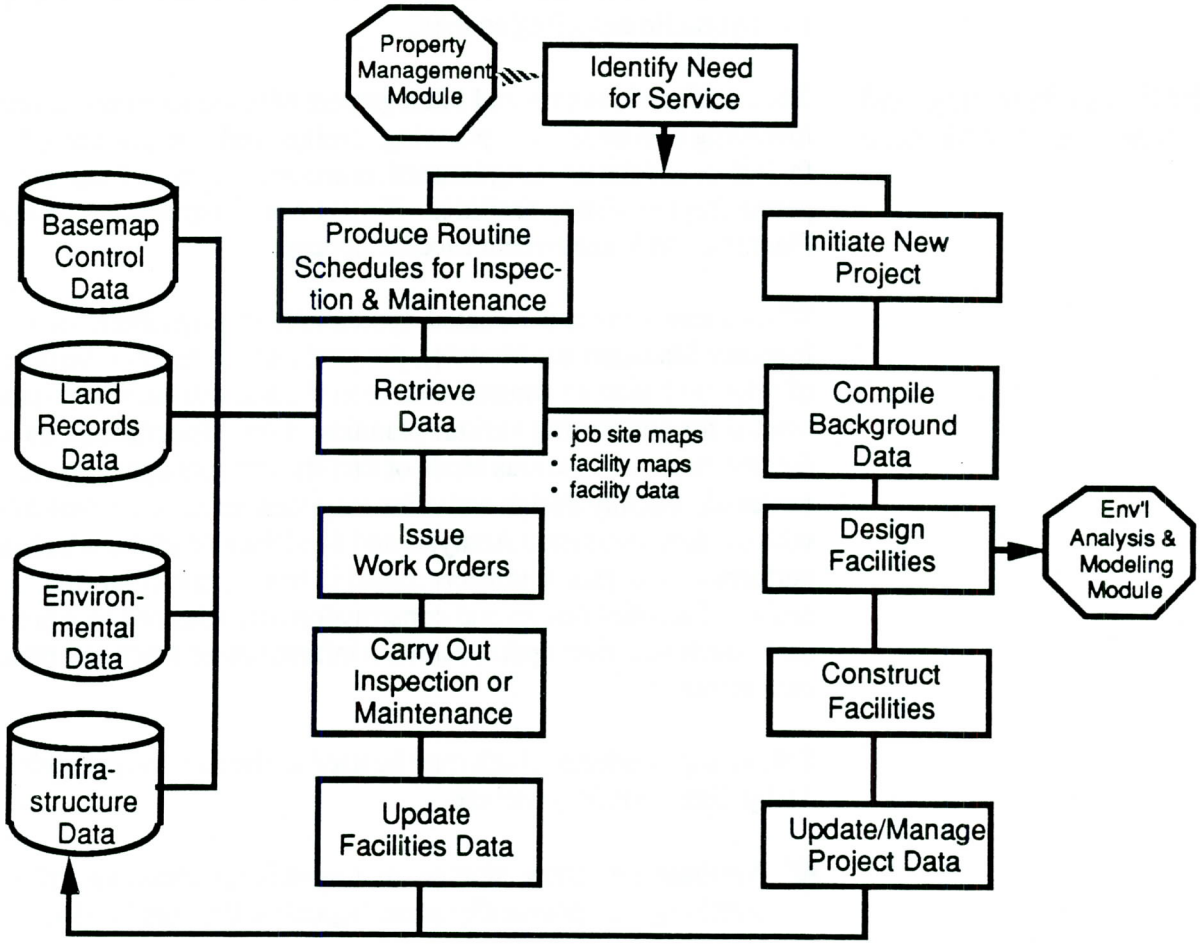
When a new project is initiated, (potentially through interface with the Property Management Module), the module will support the retrieval of relevant basemap control, land records, and infrastructure data needed for performing various planning tasks. Specifically, existing facility maps, and various kinds of facility attribute data may be retrieved. Facility design activities may then result in module interface with the Environmental Analysis and Modeling Module, which may perform an analysis of impacts resulting from a particular facility design. Facilities design and construction activities produce project data which will then update relevant infrastructure maps and tabular data stores.

Software procedures which may be used in the facilities planning and design functions may include

- Attribute data entry, storage, manipulation, geocoding and address matching, and potentially some logical and/or statistical analysis of facilities and land records data.
- Geometric analysis procedures, such as polygon overlay and aggregation/districting.
- Potential use of network analysis procedures for flow simulation and area-to-network aggregation analysis.
- Generation, storage, management, and display of facility maps.

Figure 6-6

Facilities Planning and Management Module Concept



When a need for ongoing service is identified, job site maps, existing facility maps, and tabular data may be retrieved, particularly for use by field personnel. Once work orders are issued and inspection or maintenance activities are carried out, facilities tabular data stores will be updated as needed.

Procedures which may be employed in carrying out facilities management functions may include

- Facilities map and attribute data update and maintenance.
- Spatial and attribute data retrieval and analysis for preparing maps and reports to aid in maintaining infrastructure facilities.
- Workload scheduling and monitoring for inspection and maintenance activities.

The Facilities Planning and Management Module can be used by the Operations and Maintenance Branch for its activities involving scheduling maintenance and routine inspections, and providing map and tabular data to support these activities. It can also be used by the Planning, and Project Management Branches in planning, implementation, and management of flood control projects.

Permit and Inspection Module

The Permit and Inspection Module supports the issuance of various types of permits, such as drainage clearances and land use permits, as well as the construction site inspection process. The module draws upon all data components in compiling data for review of permit applications and plans, including environmental, land use, and property characteristics data. It depends on the Relational Database Interface (RDBI) with the INGRES database to obtain and display permit attribute data. Based upon the approval or denial of permits, and the completion of inspections, the module supports the update of permit and inspection files, again through the RDBI to INGRES. In addition, it may support the update of zoning files using new data received in applications from other County agencies.

Software capabilities which will be employed in the Permit and Inspection Module include

- Tabular data management and update.
- Query and display of cartographic data.
- Cross-referenced geocoding to enable data retrieval by site address, project number, or other identifiers.

Figure 6-7 illustrates the Permit and Inspection Module concept.

Users of the Permit and Inspection Module may include the Stormwater Drainage Branch to support drainage permit issuance, and the Floodplain Management Branch to support floodplain use permit issuance and construction site inspection activities.

Public Inquiry Module

The Public Inquiry Module provides tools for responding to various types of inquiries and complaints, as well as producing displays, maps and presentation graphics. The module provides access to all map and tabular data components, through software capabilities such as the following:

- Rapid spatial and tabular data retrieval via terminal display in response to inquiries and complaints.
- Data manipulation and analysis capabilities for response to specialized queries.
- Spatial data composition, display, and hard copy production capabilities.

The Public Inquiry Module concept is illustrated in **Figure 6-8**. The Module can be used by the GIS Section and Environmental Branch in producing maps, displays, and presentation graphics, and by other branches for responding to general inquiries and complaints.

Figure 6-7

Permit and Inspection Module Concept

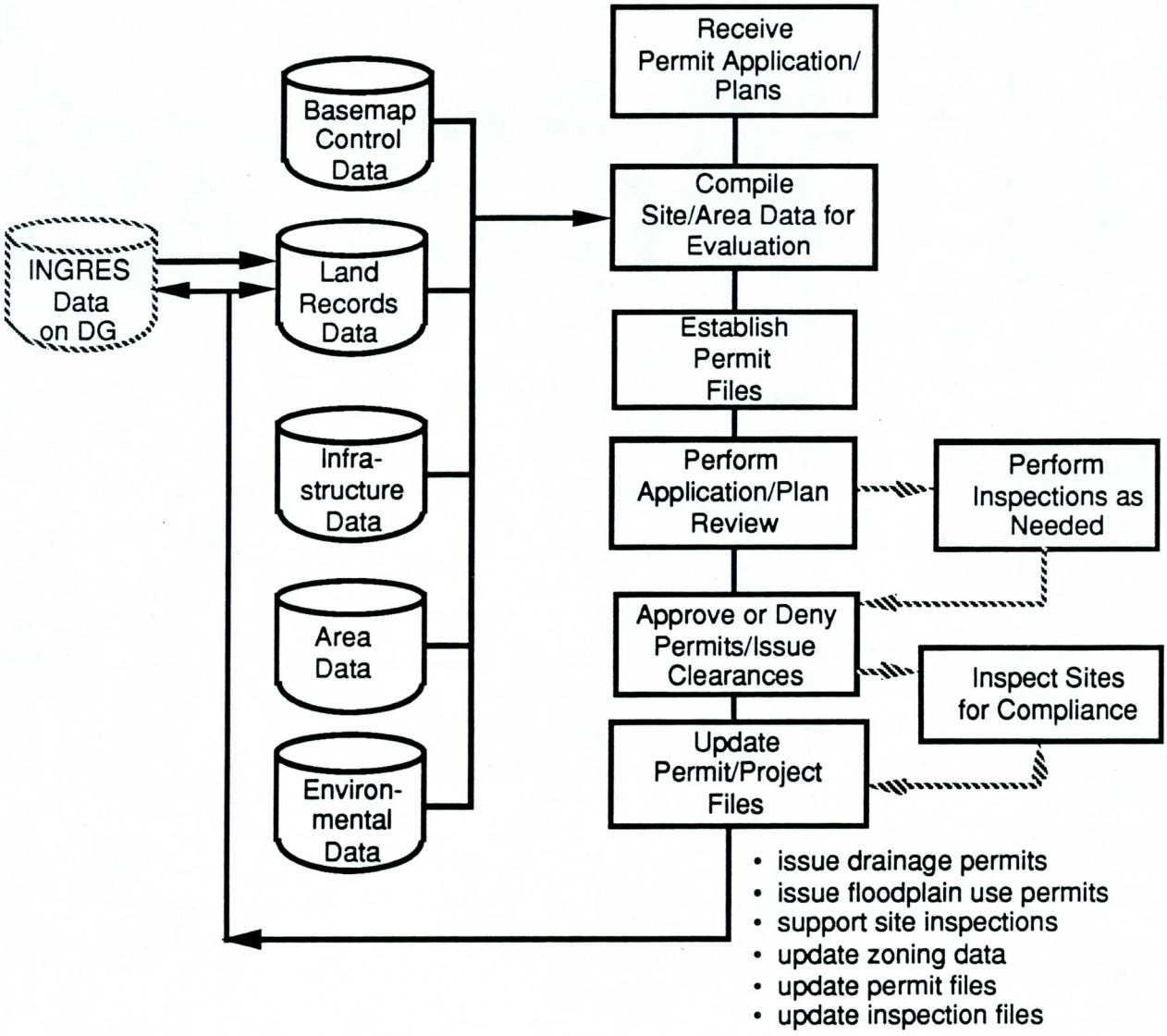
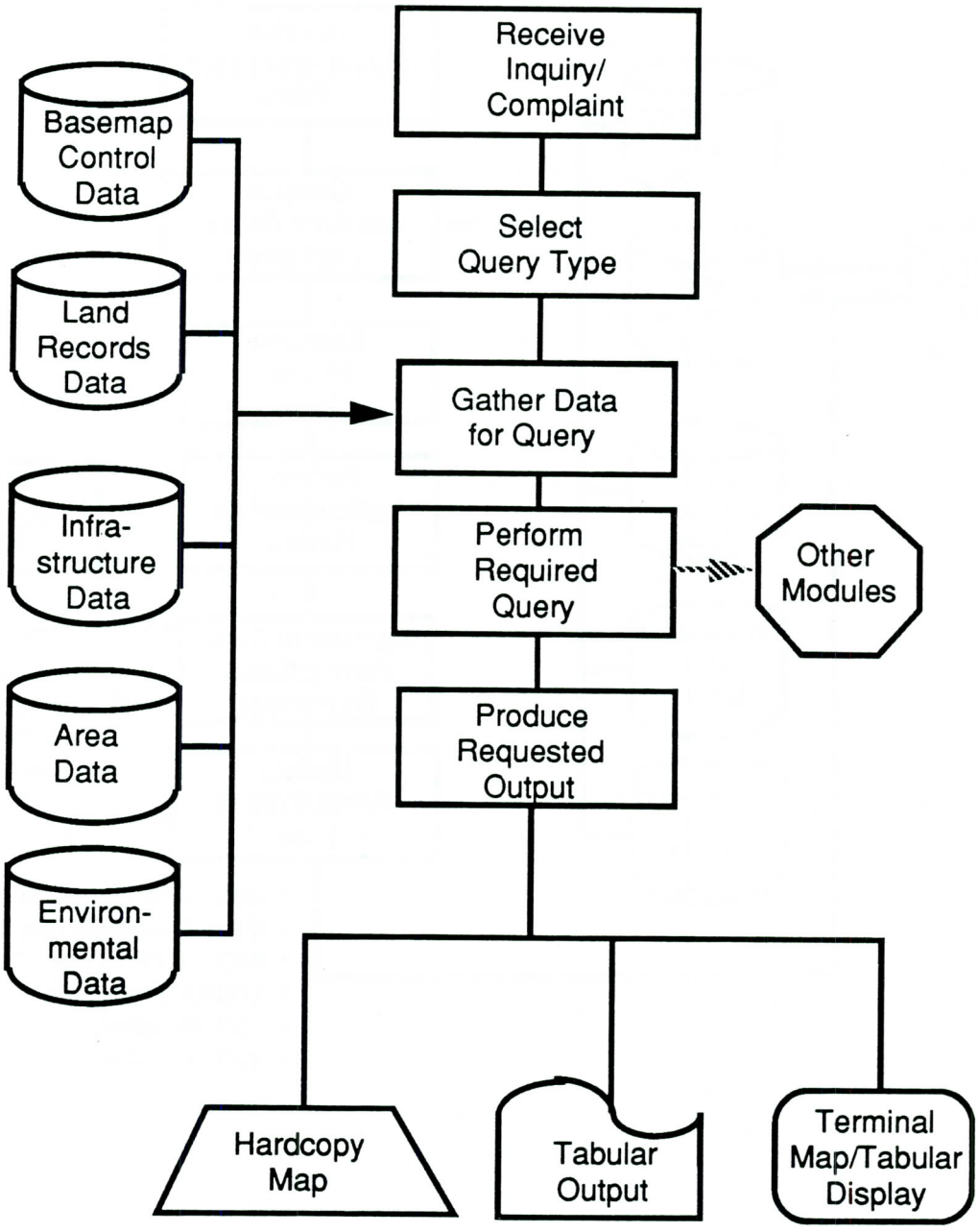


Figure 6-8

Public Inquiry Module Concept



Flood Hazard Analysis and Modeling Module

The Flood Hazard Analysis and Modeling Module supports some of the specialized District analytical requirements pertaining to flood and inundation hazards. In this module, the GIS will be interfaced with some existing software systems, including ALERT software and DAMBRK software, for portraying analytical results in spatial form. To this end, the module will draw upon basemap control, infrastructure, and environmental data components. Analytical and map products generated within this module may then be utilized in the Environmental Analysis and Modeling, and Facilities Planning and Management Modules. The Flood Hazard Analysis and Modeling Module concept is shown in **Figure 6-9**.

Mechanisms and procedures for interface of existing software functions with the GIS will be developed in this module. GIS geometric analysis, map composition, and display procedures will also be utilized. Products of this module may include, but not be limited to real-time flood level maps, historic flood data maps, and dam break inundation maps.

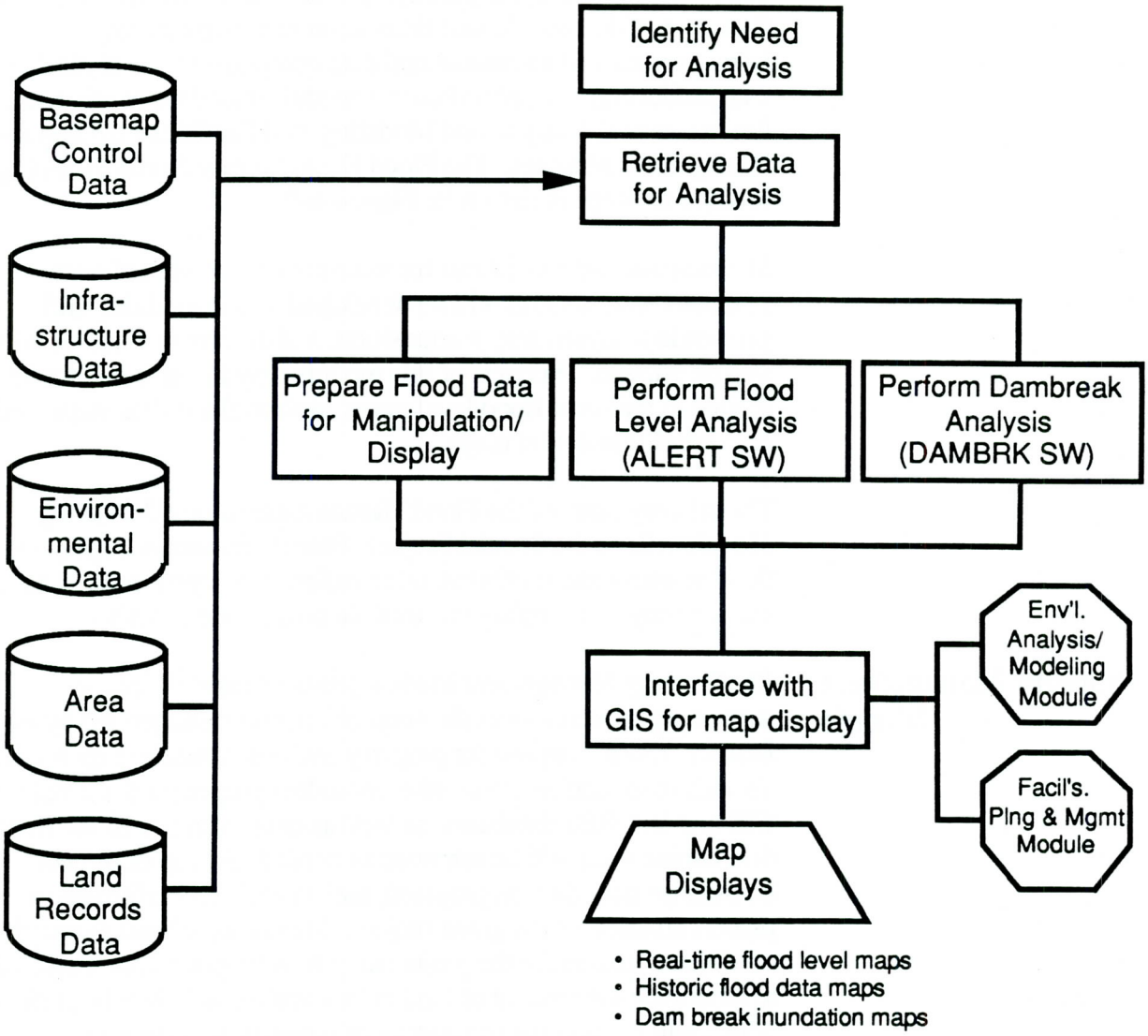
The primary users of the Flood Hazard Analysis and Modeling Module will be the Special Projects Branch, for use in displaying flood warning and dambreak information in mapped form. The GIS Section may also employ this module on a periodic basis.

Property Management Module

The Property Management Module provides capabilities for supporting property analysis, acquisition, and management by the District. Once a request for property analysis is received (potentially through work performed in other modules) property-related files in the GIS and INGRES databases, as well as data from any of the five GIS data components will be retrieved as needed. A map of project boundaries may then be prepared, and an analysis performed of parcels affected by the given project. Maps and/or legal descriptions of affected parcels for the project may then be generated. Calculations to determine the amount of land to be acquired will then be performed, which will support the processing of property acquisition.

Figure 6-9

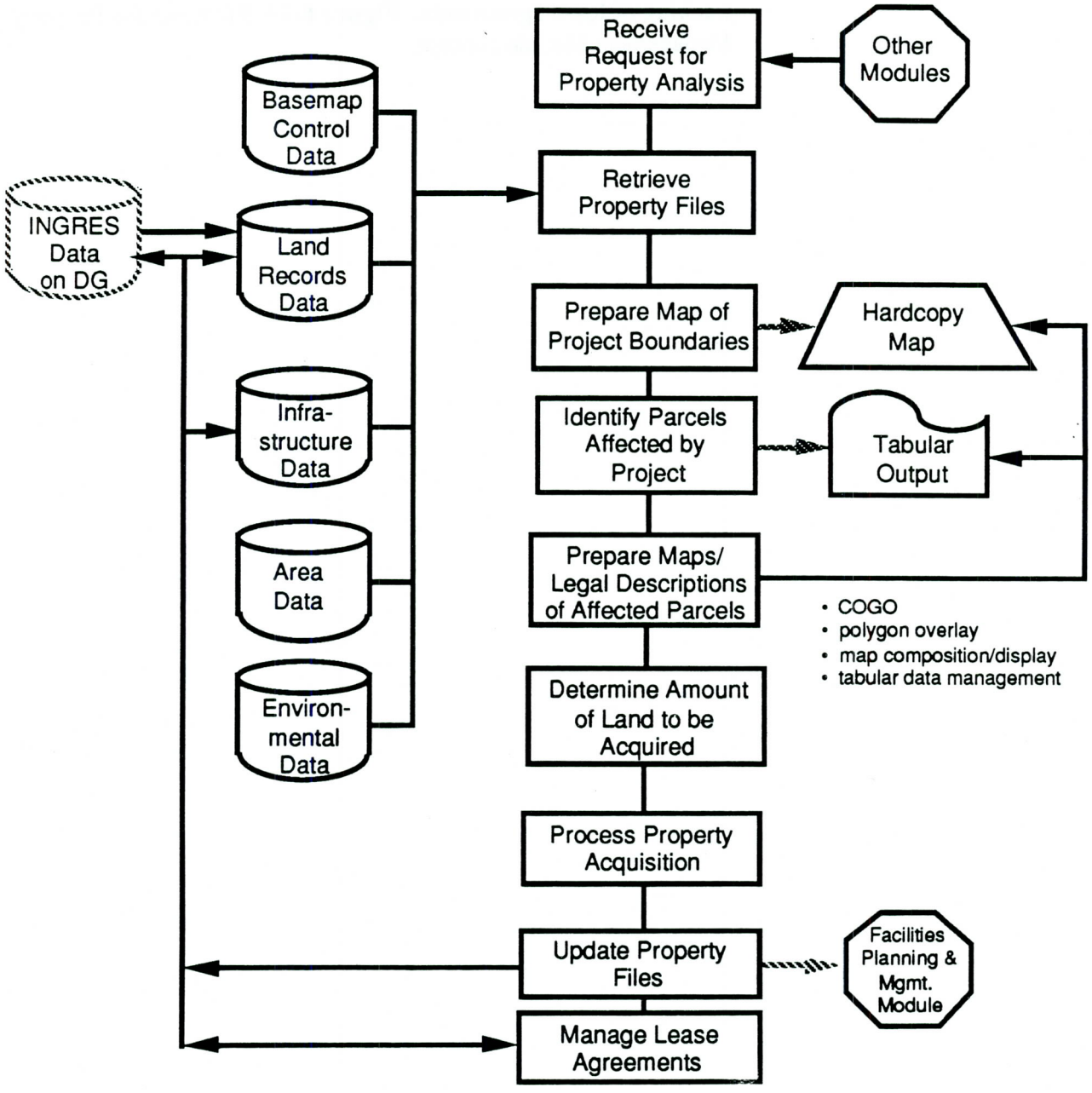
Flood Hazard Analysis and Modeling Module Concept



Completion of an acquisition transaction will then result in the update of property files in both GIS and INGRES databases, which in turn may initiate activities within the Facilities Planning and Management Module. The module will also support management and oversight tracking of lease agreements. **Figure 6-10** illustrates the Property Management Module concept.

Figure 6-10

Property Management Module Concept



Existing and Planned GIS Hardware/Software System

7.0

7.1 Overview

The District has acquired hardware and software for its system, as well as initiated procurement for further system acquisitions. The discussion of existing and planned GIS hardware/software systems that is presented below should be reviewed with the caveat that changes have most likely occurred since the preparation of this report. Limited recommendations are made concerning additional hardware requirements beyond those already planned by the District.

7.2 Existing Hardware/Software Systems

The District currently employs a Data General MV-40000 minicomputer system, the primary use for which is office automation activities. This system is interfaced via Ethernet to one DG AViiON 5100 file server with ARC/INFO® software, and four AViiON workstations (3 diskless 16 MB and 1 diskfull with 19" monitor) in the GIS Section. Thirty PCs can currently access this network. Four X Windows terminals are employed, as well as two CalComp pen plotters and two 9100 series digitizing boards. The Information Systems Branch is responsible for operating and supporting this equipment. The GIS Section, in particular, is responsible for all GIS-related functions for the District. **Figure 7-1** provides an illustration of the District's existing and planned hardware system configuration.

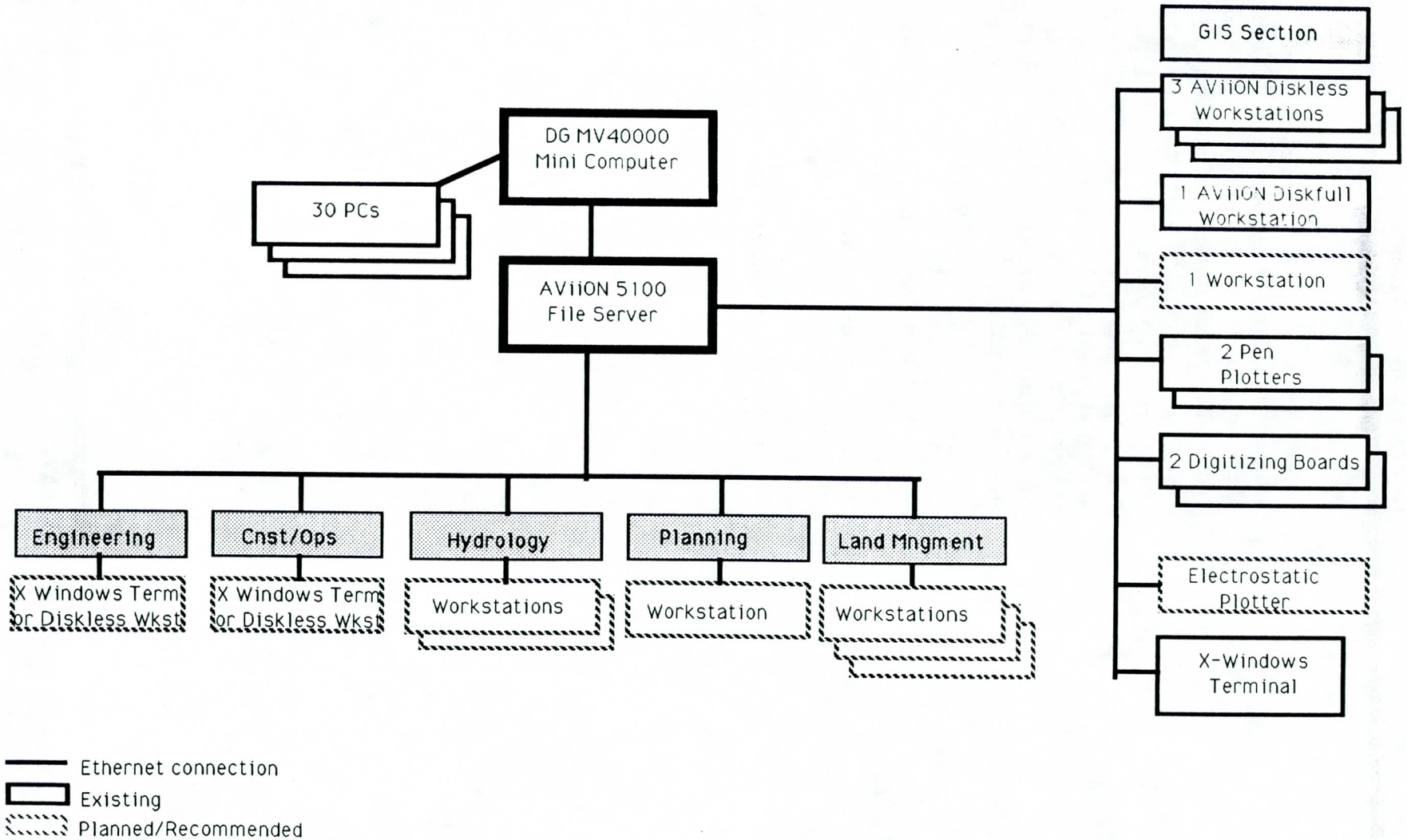
In addition to the use of ARC/INFO, the District has licenses for employing AutoCAD and the ALERT flood warning packages on selected District personal computers. AutoCAD is now used for sketching, chart production, general graphics, engineering plan modification, and floodplain mapping. The HEC-1 and HEC-2 models are currently used on the PCs, as well as the DG minicomputer (for larger projects). A COGO program is used for property acquisition studies. INGRES is being used to develop SQL databases for parcels owned and managed by the District, and also for other District functions.

7.3 Planned Hardware/Software Systems

Around March of 1991, the GIS Section is expecting to move to a new location, thereby alleviating current space limitations. Seven additional workstations are budgeted for acquisition at that time, including one for the GIS Section, two for Hydrology, one for Planning, and three for Land Management. An electrostatic plotter is also on order. The additional workstations should be allocated to those users who will be involved in high-volume map data entry, query, and/or demanding analytical transactions. For those users with anticipated medium-low query and analysis requirements, an X Windows terminal or diskless workstation is recommended.

Figure 7-1

Existing & Planned
Hardware System Configuration



As budgeted hardware acquisitions are completed, and the GIS design is implemented, it will be appropriate for the District to refine and modify certain existing operations. Two important GIS-related functions may benefit from adaptations to existing District operating procedures. First, the Land Management Division is now using a coordinate geometry package without an underlying data structure to create property files for the estimated 4,000 district-owned properties. As many as three workstations are budgeted to support this effort in the near future. It would be beneficial for the District to use software with an underlying data structure (useful for flexible data manipulation and analysis) in creating these records. District staff has voiced interest in moving to ARC COGO to support this work effort.

Second, the District plans to employ the GIS (rather than CADD software) for creating, storing, and maintaining floodplain maps in the future. As individual studies are performed, the District now modifies and improves the detail and accuracy of existing floodplain maps. The District hopes to establish an agreement with the Federal Emergency Management Administration whereby updated maps created by the District may be passed on to FEMA in digital form.

565/n

System Management, Staffing, and Training Recommendations

8.0

8.1 Overview

In this section, proposed design concepts for GIS system management, as well as staffing and training recommendations are presented. Key GIS administrative functions are first described, followed by a summary of roles typically found in support of these functions in a complete GIS system. A proposed GIS management structure is introduced. Training programs which will be important for fulfilling the array of functions and roles needed by the District are described.

8.2 GIS Administrative Functions

This section provides an overview of required administrative functions for a typical GIS organization. This information has evolved through ESRI's experience over the past decade working with local governments to develop organizational structures for managing multi-agency GIS systems. The information is intended to be used by the District as a guide in developing its own organization and staffing for the GIS.

Long-term administration of a GIS involves a broad range of general functions, from overseeing computer operations to coordinating inter-departmental user activities. These functions are carried out by various groups and staff within the GIS organization. As the system grows and matures, these functions and the groups responsible for performing them will probably change or expand. In the context of the organizational and administrative design, it is important to recognize the range of general functions associated with GIS implementation and administration. These functions help define how the GIS organization is structured and determine the staff resources and training required to build and maintain the organization.

Some of the general functions carried out by the GIS organization are listed below. Each function requires specific levels of managerial and technical expertise, as well as varying degrees of staff support.

- **System design and planning.** Design and planning activities are required not only in the early stages of the project, but also as an ongoing function as system requirements are continuously refined. Planning is required to respond to any changes in the organizational, technical, or political environment which the District GIS must support.

- **Coordination of system implementation and operation.** Implementation and operation of the GIS will require high level coordination to ensure that all user groups are working within a common framework.

- **Hardware and software acquisition and maintenance.** The GIS organization is responsible for assessing various technologies and vendors for hardware/software selection and

acquisition. This function also involves oversight and coordination of hardware and software vendor maintenance contracts, as well as in-house maintenance activities.

- **Development of database design and data standards.** GIS staff are required to develop and maintain database designs and data standards for the GIS. A comprehensive data dictionary and data standards document should be developed for this purpose.

- **Data conversion and maintenance.** GIS staff are required to automate and update both cartographic and attribute data in the GIS. Data automation can also be performed by outside contractors.

- **Development and maintenance of procedures for system operation.** Operational procedures should be established and clearly documented to ensure uniformity throughout the system. Documentation is used as a resource for both new and established users of the system.

- **Development and enforcement of quality control standards and any data security procedures.** The GIS organization is responsible for overseeing quality control of the database and operational procedures. This function also involves assessing any data security requirements, establishing workable security procedures, and maintaining them.

- **User support.** GIS users will require technical support in developing GIS databases and applications. This support will include database design, applications development, programming, and so forth. It may be provided by in-house experts or by outside consultants.

- **Training.** The full spectrum of GIS staff requires training, ranging from a general introduction to GIS concepts for managers and administrators, to more advanced technical training for data entry staff, data processors, and programmers. Staff training is discussed in more detail in Section 8.5.

8.3 Identification of Personnel/Roles Needed to Support the GIS

In this section, the GIS personnel roles needed to support identified functions within the GIS organization are described. This is followed by a description of existing and planned GIS positions within the District.

A broad range of staff roles and functions is required to support the GIS. Eleven such general roles have been identified which embody the needed administrative and technical skills to support the GIS. These roles are useful for defining what staff capabilities are required for operation of the GIS; they are not intended to delimit the respective responsibilities of existing or future personnel. Typically, staff responsibilities are dynamic in nature. In the early stages of system development, one person may fill many of these roles. As the system grows and matures, responsibilities are often distributed and staff will tend to become more specialized. Descriptions of the eleven typical GIS roles are provided below.

- ***GIS Management.*** The allocation of management responsibilities depends on the size of the GIS organization. In a small organization, one person may perform both high-level and technical-level management duties. In larger organizations, those responsibilities may be delegated among several staff. Most organizations have a ***Program Coordinator*** who is responsible for high-level management of the overall GIS program. This position must be filled by a person with a broad knowledge of GIS applications, capabilities, and overall system requirements. In many cases, the day-to-day management responsibilities of GIS projects, staff, and budget are delegated to a ***Project Manager***. This middle-level management position is usually only required in larger GIS organizations. The ***Applications Manager*** oversees the development of the GIS database and applications, and directly supervises lower-level production staff.

- ***System Administrator.*** One person should act as overall System Administrator for the GIS program. The System Administrator is knowledgeable and experienced in maintaining computer systems, including all hardware, software, telecommunications, peripherals, and associated supplies. The System Administrator must be familiar with GIS operations, how

they differ from traditional data processing systems, and how those differences affect system usage and administration. The System Administrator will have responsibility for assuring that GIS facilities are functioning properly at all times and resolving problems related to service interruptions or failures. Coordination with the administrators of non-GIS systems is also critical due to the interdependencies between computer hardware for GIS and non-GIS systems.

- ***Database Manager.*** The Database Manager is responsible for managing the spatial and tabular databases of the GIS. This role requires knowledge of the techniques and procedures for creating and maintaining automated map libraries and data dictionaries. The Database Manager plays a primary role in overseeing data automation and maintenance, and is involved in logical detailed database design, and the design and maintenance of standards related to data entry and update. The Database Manager works with users to implement the GIS data standards and quality assurance programs through creation and update of the data dictionary and development of automated data validation functions.

- ***Documentation Specialist.*** The Documentation Specialist assists the Database Manager in documenting the GIS database designs, data standards, operational procedures, and quality assurance programs. The Documentation Specialist is responsible for maintaining a common data dictionary for all system users, which contains the logical design of the GIS, data definitions, and coding schemes. This Documentation Specialist may also assist the Database Manager in maintaining both automated and conventional map libraries and document repositories.

- ***GIS Analyst.*** The GIS Analyst assists users in identifying and defining appropriate applications of the system and associated GIS products. The Analyst also works with users in planning and designing the analytical procedures and methodologies for performing the applications. The GIS Analyst is responsible for conducting in-house training, and tracking progress on system implementation and application projects. To perform these

functions, the Analyst needs specific knowledge of the computer operating system, the GIS software and its uses, GIS concepts, database design principles, and application design principles. The GIS Analyst should also have the ability to plan and communicate specific work tasks for database creation, management, applications development, and ongoing maintenance. The Analyst needs a basic understanding of the users' data, functions, and tasks for which the applications are to be utilized.

- ***Applications Programmer.*** This role requires proficiency in writing, testing, and documenting GIS application programs. The programming is typically based on designs developed by the GIS Analyst and programmed using the fourth-generation languages relevant for GIS applications development. The Applications Programmer is the developer of specialized applications software to meet specific user needs, ranging from the creation of special data conversion programs to the development and maintenance of user macros that facilitate system access by inexperienced users (e.g., menu-driven procedures).

- ***System Programmer.*** The System Programmer must be proficient at programming with FORTRAN, COBOL, or similar computer languages and must be knowledgeable regarding the use and maintenance of operating systems. Responsibilities include systems-level programming, writing data conversion programs, and developing interfaces to existing computer systems. The System Programmer role may, initially, be performed by the System Administrator.

- ***Cartographer.*** The Cartographer requires a strong background in map drafting/cartography with a working knowledge of land surveying techniques and geodetic control principles. The Cartographer commonly provides support at two key phases of GIS operation: 1) data entry, and 2) map display. For data entry, the Cartographer compiles and integrates map data for automation from diverse sources such as existing maps, aerial photography, and satellite imagery. The Cartographer also addresses ground control standards and solves problems related to the registration of different map layers. For map display, the Cartographer designs

high quality map and graphic products for output by the system; this requires a knowledge of cartographic design principles, graphic composition, and map production techniques.

- ***Geographic Data Processor.*** The Data Processor plans and sequences processing steps for database creation, application, and display. The Data Processor is also responsible for management of digital map layers and data files within a project work space and for performing complex processing functions such as analytical modeling and plot creation. The role may also include providing supervision and instruction to junior-level data processors, digitizers, and cartographers. To perform these functions, the Data Processor must know the software at the command level, know the computer operating system, and have the ability to design day-to-day processing tasks. The Data Processor should have considerable experience in generating map and report products using the system and have knowledge of map resolution, scale, and other elements of cartographic composition.

- ***Data Entry Specialist.*** Data entry staff include digitizers and keypunchers who enter map and tabular data into the GIS. In addition to performing data entry functions, these personnel may perform map editing, quality control checking, and basic geoprocessing tasks as outlined and directed by a senior Data Processor or GIS Analyst. The Data Entry Specialist role requires experience in executing software commands, knowledge of digitizing and data entry procedures, and experience using the computer operating system. This role may be performed by existing staff within the user divisions who have received GIS training.

- ***End User.*** The end users should have a general knowledge of GIS functions and capabilities as well as an understanding of how GIS technology can be applied to meet their needs. The users typically identify potential system applications, define products to be generated by the applications, perform data collection, and coordinate with other users of the system regarding shared database and software needs. It is important that end users have a knowledge of the kinds of GIS products that are available to meet

their application needs and of the overall software capabilities of the system. Users must also be able to identify resource requirements (software, hardware, data, time, personnel) for producing the desired products. It is the needs of the GIS users that the system must be designed to meet.

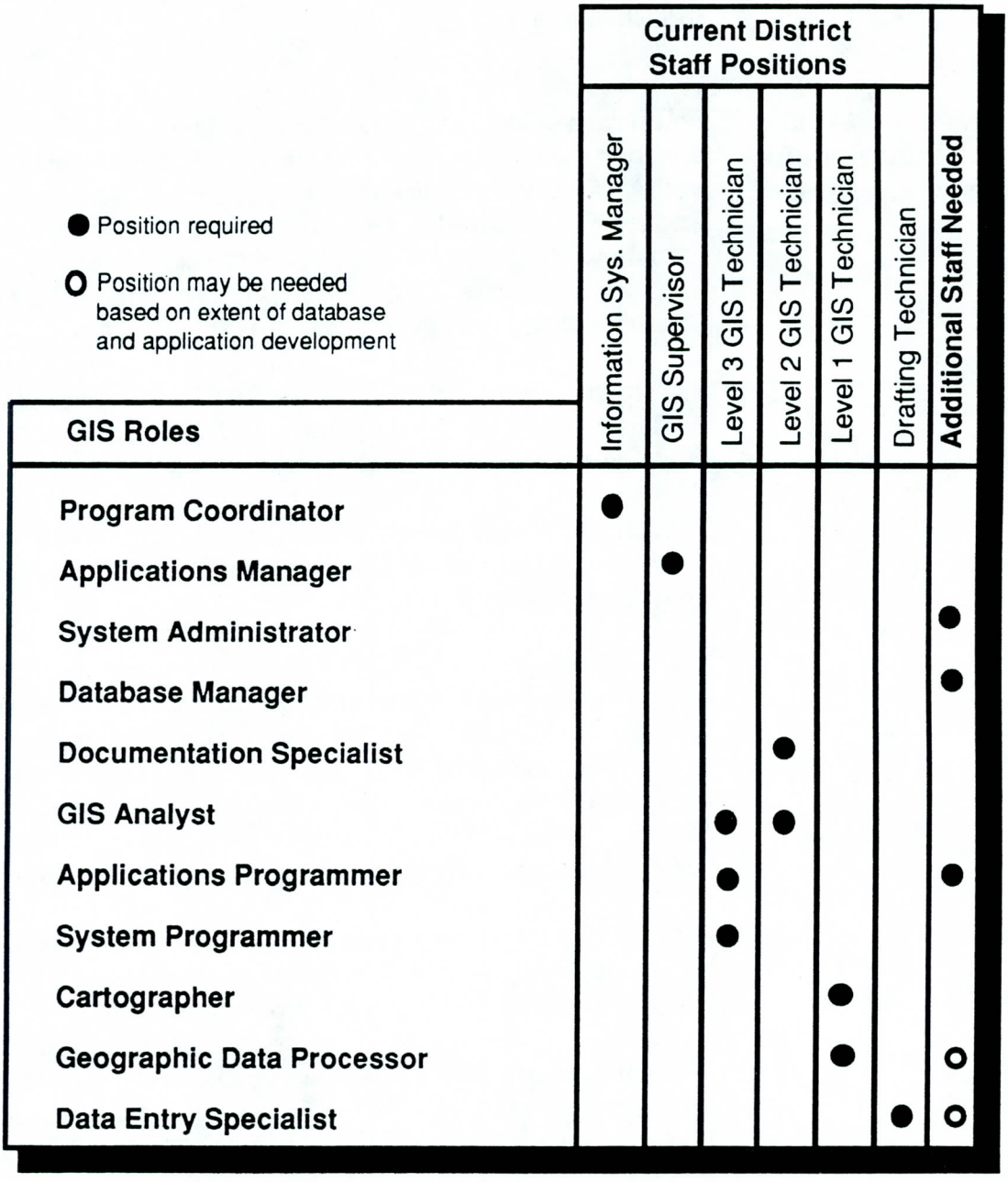
GIS operations are currently performed by the GIS Systems Section of the Information Systems Branch of the Administrative Division. The Information Systems Branch Manager, who is responsible for operation and maintenance of all computers owned by the District, also directs and coordinates GIS development activities. The GIS Systems Section currently performs both GIS and CAD functions, and has five GIS/CAD-related job classifications and eight current GIS/CAD-related positions. These personnel are now involved in data entry, data management, drafting, programming, and system management activities. The job titles, along with existing/planned slots are as follows:

- One (1) GIS Supervisor
- One (1) Level 3 GIS Technician (planned)
- Two (2) Level 2 GIS Technicians (one currently vacant)
- Two (2) Level 1 GIS Technicians (currently vacant)
- Two (2) Drafting Technicians

Figure 8-1 suggests proposed GIS roles and functions to be undertaken by current staff classifications. The Information Systems Manager should fill the role of GIS Program Coordinator, to perform high-level management of the overall program. The GIS Supervisor should assume the position of Manager of the day to day operations of the Sections, overseeing the development of the GIS database and applications, and managing staff. Additional staff will be needed to perform database management and system administration functions. Initially, these responsibilities could be assumed by one person, with the addition of a second as system growth demands. A single Level 3 GIS Technician can initially assume roles of Senior GIS Analyst, Applications Programmer, and System Programmer, but additional Applications Programmers will likely be needed to undertake full-scale development of the application modules. Level 2 GIS Technicians can

Figure 8-1

District Proposed Project Staff Roles



perform roles of GIS Analyst and Documentation Specialist, and Level 1 GIS Technicians can take on cartographic and data processing tasks. Depending on the level of in-house database development undertaken by the District, additional data processors and data entry specialists may be needed.

8.4 Organizational Structure for System Management

This section describes a proposed organizational structure for the operation and management of the District GIS. The structure is intended to meet the basic GIS administrative functions and staffing requirements described in Sections 8.1 and 8.2. This structure was formulated based on the interviews and discussions with District staff. It is intended to serve as a foundation for further discussions with the District, leading to concept refinement as appropriate.

The proposed organizational structure for GIS management is shown in **Figure 8-2**. A brief description of each component within the proposed structure is provided below.

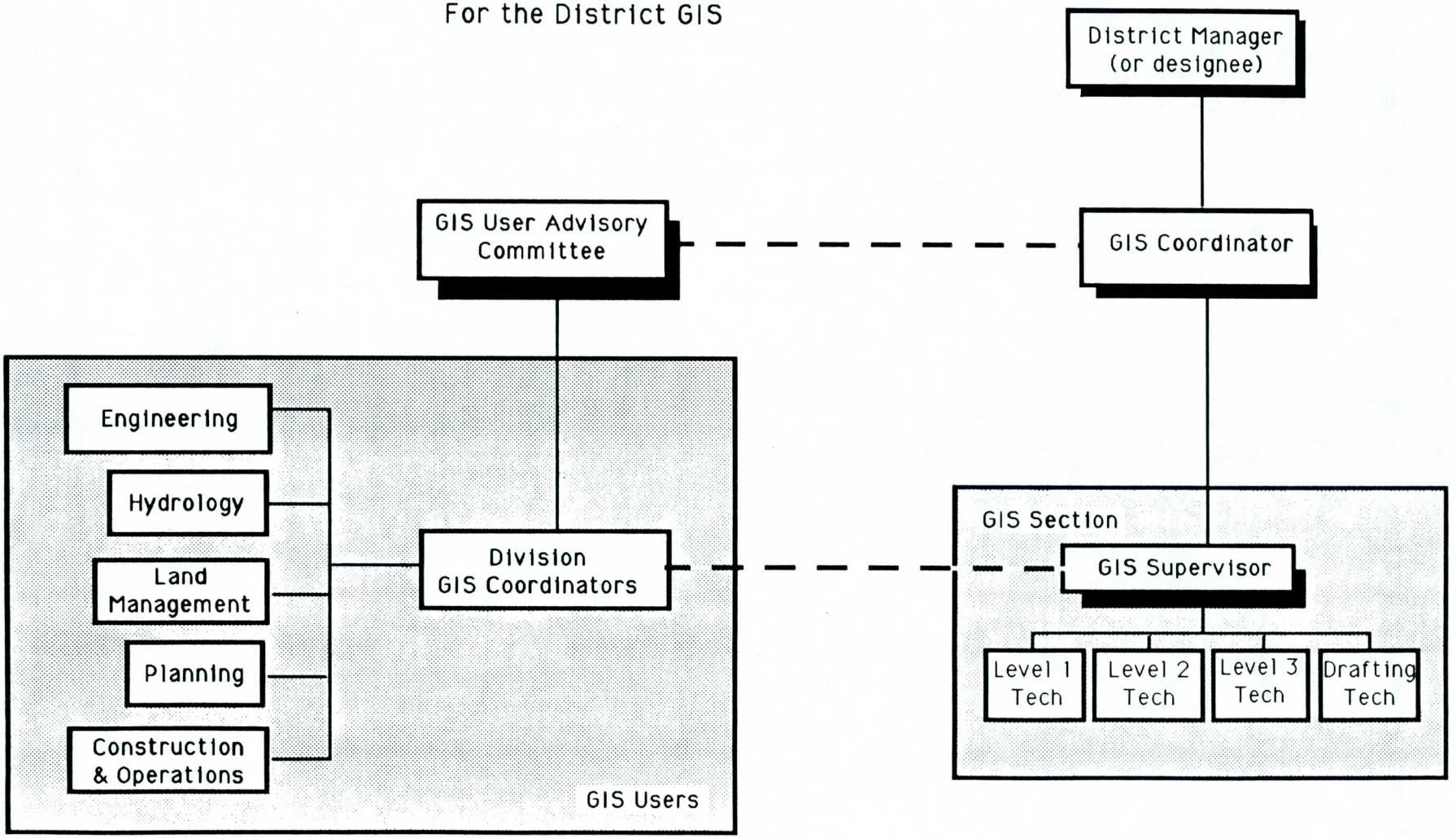
The **Chief Engineer/General Manager** (or designee) provides program oversight, and can direct coordination among District divisions and branches.

The System is guided by a **GIS Coordinator**, who oversees system operations in accordance with described functions of the program coordinator. The GIS Coordinator oversees all District staff involved in GIS operations and management. The GIS Coordinator also plays an important role in coordinating with the GIS User Advisory Committee, and as well as in guiding and interacting with the staff of various divisions involved in building and or using the GIS.

A GIS User Advisory Committee, comprised of the District manager/designee, and the directors of each division which will use the GIS, including Administration, Construction and Operations, Engineering, Hydrology, Land Management, and Planning and Project Management; aids in developing goals and strategies related to GIS implementation, and resolves coordination issues as they arise. It also serves as a staff-level decision-making body.

Figure 8-2

Proposed Organizational Structure
For the District GIS



The **GIS Section** is responsible for supporting many of the GIS-related activities of the District; these include most data entry, drafting, geographic data processing, database management, applications programming and management, system analysis, system programming, system administration, and documentation responsibilities. The GIS Supervisor manages and oversees GIS Section responsibilities, as well as provides support for the GIS Coordinator. Staff within the GIS Section, including GIS technicians and drafting technicians are available to support specialized GIS application needs of users in other divisions.

Staff within **GIS User Divisions**, including Construction and Operations, Engineering, Hydrology, Land Management, and Planning and Project Management, will perform analysis, query, and display functions using the GIS. Appointment of a part-time GIS coordinator by each Division, to work with the GIS Section and User Advisory Committee regarding both technical and administrative issues, is an efficient way to address user needs and applications on an ongoing basis.

8.5 Staff Training

The staff of the GIS organization will require special training in GIS technologies to perform the roles designated above. Adequate staff training is one of the most critical factors in successfully implementing a GIS. Training can be provided by GIS hardware and software vendors in two ways: either on-site at offices, or off-site at the vendor's own training facilities. The method chosen will depend on the type of training course, the number of people being trained, costs (including airfare, food, lodging), and availability of space and computer facilities.

Five general types of training are required during GIS implementation. These general categories cover a broad range of skills needed to perform the GIS roles discussed in the previous section, and are consequently targeted to different audiences. Some of the training is general in nature, designed to introduce the technology to a wide audience of managers and supervisors. More advanced technical training is required for selected personnel who will perform highly specialized geoprocessing functions. Each of the five general training

categories are listed below, along with examples of specific training courses that are within each category. These training courses are cross referenced to the GIS staff roles in **Figure 8-3**.

1. **GIS Concepts Orientation**

   - **Introduction to GIS.** This course is usually structured as a short seminar and is intended primarily for administrators, managers, or end users with little or no knowledge of GIS technology. The training introduces the most important concepts behind GIS technology, the major components of a GIS, and applications of GIS technology. Some light technical material is included to discuss the concepts of topology, map projections, and other GIS functions. Additional issues to be addressed include organizational considerations in implementing and managing a GIS, and the importance of database principles in GIS. This introductory-level course is not necessary for technical staff who are taking the basic software training.

2. **Hardware System Administration and Operating System**

   - **System Administration.** This course will train upper level staff in computer system administration and maintenance. Topics covered will include hardware installation and maintenance, peripheral device installation and interfacing, operating system commands, directory structure, file protection and security, and system backups. This course is provided through the GIS hardware vendor, and should be taken by the system administrator, database manager, system programmers, and, optionally, by the project manager.

   - **Operating System.** This type of course is intended for staff whose functional role requires learning the details of the hardware operating system. Most other staff and users of the GIS will gain sufficient knowledge of the operating system during the basic software training or end user training. The operating system training will cover operating system

Figure 8-3

Training Requirements by Job Classification

● Recommended

○ Optional

	TRAINING	Job Classification: Information Sys. Manager	GIS Supervisor	Level 3 GIS Technician	Level 2 GIS Technician	Level 1 GIS Technician	Drafting Technician	Division Coordinators	Division Users
1	Introduction to GIS								○
2	System Administration		●	●	○				
	Operating System		●	○	○				
3	Basic Software Training	○	●	●	●	●	○	●	○
4	Database Design		●	●	●			○	
	Applications Programming		○	●	○			○	
	Geographic Analysis		○	●	●			○	
	Cartographic Production			○	●	●		○	
5	Data Automation and Processing					●	●	○	
	End User Application Training							●	●

commands, utilities, and the directory structure. This course is provided by the hardware vendor and should be taken by the system administrator, database manager, system programmers, and, optionally, by most of the other categories of staff.

3. **Basic Software Training**

- **Basic Software Training.** This course will provide basic training and hands-on experience with the GIS software, and is required by most of the staff in the GIS organization. The course will include a general introduction to GIS, data automation techniques, database management, and data utilization and analysis. Typically, this course will provide staff with an introduction to the most commonly used functions of the GIS software through the use of video, slides, technical handouts, lectures, and exercises. The training will emphasize a hands-on approach to learning, which can be carried over into actual practice following the course. The length of this training is typically several weeks in duration, and should be taken by all categories of staff in the GIS organization, and, optionally, by departmental end users.

4. **Advanced Software Training**

- **Database Design.** This course will give staff an introduction to database design methodology, including the considerations of project scope, resource requirements, user needs, data sources, data quality, and database project management. Staff will acquire a basic knowledge of the concepts and process of designing and building a large, integrated, and well-structured GIS database. Topics covered will include user needs assessment, requirements analysis, conceptual design, and physical/detailed design. This course should be taken by the database manager, GIS analysts, and, optionally, by applications programmers.

- **Applications Programming.** This course will provide programming staff with the skills necessary to design, build,

and maintain their own GIS application programs using a fourth-generation programming language. Topics covered will include an introduction to coding, system design and implementation, program specification, and application production. This course is intended for high-level technical staff and should be taken by applications programmers, system programmers, and, optionally, by the database manager, GIS analysts, and advanced geographic data processors.

- **Geographic Analysis.** This type of training is intended to teach the basic concepts of geographic analysis and provide staff with the skills necessary to develop and implement complex spatial analysis models. Topics covered will include logical model design, verification, and basic modeling techniques using both spatial and tabular data. This training will strongly emphasize programming techniques using the attribute database portion of the GIS. This course is intended for high level technical staff and should be taken by GIS analysts, applications programmers, and, optionally, by the database manager.

- **Cartographic Production.** This course will introduce staff to basic cartographic design principles, map composition, graphic layout, symbology, and map production techniques for producing high quality computer-generated maps. Topics covered will include creating custom symbols and look-up tables, use of titles and legends, and the placement and use of map annotation. Emphasis will also be placed on developing application macros for producing a series of standard map products. This course should be taken by cartographers, GIS analysts, and, optionally, by applications programmers and advanced geographic processors.

5. Production/End User Training

- **Data Automation and Processing.** This type of training will provide lower-level technical staff with the skills necessary to perform digitizing, key entry of tabular data, and

geographic data processing functions. This course will emphasize hands-on training with the software and hardware devices used in a production environment, and will go beyond the scope of the basic software training course outlined above. This type of training would be taught by in-house staff of the GIS that have already been trained and have experience in GIS automation. This training should be provided to geographic data processors, data entry specialists, and, optionally, to certain end users.

- **End User Application Training.** Application training will provide end users with the skills required to run and maintain specific applications of the GIS. This type of training will vary in scope from informal hands-on instruction to a more structured classroom environment. The training would be provided by an in-house GIS analyst or programmer who developed the application.

Implementation Strategy

9.0

9.1 Overview

This section addresses the components of a proposed implementation strategy for GIS development for the District. The implementation strategy focuses on tasks and resources required to develop and maintain all components of the District's GIS: database, organization and staffing, hardware/software, and GIS applications. It provides a description of the work program, including a description of each task, its duration, entity(s) responsible for implementation, and dependencies on other tasks. It also presents an overall implementation schedule and provides estimates of resource needs to carry out the implementation plan.

Several key factors affect the District's approach to overall GIS implementation and, in particular, its approach to database development and maintenance. The District relies on outside sources for a substantial portion, perhaps as much as 50 percent, of its geographic data needs. As these sources develop their data in digital format, the possibilities for data exchange grow, along with the need for development of standards and procedures for data automation and exchange. Cooperative agreements for data sharing, coupled with

data automation and documentation standards, are mechanisms the District can use to provide for the integrity and quality of data received from other County departments, utility companies, state agencies, etc. Where data is unlikely to be available in digital form, the District should carefully consider how much of this data it is willing to automate and maintain over time.

The District's approach to development of the database will to a large extent be project-driven. In some cases, countywide data coverage may not be needed to support District GIS applications. Instead, these data may be developed on a project by project basis, as dictated by user division priorities. For example, GIS support will be provided for the Salt/Gila River projects (floodplain delineation/sediment transport and master plan/EIR). Such an approach to GIS implementation requires particular attention to organizational and database development issues, to ensure coherent and logical implementation over time.

9.2 Work Program

The Implementation Strategy work plan addresses the execution of major GIS components in a series of four development tracks. Track 1 addresses tasks associated with the organization and management of the District's GIS. Track 2 describes tasks necessary to support the design and development of the database. Track 3 describes tasks related to development of user applications and menu interfaces. Track 4 is concerned with installation of supporting hardware/software/communications systems.

The District has made considerable progress in the past two years in addressing its hardware/software system and organization/ management requirements, and in implementing these two GIS components. Thus, the focus of remaining implementation is on database and application development. Tasks required to implement these two GIS components are described below, along with tasks remaining in the areas of organization/management and hardware/software system. Each task is described in terms of its requirements, expected length of time for completion, and responsibilities for accomplishment.

Work tasks for each development track are as follows:

TRACK 1: ORGANIZATION/MANAGEMENT
- Formalize Organization/Management Structure
- Develop Annual Plan of Work and Budget
- Develop Cooperative Agreements for Data Sharing/Update
- Select/Hire GIS Support Staff
- Provide GIS Training

TRACK 2: DATABASE DEVELOPMENT
- Develop Data and Automation Standards and Procedures
- Develop Physical Database Design
- Develop RFP Specifications, Criteria for Evaluation/Selection of Vendors
- Prepare/Provide Automation Source Material
- Load Contractor Data
- Perform In-house Data Automation

TRACK 3: APPLICATION DEVELOPMENT
- Prioritize Applications
- Develop First Priority Applications
- Develop Second Priority Applications
- Develop Third Priority Applications

TRACK 4: HARDWARE/SOFTWARE/COMMUNICATIONS
- Test Relational Database Interface
- Monitor/Evaluate Hardware/Software Expansion Needs

Track 1: Organization/Management

Task 1-1: Formalize Organization/ Management Structure

Description: This task involves formalizing the District's existing GIS organizational and management structure, by outlining the structure and function of the organization, and defining responsibilities and prerogatives of participants, including the GIS Coordinator, User Advisory Committee, GIS Section, and User Divisions. Existing conventions and commitments should be made explicit. This task also involves addressing policies and procedures for system access and use, security considerations, and responsibilities for data development and update.

Timing/Duration: This task should be carried out very early in the implementation process, and can be accomplished over a three to four month period.

Responsibility: The GIS Coordinator, in conjunction with the User Committee can share responsibility for completion of this task.

Task 1-2: Develop Annual Plan of Work and Budget

Description: The implementation plan presented herein is intended to provide general guidelines for the overall effort. It will be necessary on an annual basis to review, revise, and detail the implementation plan, based on changing priorities, funding levels, and GIS experience gained. Because a substantial portion of the District's GIS database development will be project-driven, and because data will be obtained from outside sources, it is important to have a clear picture of what is to be accomplished during the year, how all elements will be integrated over time, and which elements can be addressed during the upcoming year. The annual work plan should provide a detailed strategy for accomplishing GIS objectives for the year. It should address such database development issues as data to be automated by the contractor, coordination of in-house automation with contracted automation, provision of data, and oversight of contractor activity. The annual work plan should contain a staffing requirements element, which identifies positions needed, salary ranges, and assignments for the year. It should assess funding requirements, address timelines and milestones, and identify special projects to be undertaken during the year.

Timing/Duration: Annual work plan development can be accomplished over a two to three month period. Timing of annual GIS plan development should correspond with the District annual budget development cycle, so that implementation objectives are in line with realistic funding levels.

Responsibility: The User Advisory Committee should provide review and input to the annual work plan, as developed by the GIS Coordinator/staff.

Task 1-3: Develop Cooperative Agreements for Data Sharing/Update

Description: The District has developed an agreement with the County Highway Department for use of its road centerline file. As other entities providing map data to the District begin to automate these data, the opportunities for digital data exchange expand. Development of cooperative agreements for sharing and updating of data layers provides a mechanism by which the District could access parcel, planning, water, sewer, and other data layers from County and private entities in exchange for providing District-developed floodplain and environmental layer data to these entities. Cooperative agreements can specify data format, quality, completeness, update frequency, documentation requirements, and so forth, providing for quality control in the data exchange process.

Timing/Duration: The possibilities for data exchange should be explored and updated continuously. Development/update of cooperative agreements may occur periodically throughout the implementation phase.

Responsibility: Communication with other data-producing entities can be done by the GIS Coordinator. Cooperative data sharing agreements can be drafted by the GIS Coordinator/staff and reviewed by the User Advisory Committee.

Task 1-4: Select/Hire GIS Support Staff

Description: The District has made considerable progress in staffing the GIS Section. Additional staff needs beyond the current level have been preliminarily identified, however (see Section 8.0). Selection and hiring of additional staff will be required during the GIS implementation process to support an expanding database, applications, and number of users. Through development of an annual work plan these staffing needs can be specified for the upcoming year(s). Candidates with the appropriate qualifications and experience should be recruited, screened, interviewed, and selected. Standard position descriptions should be developed for recruiting purposes. The general position descriptions provided in Section 8.0 of the report can be used to develop a more detailed specification of qualifications and responsibilities.

Timing/Duration: Staffing requirements should be reviewed at least annually, followed by selection and hiring of appropriate positions.

Responsibility: Assessment of staff needs can be done by the GIS Coordinator. Selection and hiring of staff should be performed according to District policies and procedures.

Task 1-5: Provide GIS Training

Description: The District has made considerable progress in providing GIS training, and should continue to train staff and users on the system. Training requirements are identified for GIS staff positions in Section 8.0 of this report. Hardware training should include instruction about the operating system and use of peripheral devices. Software training should include basic and advanced GIS software training and production/end user training. Staff involved in system operation, use, and maintenance, including programmers, system and database management staff, and selected users should be provided training. Also, users should be provided training sessions when major system upgrades and technology advances warrant such action.

Timing/Duration: Training of users should occur periodically throughout the implementation phase. Training needs should be identified in the annual work plan.

Responsibility: The User Advisory Committee can contribute to the identification of user training requirements. Actual training can be provided on an as-needed basis by hardware/software vendors, at least in the initial implementation stages. As use of the system grows, the District may consider assigning responsibilities for ongoing user training to a GIS Section staff person and/or Division GIS Coordinators.

Track 2: Database Development

Task 2-1: Develop Data and Automation Standards and Procedures

Description: This task involves development of database standards and procedures for automation. Database standards should be established to address requirements for data sources, map projections, map accuracy and resolution, logical consistency, and data completeness. Attribute file standards, code classification schemes, and item definition standards should be developed. Automation standards should be set for data integration and preparation, establishing topology, and acceptable level of error. Automation procedures, including manuscript preparation, cartographic feature automation, basic processing, attribute assignment, and advanced processing should be addressed. Quality assurance criteria for data quality should be established, along with procedures for quality control during the automation process. Policies and standards for documentation of data sources, automation methods, and products should be set. Criteria for data transmittal should be developed.

Timing/Duration: Development of data standards and automation procedures should occur in the initial stages of implementation, over a six to nine month time frame.

Responsibility: Data standards and automation procedures should be developed by the GIS Coordinator and staff, with review and input from the User Advisory Committee.

Task 2-2: Develop Physical Database Design

Description: Drawing on the framework provided by the conceptual database design, this task involves development of a detailed physical database design which addresses the five primary components of the database. These components include

- Cartographic layers
- Feature attribute tables
- Related lookup tables
- Map annotation (text)
- Map library structure

The physical design focuses on defining the specific data elements, physical formats, and coding schemes of the database, and should be

documented in a data dictionary. In designing these components to meet specific application requirements, underlying goals should be to maintain data consistency and integrity, reduce data redundancy through normalization of the database, and increase system performance while maintaining maximum user flexibility. In addressing performance and user flexibility issues, consideration should be given to which related attribute files should reside in INFO and which should be designed as INGRES files.

Development of a database design is a critical step in the implementation process, and should precede data automation tasks. The physical database design should provide the structure and content of the database for all automation, both contracted and in-house. The approach to data automation will largely be on a project area by project area basis. The database design should contain an overall strategy for automation of layers, which considers such factors as coverage, input scale, and method of automation, as shown in **Figure 9-1**.

Specification of the database should also be coordinated with the application development process to ensure that the database will properly and completely support the applications. As such, periodic review and update of the database design will be necessary with a phased approach to application development.

Timing/Duration: Database design should occur in the early stages of implementation, in concurrence with development of data standards and prior to actual automation. Estimated time for database design is six to nine months.

Responsibility: GIS Section staff should take the lead in database design. Database design for current contractor projects (i.e., Salt/Gila Rivers) can provide significant input to the overall District database design.

Figure 9-1

Database Automation
Implementation Approach

LAYER	INPUT APPROACH/ COVERAGE	INPUT SCALE	IN-HOUSE AUTOMATION	CONTRACTED AUTOMATION	OBTAIN DIGITAL FORMAT
Control points	CW	1:1200	25%	50%	25%
PLSS	CW	1:24000			100%
Topography	CW	1:24000			100%
Topography	PA	1:1200	10%	90%	
Planimetry	PA	1:1200	75%	25%	
Parcels	PA	1:1200	100%		
Easements	PA	1:1200	100%		
Project Boundaries	PA	1:1200	75%	25%	
Street Centerlines	CW	1:24000			100%
Storm Drainage	PA	1:1200	20%	80%	
Sewer	PA	1:1200	75%	25%	
Water	PA	1:1200	75%	25%	
Electric	PA	1:1200	75%	25%	
Gas	PA	1:1200	75%	25%	
Communications	PA	1:1200	75%	25%	
Political Boundaries	CW	1:24000	75%	25%	
Zoning	CW	1:24000			100%
Hydrology	CW	1:24000			100%
Hydrology	PA	1:1200	75%	25%	
Floodplain	CW	1:1200	50%	50%	
Precipitation	CW	1:24000	90%	10%	
Soils	CW	1:24000			100%
Slope	PA	1:1200	75%	25%	
Land Use	CW	1:24000			100%
Natural/Cultural Features	CW	1:24000			100%
Environmental Monitoring Sites	CW	1:24000	75%	25%	
Waste Discharge	CW	1:24000	75%	25%	
Solid/Hazardous Waste	CW	1:24000	75%	25%	
Surficial Geology	CW	1:24000			100%
Depth to Groundwater	CW	1:24000	75%	25%	
Groundwater Contamination	CW	1:24000	75%	25%	

*PA-automation will occur on a project area by project area basis. Not likely to result in complete county-wide coverage

*CW-layer will be designed as a county-wide coverage; automation is independent of project area work

Task 2-3: Develop RFP Specifications, Criteria for Evaluation/Selection of Vendors

Description: RFPs for database development should define technical specifications and cost requirements for data automation. Specifications should be based on the physical database design, data standards, and automation procedures developed in previous tasks. Specifications should address layers/attributes to be automated, their format, scale of automation, accuracy requirements, product deliverables, quality tolerances, and automation procedures. Criteria for the evaluation and selection of vendors should be developed to assure vendor responsiveness to technical requirements, and capabilities to provide the quality of product needed within the appropriate time frame and cost parameters.

Timing/Duration: Development of RFP specifications and vendor selection criteria should occur in the early stages of implementation, drawing on specifications developed in the database design and data standards formulation process.

Responsibility: The GIS Coordinator and staff should take the lead in carrying out this task, with input and review provided by the User Advisory Committee.

Task 2-4: Prepare/ Provide Automation Source Material

Description: The data automation process should begin with an organized, complete, and accurate set of source materials. These materials should be collected, organized, and prepared for automation. Preparation of materials may include manual editing of maps and compilation/restructuring of tabular records.

Timing/Duration: Organization and compilation of data source material can begin during the database design process.

Responsibility: Preparation of automation source material should be accomplished by the GIS Section staff, in cooperation with Division staff.

Task 2-5: Load Contractor Data

Description: Incremental loading of data will provide users with access to portions of layers/attributes as they are automated. This will allow testing and use of applications with the appropriate data, as well as testing and refinement of data use and management procedures. As portions of data layers are completed and quality checked, they can be loaded on the system. Mechanisms should be established to advise users of new data on the system and to phase out use of manual data.

Timing/Duration: Data loading can occur incrementally throughout the implementation period.

Responsibility: Data loading should be done by the GIS Section staff.

Task 2-6: Perform In-House Data Automation

Description: Although a large portion of the District's database is expected to be automated by contractors or obtained in digital format, some in-house data automation is anticipated. For example, it may be necessary to automate a test database to be used in the testing of applications programs. In-house data automation should conform to the physical database design, and adhere to established data standards and automation procedures. It should include, at minimum, creation of a map library structure and automation of geodetic control layers. The District's ability to automate map layers will depend on staff and funding availability. In-house automation plans and goals should be addressed in the annual plan of work.

Timing/Duration: Data automation follows the design of the database, development of standards, and preparation of source materials. It may occur throughout the implementation phase, depending on need and staff availability.

Responsibility: Data automation is the responsibility of the GIS Section staff. Some automation of tabular data may be done by user Division staff.

Track 3: Application Development

Task 3-1: Prioritize Applications

Description: Application modules have been identified on a conceptual level based upon the information gathered in the user needs assessment. These seven modules together describe the initial functional requirements of the GIS. The first step in the application development process is to set priorities for development of applications. Factors to consider in establishing initial priorities include perceived need, visible impact on District operations and products, relative complexity and required interfaces, budgetary considerations, and programming staff availability.

It may be possible and in fact desirable to initially program only a portion of the functionality of a particular application module. For example, the Data Entry and Maintenance Application Module is intended to provide a set of automated procedures for the development and continued update of most GIS map layers. However, an initial high priority of the District may only be floodplain map automation/maintenance, and thus application development may need to focus on a user interface for automated data entry/maintenance for floodplain related layers, and production of floodplain maps and reports. It may be necessary to automate a test database to use in the applications testing process.

Timing/Duration: The process of setting priorities for application development should occur in early implementation stages, over a three to four month period.

Responsibility: Prioritizing applications should be a joint effort of the User Advisory Committee, GIS Coordinator and staff, and Division Coordinators. Input should be solicited from each user Division.

Tasks 3-2, 3, 4: Develop First, Second, Third Priority Applications

Description: Development of each application should follow a standard methodology consisting of the following steps:

- Requirements Analysis/Functional Description
- Conceptual System Design
- Prototyping
- Detailed System Design
- Coding/Testing/Documentation
- Installation and Training

Requirements Analysis and Functional Description: The first step in the development process is to review the application module concepts as described in this document to determine: 1) application objectives, 2) general processes and software functionality to be addressed, 3) primary data used and/or generated, and 4) outputs or products to be generated through the application. Follow up interviews with staff who perform functions supported by the applications should be conducted. Results should be analyzed to identify specific user groups for the applications, the specific functions that the applications must perform, the data sources used, the products created, and the detailed procedures now in use to carry out the functions. The product of this task should be a functional description of the application.

Conceptual System Design: For each of the applications identified in the requirements analysis task, a conceptual system design should be prepared which describes the major functionality of the applications. The system design should focus on the user interface and menu structure of the applications. The functionality of each module and menu option should be described using text and diagrams.

Prototyping: Application prototype development provides an opportunity for evaluating the database and application design standards and protocols prior to extensive development. Prototyping can help potential users to specify detailed needs and enhancements interactively as they view a demonstration. The need for and extent of prototyping is variable, however,

depending on such factors as the complexity of the application, the ability of users to define interface and functional requirements, and the need to test and prove alternative development methods. This approach can provide an effective way of identify refinements and make design modifications before formal coding begins.

Detailed System Design: Preparation of a detailed programming design guides the phasing and execution of application development steps. A detailed design should provide programming specifications for data input, management and retrieval procedures, and data output and reporting requirements. User interface capabilities, such as menus, data entry views, map characteristics, and report formats should be addressed. Data formats, file structures, and key data items to be used in linking files with other database components should be addressed. The actual coding of the applications is based on the detailed system design.

Coding, Testing, Documentation: In this step, the code is written and tested. Applications program coding and testing should conform with the detailed design described above. The application development process involves a systematic process of testing, first with small prototype data sets, followed by an actual data set. Users should be an integral part of the review and testing process. Coding and testing activities also involve thorough documentation, both of a technical and user-oriented nature. Three basic types of documentation should be prepared: 1) program documentation as comment statements in the source code, 2) technical documentation describing the structure of application programs, and 3) user documentation guiding the user through the application steps.

Installation and Training: Once the application is operational on the developer's system, it can be moved into the District's computing environment for general access. Applications training should be provided to users, and should involve hands-on system use.

Timing/Duration: The time required for development of application modules is variable, depending on such factors as the size and complexity of the application, and the number, skill level, and percent of time of applications programmers available. Generally, the process of application development, from functional description through installation and training is estimated to require six to nine months per application.

Responsibility: GIS staff should be responsible for the development of user application modules.

Track 4: Hardware/Software/Communications

Task 4-1: Test Relational Database Interface

Description: The District has virtually completed its initial hardware/software acquisition, installation, and testing, with the exception of the relational database interface (RDBI) software, which provides the connection between the GIS software and RDBMS. This interface will allow for the use of existing RDBMS data and feature attributes with the GIS. Once the RDBI is installed, the District should spend some time testing it to optimize design of attribute files and enhance system performance. A thorough understanding on the part of applications programmers of the capabilities and limitations of the interface will ensure optimal use of the RDBI in applications programs.

Timing/Duration: This activity should be performed during the early stages of database design and prior to development of applications programs, and can occur over a two to three month period.

Responsibility: GIS Section staff should perform this activity.

Task 4-2: Monitor/Evaluate Hardware/Software Expansion Needs

Description: As development of the database progresses and user applications are completed and available for District staff to use in support of daily operations, requirements for additional hardware/software should be examined. An assessment of need for additional equipment would be followed by steps of preparation of specifications and an RFP, evaluation and selection of products, preparation of sites for installation, installation of equipment, and providing user training and support.

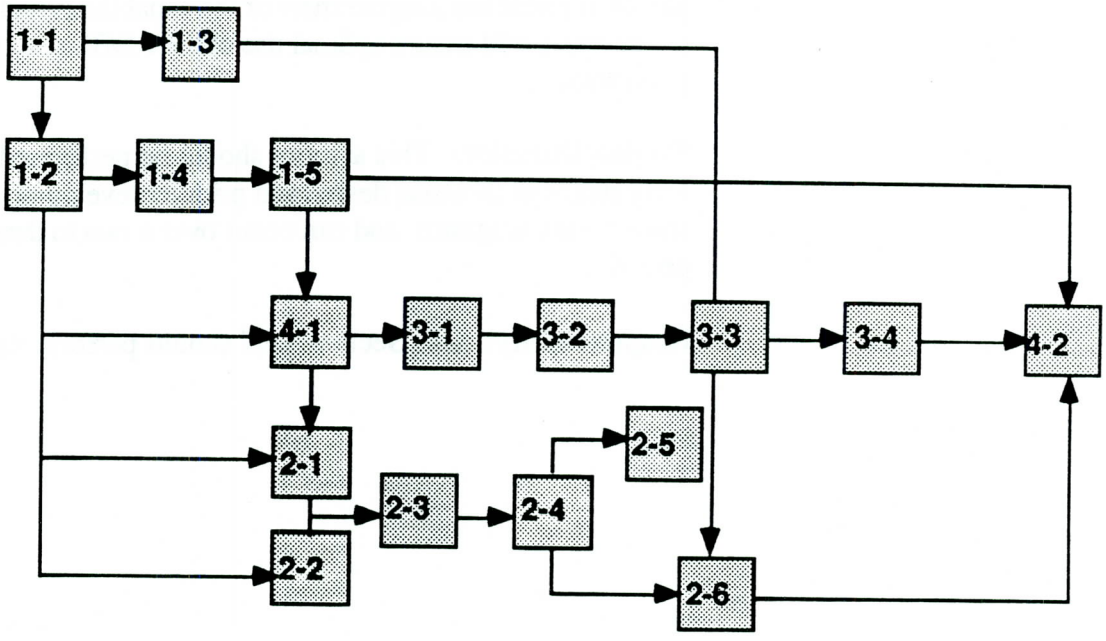
Timing/Duration: Assessment of need should occur periodically throughout the implementation phase.

Responsibility: Monitoring hardware/software expansion needs should be done by the GIS Coordinator, in conjunction with the User Advisory Committee and Division Coordinators.

Task Dependencies

Relationships and dependencies between tasks are shown in **Figure 9-2**. Task numbers shown on the figure correspond to those of the task descriptions above.

Figure 9-2
Task Dependencies



9.3 Implementation Schedule

The implementation schedule, as shown in **Figure 9-3**, illustrates the general time requirements and phasing of work tasks described previously. The schedule reflects the four component GIS development tracks, and is phased based on considerations of implementation objectives, task dependencies, priority activities, and resource requirements. It is presented in quarter year periods, to allow for flexibility in planning work task performance and to recognize the difficulty in planning in detail for some activities more than one year in advance. Development of an annual work plan, as described in Task 1-2, provides for annual reassessment and detailed planning of upcoming work tasks. This regular planning should occur to assure implementation occurs according to evolving priorities, funding realities, and staff resource availability.

9.4 Resource Requirements

This section provides estimates of resources needed to implement the GIS as developed in the conceptual design process, along with estimated costs of those resources, where available. Resource needs are addressed by each of the four GIS development tracks, and include explanations of assumptions upon which estimates are based as well as information sources where applicable. Cost estimates presented are intended to only indicate the general magnitude of financial resources needed for GIS development in the District.

Resource requirements for ***Track 1: Organization and Management*** include additional GIS Section staff and training. GIS staff positions needed to support the District's operations were identified in Section 8.0. These include GIS Database Manager, System Administrator, and Applications Programmer positions. These positions should be Level 2 and 3 GIS Technician positions, at estimated annual salaries of $30,000–33,000 and $35,000–38,000, respectively (based on proposed entry level salary ranges provided by the District, including salaries and benefits).

Training costs are calculated based on the premise of one week of training per year for GIS Section staff (8 current and 3 planned) and 5 Division Coordinators. At an estimated cost of $300 per person per day, annual training costs would average $24,000 per year.

Figure 9-3
Proposed GIS Implementation Schedule
Maricopa County Flood Control District

TRACK 1: ORGANIZATION/MANAGEMENT

- Formalize Organization/Management Structure
- Develop Annual Plan of Work and Budget
- Develop Cooperative Agreements for Data Sharing/Update
- Select/Hire GIS Support Staff
- Provide GIS Training

TRACK 2: DATABASE DEVELOPMENT

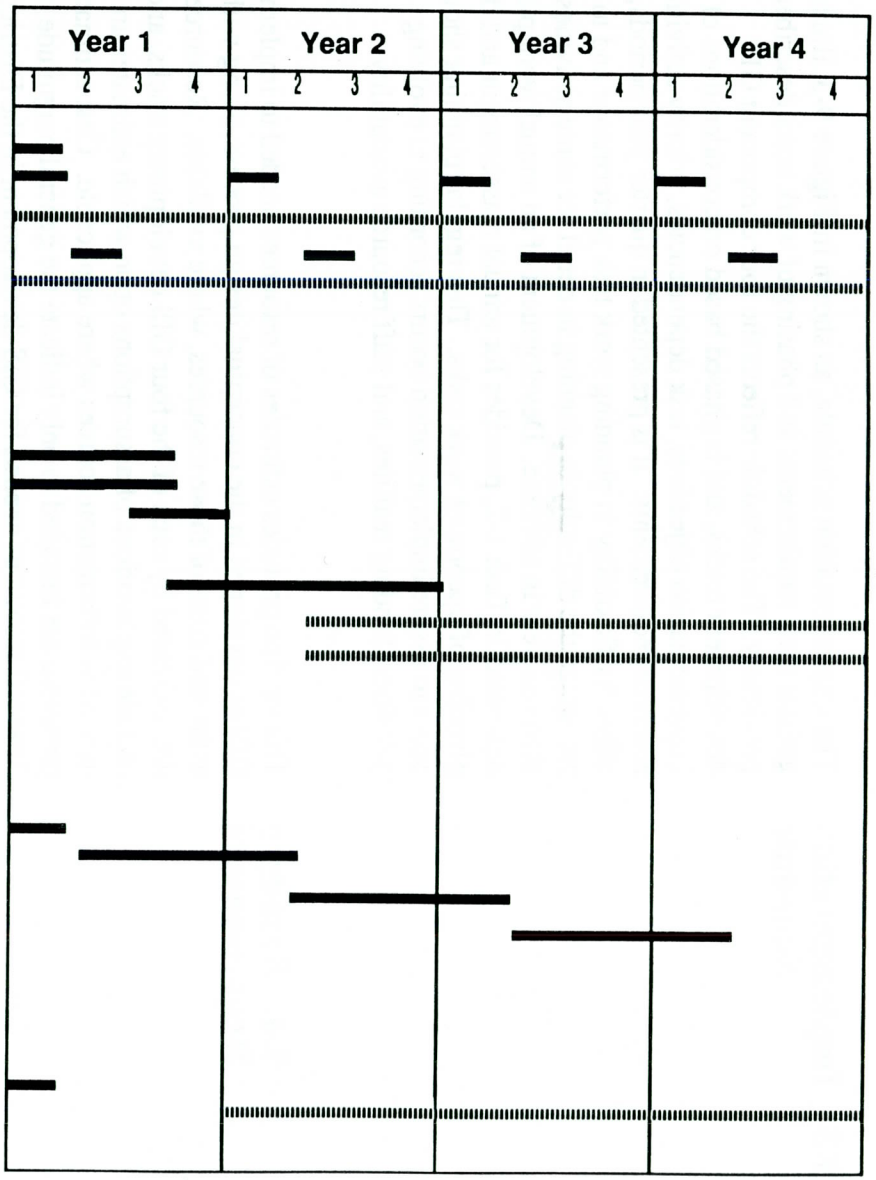
- Develop Data and Automation Standards and Procedures
- Develop Physical Database Design
- Develop RFP Specifications, Criteria for Evaluation/ Selection of Vendors
- Prepare/Provide Automation Source Material
- Load Contractor Data
- Perform In-house Data Automation

TRACK 3: APPLICATION DEVELOPMENT

- Prioritize Applications
- Develop First Priority Applications
- Develop Second Priority Applications
- Develop Third Priority Applications

TRACK 4: HARDWARE/SOFTWARE/COMMUNICATIONS

- Test Relational Database Interface
- Monitor/Evaluate Hardware/Software Expansion Needs



Resource requirements for ***Track 2: Database Development*** are based on figures by the District for contracted database development. These figures include a current year estimate of $1.2 million and a next year estimate of $1.8 million. Also, some GIS Section staff time is anticipated to be devoted to database development. This could involve hiring additional staff for data processing and data entry.

Resource requirements for ***Track 3: Applications Development*** consist of GIS Section staff time for applications design and development. Staff positions which should be involved in developing applications include GIS analysts, applications programmers, and documentation specialists. The applications as described in Section 6.0 can be expected to require an estimated six person months of effort each, with variation in this level of effort due to increasing or decreasing scope or complexity.

Resource requirements for ***Track 4: Hardware/Software*** have to a great extent been previously addressed. A estimated $430,000 has been expended on the purchase of GIS hardware/software/communications equipment, and expenditure for the current year is estimated at about $500,000. Beyond this, no major expenditures are anticipated for the next few years, although the need for additional equipment will be monitored throughout the implementation period.

565/p

Appendix A

Interview Summaries

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Appendix A—Interview Summaries

Maricopa County Flood Control District
Division: Administration
Branch: Information Systems/GIS Section
Date: March 29, 1991
Interviewee: Marta Dent, GIS Supervisor

GIS-Related Tasks

1. Map floodplain delineations. The GIS Section maps floodplain delineations to support the Hydrology Division. This includes drafting cross-section lines onto topographic maps, drafting floodplain boundaries that result from the output of the HEC-2 model, and digitizing those boundaries using AutoCAD. The resulting digital maps are overlaid with the 1"=1200' zoning basemap for use at the public counters.

2. Map land ownership and project boundaries. This task is performed to support the Land Management Division which provides the GIS Section with legal description maps for individual parcels on separate sheets of paper. The GIS Section edgematches the information and prepares a digital map of the entire project area using AutoCAD.

3. Prepare maps for public information. This task is performed to support the Public Information Branch of the Administration Division. The maps are produced using AutoCAD or Intergraph and may include location maps and various types of flyers, brochures, and other presentation graphics.

4. Draft schematic diagrams for flow path models. This task is performed to support the Hydrology Division. The GIS Section drafts subbasins and concentration point symbols showing the connectivity of all elements in the flow model.

5. Map soils. This task is performed to support the Hydrology Division. Watershed boundaries are overlaid with soil maps to create Watershed Soil Maps.

Data Used/Generated

- Topography
- Floodplain boundaries
- Floodplain cross-section locations
- Project boundaries
- Parcels
- Watershed boundaries
- Subbasins
- Concentration points
- Soils

Products

- Floodplain Delineation Maps
- Strip Maps
- Quarter Section Index Maps
- Flow Path Model Schematic
- Watershed Soils Map

Potential GIS Applications

- Data entry and editing. The GIS Section will be responsible for supporting other District divisions by entering and maintaining map data in the GIS.

- Overlay and analysis to create maps and GIS products for other District divisions.

- Map composition and production.

Maricopa County Flood Control District
Division: Construction and Operations
Branch: Environmental
Date: March 29, 1991
Interviewee: Catesby Moore, Environmental Program Manager

GIS-Related Tasks

1. Produce maps required by NPDES for industrial and stormwater drainage. Maps include all tributaries of U.S. waters, drainage basins, location of outfalls, and monitoring locations.
2. Maintain vegetation, wildlife, and soils inventory for all project areas. This task is part of the Branch's general function of maintaining vegetative erosion control improvements to District properties.
3. Conduct environmental review of District projects to identify potential impacts on Superfund sites, landfill sites, archaeological sites, and endangered/threatened species.

Data Used/Generated

- Hydrology
- Drainage basins
- Monitoring locations
- Location of outfalls
- Location of permit holders
- Types of discharge
- Irrigation canal discharge
- Industrial sites
- Dairy and agricultural sites
- Landfill sites
- Superfund sites
- Archaeological sites
- Land use
- Vegetation
- Soils
- Wildlife
- Endangered/threatened species
- Rainfall

Products

- Groundwater Contamination Map
- Land Use Map
- Threatened and Polluted River Reaches Map

Potential GIS Applications

- Aggregate information by stream segment, basin, and EPA river reach classification.
- Tool for locating potential monitoring sites.
- Tool for determining groundwater use within specified areas by combining well permit data, water quality, and land use data by aquifer.
- Access maps of endangered species locations, archaeological resources, soils data, landfill sites, and EPA monitoring locations.
- Access industrial site locations, discharge maps, and monitoring data to assess compliance.
- Prepare maps for Environmental Assessments.
- Prepare maps for public information meetings.
- Produce drainage map required by Federal Agency with land use, permit holders, discharge, industrial, dairy, agricultural sites, and irrigation canal discharges.

Maricopa County Flood Control District
Division: Construction and Operations
Branch: Operations and Maintenance
Date: March 29, 1991
Interviewees: Bob Payette, Chief, Construction and Operations Division
Ellery Biathrow, Deputy Chief, Construction and Operations Division

GIS-Related Tasks

1. Maintain District projects and facilities including dams, bridges, fences, underground facilities, electrical lines, and vegetation.

Data Used/Generated

- Project structures
- Public rights-of-way
- Fences
- Underground facilities
- Electrical facilities
- Maintenance records

Products

- Project and Structure Location Maps
- Facilities Maps
- Scheduling Chart

Potential GIS Applications

- Facilities management application for scheduling maintenance and inspections by type of structure.
- Provide job site maps to field personnel with location and type of maintenance required.
- Access maps of underground facilities in conjunction with public facilities to evaluate project requirements.
- Access maps of utility locations including electrical, gas, telephone, and cable lines.

Maricopa County Flood Control District
Division: Engineering
Branch: Stormwater Drainage
Date: March 28, 1991
Interviewee: Steve Tucker, Stormwater Drainage Branch Manager

GIS-Related Tasks

1. Review permit applications for compliance with drainage regulations. This task includes reviewing both conceptual and detailed site plans submitted by the applicant, inspecting sites if necessary, and approving or denying a permit.
2. Issue drainage clearances.
3. Inspect sites for compliance with drainage regulations.
4. Respond to drainage inquiries and complaints.

Data Used/Generated

- Topography
- Roads
- Soils
- Rainfall
- Delineated floodplains
- Zoning
- Parcels/easements/land ownership
- Drainage tracts
- Drainage basins/concentration points/discharge
- Proposed land use
- Incorporated area boundaries
- Permit application sites
- Drainage clearance status

Potential GIS Applications

- Compile basic information about properties for permit evaluation including location, zoning case number(s), zoning designation, whether in or out of floodplain, topography, relevant drainage studies, finish floor criteria, wall criteria, and so forth.

- Maintain records on inspection and clearance status of permit applications and properties.
- Overlay incorporation boundaries to determine jurisdiction.

Maricopa County Flood Control District
Division: Hydrology
Branch: Floodplain Management
Date: March 28, 1991
Interviewees: Joe Tram, Floodplain Management Branch Manager
Pedro Calza

GIS-Related Tasks

1. Delineate floodplains. This task includes flying aerial photography of the study area and generating a contour map through photogrammetric means, generating floodplain lines using the HEC-2 model, and drafting floodplain boundaries onto the Floodplain Zoning Maps. The data are distributed to the Federal Emergency Management Administration (FEMA) for use in compiling the Flood Insurance Rate Maps (FIRM).

2. Regulate floodplain development. The Floodplain Management Branch issues Floodplain Use Permits and inspects construction sites for compliance with floodplain use regulations.

3. Provide project design support to Engineering Division.

Data Used/Generated

- Aerial photos
- Topography
- Hydrology
- Floodplains
- Permit application sites/permit files
- Parcels/property ownership
- Landfill sites

Products

- Floodplain Delineation Map
- Floodplain Work Map
- Flood Profile Map
- Solid Waste Landfill Sites Map
- Permit Application Sites Map
- Permit Application Files

Potential GIS Applications

- Production of floodplain delineation maps.
- Production of project location and permit site maps.
- Storage and maintenance of project and floodplain history data.
- Overlay analysis of topography, floodplains, and property information.

Maricopa County Flood Control District
Division: Hydrology
Branch: Special Projects
Date: March 29, 1991
Interviewee: Joe Rumann, Manager, Special Projects Branch Manager

GIS-Related Tasks

1. Manage real-time flood warning system. The Special Projects Branch coordinates with Civil Defense for emergency response and evacuations, dispatches crews to handle problems in the field, and coordinates with other jurisdictions on flood-related matters. The branch is currently using a PC-based system with ALERT software to monitor flood levels in real time at gauge stations. Part of this system is a three-dimensional physical model of topography and drainage features equipped with light bulbs to alert staff when rainfall is beginning at any of the gauge stations.

2. Prepare dam break analysis. The branch uses the DAMBRK program to model and predict the results of dam breaks and prepare dam break inundation maps.

3. Review hydrology projects. Hydrology projects are reviewed by Special Projects for special considerations regarding flood hazards.

Data Used/Generated

- Flood gauge locations
- Topography
- Hydrology
- Stream roughness attributes
- Topography
- Roads
- Land use
- Soils
- Cultural features

Products

- Dam Break Inundation Map

Potential GIS Applications

- Display real-time flood level readings of gauge stations on a map.
- Map historical flood data from monitoring stations.
- Prepare dam break inundation maps using input from DAMBRK model.

Maricopa County Flood Control District
Division: Hydrology
Branch: Watershed Management
Date: March 29, 1991
Interviewees: Doug Plasencia, Watershed Branch Manager
Tom Donaldson, Hydrologist

GIS-Related Tasks

1. Perform hydrologic and hydraulic modeling studies to identify flood hazards using watershed, soils, rainfall, land use, topographic, and vegetation data. The HEC-1 model is used to perform surface water modeling.

2. Provide project support to the Planning and Project Management Division on hydrology aspects of Area Drainage Master Studies (ADMS). This includes providing hydrologic data for cost/benefit studies of District projects.

3. Review projects of other jurisdictions to collect data on existing and proposed development.

Data Used/Generated

- Watersheds/drainage basins
- Hydrology/flow paths/concentration points
- Topography
- Slope
- Soils/hydrologic soil groups
- Aerial photos
- Existing land use
- Future land use
- Rainfall
- Floodplain delineations
- Flood records
- Parcel/property ownership
- Buildings/structures/improvements
- Assessor's data
- Existing/pending/proposed developments

Potential GIS Applications

- Develop input file for HEC-1 model by calculating characteristics of drainage basins using overlay analysis. These inputs would include basin area, slope, soil types, land use, rainfall, length of flow paths, loss rate parameters, impervious surface area, and so forth.
- Aggregate pending and proposed developments by drainage basin and calculate percentages of land use types.
- Map historical flood data for use in long-range planning of flood control projects.

Maricopa County Flood Control District
Division: Land Management
Branch: Property Engineering
Date: March 28, 1991
Interviewees: Ed Opstein, Chief, Land Management Division
Erv McLuty, Property Engineering Branch Manager

GIS-Related Tasks

1. Map project boundaries. Project limits are obtained from Engineering Division.

2. Identify parcels affected by a project. This is done as a preliminary step in determining the ownership of affected parcels and the amount of land that must be acquired by the District.

3. Prepare detailed maps and legal descriptions of individual parcels affected by a project based on preliminary reconnaissance.

4. Determine the amount of land that must be acquired by the District. The final determination is based on an accurate field survey.

5. Manage District properties. This includes maintaining basic information about properties, managing lease agreements, and disposing of improvements.

Data Used/Generated

- Parcel boundaries
- Plat maps
- Assessor's data
- Title reports
- Project boundaries
- Floodplain delineations
- State and Federal lands
- Roads
- Aerial photos
- Township/range/section grid
- Detailed survey data
- District property files

Products

- Project Index Map
- Project Location Map
- Section Plat Map
- Strip Map
- Parcel Legal Description

Potential GIS Applications

- Input property boundary information using COGO tools.
- Overlay project boundaries, floodplains, and property information to create maps and perform analysis.
- Generate property ownership lists and reports using the overlay function.
- Maintain information on acquisition status of individual properties by project or project reach.
- Maintain records for property management, including the location of District properties, when acquired, special conditions, leases, easements, and so forth.

Maricopa County Flood Control District
Division: Planning and Project Management
Branch: Planning
Date: March 27, 1991
Interviewee: Greg Rodzenko, Water Resources Planner

GIS-Related Tasks

1. Identify flood control projects for the District. This includes flooding and drainage problems associated with development or proposed development. Projects are prioritized based on a comprehensive analysis of the economic impacts of a project.

2. Compile and analyze data to support Area Drainage Master Studies (ADMS).

3. Coordinate with various federal, state, and local agencies on flood control projects.

Data Used/Generated

- Hydrology
- Topography
- Aerial photos
- Floodplains
- Parcel boundaries
- Assessor's data/property values
- Soils
- Rainfall
- Land use
- Vegetation
- Buildings/structures/improvements

Products

- Area Drainage Master Study (ADMS)
- Environmental Assessment Reports

Potential GIS Applications

- Compile data from other divisions and agencies to support hydrologic and economic analyses.

- Calculate value of parcels in floodplains using overlay function. This task would be performed as part of economic cost/benefit analysis of flood control project.

- Produce maps for publication in ADMSs and Environmental Assessment Reports.

Maricopa County Flood Control District
Division: Planning and Project Management
Branch: Project Management
Date: March 27, 1991
Interviewee: Ed Raleigh, Project Management Branch Manager

GIS-Related Tasks

1. Compile background data for use in project implementation. This includes maps of all existing utility lines, easements, rights-of-way, and so forth, that are potential obstacles to construction. Most of this information is provided by outside agencies and utility companies.

2. Analyze the information collected in Task 1 to determine the locations of existing facilities and the impacts they will have on project planning and implementation.

3. Manage and store project records. Project records include construction drawings, maps, reports, legal descriptions, and calculations.

Data Used/Generated

- Water lines
- Sewer lines
- Gas lines
- Telephone lines
- Electrical lines
- Cable TV
- Parcel boundaries
- Topography (2' contours)
- Aerial photos

Potential GIS Applications

- Compile data from other sources regarding the location of existing facilities. This assumes that other agencies maintain their map data in a digital format, and that the District would have access to that data for input to a GIS. In the short term, it is unlikely that much of the required data could be compiled in a GIS format.

- Map the location of projects and maintain tabular information such as project cost, when it was built, project manager, inspector, and so forth. This application could also be used as an indexing tool for locating physical records related to the project, such as construction drawings in office files.

- Scheduling and planning tool to facilitate project coordination among agencies.

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Appendix B

Data Inventory

Environmental Systems Research Institute, Inc.
380 New York Street, Redlands, CA 92373

(714) 793-2853
FAX (714) 793-5953
Telex 910 332 1317

Data Inventory
Maricopa County Flood Control District

Name:	Aerial Photography
Data Source:	Consultant
Description:	Usually provided with approved project. Aerial surveys may be flown at different altitudes over a project area.

Category:	Basemap
Data Set:	Planimetric Features
Format:	Imagery
Media:	Paper
Base Map:	N/A
Scale:	Varies
Coverage:	Project areas or as contracted
Update Frequency:	2 surveys/year
Frequency of Use:	Regular reference
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Area Drainage Management Study (ADMS)
Data Source:	Hydrology Division
Description:	Series of maps produced for ADMS showing solutions to drainage problems, 100-yr floodplains, drainage areas, hydrologic soil groups, current land use.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map/Text
Media:	CAD
Base Map:	N/A
Scale:	Small
Coverage:	Approx. 200 sq. mi. of Maricopa County
Update Frequency:	One time product
Frequency of Use:	Daily
Data Security:	Low
Notes:	Product of Area Drainage Management Study (ADMS). Primary aim of ADMS is to identify project solutions to drainage problems.

Data Inventory
Maricopa County Flood Control District

Name:	Arizona Hydrology Map
Data Source:	Hydrology Division
Description:	Overlays include: streams with 100-year flows of 25,000 cfs or greater, list of river and stream names referenced by number, county names and boundaries, city locations.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map
Media:	CAD
Base Map:	State map
Scale:	Small
Coverage:	Arizona
Update Frequency:	Low
Frequency of Use:	?
Data Security:	Low
Notes:	Maps used for display purposes, public information, and reference.

Data Inventory
Maricopa County Flood Control District

Name:	Assessor's Data
Data Source:	County Assessor's Office
Description:	Tabular data about property ownership including owner's name, address, value of property, legal description, etc.

Category:	Land Records
Data Set:	Property Ownership
Format:	Tabular
Media:	Digital
Base Map:	N/A
Scale:	N/A
Coverage:	Maricopa County
Update Frequency:	Frequent updates
Frequency of Use:	High
Data Security:	Low

Notes: Assessor's data is currently available on microfiche which is updated yearly. The District should consider requesting access to Assessor's data by means of digital tape transfer or direct communications link.

Data Inventory
Maricopa County Flood Control District

Name:	Blue Stake Reference Maps
Data Source:	Engineering Division
Description:	Quarter Section Maps with cross-section drawings depicting locations of underground facilities.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Map
Media:	Manual
Base Map:	Quarter Section Map
Scale:	1"=100'
Coverage:	Project areas
Update Frequency:	Project dependent
Frequency of Use:	Project Dependent
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Brochures and Publications
Data Source:	Administration Division/Public Involvement Branch
Description:	Maps contain proposed or existing project boundaries and structures overlain on street map. Text in brochure includes project history and description.

Category:	Land Records
Data Set:	Project Boundaries
Format:	Map/Text
Media:	CAD
Base Map:	Street Map
Scale:	Varies
Coverage:	Project areas
Update Frequency:	Project dependent
Frequency of Use:	Frequent use
Data Security:	Low

Notes: Publications for public counter about individual FCD projects.

Data Inventory
Maricopa County Flood Control District

Name:	Buried Facility Map
Data Source:	Mountain Bell
Description:	Telephone facilities including existing, proposed, and abandoned plants, closures, manholes, buried splices, and poles. Facilities are drafted onto parcel basemap.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Map
Media:	Paper
Base Map:	Parcel basemap
Scale:	1"=100'
Coverage:	Maricopa County
Update Frequency:	?
Frequency of Use:	Project dependent
Data Security:	Low
Notes:	Used to determine approximate location of facilities for project planning. Exact locations are determined in the field.

Data Inventory
Maricopa County Flood Control District

Name:	Cable Television System Map
Data Source:	American Cable Television, Inc.
Description:	Cable TV facilities. Facilities are drafted onto parcel basemap.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Map
Media:	Paper
Base Map:	Parcel basemap
Scale:	1"=100'
Coverage:	Cable TV service area
Update Frequency:	?
Frequency of Use:	Project dependent
Data Security:	Low
Notes:	Used to determine approximate location of facilities for project planning. Exact locations are determined in the field.

Data Inventory
Maricopa County Flood Control District

Name:	Channel Cross-Section Map
Data Source:	Planning and Project Management Division
Description:	Small-scale street map showing existing and proposed channels. Insets of channel cross-sections show channel dimensions, stream velocity and volume.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map
Media:	Paper
Base Map:	Unknown
Scale:	Unknown
Coverage:	Project areas
Update Frequency:	Yearly updates on base map
Frequency of Use:	Project dependent
Data Security:	Low
Notes:	Approximately 100 map sheets purchased.

Data Inventory
Maricopa County Flood Control District

Name:	City Limits Sheet
Data Source:	County Highway Department
Description:	Map showing township/range/section lines, major streets, city limit lines, annexed areas, and boundary dimensions.

Category:	Administrative Area
Data Set:	Political Boundaries
Format:	Map
Media:	Paper
Base Map:	County Highway Map
Scale:	?
Coverage:	Maricopa County
Update Frequency:	Frequent
Frequency of Use:	Daily
Data Security:	Low

Notes: These maps are used to determine jurisdictional responsibility for project work, handling complaints, etc.

Data Inventory
Maricopa County Flood Control District

Name:	Construction Plans
Data Source:	Engineering Division
Description:	Construction plans for projects. Includes index, general notes, plan & profiles, structural details, traffic control plan, channel cross-section, soils data sheets.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Plan
Media:	CAD
Base Map:	N/A
Scale:	Large
Coverage:	Project areas
Update Frequency:	Project dependent
Frequency of Use:	Frequent
Data Security:	Low

Notes: Construction plans are generally not considered to be part of GIS application. Plans may be used as data source for input of project boundaries or facilities into GIS.

Data Inventory
Maricopa County Flood Control District

Name:	County Hydrology Map
Data Source:	Administration Division/GIS Section
Description:	General map showing County boundaries, township/range lines, major roads, place names, municipal boundaries, hydrologic features, watersheds, project locations.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map
Media:	CAD
Base Map:	N/A
Scale:	Small
Coverage:	Maricopa County
Update Frequency:	One time product
Frequency of Use:	High
Data Security:	Low

Notes: Map used as general reference throughout District and for public information. Features are stored as layers in AutoCAD which can be graphically overlayed as required for creating specific products. Data is not considered to be highly accurate.

Data Inventory
Maricopa County Flood Control District

Name:	Dam Break Inundation Map
Data Source:	Hydrology Division
Description:	Shows flooded areas and water depths which would result from a dam break.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map
Media:	Manual
Base Map:	USGS quad sheet
Scale:	1:24000
Coverage:	Dam locations
Update Frequency:	Project dependent
Frequency of Use:	?
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Detail Plan
Data Source:	Land Management Division
Description:	Detailed engineering plans for Federal flood control projects with property boundary lines drafted on top.

Category:	Land Records
Data Set:	Property Ownership
Format:	Plan
Media:	Paper
Base Map:	Corps of Engineers Detail Plan
Scale:	Varies (1"=40')
Coverage:	Corps of Engineers project areas
Update Frequency:	Project dependent
Frequency of Use:	?
Data Security:	Low
Notes:	Used by Land Management Division for land acquisition purposes.

Data Inventory
Maricopa County Flood Control District

Name:	Electric Distribution Map
Data Source:	Arizona Public Service Company
Description:	Underground electric distribution facilities. Facilities are drafted onto parcel basemap.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Map
Media:	Paper
Base Map:	Parcel basemap
Scale:	1"=100'
Coverage:	Maricopa County
Update Frequency:	?
Frequency of Use:	Project dependent
Data Security:	Low

Notes: Used to determine approximate location of facilities for project planning. Exact locations are determined in the field.

Data Inventory
Maricopa County Flood Control District

Name: Flood Hydrograph

Data Source: Hydrology Division

Description: Graph of flood depth vs. time at an individual gauging station.

Category: Environmental

Data Set: Hydrology/Drainage

Format: Graph

Media: Digital

Base Map: N/A

Scale: N/A

Coverage: Maricopa County

Update Frequency: Realtime monitoring

Frequency of Use: As required

Data Security: Low

Notes: Part of realtime flood warning system using ALERT software.

Data Inventory
Maricopa County Flood Control District

Name:	Flood Insurance Rate Map (FIRM)
Data Source:	Federal Emergency Management Agency (FEMA)
Description:	Official map delineating 100 and 500-yr flood zone boundaries, flood zone designations, hydrologic features, township/range/section lines, and streets.

Category:	Environmental
Data Set:	Floodplains
Format:	Map
Media:	Paper
Base Map:	Unknown
Scale:	1:24000
Coverage:	Maricopa County
Update Frequency:	?
Frequency of Use:	High
Data Security:	Low

Notes: Original base data to create FIRM maps was provided to FEMA by the Hydrology Division. Map is used primarily for real estate purposes.

Data Inventory
Maricopa County Flood Control District

Name:	Flood Insurance Study Work Map
Data Source:	Hydrology Division
Description:	100 and 500-yr flood zones, base flood elevations, floodway lines, thalweg, channel cross-sections, corporate limits, topography.

Category:	Environmental
Data Set:	Floodplains
Format:	Map
Media:	Digital basemap/Manually drawn flood limits
Base Map:	Topographic basemap
Scale:	1"=400'
Coverage:	Drainage study areas
Update Frequency:	Project dependent
Frequency of Use:	Daily
Data Security:	Low

Notes: Floodplain limits transferred to Floodplain Delineation Map showing parcels for use at public counters. The Work Map is used by FEMA as the base information for FIRM maps. Structural scenarios created with HEC model using vegetative and other potential changes. Floodplains have been converted to digital form (AutoCAD) for approximately 100 square miles of County. Desire parcel overlay in future.

Data Inventory
Maricopa County Flood Control District

Name:	Flood Profile
Data Source:	Hydrology Division
Description:	Channel cross-section plot, stream bed and flood surface profiles along a reach of channel.

Category:	Environmental
Data Set:	Floodplains
Format:	Graph
Media:	Manual and Digital
Base Map:	N/A
Scale:	N/A
Coverage:	Maricopa County
Update Frequency:	Project dependent
Frequency of Use:	?
Data Security:	Low

Notes: Data used by FEMA for creating FIRM maps.

Data Inventory
Maricopa County Flood Control District

Name:	Floodplain Delineation Map
Data Source:	Hydrology Division
Description:	Flood zone designations and flood elevations overlain on parcel map

Category:	Environmental
Data Set:	Floodplains
Format:	Map
Media:	Mylar
Base Map:	Planning and Zoning parcel map
Scale:	Varies (1"=1200')
Coverage:	Maricopa County
Update Frequency:	Project dependent
Frequency of Use:	Daily
Data Security:	Low

Notes: This map is used for providing information at public counters.

Data Inventory
Maricopa County Flood Control District

Name:	Floodplain Index Map
Data Source:	Administration Division/GIS Section
Description:	Index for finer resolution maps and map sections by Township/Range blocks.

Category:	Environmental
Data Set:	Floodplains
Format:	Map
Media:	CAD
Base Map:	County Basemap
Scale:	Small
Coverage:	Maricopa County
Update Frequency:	One time product
Frequency of Use:	Daily
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Floodplain Use Permit/Variance Applications
Data Source:	Hydrology Division
Description:	Table of permit applications including case number, date, applicant name, type of request, location, hearing date, action taken.

Category:	Land Records
Data Set:	Permits/Applications
Format:	Tabular
Media:	Manual
Base Map:	N/A
Scale:	N/A
Coverage:	Maricopa County
Update Frequency:	Upon receipt of permit application
Frequency of Use:	Daily
Data Security:	Low
Notes:	List of permit/variance applications is associated with floodplain use permit files. Unique identifier is case number.

Data Inventory
Maricopa County Flood Control District

Name:	Flow Model Schematic
Data Source:	Hydrology Division
Description:	Schematic representation of subbasin boundaries, flow paths, concentration points, roads, bridges, and basin outlet.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Schematic Diagram
Media:	Manually drawn and CAD
Base Map:	N/A
Scale:	N/A
Coverage:	Drainage study areas
Update Frequency:	Project dependent
Frequency of Use:	Daily to weekly - project dependent
Data Security:	Low
Notes:	Diagram is used to show connectivity of elements in flow model which are used as inputs to HEC-1 model.

Data Inventory
Maricopa County Flood Control District

Name: Gas Distribution Map

Data Source: Arizona Public Service Company

Description: Gas distribution facilities. Facilities are drafted onto parcel basemap.

Category: Infrastructure

Data Set: Facilities/Utilities

Format: Map

Media: Paper

Base Map: Parcel basemap

Scale: 1"=100'

Coverage: Gas service area

Update Frequency: ?

Frequency of Use: Project dependent

Data Security: Low

Notes: Used to determine approximate location of facilities for project planning. Exact locations are determined in the field.

Data Inventory
Maricopa County Flood Control District

Name:	General Highway Map of Maricopa County
Data Source:	Arizona DOT
Description:	Roads, township/range/section lines, landforms, drainage, buildings, landmarks.

Category:	Infrastructure
Data Set:	Roads/Streets
Format:	Map
Media:	Paper
Base Map:	Arizona DOT
Scale:	Approx. 1"=2 miles
Coverage:	Maricopa County
Update Frequency:	?
Frequency of Use:	Project dependent
Data Security:	Low
Notes:	Approximately 11 map sheets with 62 supplemental sheets.

Data Inventory
Maricopa County Flood Control District

Name:	Grading and Drainage Plan
Data Source:	Developer/Consultant
Description:	Plans include site boundaries, streets, lots, topography, grading details, and drainage details.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Plan
Media:	CAD or manual
Base Map:	N/A
Scale:	Varies (1"=40')
Coverage:	Project areas
Update Frequency:	?
Frequency of Use:	Daily
Data Security:	low

Notes: Grading and drainage plans are submitted by developers for review by the Engineering Division/Stormwater Drainage Branch. Plans are prepared by consultants.

Data Inventory
Maricopa County Flood Control District

Name:	Groundwater Contamination Map
Data Source:	Construction and Operations Division
Description:	County boundaries, major roads, major rivers, contamination areas by type of contaminant.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map
Media:	CAD
Base Map:	N/A
Scale:	Small
Coverage:	Phoenix and vicinity
Update Frequency:	?
Frequency of Use:	?
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	HEC-1 Model Data
Data Source:	Hydrology Division
Description:	Output of HEC-1 model. Summary of peak flows, average flows, and maximum stages for specified stations.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Tabular
Media:	Digital
Base Map:	N/A
Scale:	N/A
Coverage:	Drainage study areas
Update Frequency:	Project dependent
Frequency of Use:	Daily
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	HEC-2 Model Data
Data Source:	Hydrology Division
Description:	Water surface profile data output by HEC-2 hydrologic model

Category:	Environmental
Data Set:	Floodplains
Format:	Tabular
Media:	Digital
Base Map:	N/A
Scale:	N/A
Coverage:	Drainage study areas
Update Frequency:	Project dependent
Frequency of Use:	Daily
Data Security:	Low

Notes: Output of HEC-2 model used to delineate floodplains

Data Inventory
Maricopa County Flood Control District

Name: Highway Construction Map

Data Source: Planning and Project Management Division

Description: Proposed highway construction overlaid on contour map.

Category: Infrastructure

Data Set: Roads/Streets

Format: Map

Media: CAD

Base Map: Topographic map

Scale: 1"=400'

Coverage: Project areas

Update Frequency: Project dependent

Frequency of Use: Project dependent

Data Security: Low

Notes: Private consultants set ground control and perform aerial mapping to create basemaps.

Data Inventory
Maricopa County Flood Control District

Name:	Highway Plan and Profile
Data Source:	Arizona DOT
Description:	Aerial photo overlaid with highway plan and profile drawings. Shows drainage structures.

Category:	Infrastructure
Data Set:	Roads/Streets
Format:	Plan
Media:	Manual overlays entered in CAD
Base Map:	Aerial photos
Scale:	1"=400' horizontal 1"=40' vertical
Coverage:	Project areas
Update Frequency:	Project dependent
Frequency of Use:	Project dependent
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Land Use Map
Data Source:	Construction and Operations Division
Description:	Land use map defined by basin boundary showing irrigated lands, mineral districts, grazing lands, lakes, forested lands, cities, CAFOs, Superfund sites, landfills, NPDES locations.

Category:	Environmental
Data Set:	Land Use/Land Cover
Format:	Map
Media:	CAD
Base Map:	County Watershed Map
Scale:	Small
Coverage:	Individual river basin
Update Frequency:	Project dependent
Frequency of Use:	?
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Maricopa County Highway Map 1990
Data Source:	Maricopa County Highway Department
Description:	Commercially available map, includes streets, street names, political subdivisions, township/range lines, landforms, major rivers, towns.

Category:	Infrastructure
Data Set:	Roads/Streets
Format:	Map
Media:	Paper
Base Map:	N/A
Scale:	Approx. 1"=4 mile
Coverage:	Maricopa County
Update Frequency:	Frequent
Frequency of Use:	Frequent
Data Security:	Low
Notes:	

Data Inventory
Maricopa County Flood Control District

Name:	Operations and Maintenance Responsibilities Chart
Data Source:	Construction and Operations Division
Description:	Table of projects and continuing maintenance responsibilities. Maintenance categories include erosion repair, fence repair, debris removal, etc.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Tabular
Media:	Digital
Base Map:	N/A
Scale:	N/A
Coverage:	Maricopa County
Update Frequency:	Project dependent
Frequency of Use:	On-going
Data Security:	Low

Notes: Used to schedule maintenance activities for District projects.

Data Inventory
Maricopa County Flood Control District

Name: Parcel Legal Description Map

Data Source: County Assessor's Office

Description: Detailed parcel maps including parcel dimensions, bearings, street names, township/range, parcel number, channel location, high water mark.

Category: Land Records

Data Set: Property Ownership

Format: Map

Media: Paper

Base Map: N/A

Scale: 1"=100', 1"=200'

Coverage: Project areas

Update Frequency: Project dependent

Frequency of Use: Daily

Data Security: Low

Notes: Legal description maps are drafted by the Land Management Division using data from the County Assessor's office. The maps are then digitized and pieced together by the GIS Section using AutoCAD.

Data Inventory
Maricopa County Flood Control District

Name:	Permit Application Sites
Data Source:	Hydrology Division
Description:	Permit site, case number, and applicant name hand-drafted onto County street map pages.

Category:	Land Records
Data Set:	Permits/Applications
Format:	Map
Media:	Map book
Base Map:	Phoenix Metropolitan Street Atlas
Scale:	Approx. 1"=4 mile
Coverage:	Maricopa County
Update Frequency:	Upon receipt of permit application
Frequency of Use:	Daily
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Phoenix Metropolitan Street Atlas
Data Source:	Wide World of Maps
Description:	Commercially available street map showing all roads and streets, major landmarks, city limits, township/range/section lines, state plane grid, and landforms.

Category:	Infrastructure
Data Set:	Roads/Streets
Format:	Map
Media:	Map book
Base Map:	N/A
Scale:	Approx. 1"=4 miles
Coverage:	Phoenix metropolitan area
Update Frequency:	?
Frequency of Use:	Daily
Data Security:	Low

Notes: This map source is used as a general reference for locating streets, responding to inquiries, and determining jurisdictional responsibility.

Data Inventory
Maricopa County Flood Control District

Name: Plan and Profile

Data Source: City of Phoenix

Description: As built drawings of facilities, traffic and detour plans, bridges, foundation plans.

Category: Infrastructure

Data Set: Facilities/Utilities

Format: Plan

Media: Paper

Base Map: N/A

Scale: Varies

Coverage: Project areas

Update Frequency: ?

Frequency of Use: Regular reference

Data Security: Low

Notes: City of Phoenix drafts plan & profile map information onto quarter section maps.

Data Inventory
Maricopa County Flood Control District

Name:	Plat Map
Data Source:	Developer/Consultant
Description:	Subdivision plan showing lots, bearings, dimensions, building setbacks, easements, drainage tracts, and streets.

Category:	Land Records
Data Set:	Property Ownership
Format:	Map
Media:	Paper
Base Map:	N/A
Scale:	Varies (1"=400')
Coverage:	Developed areas
Update Frequency:	?
Frequency of Use:	Daily
Data Security:	Low

Notes: The Stormwater Drainage Branch of the Engineering Division uses plat maps to review drainage plans for new developments.

Data Inventory
Maricopa County Flood Control District

Name: Precipitation Data

Data Source: Hydrology Division

Description: Data recorded by precipitation sensors at hourly intervals.

Category: Environmental

Data Set: Rainfall

Format: Tabular

Media: Digital

Base Map: N/A

Scale: N/A

Coverage: Maricopa County

Update Frequency: Realtime

Frequency of Use: Continuous

Data Security: Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Precipitation Map
Data Source:	National Oceanic & Atmospheric Admin. (NOAA)
Description:	Isopluvial map of rainfall in inches for a particular storm interval.

Category:	Environmental
Data Set:	Rainfall
Format:	Map
Media:	Atlas
Base Map:	County basemap
Scale:	Small
Coverage:	Maricopa County
Update Frequency:	?
Frequency of Use:	High
Data Security:	Low

Notes: Source: NOAA Atlas, prepared for the Soil Conservation Service.

Data Inventory
Maricopa County Flood Control District

Name:	Project Display Map
Data Source:	Land Management Division
Description:	Blue line maps on aerial photo base. Overlays may include: project or channel boundaries, floodplains, natural channel, acquired properties, existing and proposed structures, watershed boundaries.

Category:	Land Records
Data Set:	Project Boundaries
Format:	Map
Media:	CAD or manually drawn
Base Map:	Aerial photos
Scale:	Varies
Coverage:	Project areas
Update Frequency:	One time product
Frequency of Use:	?
Data Security:	Low
Notes:	Large poster board display products used for display purposes and visual interpretation of land use in vicinity of District projects.

Data Inventory
Maricopa County Flood Control District

Name:	Project Index Map
Data Source:	Land Management Division
Description:	Index map showing project boundaries, township/range lines, major streets, section, page, and parcel numbers.

Category:	Land Records
Data Set:	Project Boundaries
Format:	Map
Media:	CAD
Base Map:	N/A
Scale:	Varies (1"=8000')
Coverage:	Project areas
Update Frequency:	Project dependent
Frequency of Use:	?
Data Security:	Low

Notes: Used as reference to access detailed map sheets, section plats.

Data Inventory
Maricopa County Flood Control District

Name:	Project Location Map
Data Source:	Planning and Project Management Division
Description:	Various small-scale maps showing the locations of District projects, potential joint drainage projects with outside agencies, proposed channel construction, etc.

Category:	Land Records
Data Set:	Project Boundaries
Format:	Map
Media:	CAD
Base Map:	Street map
Scale:	Varies
Coverage:	Project areas
Update Frequency:	Project dependent
Frequency of Use:	Project dependent
Data Security:	Low
Notes:	These maps are used for both in-house reference and public information.

Data Inventory
Maricopa County Flood Control District

Name:	Property Location Map
Data Source:	Land Management Division
Description:	Project boundaries, 100-year floodplains, SPF, property ownership, state lands, street names, Assessor's no., book, map, folder and section numbers.

Category:	Land Records
Data Set:	Property Ownership
Format:	Map
Media:	CAD
Base Map:	N/A
Scale:	varies (1"=1750', 1"=400')
Coverage:	Project areas
Update Frequency:	Project dependent
Frequency of Use:	High
Data Security:	Low

Notes: Map is used by Land Management Division for preliminary reconnaissance to locate properties with respect to project boundaries and floodplains. Map facilitates requests for title report searches.

Data Inventory
Maricopa County Flood Control District

Name:	Quarter Section Map
Data Source:	City of Phoenix Engineering Department
Description:	Parcel maps showing parcel boundaries, parcel numbers, parcel dimensions, easements, rights-of-way, and street centerlines.

Category:	Land Records
Data Set:	Property Ownership
Format:	Map
Media:	Paper
Base Map:	N/A
Scale:	1"=100'
Coverage:	City of Phoenix
Update Frequency:	?
Frequency of Use:	Project dependent
Data Security:	Low

Notes: Used to determine approximate location of property lines for project planning and property acquisition. Exact locations are determined in the field.

Data Inventory
Maricopa County Flood Control District

Name:	Section Plat Map
Data Source:	County Assessor's Office
Description:	Section map showing parcels, dimensions, bearings, property owners, streets, parcel numbers, book, map, folder and section numbers, project boundaries.

Category:	Land Records
Data Set:	Property Ownership
Format:	Map
Media:	Paper
Base Map:	Quarter Section Map
Scale:	Varies (1"=400')
Coverage:	Project areas
Update Frequency:	Project dependent
Frequency of Use:	Frequent reference for property acquisition
Data Security:	Low

Notes: Property Engineering Branch creates pencil sketch on vellum, then gives to GIS Section to automate using CAD. Map is used to identify and locate properties with respect to District projects.

Data Inventory
Maricopa County Flood Control District

Name:	Sewer Facilities Map
Data Source:	City of Phoenix Water & Sewers Department
Description:	Sewer facilities map. Facilities are drafted onto parcel base map.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Map
Media:	Paper
Base Map:	N/A
Scale:	1"=100'
Coverage:	City of Phoenix
Update Frequency:	?
Frequency of Use:	Project dependent
Data Security:	Low

Notes: Used to determine approximate location of facilities for project planning. Exact locations are determined in the field.

Data Inventory
Maricopa County Flood Control District

Name:	Soil Conservation Service Maps
Data Source:	Soil Conservation Service (SCS)
Description:	Soil unit boundaries and soil classifications.

Category:	Environmental
Data Set:	Soils
Format:	Map
Media:	Paper
Base Map:	N/A
Scale:	1:24000
Coverage:	United States
Update Frequency:	?
Frequency of Use:	High
Data Security:	Low

Notes: Used to define soil types within watershed basins for hydrologic modelling, and also for general reference.

Data Inventory
Maricopa County Flood Control District

Name: Solid Waste Landfill Sites Map

Data Source: Hydrology Division

Description: Landfill sites and dumps located near floodplains.

Category: Environmental

Data Set: Landfills/Hazardous Waste Sites

Format: Map

Media: CAD

Base Map: County basemap

Scale: Small

Coverage: Maricopa County

Update Frequency: Project dependent

Frequency of Use: ?

Data Security: low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Storm Drain Map
Data Source:	City of Phoenix
Description:	Storm drain facilities overlain on quarter section parcel maps.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Map
Media:	Paper
Base Map:	Quarter Section Map
Scale:	1"=100'
Coverage:	Project areas
Update Frequency:	?
Frequency of Use:	Regular reference
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Strip Map
Data Source:	Land Management Division
Description:	Flood zones and affected parcels used for property acquisition analysis.

Category:	Land Records
Data Set:	Property Ownership
Format:	Map
Media:	CAD
Base Map:	Unknown
Scale:	Varies
Coverage:	Project areas
Update Frequency:	Project Dependent
Frequency of Use:	Project Dependent
Data Security:	Low

Notes: This map product is used to calculate parcel "take" areas. Product is combined information from Hydrology and Land Management Divisions. Floodplain Management Branch provides floodplain delineation information. Land Management Division provides parcel locations from individual plat maps and legal descriptions.

Data Inventory
Maricopa County Flood Control District

Name:	Telemetered Gauge Locations
Data Source:	Hydrology Division
Description:	Point locations of stream gauges, streams, and stream names. Special Projects Branch uses data from gauges for ALERT program.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map
Media:	CAD
Base Map:	?
Scale:	Not to scale
Coverage:	Maricopa County
Update Frequency:	Project dependent
Frequency of Use:	?
Data Security:	Low

Notes:

Data Inventory
Maricopa County Flood Control District

Name:	Threatened and Polluted River Reaches
Data Source:	Construction and Operations Division
Description:	Locations of river reaches that are fully, partially or not threatened by pollution. Location of EPA designated reaches and fixed monitoring sites.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map
Media:	CAD
Base Map:	County Watershed Map
Scale:	Small
Coverage:	Individual river basin
Update Frequency:	Project dependent
Frequency of Use:	?
Data Security:	Low
Notes:	Inset map of Arizona with major drainage areas shown.

Data Inventory
Maricopa County Flood Control District

Name:	Topographic Map
Data Source:	City of Phoenix
Description:	Topographic map with 2-foot contour intervals, rights-of-way, and street names. No parcels are shown.

Category:	Basemap
Data Set:	Topography
Format:	Map
Media:	Paper
Base Map:	Quarter Section Map
Scale:	1"=100'
Coverage:	City of Phoenix
Update Frequency:	One time product
Frequency of Use:	Project dependent
Data Security:	Low
Notes:	Accurate elevation information is used for project planning. Require at least 4-foot contour interval accuracy.

Data Inventory
Maricopa County Flood Control District

Name:	USGS 7.5' Quad Sheet
Data Source:	U.S. Geological Survey (USGS)
Description:	Standard USGS map showing topographic contours, elevation points, roads, streams, vegetation, landmarks, place names, buildings, etc.

Category:	Basemap
Data Set:	Topography
Format:	Map
Media:	Paper/Digital
Base Map:	N/A
Scale:	1:24000
Coverage:	United States
Update Frequency:	As required
Frequency of Use:	High
Data Security:	Low

Notes: USGS 7.5' quad sheets are used for general reference throughout the District. They provide base information for a wide variety of geographic features, and are generally considered the best source for medium-scale topographic information. The data are also available in digital form from the USGS as Digital Elevation Model (DEM) and Digital Line Graph (DLG) files.

Data Inventory
Maricopa County Flood Control District

Name:	Water Distribution Map
Data Source:	City of Phoenix Water & Sewers Department
Description:	Underground water distribution facilities. Facilities are drafted onto parcel basemap.

Category:	Infrastructure
Data Set:	Facilities/Utilities
Format:	Map
Media:	Paper
Base Map:	Quarter Section Map
Scale:	1"=100'
Coverage:	City of Phoenix
Update Frequency:	?
Frequency of Use:	Project dependent
Data Security:	Low
Notes:	Used to determine approximate location of facilities for project planning. Exact locations are determined in the field.

Data Inventory
Maricopa County Flood Control District

Name:	Watershed Boundary Map
Data Source:	Hydrology Division
Description:	Drainage basin boundaries, developed areas, flow paths.

Category:	Environmental
Data Set:	Hydrology/Drainage
Format:	Map
Media:	Paper
Base Map:	USGS quad sheet
Scale:	1:24000
Coverage:	Drainage study areas
Update Frequency:	Project dependent
Frequency of Use:	Project dependent
Data Security:	Low

Notes: Watershed boundaries are hand-drawn onto USGS quad sheet base. Used to develop inputs for hydrologic models.

Data Inventory
Maricopa County Flood Control District

Name:	Watershed Soils Map
Data Source:	Hydrology Division
Description:	Soil unit boundaries, soil classifications, and watershed boundaries.

Category:	Environmental
Data Set:	Soils
Format:	Map
Media:	Manual
Base Map:	Soil Conservation Service Map
Scale:	1:24000
Coverage:	Maricopa County
Update Frequency:	Project dependent
Frequency of Use:	High
Data Security:	Low

Notes: Used for hydrologic modelling. Tabular data includes percentage of soil groups and soil map units within a drainage basin.

Data Inventory
Maricopa County Flood Control District

Name:	Zoning Map
Data Source:	County Department of Planning and Zoning
Description:	Zoning boundaries, designations, and case number on medium scale parcel basemap. Map shows streets and street names but no detailed information related to parcels.

Category:	Administrative Area
Data Set:	Zoning
Format:	Map
Media:	Paper
Base Map:	County Parcel Map
Scale:	Medium
Coverage:	Developed areas
Update Frequency:	?
Frequency of Use:	Daily
Data Security:	Low

Notes: A copy of the zoning map accompanies applications for zoning changes, special uses, etc. that are submitted to the County Department of Planning and Zoning. The Engineering Division checks the applications for compliance with drainage regulations during the review process.