CENPD-DM(CENPW-IM/3 Mar 88) (18) 1st End Mr. Brittain/fna/3714
SUBJECT: Approval to Acquire a Geographic Information Management System (GIS)

DA, North Pacific Division, Corps of Engineers, PO Box 2870, Portland, Oregon 97208-2870 25 March 1988

FOR: Commander, Walla Walla District, ATTN: CENPW-DM

Approval is granted to proceed with acquisition of a Geographic Information System (GIS). It is also requested that a quarterly progress report be furnished validating savings and evaluating the feasibility of implementing the system throughout CENPW, CENPP, and CENPS. Point of contact for GIS for CENPD is Mr. Frank McDonald, CENPD-PL-E.

FOR THE COMMANDER:

JAMES R. FRY
Colonel, Corps of Engineers
Deputy Commander

2 Encls
nc

DEPARTMENT OF THE ARMY
WALLA WALLA DISTRICT, CORPS OF ENGINEERS
201 NORTH THIRD AVENUE
WALLA WALLA, WASHINGTON 99362-1876

Reply To
Attention Of:

CENPW-IM (25-2) 3 March 1988

MEMORANDUM FOR: Commander, North Pacific Division, ATTN: Chief, Information Management Office

SUBJECT: Approval to Acquire a Geographic Information System (GIS)

1. References:

a. Memorandum, CENPW-IM, dated 23 November 1987, subject: same as above (Encl 1).

b. Memorandum, CENPD-IM, dated 23 December 1987, subject: same as above (Encl 2).

2. The report submitted by the HQNPD Streamlining Committee and approved by the Division Commander recommended that the Walla Walla District mission functions remain essentially unchanged. In accordance with reference 1.b., the District's Geographic Information System (GIS) Study has been reviewed for possible changes in workload and benefits that would occur because of streamlining. District streamlining will not affect the application of GIS and it is planned to proceed with the acquisition of the system as outlined in the study.

RICHARD M. ELY
LTC, CE
Acting Commander

2 Encls

DEPARTMENT OF THE ARMY
WALLA WALLA DISTRICT, CORPS OF ENGINEERS
201 NORTH THIRD AVENUE
WALLA WALLA, WASHINGTON 99362-1876

Reply To
Attention Of:

CENPW-IM (18-3a) 23 November 1987

MEMORANDUM FOR: Commander, North Pacific Division, ATTN: Chief, Information Management Office

SUBJECT: Approval to Acquire a Geographic Information System (GIS)

1. Enclosed is a copy of Walla Walla District's Geographic Information System (GIS) Study (Encl 1). This study focuses upon the requirements and costs for utilizing the computer sciences and associated technology for the planning and management of the District's geographically distributed resources such as vegetation, soils, hydrography, cultural resources, recreation facilities, etc., GIS is an extension of our Computer Aided Design and Drafting (CADD) functions into the land use and environmental areas using master planning techniques.

2. The study has been reviewed by the District's Information Management steering committee. The committee concurred that the District should proceed with the acquisition of a five-workstation GIS with phased implementation over a 4-year period. GIS applications are included in the technical specifications of the Corps-wide CADD
contract under Master Planning. Because of the favorable pricing, ease of procurement, and assurance that GIS and CADD will be totally compatible, the GIS hardware and most of the software will be purchased from the Corps-wide CADD Contract DACW87-87-D-0092. A breakdown of GIS hardware and software costs by item and fiscal year are shown on Encl 2 and 3. The costs shown on the enclosures differ somewhat from the costs in the GIS study. The study costs were based upon estimates, whereas Encl 2 and 3 costs are based upon line-item prices from the
Corps-wide CADD contract. PRIP funds have been requested and approved
to purchase the GIS hardware that will be installed in FY 88. Fiscal year operating monies will be used to acquire the GIS software. The FY 88 installation of GIS hardware is part of the District's Automated Resource Master Plan (ARMP).

3. A summary of the GIS is on page 15, paragraph 9.0, of the enclosed study. As stated in the summary, completing the District's assessed GIS workload with modern technology, rather than manual methods, results in a savings to the District of approximately $1 million over the 7-year useful life of the system.

CENPW-IM (18-3a)
SUBJECT: Approval to Acquire a Geographic Information System (GIS)

4. Request authority to procure 3 total GIS system with phased FY procurements of hardware .and software as shown on Enc1 2 and 3.

Total hardware cost is estimated to be $245,871 and total software costs will be $96,88. Purchases will be made by the Contracting Officer in accordance with applicable procurement directives.

FOR THE COMMANDER:

RICHARD M. ELY
LTC, CE
Deputy Commander

3 Encls . .

DEPARTMENT OF THE ARMY
WALLA WALLA DISTRICT, CORPS OF ENGINEERS
201 NORTH THIRD AVENUE
WALLA WALLA, WASHINGTON 99362-1876

Reply To
Attention Of:

CENPD-IM (25-5b) 23 December 1987

MEMORANDUM FOR: Commander, Walla Walla District, ATTN: Chief, Information Management Office

SUBJECT: Approval to Acquire a Geographic Information System (GIS)

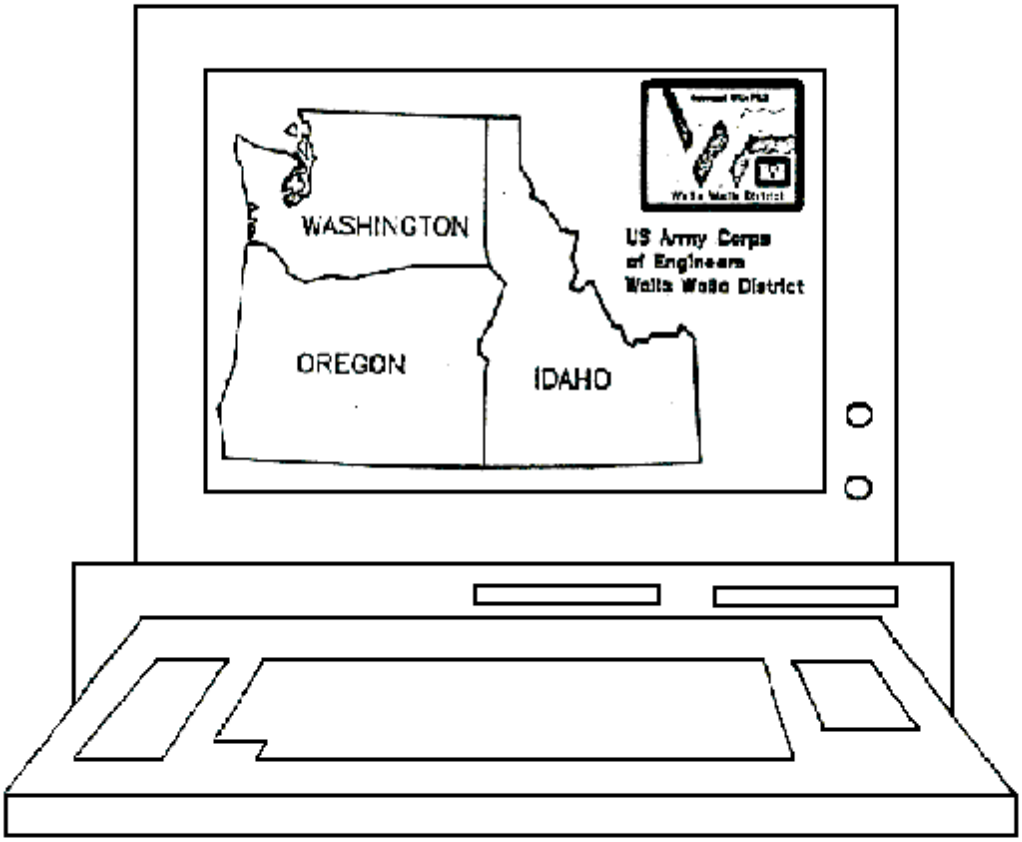
1. Refer to your memorandum, dated 23 November l987, subject as above.

2. Your request is approved subject to re-validation of benefits based on workload projections for CENPW resulting from the CENPD Streamlining Study. No GIS acquisitions should be made prior to completion of the study.

FOR THE COMMANDER:

JAMES R. FRY
Colonel, Corps of Engineers
Deputy Commander

Justification & Acquisition Plan
for
Walla Walla District
Geographic Information System
Computerized Map & Resource Analysis



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1. Background

1.1 General. The Walla Walla District is a Civil Works District established in 1948 to assume responsibility for the Snake River Watershed. Until the mid 70's, the workload consisted primarily of large dam project construction on the Snake and Columbia River systems. Since that time projects have gotten smaller and more emphasis has been put on Operations and Maintenance work. There is a greater need to manage water and lands and mitigate resource problems created by the construction years. Budgets and personnel to accomplish these important but different activities have been reduced to levels that make it necessary to utilize the most efficient methods available. The need to access and analyze natural resource data in a timely and efficient manner has become critical for those establishing policy, making decisions, and planning management activities.

The Corps manages and plans for the uses of geographically distributed natural resources such as vegetation, soils, recreational opportunities, and cultural resources. To locate and manage them, the Corps uses manually prepared maps and map overlays. These traditional methods are dependent upon personnel ceilings and/or project time frames to accomplish the tasks at hand. Also, some analysis are virtually impossible to accomplish using manual methods.

Possible alternatives to accomplish the workload include:

1. Increasing or reassigning personnel in required areas to complete planning and resource management tasks using the existing manual mapping and mapping analysis methods.

2. Providing automated map analysis capabilities for lands, resource management, and master planning specialists.

3. Continuing to forgo or postpone some of the work.

Increasing personnel is no longer a viable option for most managers in these days of stringent personnel ceilings. Reassigning personnel can sometimes be accomplished and with some efficiency if the workload for the reassigned is not just as large and critical as the other. However, with a smaller workforce being asked to accomplish the district workload, an effort must be made to increase their efficiency.

Work also cannot be postponed or forgone for long without potentially serious consequences occurring at some point. These might include environmental, budgetary, workforce level, sociological consequences brought on by internal and external reviews of our accomplishments.

Often, the amount of information we need to use surpasses our ability to manage it. An Automated Geographic Information System (GIS) can help solve this problem by allowing the resource manager to rapidly examine numerous alternatives and management options. The manager can recall information from the system
without depending solely on his own memory, (and which is never “lost”), and conduct analyses which were not possible using manual procedures.

A Geographic Information System (GIS) can provide the capability to analyze and interpret information for a broad range of resource management and master planning applications. It can be used to address significant questions in a variety of critical areas, and is a powerful analytical tool capable of handling a vast quantity of data in a timely, effective manner that allows for assessment of various alternatives.

A GIS stores, displays, retrieves, and analyzes spatial data (data located on the earth s surface). It is similar to other automated information systems except that it handles spatial data instead of just words and numbers. Since spatial data can be tied to specific geographic locations, the system can model or simulate land uses and resources values.

An automated GIS is more than a sophisticated filing system for maps. It is most valuable as an analytical tool to assist decision makers. Typical analyses performed are: calculation of area, overlaying and compositing, calculation of proximity. These types of analyses distinguish a GIS from simpler computer mapping systems. Most computer analyses of geographic data bases involve combinations of search, measurement, and data comparison.

GIS technology, under development for at least 20 years, has advanced substantially in the past 6 to 8 years. Although its subject matter is often simple, the computer systems required are complex and demand the latest advances in computer technology.

GIS technology can reduce the number and cost of maps needed in routine operations, while at the same time reducing the cost of analysis. The number of maps needed will be less because the comparisons between maps, compilation of map combinations, and analysis of map quantities (areas, for example), can be done inside the computer.

For many Corps activities a GIS could significantly reduce the need for manually drafted paper maps, replace many manual procedures, and provide the user with the latest information through a variety of displays. GIS 8 have the potential of being even more pervasive than our current manual mapping.

A GIS is not intended to make decisions. It is a tool the manager uses to help make decisions and leaves a clear, documented, and retraceable path from which those decisions are made. For more information on GIS operation see Appendix B.

1.2 Methodology

A GIS study team was brought together to look at the potential applications of GIS technology to the District workload. A needs assessment was done over a period of several weeks in the various district organizations to determine: Can GIS accomplish tasks in our organizations, would a GIS be more efficient than current methods, and what were the needs of the office in workload and equipment/software to accomplish them.

The results of the assessment were compiled by lnformation Management Office, Information Requirements and Planning (IRP) Branch, and are contained in Appendix A by primary organization. It is noteworthy that many organization tasks are simply not performed or performed rarely because of limited personnel in resource inventory and management and planning offices. Many tasks that are deemed too costly in terms of personnel time and effort could be done quickly and relatively easily on a GIS system.

The Information Management Office has reviewed a variety of possible GIS hardware and software options that are available and meet the basic needs of the District (based on GIS scoping committee). Software is most critical in developing a GIS system. The District GIS Committee has noted one software need that is unusual in comparison to many land/resource management systems. This is the need to integrate quickly and accurately lands and resource management data with design drawings developed in the engineering organizations. Several GIS systems available can accomplish this type of work, however, the ease with which it is accomplished differs by orders of magnitude. Systems differ widely in both host equipment, software functionality, and cost.

Several basic system configurations have been discussed. These include:

1. Large central CPU, 5 hi-resolution graphics terminals, pen plotter, large drafting digitizing table.
2. Moderate central CPU and/or file server, 5 hi-resolution graphics intelligent engineering workstations, pen plotter, large drafting digitizing table.
3. Micro based software with stand-alone micro citations and same plotter and digitizing equipment.
4. Mix of the above.

We are unaware, at this time, of any definitive HQUSACE specifications for GIS technologies. we have, therefore, attempted to contact experts that are current with the state-of-the-art in GIS systems for advice. One such source is the Topological Laboratory at Fort Belvoir, VA. One primary conclusion that we drew is that there is little in the way of fully functional (software) and fully capable (hardware) for microcomputers to perform according to the District's GIS needs.

Of the two central host options, we have come to the conclusion that the future technologies, both hardware and software, are moving toward the intelligent engineering workstations, with networking to a central CPU and/or file server. This

configuration provides the maximum efficiency for CPU utilization, and maximum flexibility for end-users. It also provides flexibility for management to alter the course of system development in subsequent years as needs for GIS change or technology changes rapidly.

2.0 Decision-making Process.

2.1 Existing. The existing GIS process in the District is essentially a manual analysis of a composite resource (wildlife, vegetation, soils, etc.) or theme (proximity, combination of resources, etc.) maps. Landscapes architects, wildlife biologists, real estate specialists, other data map users and analyzers manually construct base maps, resource maps, and theme maps and then have the maps drafted 80 they can be reproduced. To analyze geographic data, the resource maps are hand evaluated by overlaying the resource maps and composite maps. This requires all maps under evaluation to be of the same scale. When new data is available or when there is more than one option, it is necessary to analyze the data by hand. Area and linear measurements are also calculated by manual means. Resource maps are updated manually as new information becomes available. After the resource maps are updated the composite maps also need to be revised manually. All of this is extremely labor extensive which limits the options that can be examined.

2.2 Proposed. A computerized GIS will automatically perform actions currently completed by hand plus other actions attainable only through automated methods. It will enter, store, analyze, and display digital map and map overlay thematic data layers to analyze proposed actions and alternatives for project development, master planning, habitat evaluation, and other mapping. It will include the ability to digitize maps and related spatial data, edit the digitized data easily, perform multiple layer map theme overlap with new map generation (incl. boolean operations on lines, points, polygons) and plot the desired map on a pen or raster plotter. The data for a base theme, or resource map of a particular location need to be entered just once. The data can be accessed by all users.

One of the Corps major tasks is to prepare planning documents to aid in making and implementing resource management decisions. The collection of baseline resource data for these planning documents has made it necessary to develop automated systems to store, analyze, and portray this data. The graphic displays for these planning efforts, however, are for the most part still manually generated and revised. All of these planning efforts require the use of maps, overlays, graphs, and charts, which are now produced manually. Revisions, updates, and additions, some of which are extensive, are also accomplished with more costly manual technique 5 .

3.0 District Workload Projections.

3.1 General.

The District GIS workload projections for the upcoming 7 years (the anticipated life cycle of ADP equipment) is based on the Districts continuing role change from construction works to the operation and management of the District projects. The analysis of the workload included Master Plans of the District's Civil projects, feasibility studies, resource inventory and location analysis, resource mapping, environmental assessments, flood projection, dam safety, survey monumentation, operational management planning, and editing of GIS data base.

3.2 Civil Works.

Each of the six District's projects scheduled for Master planning during the projected 7 years requires at least 5 man-years to complete manually. The larger projects will take considerably longer. During the formulation stage, input from various offices will be incorporated into the Master Plan. Once the Master Plan for a project is completed, the management and implementation of policies can occur using the Master Plan as a guide.

3.3 Other Works.

Walla Walla District has received some military projects for design and completion, and anticipate an increased workload during the projected years that will require Master Planning. Walla Walla District has also been designated as the General Support District to the Seattle District for mobilization planning and preparedness. In this role, the Walla Walla District has primary responsibility for major mobilization mission, GIS will be extremely helpful in accomplishing these tasks.

4.0 Equipment/Software Requirements.

Based on the anticipated utilization of the automated GIS, the following initial system configuration and training with later augmentation is determined necessary to meet the District s mission. See Charts 1.1-1.4 for a visual representation of the proposed configurations.

4.1 Hardware Configuration.

Description of equipment/service	Number by FY			
Hardware	88	89	90	91
Intelligent Graphic Work station	1	1	1	1
32-bit, 8Mb				
156 Mb Hard Disk	1	1	1	1
LAN Interface		3	1	1
Digitizing Table	1			
File/Plot Server		1		
32-bit, 16Mb				
156 Mb Hard Disk		5	2	
1600/6250 bpi, Mag. Tape w/c		1		
Floppy Disk		1		
LAN Interface		1		
Graphics Workstation		1		
Plotter, Pen 33" wide	1			
LAN		1		

4.2 Software Configuration.

Description of equipment/service	Number by FY			
Hardware	88	89	90	91
Intelligent Workstation				
UNIX with PC-DOS window	1	1	1	1
Plotter Interface	1	1	1	1
GIS Package	1	1	1	1
LAN Protocol		3	1	1
File/Plot Server				
Unit with PC-DOS window		1		
GIS (Input/Edit)		1		
LAN Protocol		1		

4.3 Training.

Description of equipment/service	Number by FY			
Hardware	88	89	90	91
Training				
GIS System Manager	2			
Workstation Operator	4	4	2	2
(Standalone/On-line)				
Computer Operator		3		
Program/Analyst		2		
Manual/Documentation				
Reference Manuals (sets)				
Workstation	1	2	1	1
File/Plot Server		1		
GIS User Manuals (sets)	4	4	2	2

4.4 Site Preparation.

Adequate space, power, and air conditioning to install and operate the proposed GIS system already exists to allow installation of the central processing system with only minor non-structural modifications.

The graphic workstations emit some heat and may require additional cooling to keep the temperature of the workstation area down to acceptable operating temperature.

Some site work is required to connect cables between workstations in a network.

4.5 Workstation Utilization.

The installation and implementation to a full district Geographic Information System (GIS) is planned to be a gradual phase-in process of equipment over four years as more data is entered into the system each year and becomes available to other GIS users. An initial configuration consisting of a standalone graphic workstation with a large digitizing table and a pen plotter to enter the base map and resource data necessary for analyzing and plotting various options in the development of a Master Plan for a district project. The second phase connects the original configuration, a graphic workstation, a standalone graphic workstation and a file/plot server with a 6250 bpi magnetic tape drive and 780 Mb disk storage to a local area network. The network and the file/plot server makes possible the sharing of data and the plotter between the workstations. The existing digitizer will connect to the new graphic workstation for direct data entry into the file server disks. The standalone workstations can access the file server through the network, download data from the server to the workstation, and process the data in the standalone mode. This configuration is the minimum operating system. The third phase will add an additional standalone workstation, if required, to the system and an additional 312 megabytes of disk storage to the file/plot server. The fourth phase will add an additional standalone workstation for project management and assistance. It will primarily be used by the GIS coordinator/manager for work on all projects and design and implementation of the more difficult analysis algorithms.

5.0 Production Goals and Costs.

5.1 Production Goals. Based on experiences of others and proposed projects, the production goals are established for the overall system (not discipline specific). The goals are considered attainable for the District are as follows:

FY Portion	Comparison Factor*
88	
1st 3 mo	.4
2nd 3 mo	1.0
3rd 3 mo	1.5
4th 3 mo	1.5
89	
1st 3 mo	2.0
Rest	2.0
90	
All	2.5
91	
All	2.5
92	
All	2.5-3.0

*Comparison factor is the ratio of amount of work that can be accomplished using the GIS system versus the amount that can be accomplished using present methods.

5.2 Hardware/Software Costs. The hardware and software costs were based on industry estimates and no allowance was made for GSA price agreements. The estimated costs for the 3-workstation system minimum configuration (phase 1 and phase 2) are $164,000 for the hardware and $47,500 for the software. The estimated costs for the 4-workstation configuration (minimum configuration plus phase 3) are $204,000 and $65,000. The estimated costs for the 5-workstation configuration (4-station configuration plus phase 4) are $233,000 and $82,500. See Figure 1.1 and Tables 1.5 through 1.9 for system cost details and for costs by Fiscal Year.

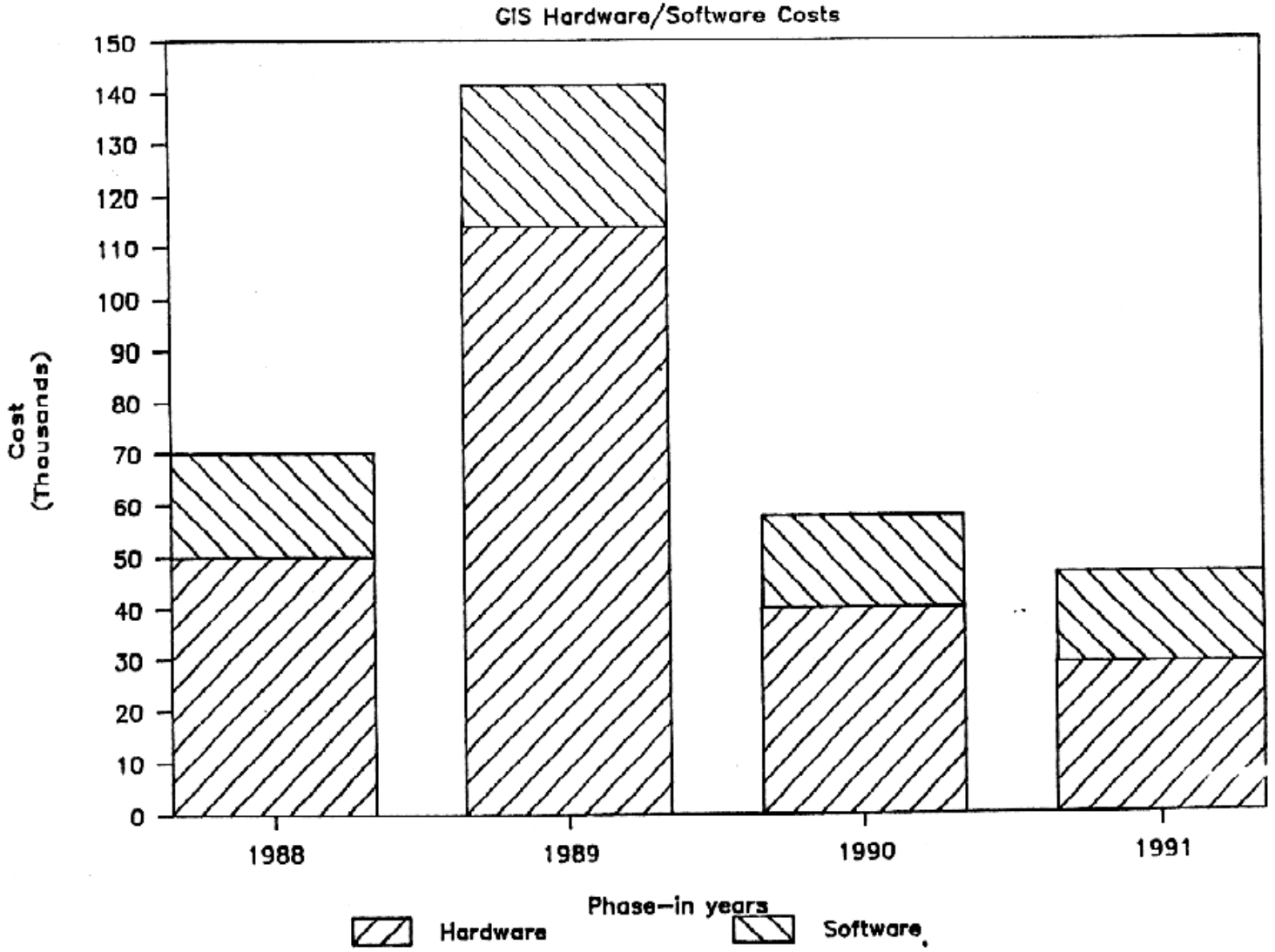
5.3 Maintenance Costs. Typically, the maintenance cost for the size of system proposed is approximately 10% of the total hardware cost per year, payable monthly. This cost is for work day maintenance not including weekends and holidays. Other than normal hours service is available but costs extra. Normal business hours are considered to be 0800 to 1700 hours, Monday through Friday. Responsible time is specified in the contract as needed, with more cost involved for faster response times.

6.0 Intangible Considerations.

6.1 General.

There are many intangible, indirect, or unguantifiable benefits that result from implementation of a GIS system that are very difficult to express in quantifiable terms that are needed for a cost/benefit analysis. They are many of the things that make work easier and better and generally are expressed in terms of better quality.

Figure 1.1


GIS Hardware/Software Costs
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Cost (Thousands)
1988
1989
1990
1991
Phase-in years
Hardware
Software

6.2 Data Can Be Reviewed Prior To Printing.

Data themes can be reviewed prior to printing. Theme maps can be reviewed by the respective divisions doing a review process. This is impossible using the manually drafted method, due to the 5 to 10 sheets per data theme.

6.3 Extended Use of Mapped Data.

The Master Planning process takes several man years. A long period of time passes before the data themes are printed. The automated system would allow viewing of the themes and also allow the data to be used immediately. The data can be used by OCR, Engineering, Real Estate, and Planning Divisions in their work.

6.4 Ability to Analyze More Alternatives.

When generating alternatives manually, the amount of time required prohibits more than one plan. The use of an automated system will allow more than one alternative. This will allow the decision making process to be better documented and allow a wider range of views.

6.5 Common Framework for Analysis and Data Sharing.

The automated system would improve communication and coordination between personnel in the District, Project Offices, and NPD. A common framework will create data consistency and conformity, increase the productivity of specialists, and foster data sharing between disciplines and agencies.

6.6 Storage and Backup.

An automated system will require less storage space then paper maps. The option would be available to eliminate mylars used for reproduction. The ability will be available to store data on floppy disks and magnetic tape.

6.7 Work For Others.

Just as the CADD system and Digital Aerial Mapping, the GIS would be an additive tool in securing “Work For Others.”

7.0 Tangible Considerations.

7.1 General. Tangible considerations are discussed in terms of any project design and development whether it be Master Planning or project level implementations. The phases of any project are broken down and discussed according to advantages of GIS over manual methods and/or disadvantages.

7.2 Data Entry.

Initial automated data entry efforts are estimated to require 10 to 25 percent more time than comparable tasks accomplished with manual methods, if the information is not currently available. However, certain data may be available from other agencies on computer tape and can be entered directly into the system. For example, base map information (contours, cultural features, vegetation, cadastral) from 7.5 minute quads is available on computer tape from U.S. Geological Survey (USGS). Benefits between 40 and 60 percent will occur through time as more data are entered and stored in the system eliminating the requirement to draft and redraft maps and manually transfer information to other media such as clear mylar. Only the original maps need to be updated because certain maps are generated with the system. A large number of maps can be created without digitizing based on combinations of existing data such as land use alternatives, conflicts, and percent of slopes maps. Therefore, fewer data themes need to be digitized than manually drafted. Without a GIS system these maps would have to be manually drafted. Advances in technology such as scanning techniques for digitizing and interactive data editing, will further reduce the time required for data entry to zero resulting in substantial savings. Similar re-use of data for all applications after initial data entry will make the number of work months required for data entry negligible. Therefore, it is estimated that between 40 to 60 percent savings following the construction of a data base is very conservative for data entry.

7.3 Data Manipulation.

Manual methods for manipulating large amounts of data are very labor intensive and error prone, whereas using an automated GIS for retrieving, sorting, and reformatting information requires comparatively little time. Additionally automated methods become more efficient as the amount or complexity of data increases. Examples are computer generated percent of slope maps. Manually the percent of slope would have to be calculated by hand and re-drafted. If a new or more in depth breakdown of slope was later needed the process would have to done again by hand. In an automated mode, the task would involve entering a few commands at the screen. Again, the labor-intensive tasks are performed by the computer. The estimated time saving with automation is between 70 and 90 percent.

7.4 Data Analysis.

Benefits for performing analytical functions with automation are substantial. Time spent directing the computer to perform the labor-intensive tasks normally performed by people is minimal. The amount of time required to initiate automated analysis remains relatively constant, regardless of the size, complexity, or accuracy of the data and desired needs. In contrast, the time required to perform manual analysis increases rapidly with complexity, quantity, and accuracy (collectively or individually). The time savings i6 conservatively estimated to be 70 to 90 percent. In addition to generating geographic areas, the acreage of each mapped area is automatically produced. Examples of complex data sets include attractiveness, vulnerability, and compatibility mapping which are portions of the maps needed to construct a land use suitability map. In a manual mode the task would involve overlaying theme maps on a light table and hand tracing and final drafting.

7.5 Data Output.

Substantial benefits are evident with data output tasks. Manual methods involve drafting maps and/or composing tables and diagrams. These methods are labor intensive whereas the automated methods only require setting parameters for the desired output. The amount of benefits increase proportionately with the amount and complexity of data. Additionally, many products would not be and could not be produced because of the amount of time required with manual methods. Thus the time savings are estimated conservatively at 70 to 80 percent for generating output.

7.6 Data Import/Export.

Time savings associated with copying and transferring digital map data between locations are estimated at 60 to 70 percent of the time required to manually copy and transfer maps between physical locations and between varying scales. Other federal agencies are now using or in the process of obtaining GIS systems. Much information is now available from other agencies which can be used during a project. Recently the Washington Department of Game suggested that their evaluation data for Lower Snake River Compensation Plan be placed on State of Washington 8 GIS system. This data would be easily transfer to the Corps using an GIS system. The Walla Walla district would also be able to provide “work for others” and other agencies with data that we generate and use.

7.7 Improvement in Publication of Data.

Each data theme has an average of 5 to 10 sheets or layers. Each layer must be registered to the other very carefully. Manually this is only possible by registering one layer at a time to another. The manual method produces errors of misregistration that show up in printing. However, using an automated GIS system, all sheets can be viewed on one screen at one time using different colors or shading for each layer. The common registration framework for all data in the GIS eliminates misregistration and improves printing. This will conservatively save 50 percent of the drafting time by reducing manual drafting problems, reducing map production time through plotters, and reducing the redrafting required after each map change.

7.8 Financial, Social and Ecological Benefits.

In addition to all the benefits listed above the GIS system will conservatively save approximately $20,000 annually for the Master Planning phases configured with 1 standalone workstation as shown in the FY-88 configuration proposal. This is based on the amount of time inputting, analyzing, updating, and outputting data under current scheduling and budgeting. The automated system will allow the Corps to better serve public needs and also help make decisions to provide better stewardship on the the resources the Corps is responsible.

7.9 Manpower Savings.

Manpower savings utilizing the automated GIS is estimated to be 60% of the existing manual methods. Currently the District work load to complete Master Planning, Operations Management Planning, and Real Estate and Engineering applications in the next seven years would require 806 work months. Current manpower ceilings will not support this. Work will have to be performed more efficiently or be forgone. An automated GIS would reduce the work months to 324, a 7 year goal attainable without increase in personnel. Summary of manpower savings is included in Tables 1.1 through 1.4.

7.10 Cost Savings.

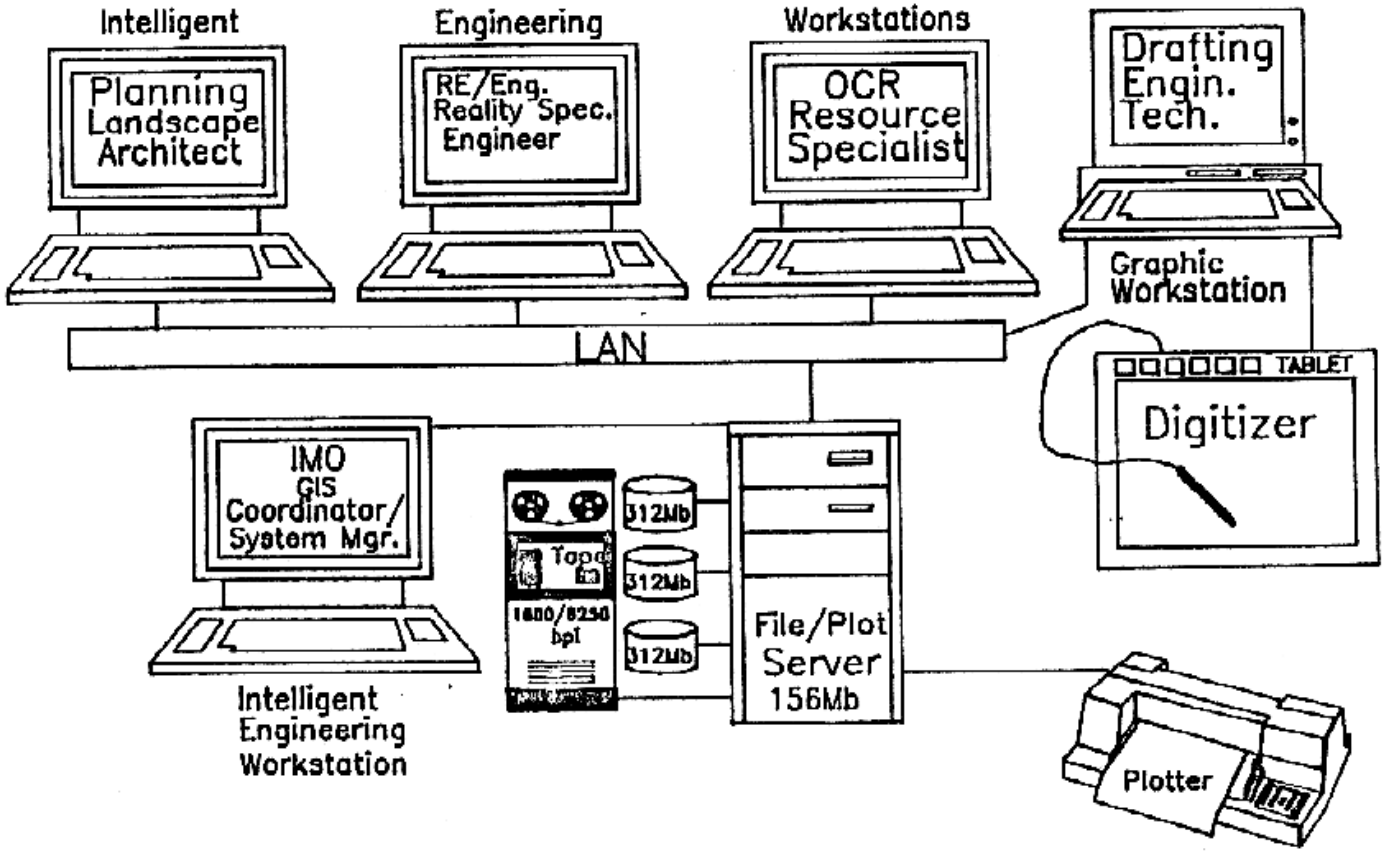
To determine the real dollar savings that could be realistically expected through the purchase of an automated GIS, an estimated cost for system purchase and software development was established for a minimum three workstation system, a four workstation system, and five workstation system. The annual maintenance agreements were estimated at 10% of the hardware costs and the entire system was amortized over a seven year period. The total operating costs of the three systems were compared separately with the cost of the existing manual methods and a projected savings for the system life were $946,285, $1,070,690, and $999,451 respectively. A summary of these costs are included in Tables 1.9 through 1.11.

8.0 Organizational Recommendations.

A proposed GIS system organization i8 described in the following Chart 1.0. The overall system project coordination/management is located in IMO to take advantage of existing GIS project expertise. Each workstation is located as shown in the Chart to accomplish priority workloads as considered by the GIS study team. The resource specialists utilizing the workstations remain in existing organizational channels. Data entry would be located in Drafting to maintain organizational/supervisory integrity with existing manual systems .

Chart 1.0

Geographic Information System Equipment–Primary User Configuration



9.0 Summary

The present manual system of data storage, retrieval, display, and analysis is inadequate to handle the management issues and challenges facing land use planners today. The present planning system of base maps and overlays is incapable of displaying or comparing the various data layers at the same scale which is necessary for resolving issues such as forestry resource management, cultural resource management, recreation management, wildlife habitat and fisheries management and many others. Much of the resource inventory data is not readily available for decision making or multiple-use planning without major commitments of work months.

Implementation of an automated GIS will provide an efficient new tool for management of the public land resources. Data which was once rolled up on a map stuck in a corner or filed away in a storage cabinet and known only to a few will now be available for automated search, measurement, calculation, comparison, analysis, and display.

The goal of GIS is not to replace people. The goal is to make the existing work months and workforce more effective, efficient, and capable of manipulating the mass of information currently required to be analyzed for resource management decisions.

GIS technology can reduce the number and cost of hard copy and manually created map manuscripts used in routine operations, while at the same time reducing the cost of analysis. The number of map products needed will be less because the separations necessary to produce combinations can be stored and generated in an automated format on a computer.

GIS is being initially proposed for District-level Resource Management Planning. Many benefits from GIS are from the later uses of the data once it i8 captured. Doing the Master Plans in GIS would set the foundation for subsequent project and activity plans, planning amendments, Environmental Assessment (EA-6), special projects, land exchanges, monitoring, potential litigation, etc. requiring additions to the initial GIS hardware and software. A minimum configuration of 3 workstations is to be implemented in two phases with additional workstations to be added as needed.

A projected dollar savings over a seven year period of 3 workstation, 4 workstation, and 5 workstation configuration costs compared to the cost of existing manual methods are $946,285, $1,070,690, and $999,451 respectively.

Table 1.1

Comparison Of Labor Costs for Master Planning
Manual vs. GIS
Based on USGS Quadrangles
Labor Source - Planning Division

		Work Months	
Project	No. Quads	Manual	GIS
McNary	19	100	40
Ice Harbor	12	60	24
Lower Monumental	10	60	24
Little Goose	12	60	24
Lower Granite	13	60	24
Dworshak	20	100	40
Luckv Peak(act. manual)	6	60	24
Total	92	500	200
Costs		$1,730,000	$692,000

Work month savings = 300.

1 work month = 173 hrs x 20.00 cost/hr = $3460
300 x $3460 = $1,038,000

Table 1.2

Comparison of Labor Costs
for
Operations Management Planning
Manual vs. GIS
Labor Source - OCR Division

	Work Months	
Project	Manual	GIS
McNary	36	14
Ice Harbor	18	7
Lower Monumental	18	7
Little Goose	18	7
Lower Granite	18	7
Dworshak	36	15
Mill Creek	12	5
Lucky Peak	24	10
Total	180	72
Costs	$622,800	$249,120

Work month savings = 108.

1 work month = 173 hrs x 20.00 cost/hr = $3460
108 x $3460 = $373,680

Table 1.3

Comparison of Labor Costs
Manual vs. GIS
Labor Source - Real Estate Division

	Work Months	
Project	Manual	GIS
McNary	12	5
Ice Harbor	12	5
Lower Monumental	12	5
Little Goose	12	5
Lower Granite	12	5
Dworshak	12	5
Mill Creek	12	5
Luckv Peak	12	5
Total	84	35
Costs	$218,400	$91,000

Work month savings = 49.

1 work month = 173 hrs x 15.00 cost/hr = $ 2600

49 x $2600 = $127,400

Table 1.4

Comparison of Labor Costs
for
Civil & Military Master Planning
Manual vs. GIS
Labor Source - Engineering Division

	Work Months	
Project	Manual	GIS
Civil	24	10
Military	18	7
Total	42	17
Costs	$145,320	$58,820

Work month savings = 25

1 work month = 173 hrs x 20.00 cost/hr = $ 3460

25 x $3460 = $86,500

Table 1.5

GIS FY-88 Equipment
Configuration Proposal

Hardware

Stand-alone Color Engineering Workstation	$29,000
UNIX, PC-DOS compatibility desirable	
Digitizing table 36x48 backlit draft base	11,000
Plotter 4/16 pen line, color	10,000
Total	50,000
Software - GIS	15,000
Plot	5,000
Total	20,000
Grand Total	$70,000

Table 1.6

GIS FY-89 Equipment
Configuration Proposal

Hardware

Stand-alone Color Engineering Workstation	$29,000
Graphic Color Workstation (Input/Edit)	15,000
File/Plot Server 22,000	
312 Addnl Disk Storage - 2 @11,000 ea.	22,000
1600/6250 Tape Unit	16,000
LAN	10 000
Total	114;000
Software - GIS (Input/Edit)	5,000
GIS	15,000
LAN Protocol	7,500
Total	27,500
Grand Total	$141,500

Table 1.7

GIS FY-90 Equipment
Configuration Proposal
(Option 2)

Hardware

Standalone Color Engineering Workstation	$9,000
312 Mb Addnl Disk Storage	11,00
Total	40,000
Software - GIS	15,000
LAN Protocol	2,500
Total	17,500
Grand Total	57,500

Table 1.8

GIS FY-91 Equipment
Configuration Proposal
(Option 3)

Hardware

Standalone Color Engineering Workstation		$29,000
Software - GIS		15,000
LAN		2,500
	Total	17,500
	Grand Total	46,500

Chart 1.1

Geographic Information System
FY–88 Equipment
Configuration Proposal

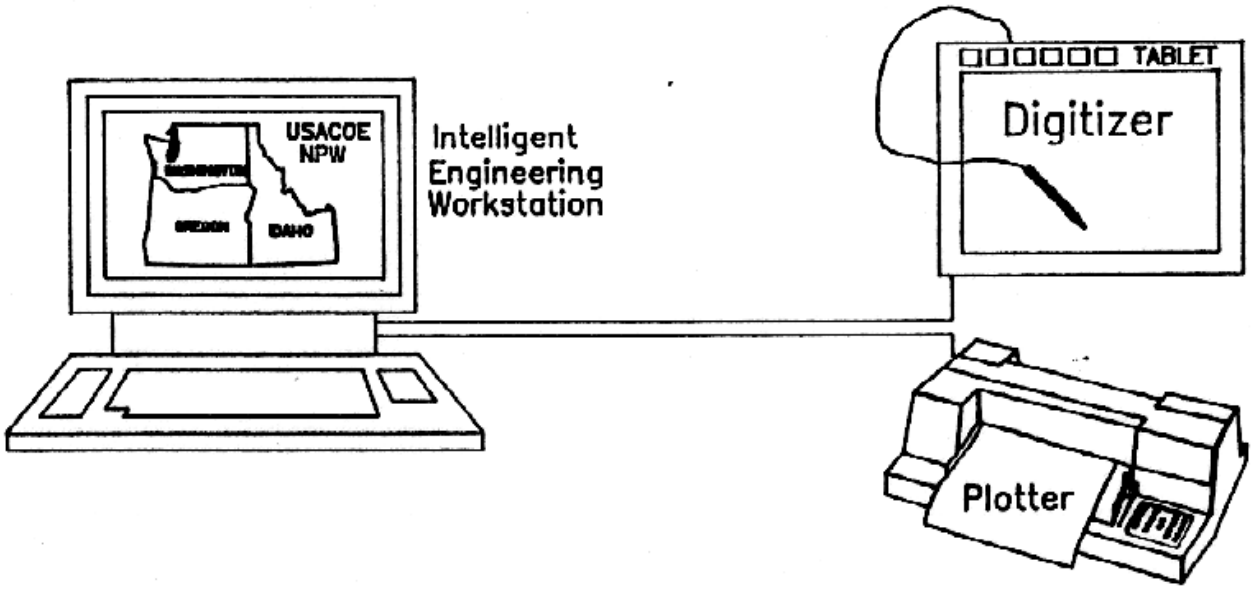


Chart 1.2

Geographic Information System
FY–89 Equipment
Configuration Proposal

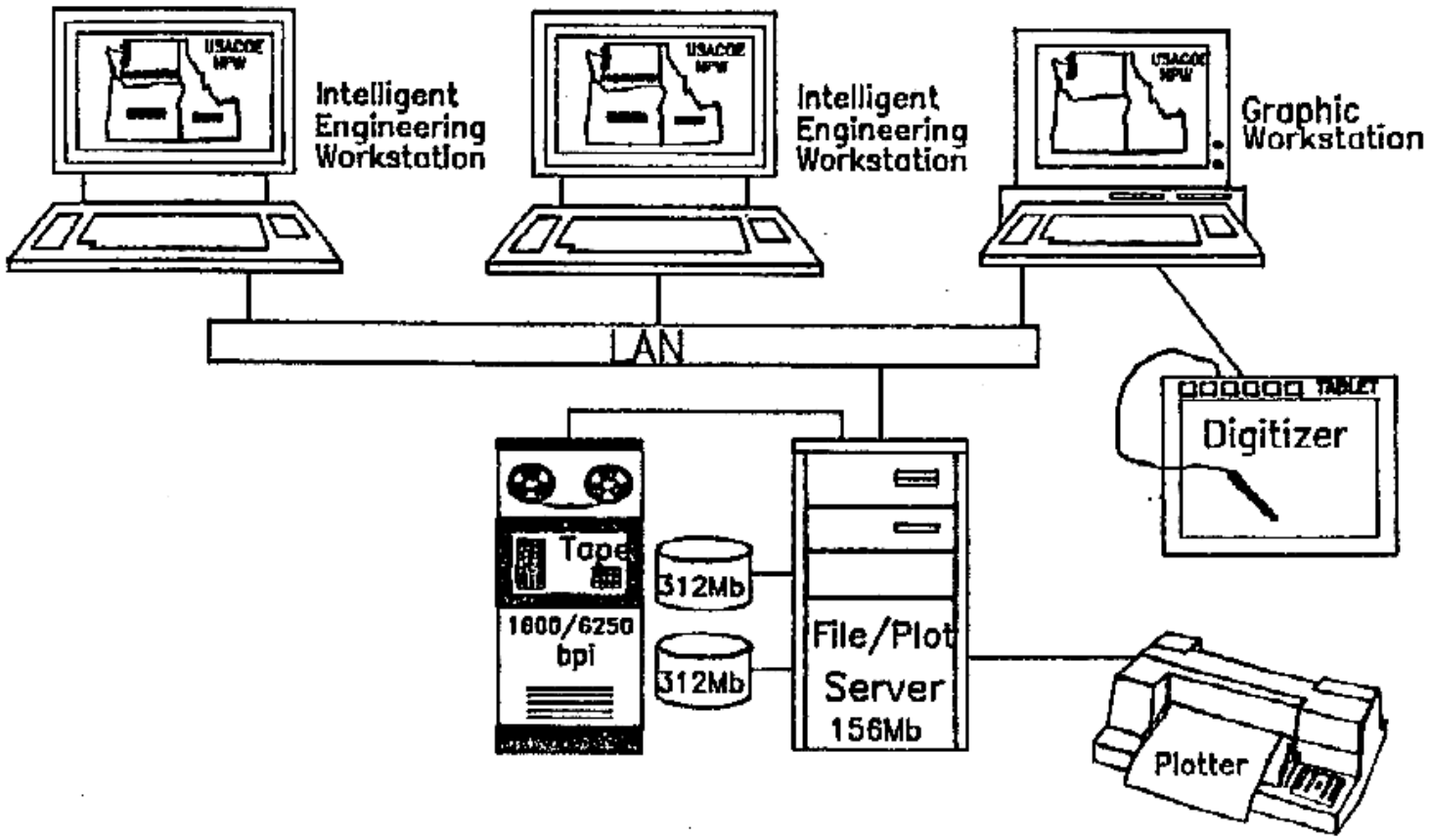


Chart 1.3

Geographic Information System
FY-90 Equipment
Configuration Proposal

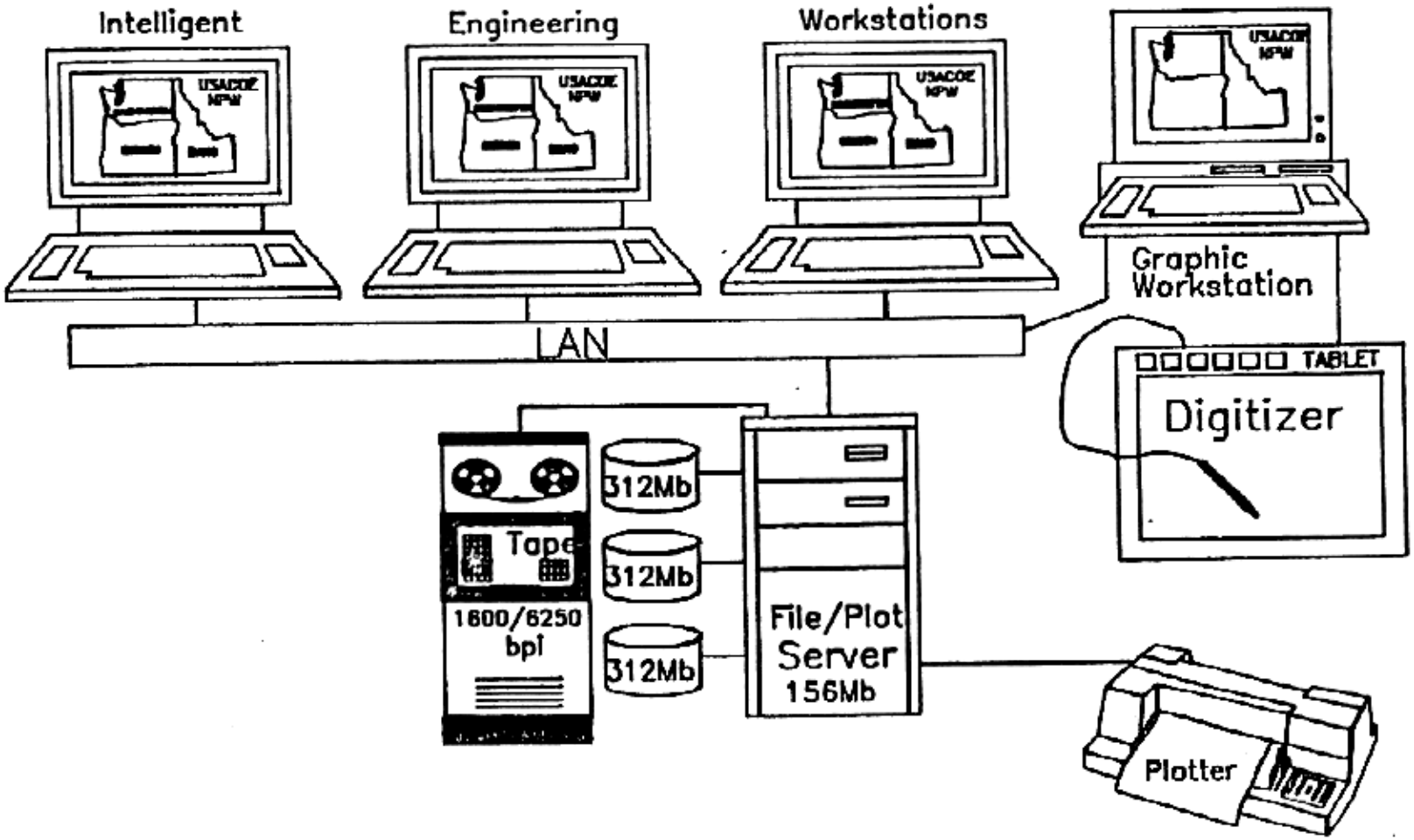


Chart 1.4

Geographic Information System
FY–91 Equipment
Configuration Proposal

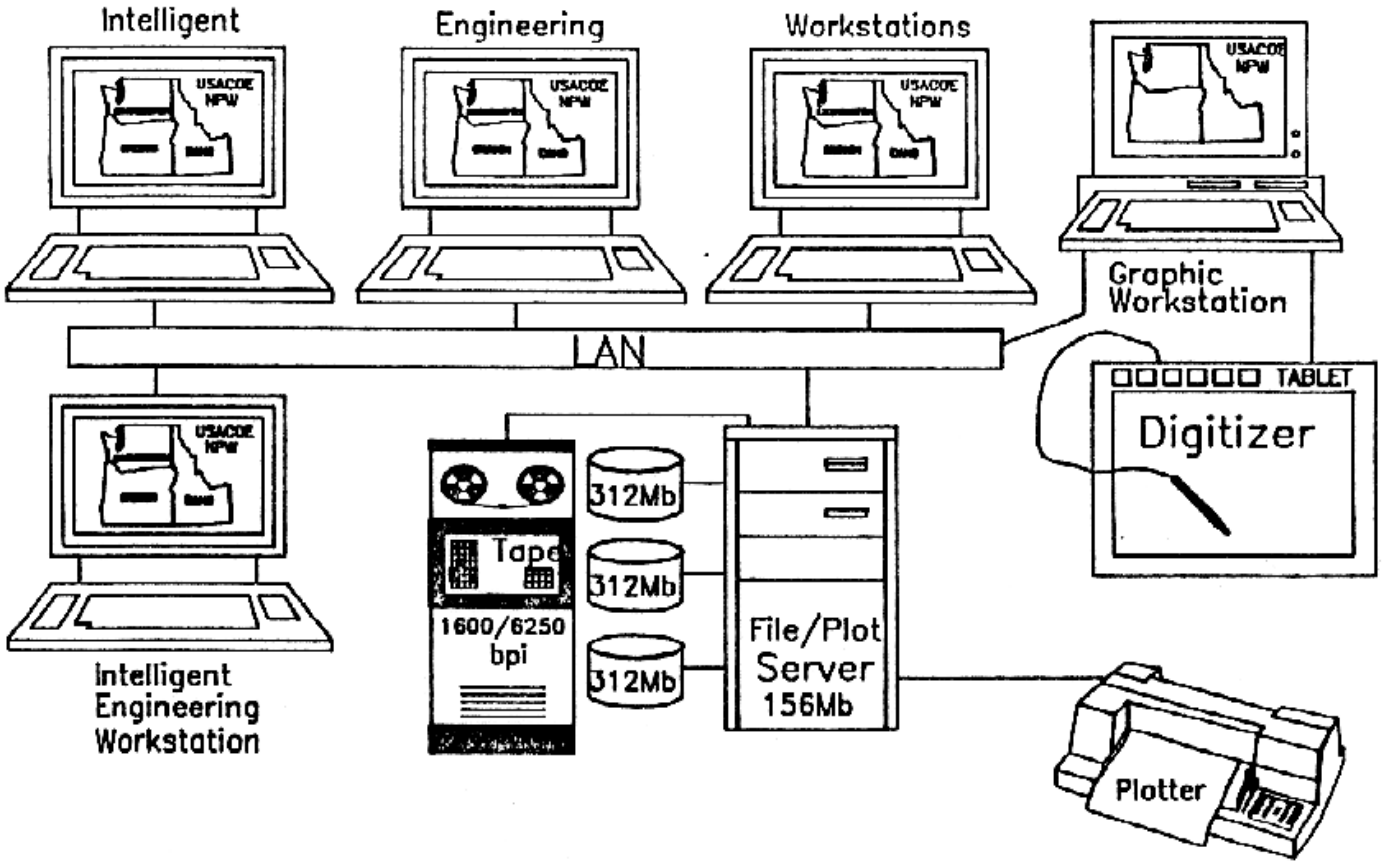


Table 1.9

Summary of GIS V6 Manual Costs
Five Workstation System
7-Year Useful System Life

Item	Avg. Annual Cost	System Life Cost
Hardware/Software	45,070	
Plant Inc.	2,330	
Insurance	1,747	
Maintenance	23,300	
ADP Support	17,000	
Total System Cost	89,447 x 7 yr =	626,129
Labor Cost (GIS)		1,090,940
Total system life cost		1,717,069
Total Labor Cost (Manual)		2,716,500
7 Year Savings		999,451

Total Hardware Cost =	233,000
Total Software Cost =	82,500
Total Cost =	415,500

*Amortized computer equipment in 7 years
*Mean Plant Inc. = tot. equip. cost x 1.07 - tot. equip. cost / 7
*Insurance = tot. equip. cost x .0075

See Figure 1.2 and 1.3.

Table 1.10

Summary of GIS vs Manual Costs
Four Workstation System
7-Year Useful System Life

Item	Avg. Annual Cost	System Life Cost
Hardware/Software	38,300	
Plant Inc.	2,040	
Insurance	1,530	
Maintenance	20,400	
ADP Support	17,000	
Total System Cost	79,270 x 7 yr=	554,890
Labor Cost (GIS)		1,090,940
Total system life cost		1,645,830
Total Labor Cost (Manual)		2,716,520
7 Year Savings		1,070,690

Total Hardware Cost =	204,000
Total Software Cost =	65,000
Total Cost =	269,000

*Amortized computer equipment in 7 years
*Mean Plant Inc. = tot. equip. Cost X 1. 07 - tot. equip. cost / 7
*Insurance = tot. equip. cost x .0075

See Figure 1.3.

Table 1.11

Summary of GIS V6 Manual Costs
Three Workstation System
7-Year Useful System Life

Item	Avg. Annual Cost	System Life Cost
Hardware/Software	30,215	
Plant Inc.	1,640	
Insurance	1,230	
Maintenance	16,400	
ADP Support	17,000	
Total System Cost	66,485 x 7 yr=	465,395
Labor Cost (GIS)		941,120
Total system life cost		1,406,515
Total Labor Cost (Manual)		2,352,800**
7 Year Savings		946,285

Total Hardware Cost = 164,000
Total Software Cost = 47,500
Total Cost = 211,500

**Real Estate and Engineering Labor Costs are not included.
* Amortized computer equipment in 7 years
* Mean Plant Inc. = tot. equip. cost x 1.07 - tot. equip. cost / 7
* Insurance = tot. equip. cost x .0075

See Figure 1.4 and 1.5.

Figure 1.2
Annual Cost Comparison, GIS vs Manual
5 Station Configuration

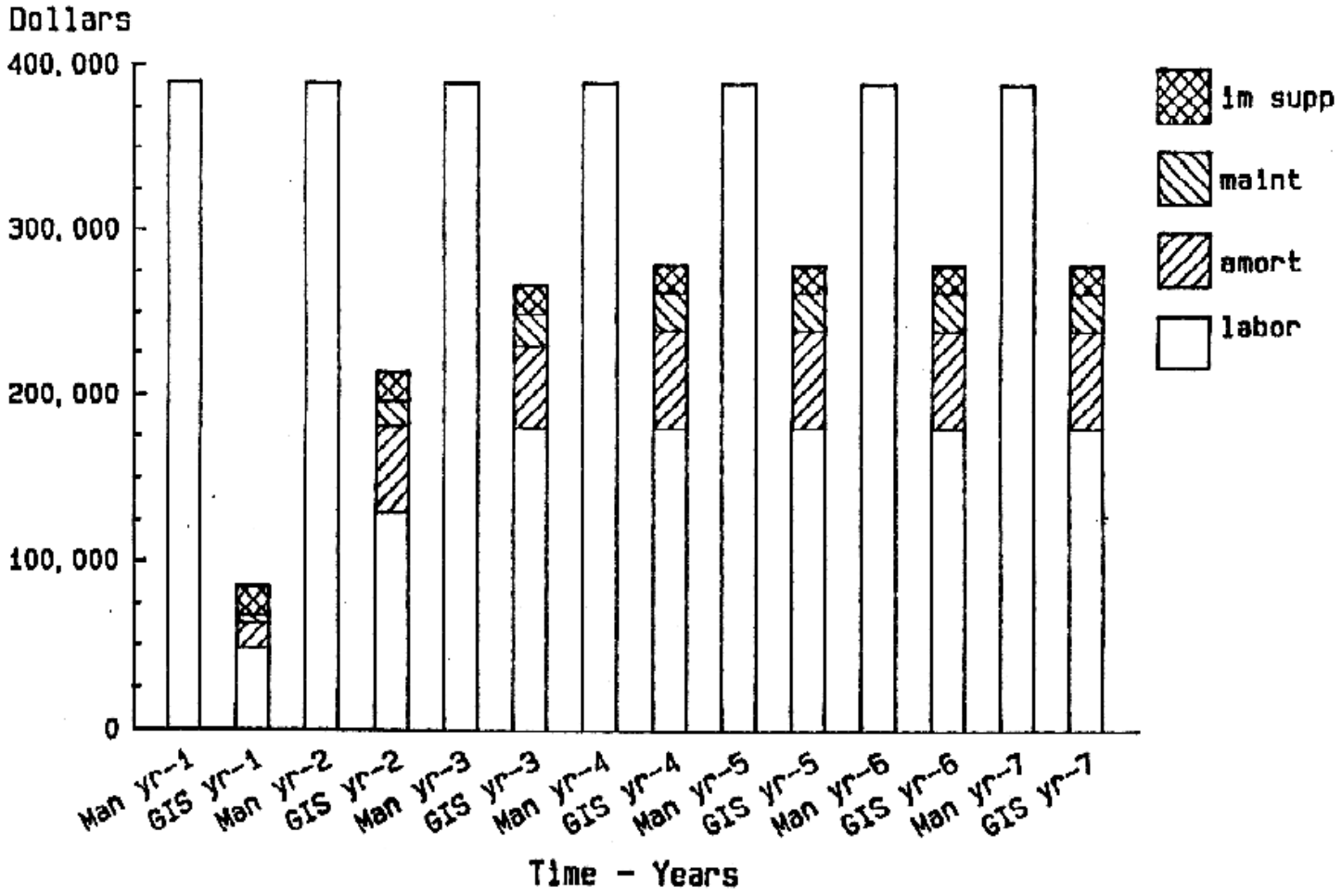


Figure 1.3

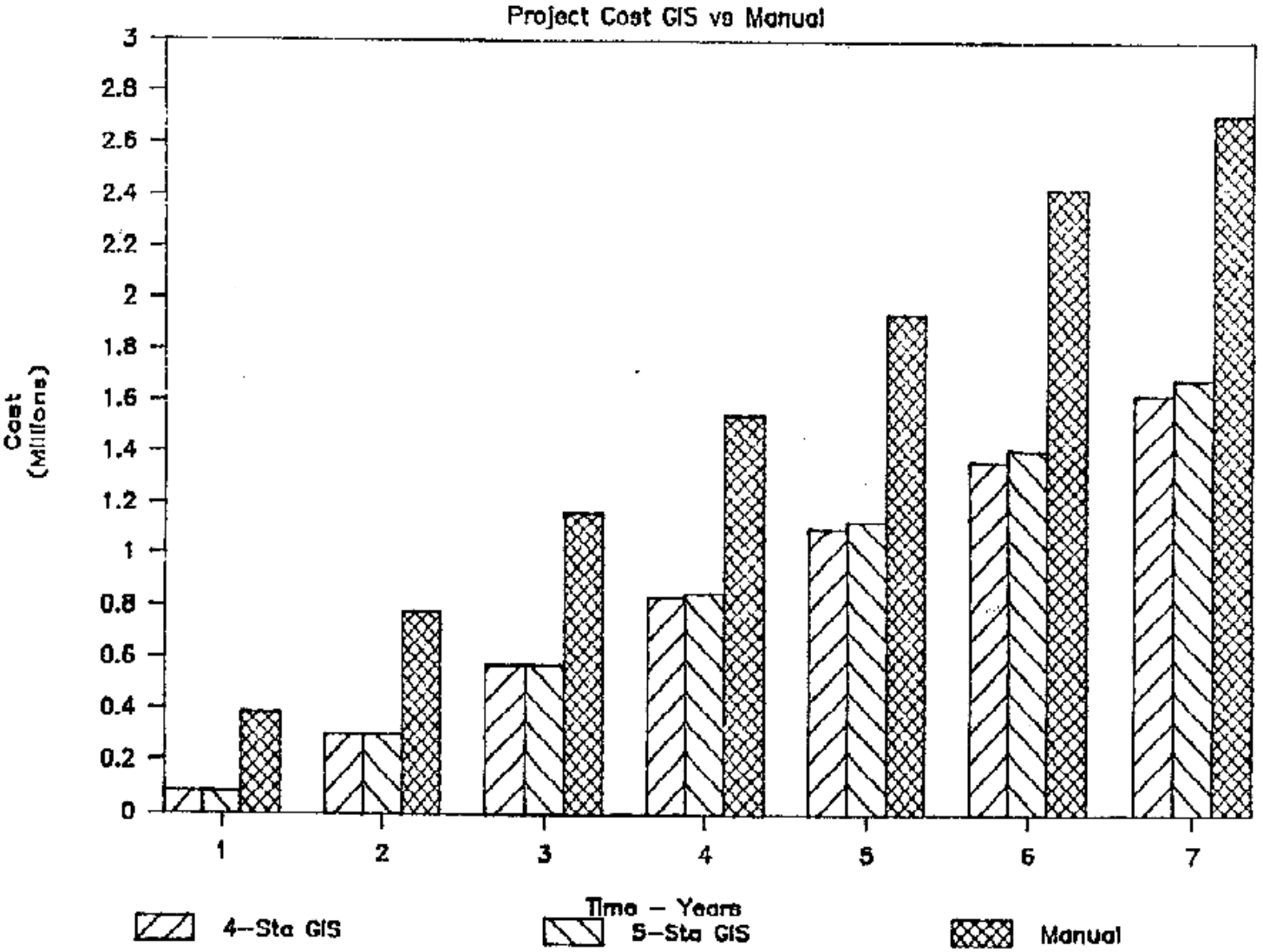
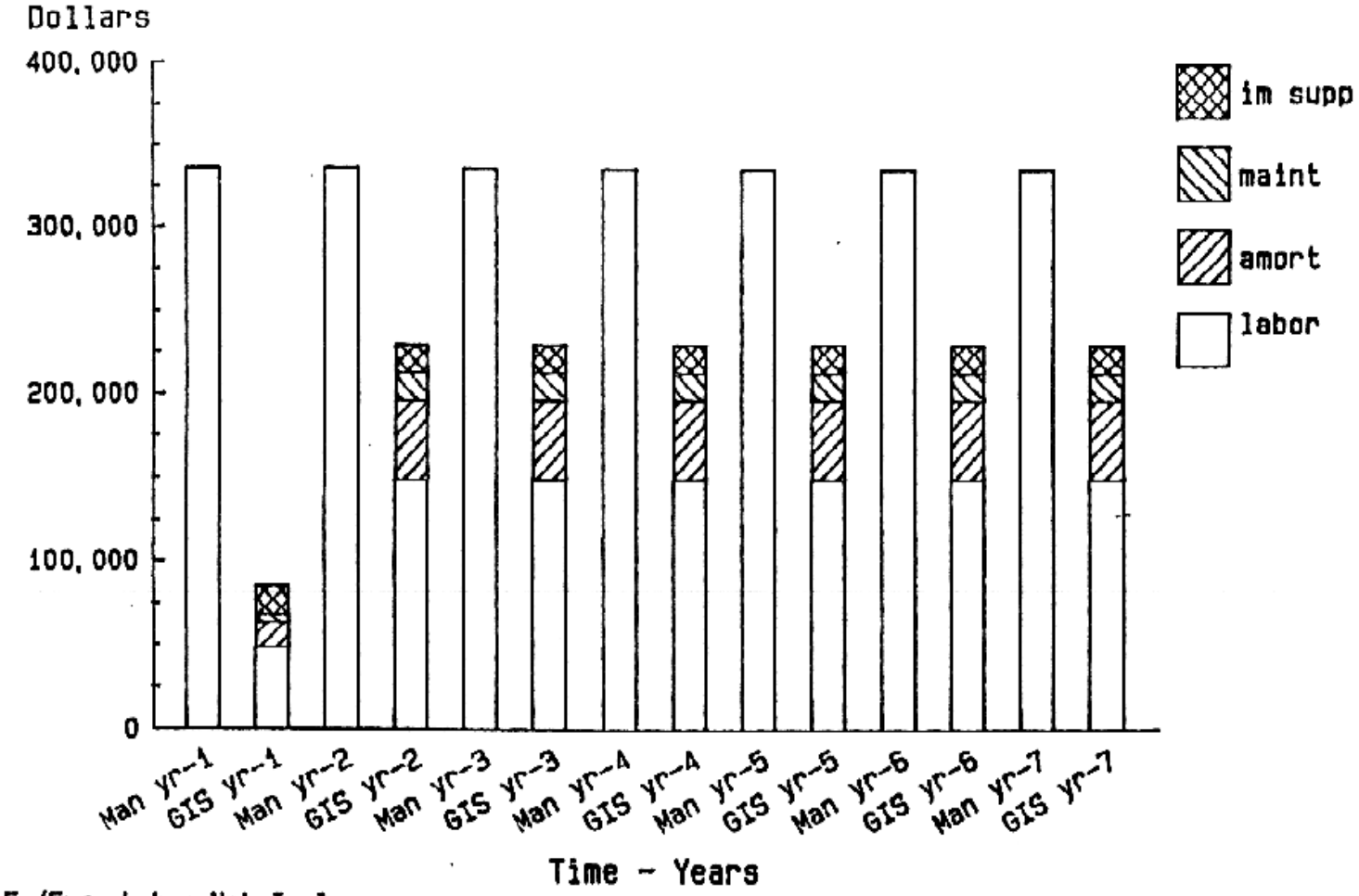
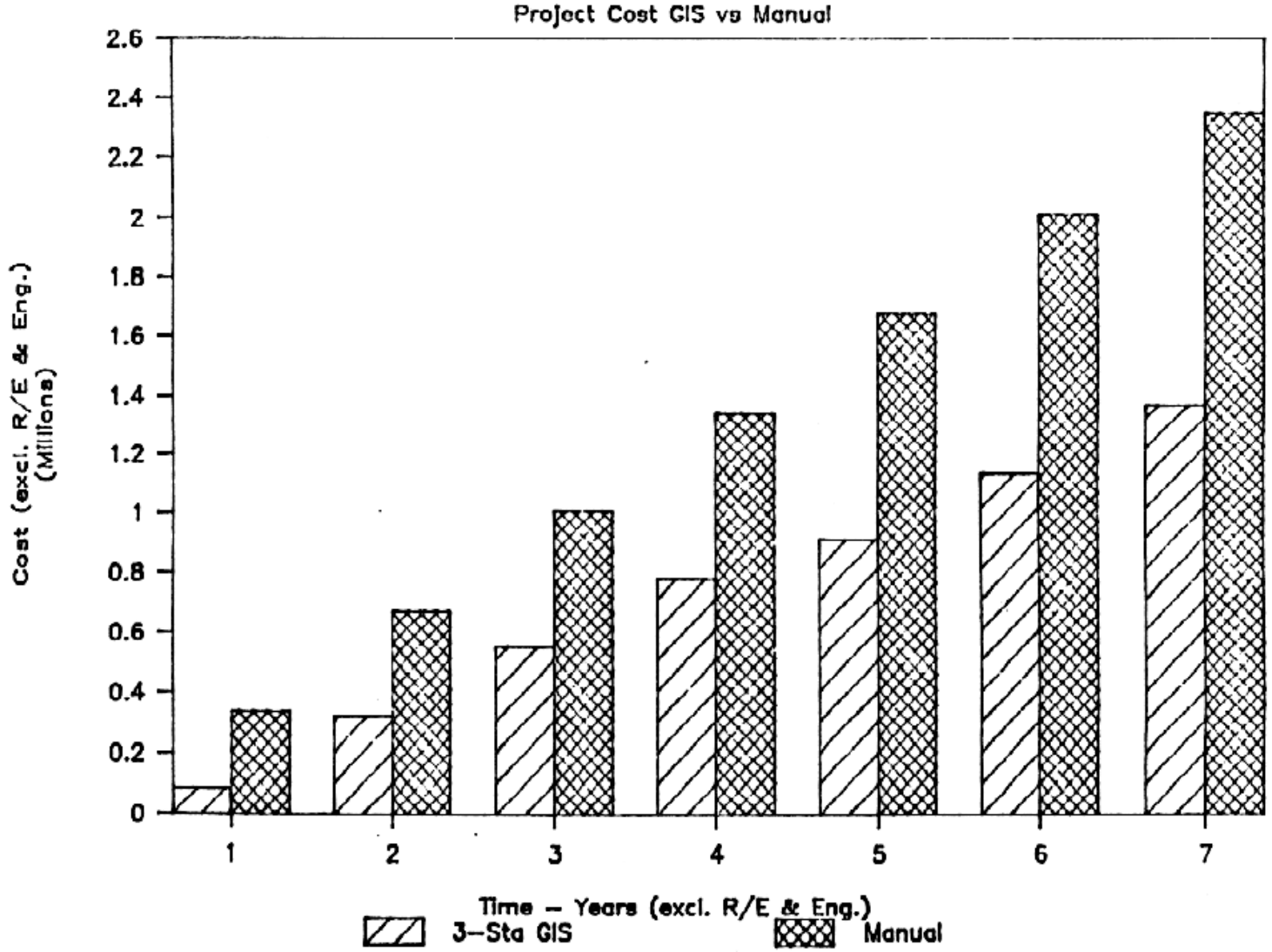

Project Cost GIS vs Manual
Cost (Millions)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
Time – Years
4–Sta GIS
5–Sta GIS
Manual

Figure 1.4
Annual Cost Comparison, GIS vs Manual
3 Station Configuration



R.E./Eng. Labor Not Incl.

Figure 1.5


Project Cost GIS vs Manual
Cost (excl. R/E & Eng.)
(Millions)
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
Time – Years (excl. R/E & Eng.)
3-Sta GIS
Manual

Appendix A

Needs Assessment for GIS End-users

Real Estate: Steve Gale handed out RE s list of possible GIS applications (Encl 1). Steve thought most of the GIS activities would be in the out-grants. Presently RE is keeping one draftsman busy full time. During the initial data entry period, the workstation usage will be high, but afterwards the usage will be about 4 hours per day. Real Estate s entry into GIS is vital to other users of GIS as a reference data base.

Engineering:

Survey and Mapping: Dick Gilman stated that Survey & Mapping s role will mainly be as data entry into GIS through the Zeiss stereoplotter digital data and the survey control points. Survey does need a method of retrieving and listing designated control points as needed other than a full blown workstation. Presently they have to hunt up old abstracts and survey books for their data. They could share a workstation with Real Estate for their needs.

Design Branch: Chris Hartman reported that the Design Branch would utilize the GIS for Master Planning about twice a year but each time it is used, it will be extensive use lasting about a month. GIS could also be used to generate slope maps in designing their FAA projects. As-built of maps is another application. Design Branch could also share a workstation. Once GIS is on line, Chris believed Engineering will have a need to interogate and utilize the data.

Planning: Blaise Grden reported on three branches in Planning with GIS applications.

(1) Hydrology: Watershed studies.

(2) Environmental Resources: Fish (mapping and analysis)
Habitat evaluation and mapping.
Cultural resources.
Environmental impacts.

(3) Plan Formulation: Master Planning on six projects.
Three levels of mapping plus analysis (local, project, regional).

Blaise stated that Planning could keep one workstation busy. Environmental Resources Branch especially will have daily need for a workstation. Master Planning will require data to be stored on a project level with local site planning within the project.

OCR: A1 Sutlick read the list of OCR's GIS applications (Encl 2). Some of the applications listed are not presently available by hand. The other applications are hand prepared. A1 stated that OCR could use a workstation full time initially and later install remote stations at the projects:

A GIS manager will be needed to run the system and would need a fully functional workstation to be able to provide all of the required support. The system configuration, as defined from an end-user standpoint is described below.

1 workstation w/digitizing table - Drafting
1 workstation - Real Estate & Engineering
1 workstation - Planning
1 workstation - OCR
1 workstation - GIS Manager

The study group thought that marrying of CADD and GIS was a good idea and we should take a hard look at developing an integrated GIS/CADD system package which will meet both functional requirements.

The system is estimated to require about 1 gigabytes of disk storage for the GIS data alone initially. This estimate is conservatively based upon the amount of 7.5 minute USGS Quadrangles within the Master Planning project areas, and estimates of the data themes and scale requirements of the various projected needs.

Encl. 1

Possible Real Estate Applications
for a Geographic Information System

1. Management and Disposal Area

    a. Real property utilization reports, Executive Order Surveys, exhibits and mapping data.
    b. Outgrant mapping for all civil works projects.
    c. Encroachment detection.
    d. Mapping for oil and gas leasing and availability.
    e. Determination of Availability of land for outgrants.
    f. Map products for outgrants and disposals.

2. Planning and Control Area.

    a. Real estate audit assemblies.
    b. Payment in lieu of taxes analyses.
    c. Recurring reports involving acreage information and analyses, ad hoc inquires.

3. Acquisition and Project Planning.

    a. Real Estate Design Memoranda, maps and analyses.
    b. Ownership maps of Local Coop. projects.
    c. Mobilization support and MMP's.

Although Real Estate Division has identified some possible applications, our needs may only justify part time use of a shared work station.

Encl. 2

OCR GIS Applications

1. Habitat Management

    a. Habitat structures mapping.
    b. Vegetation mapping.
    c. Nest locations/nesting densities evaluations.
    d. Acreages of any project category.
    e. Other geographic based data locations, such as, noxious weed control, irrigation, plantings; all aspects of data which change over time and must be related to other work.

2. Recreation.

    a. Accident/Incident reporting by area at projects.
    b. Recreation usage/densities by area or site on project.
    c. Locations of hazardous boating sites.
    d. Locations of facilities, utilities, etc. within sites.
    e. Overlays of enforcement activities and safety problems.

3. Contracts.

    a. Preparation of maps for contracts - facility locations, acreages, problem areas, work sites, etc.
    b. Monitoring progress of contracts.
    c. Monitoring problem areas; i.e., deficiencies by locations rather than numbers.

4. Navigation.

    a. Siltation of areas in river, shifting bars, areas of buildup, areas dredged, potential spoil areas.
    b. Navigation obstructions.
    c. Locations of markers and buoys.

5. Regulatory.

    a. Mapping historical data on permits; locations, previous work, problem areas.
    b. Information on violations; size/location.
    c. Overlays of potential problems - wetlands vs proposed developments.

Appendix B

GIS AS AN AUTOMATED INFORMATION SYSTEM

A Geographic Information System (GIS) is a computer system designed to store, process, and analyze spatial data. In some respects, geographic information systems are similar to other automated information systems in that they involve the following:

- Data acquisition, the collection and gathering of data;
- Data compilation, for plotting data on to a coordinate correct base, i.e., map or orthophotoquad;
- Data capture, for the collection of data, their transformation into machine readable form, and their storage and organization within the computer;
- Editing updating and reclassifying of the data files;
- Manipulation, analysis, synthesis, and retrieval of data for used defined areas;
- Generation of a variety of outputs and reports;
- Consideration of data management and system security.

But the ways in which these functions are performed are for the most part very different from other information systems—a result of the most significant characteristic of the GIS, location. Data in a GIS i8 of spatial or geographic nature, and must be geo-referenced, that is, tied to locations on the surface of the earth.

MAJOR GIS SYSTEM FUNCTIONS: The major GIS functions cover data capture, editing, analysis, output, and management.

The efficient integration of data base management, data capture, vector and raster processing, automated cartographic techniques and spatial analysis routines results in a unified GIS.

Excellent line work can be produced with the aid of the plotter, precise line work that rivals or exceeds that of a skilled cartographer and most computer installations have plotters.

Use of a GIS can reduce not only the physical space required to store the data, but also the time spent in entering, updating, cataloging and retrieving the data. Speed, accuracy, and the ability to analyze large quantities of complex spatial data are the main attributes of GIS technology. Since GIS is designed for referencing and retrieving spatially oriented geographic data, it provides the capability to analyze and interpret information for a broad range of applications.

Natural resource data is needed to respond to various policies, directives, and initiatives in support of national, regional and local decisions. The overall goals of implementing a GIS are to support the decision making process, to increase the amount of available information and to improve the utility of the information.

Use of a GIS can:

(1) Provide management with state-of-the-art technical planning capability to analyze data quickly;
(2) Provide offices with accurate information in an immediately usable and understandable form, with statistical summaries and maps at various scales;
(3) Improve coordination and efficient exchange of data between agencies in the development of resource management plans;
(4) Increased efficiency and productivity of staff resource specialists;
(5) Provides a district-wide inventory of natural and cultural resources, land ownership, land use, in a common format;
(6) Improve the consistency and quality of data;
(7) Avoid duplication of agency efforts of data collection and storage;
(8) Minimize the cost of information processing and storage facilities; and
(9) Reduce the need for re-inventory by permitting easy updating.

The three overall goals of implementing most GIS systems are:

(1) Supporting the decision making process,
(2) Increasing the availability of information, and
(3) Improve utility (for processing and data analysis)

A GIS would make various analytical techniques available to the resource specialists that are otherwise too costly or time consuming to apply on a regular basis with current capabilities. The ability of a GIS system to “model” resource conditions for answering “what if” questions greatly assists the manager in reviewing possible land management alter-natives. Using various impact scenarios, these automated techniques can create models for a variety of land use proposals.

Provide land managers with accurate information in an immediately usable and understandable form, including statistical summaries and maps at a variety of scales.

Results of analyses can be presented in various statistical and graphic formats including charts, graphs, tables, reports, narratives, maps and three-dimensional perspectives. These products are direct outputs of the GIS.

GIS provides the ability to access information based on geographic location which is clearly advantageous because virtually all natural resource data is collected on a site-specific basis. Retrieval of data is generally simplified by giving an individual the option of specifying the geographic boundaries for the required data, thereby automatically retrieving only information which is relevant to the area or issue under consideration.

Improve coordination with State, local, and other Federal agencies in the development of Resource Management Plans or other land-use based documents.

Coordination of planning efforts among various agencies becomes even more critical with the increase in volume and scope of Federal legislation and regulations, budget reductions and the expanding desire of planning authorities to assert control over the use of their lands. The complexity of expanding demands and utilization of the land and its resources requires the greater capability, objectivity and flexibility that can be provided by a GIS.

Promote an efficient exchange of data among agencies. Consolidation of common data needs will help to standardize information, thus improving the accessibility of data to all data users. This also increases the ability of each agency to make better decisions. Because other agencies such as BLM, FWS, BIA, USGS, BPA, DOE, MMS, SCS, USES and State of Oregon, State of Washington are currently using GIS software, more effective and efficient means of data storage and retrieval will facilitate greater exchange of agency data.

Improve efficiency/productivity of staff resource specialists. The ability to access resource information within specific geographic boundaries and interact with other information in the system greatly adds to the efficiency and productivity of staff resource specialists in their day-to-day and special project activities. Managers and resource specialists can quickly retrieve selected data, interact that data with other resource data, make management assessments, test alternatives, and determine courses of action on individual plans, projects or resource B .

All data can be consolidated and reformatted into a consistent and usable format. Data which currently exists in several documents at several administrative locations can be collected and entered into the system where it will be centrally located. Procedures for updating the data and interfacing with other agency data systems must also be included. Remote sensing technology offers some potential advantages as a mechanism to monitor and update. Some forms of GIS data can be synthesized (through overlays) form other data which reduces the collection needs and costs.

Part of the reason for conflict between agency planning is the result of inconsistent information. Some of these conflicts would be resolved through mutual access to each agency's data base (exchange of data). This should enhance the quality of the information available by allowing the selection of information most compatible to each agency.

Data needs common to more than one agency are presently maintained separately by each agency. This represents a duplication of agency efforts and a waste of public funds. Interfacing and/or sharing data with other government agencies greatly increases data sources and reduces duplication of efforts in collecting and analyzing the data.

The computer is the most powerful tool and the most efficient for handling extremely large amounts of information. Information stored in the computer is viewed as a central library which can be easily and quickly accessed by a number of people from different locations. Easy access to this central storage mechanism not only reduces the cost and physical storage space, but also capitalizes on the efficiency and computer speed to handle the information. Cost of processing information can thus be kept to a minimum.

Resource information stored in a computer can be easily updated, changed or added to the data base as new information i8 collected, allowing the district to maintain current status of the original inventory data. This greatly reduces repetitious inventory when there are new data needs.

The increased multiple use of this information not only promotes cooperation among individuals and agencies, but also reduces duplication of efforts in collecting, storing, and processing information within same office.

In addition to the benefit/cost ratio, field offices intending to automate for resource management should consider additional variables:

- resource management priorities
- value of the resources present
- characteristics of the land pattern
- repetitive nature of work
- activities mandated by law
- quality or accuracy of the products required
- use and life span of the products
- current level of automation available

The vast majority of resource management work performed in the field makes use of maps in some form, often in combination with the alphanumeric data bases mentioned. Using maps and analyzing the spatial relationships of data are a daily occurrence for most resource specialists and managers in the

district and other land management agencies and is a vital component to conveying the work that is done to other specialists, management, public land users, and the general public. Therefore, any system that i8 configured for use by resource specialists in field offices must be geo-referenced and have some analytical spatial graphic capability. Without the spatial graphic component, the alphanumeric data bases have only limited utility and applicability to the work performed in resource management.

The more times the data is used once it is captured, the higher the benefit/cost ratio. Many of the benefits will not be realized within the first five years. With continuing pressure from Washington to reduce budgets and personnel, it will be essential to use existing dollars and personnel in the most efficient manner. The re-utilization of data over and over rather than recapturing it each time will help managers meet these requirements. In all cases, the real savings and usefulness of GIS is in aiding the resource decision maker to make more informed decisions by providing comprehensive data. The data is spatially related to the managers area of interest, and is accessible in a timely fashion via state-of-the-art technology.

GIS ANNUAL COST
FEBRUARY 1989

HARDWARE			SOFTWARE								
FY	**DEPPEC**		**PLT INC**	**DEPPEC**	**PLT INC**	**INS**	**MAINT**	**SITE PR**	**TRAIN**	**IMO SUP**	**SOFTW**	**TOTAL**
88	0	0	0	0	0	0	2000	1200	5000	37900	56900	
89	43464	10851	6000	600	1628	23339	0	0	17000	312	103134	
90	48913	15271	16000	1630	1884	39548	0	0	17000	1800	152046	
91	64013	17309	40000	4050	1633	50308	0	0	17000	5400	199714	
92	64013	18175	3000	3150	1153	50308	0	0	17000	0	183799	
93	64013	19084	0	0	673	50308	0	0	17000	0	151078	
94	20609	20038	0	0	193	50308	0	0	17000	0	108148	
											954819	

GIS ORGANIZATIONAL COSTS
FEBRUARY 1989

ORG	**FY 88**	**FY 89**	**FY 90**	**FY 91**	**FY 92**	**FY 93**	**FY 94**	**TOTAL**
PLANNING	34965	66001	90326	112668	104743	88416	60316	557435
OPERATIONS	13041	25987	38248	63836	55782	39315	28283	264492
REAL ESTATE	5929	7431	15648	15474	15516	15564	13032	88594
ENGINEERING	2965	3715	7824	7737	7758	7782	6517	44298
	56900	103134	152046	199714	183799	151078	108148	954819

CADD ANNUAL COST
FEBRUARY 1989

HARDWARE				SOFTWARE							
FY	**DEPPEC**		**PLT INC**	**DEPPEC**	**PLT INC**	**INS**	**MAINT**	**SITE PR**	**TRAIN**	**IMO SUP**	**SOFTW**	**TOTAL**
88	0	0	0	0	0	0	2000	5000	5000	31670	43670	
89	63375	15844	0	0	2377	36461	0	0	17000	0	135057	
90	69375	18136	0	0	2126	34852	0	0	17000	0	141490	
91	69375	19043	0	0	1606	34852	0	0	17000	0	141876	
92	69375	19995	0	0	1086	34852	0	0	17000	0	142308	
93	69375	20995	0	0	565	34852	0	0	17000	0	142787	
94	6000	22044	0	0	45	34852	0	0	17000	0	79941	
											827130	

CAD/GIS SOFTWARE

PROGRAM	CLIN NO	MNT	UNIT COST	FY 88 QUA	FY 88 TOT CST	FY 88 CAD CST	FY 88 GIS CST	FY 89 QUA	FY 89 TOT CST	FY 89 CAD CST	FY 89 GIS CST	CAD MNT	GIS MNT
FORTRAN, LRG SYS	0047	504	5270	1	5270	3420	1850					328	176
DATA VIEW	0072		1500	1	1500	1500							
ENGRG TABLES	0073		1250	1	1250	1250							
BITS	0077		500	1	500	500							
IGES/ISIF	0078		2600	1	2600	1300	1300						
ENGR SITE PACK	0085		10500	1	10500	10500							
DTM	0086		8000	1	8000	4000	4000						
ARCHITECTURAL	0087		6500	1	6500	6500							
ELECTRICAL	0089		1100	1	1100	1100							
MASTER PLAN SYS	0095		23850	1	23850		23850						
INTERPLOT	0136	312	2500	1	2500	1600	900					208	104
USGS DLG-IN			3000	1	3000		3000						
USGS DLG-OUT			3000	1	3000		3000						
WORLD MAPPING			12000					1	12000		12000		
ACTEM	GSA	240	312					1	312		312		240
MICROSTATION, WS		720	1800										
WS GIS EDIT/MAP		1000	10000										
WS GIS ANALYST		1000	10000										
					69570	31670	37900		12312	0	12312	536	520

CAD/GIS SOFTWARE

FY 90

PROGRAM	CLIN NO	MAINT	UNIT COST	QUA	TOT CST	CAD CST	GIS CST	CAD MNT	GIS MNT
FORTRAN, LRG SYS	0047	504	5270						
DATA VIEW	0072		1500						
ENGRG TABLES	0073		1250						
BITS	0077		500						
IGES/ISIF	0078		2600						
ENGR SITE PACK	0085		10500						
DTM	0086		8000						
ARCHITECTURAL	0087		6500						
ELECTRICAL	0089		1100						
MASTER PLAN SYS	0095		23650						
INTERPLOT	0136	312	2500						
USGS DLG-IN			3000						
USGS DLG-OUT			3000						
WORLD MAPPING			12000						
ACTEM	GSA	240	312						
MICROSTATION, WS		720	1800	1	1800		1800		720
WS GIS EDIT/MAP		1000	10000	1	10000		10000		1000
WS GIS ANALYST		1000	10000	1	10000		10000		1000
					21800	0	21800	0	2720

CAD/GIS SOFTWARE

FY 91

PROGRAM	CLIN NO	MAINT	UNIT COST	QUA	TOT CST	CAD CST	GIS CST	CAD MNT	GIS MNT
FORTRAN LRG SYS	0047	504	5270						
DATA VIEW	0072		1500						
ENGRG TABLES	0073		1250						
BITS	0077		500						
IGES/ISIF	0078		2800						
ENGR SITE PACK	0085		10500						
DTM	0086		8000						
ARCHITECTURAL	0087		6500						
ELECTRICAL	0089		1100						
MASTER PLAN SYS	0095		23850						
INTERPLOT	0136	312	2500						
USGS DLG-IN			3000						
USGS DLG-OUT			3000						
WORLD MAPPING			12000						
ACTEM	GSA	240	312						
MICROSTATION WS		720	1800	3	5400		5400		2160
WS GIS EDIT/MAP		1000	10000	3	30000		30000		3000
WS GIS ANALYST		1000	10000	3	30000		30000		3000
					65400	0	65400	0	8160

CAD/GIS HARDWARE

				FY 88			FY 89					
PROGRAM	CLIN NO	MAINT	UNIT COST	QUA	TOT CST	CAD CST	GIS CST	QUA	TOT CST	CAD CST	GIS CST	CAD MNT	GIS MNT
CPU, LARGE SYS	0001	16440	144950	1	144950	92479	52471					8220	8220
ADDNL MEMORY	0005	80	531	8	4248	1416	2832	8	4248	4248		80	80
COMM SERVER	0007	660	7025	1	7025	4684	2341					330	330
DISK STORE, 337MB DUAL PORT	0010	1176	11200	2	22400	14900	7500					1176	1172
DISK STOR, 337MB DUAL PORT, INTRBUS	0011	2652	23100	2	46200	23100	23100					2652	2652
MAG TAPE UNIT	0014	1596	12750	2	25500	17000	8500					1596	1598
WS, INTERACT 32C	0020	4284	35160	1	35160	35160						4284	
WS, INTERVIEW 32C	0021	4284	35160	2	70320	47060	23260					5712	2856
WS, INTERPRO 220 W/MENU TABLET	0024	2604	24960	3	74880	49920	24960					5208	2604
DIGITIZE, 36X48	0035	1044	8500	2	17000	8500	8500					1392	696
ADDNL CABLING	0098	0	4	2120	7420	4945	2475	678	2374		2374		
CRT CONSOLE	0109	132	850	1	850	565	285					66	66
PLOT SERVER INTERSERVE 200	0134	2400	19350	1	19350	12900	6450					1600	800
DISK STOR, 559MB	0142	2316	18050					1	18050		18050		579
WS, INTERPRO 340	GSA	4656	33922					1	33922		33922		1164
WS, INTERPRO 340		4656	37587										
PLOTTER		3000	45000										
DISK STORAGE		600	5500										
PLOT SERVER UPGRADE		1000	10000										
					475303	312529	162674		58594	4248	54346	32916	22819

CAD/GIS SOFTWARE

FY 90

PROGRAM	CLIN NO	MAINT	UNIT COST	QUA	TOT CST	CAD CST	GIS CST	CAD MNT	GIS MNT
CPU, LARGE SYS	0001	16440	144950						
ADDNL MEMORY	0005	80	531						
COMM SERVER	0007	660	7025						
DISK STOR, 337MB DUAL PORT	0010	1176	11200						
DISK STOR, 337MB DUAL PORT, INTRBUS	0011	2652	23100						
MAG TAPE UNIT	0014	1596	12750						
WS, INTERACT 32C	0020	4284	35160						
WS, INTERACT 32C	0021	4284	35160						
WS, INTERPRO 220 W/MENU TABLET	0024	2604	24960	1	24960		24960		2604
DIGITIZER, 36X48	0035	1044	8500						
ADDNL CABLING	0098	0	4						
CRT CONSOLE, PLOT SERVER	0109	132	850						
INTERSERVE 200	0134	2400	19350						
DISK STOR, 559MB	0142	2316	18050						1737
WS, INTERPRO 340	GSA	4656	33922						3492
WS, INTERPRO 340		4656	37587	1	37587		37587		4656
PLOTTER		3000	45000	1	45000	30000	15000	2000	1000
DISK STORAGE		600	5500						
PLOT SERVER UPGRADE		1000	10000						
					107547	30000	77547	2000	13489

CAD/GIS SOFTWARE

FY 91

PROGRAM	CLIN NO	MAINT	UNT COST	QUA	TOT CST	CAD CST	GIS CST	CAD MNT	GIS MNT
CPU, LARGE SYS	0001	16440	144950						
ADDNL MEMORY	0005	80	531						
COMM SERVER	0007	660	7025						
DISK STOR, 337 MB DUAL PORT	0010	1176	11200						
DISK STOR, 337 MB DUAL PORT, INTRBUS	0011	2652	23100						
MAG TAPE UNIT	0014	1596	12750						
WS, INTERACT 32C	0020	4264	35160						
WS, INTERACT 32C	0021	4264	35160						
WS, INTERPRO 220 W/MENU TABLET	0024	2604	24960						
DIGITIZER, 36X48	0035	1044	8500						
ADDNL CABLING	0098	0	4						
CRT CONSOLE, PLOT SERVER	0109	132	850						
INTERSERVE 200	0134	2400	19350						
DISK STOR, 559MB	0142	2316	18050						
WS, INTERPRO 340	GSA	4656	33922						
WS, INTERPRO 340		4656	37587						
PLOTTER		3000	45000						
DISK STORAGE PLOT SERVER		600	5500	1	5500		5500		600
UPGRADE		1000	10000	2	20000		20000		2000
					25500	0	25500	0	2600

– GEOGRAPHIC INFORMATION SYSTEM –

BACKGROUND

- PGS Proposal #150
  - Planning Division
- PGS Review Panel
  - Recommended District GIS Study
- Information Meeting
  - Affected Division Chiefs
  - Video and Discussion
  - Concur with District GIS Study
  - IMO Tasked with Study

– GEOGRAPHIC INFORMATION SYSTEM –

STUDY TEAM

- LEADER –– Gus Kajita
- MEMBERS
  - Steve Gale –– RE
  - Dick Gilman –– ENGR
  - Blaise Grden –– PLAN
  - Chris Hartman –– ENGR
  - Al Sutlick –– OCR
  - Tom Seiner –– IMO

– GEOGRAPHIC INFORMATION SYSTEM –

STUDY APPROACH

- Assessment Of Needs
- Data Base Development
- Software Requirements
- Hardware Architecture
- Implementation Plan
- Organizational Structure
- Cost
- Benefits

– GEOGRAPHIC INFORMATION SYSTEM –

ASSESSMENT OF NEED

- Planning Division
  - Master Planning
  - Habitat Evaluation and Mapping
  - Cutural Resources
  - Environmental Impact
  - Fish Analysis
  - Watershed Studies
- 7–year Manual Labor Projection
  - 500 Man–months, 41.7 Man–years

– GEOGRAPHIC INFORMATION SYSTEM –

ASSESSMENT OF NEED

- OCR Division
  - Habitat Management
  - Recreation
  - Contracts
  - Navigation
  - Regulatory
- 7–year Manual Labor Projection
  - 180 Man–months, 15 Man–years

– GEOGRAPHIC INFORMATION SYSTEM –

ASSESSMENT OF NEED

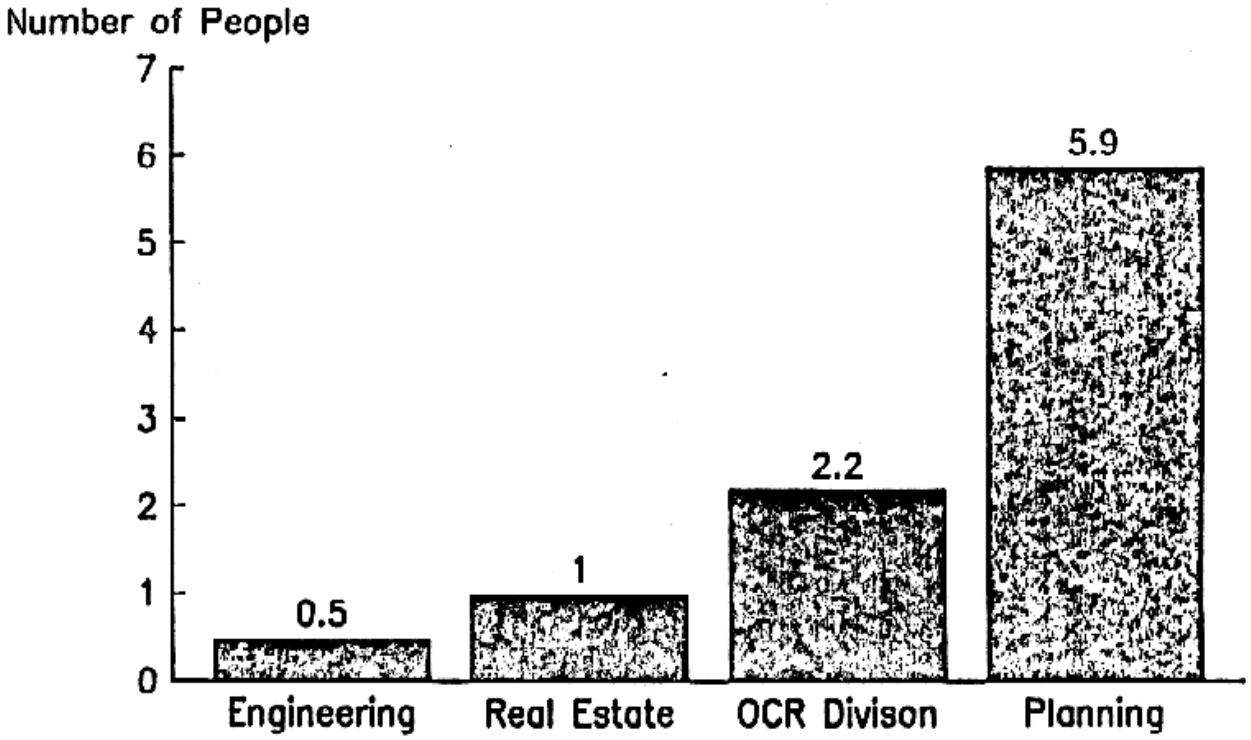
- Real Estate
  - Management and Disposal
  - Planning and Control
  - Acquisition and Project Plan
- 7–year Manual Labor Projection
  - 84 Man–months, 7 Man–years

– GEOGRAPHIC INFORMATION SYSTEM –

ASSESSMENT OF NEED

- Engineering Division
  - Master Plan
  - Scope Maps (FAA Projection)
  - As Built Maps
- 7–year Manual Labor Projection
  - 42 Man–months, 3.5 Man–years

– GEOGRAPHIC INFORMATION SYSTEM –



Annual manual effort required to complete assessed GIS applications

– GEOGRAPHIC INFORMATION SYSTEM –

DATA BASE

- Basic to GIS
- Applications Broaden as Basic Data Becomes Available
- Sources
  - Manual Entry
  - Zeiss Stereoplotter
  - CADD
  - Government Agencies
  - Private Agencies

– GEOGRAPHIC INFORMATION SYSTEM –

SOFTWARE REQUIREMENTS

- Input/edit basic data
- Digitize information
- Analyze proposed actions
- Display maps
- Integration with CADD

– GEOGRAPHIC INFORMATION SYSTEM –

HARDWARE ARCHITECTURE

- Data Entry
  - Keyboard
  - Digitizer
  - Magnetic Tape
- File Storage
  - Disk
  - Magnetic Tape
- Display Device
  - Plotter
  - Screen
- Processing Unit
  - Central Processing Unit
  - Intelligent Workstation

– GEOGRAPHIC INFORMATION SYSTEM –

IMPLEMENTATION PLAN

- Phased Procurement
  - First Year
    - Build Database
    - GIS–Plan
  - Second Year
    - GIS–OCR
  - Third Year
    - GIS–ENGR
    - GIS–RE
  - Fourth Year
    - GIS–Site Manager

Chart 1.1

Geographic Information System
FY–88 Equipment
Configuration Proposal

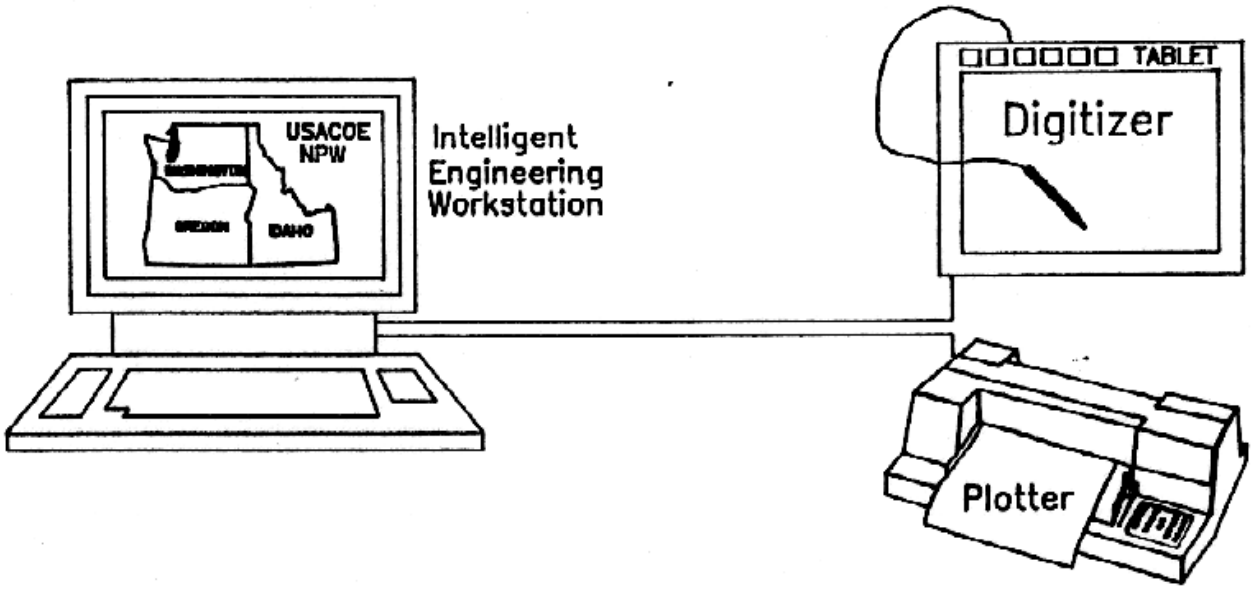


Chart 1.2

Geographic Information System
FY–89 Equipment
Configuration Proposal

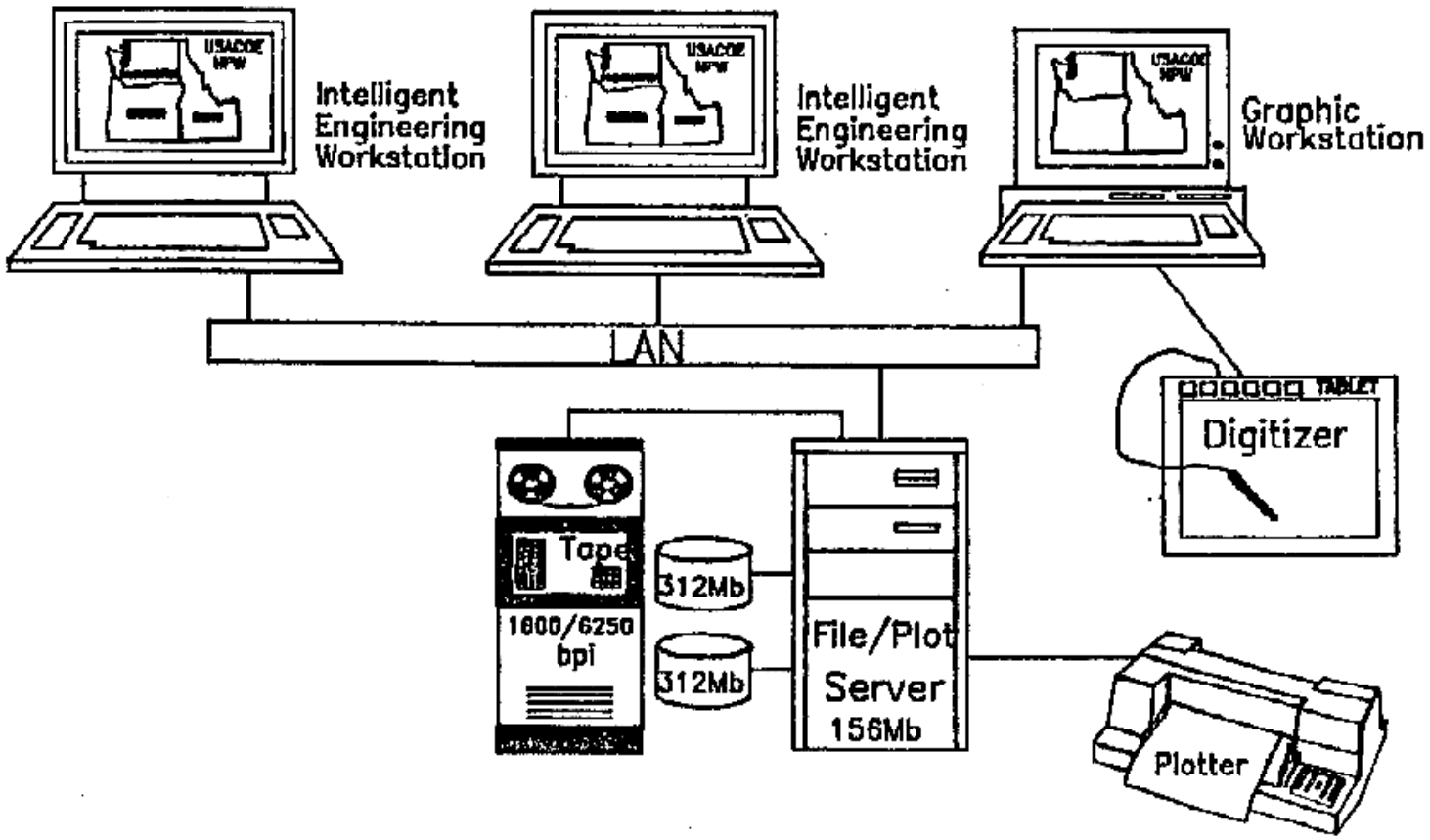


Chart 1.3

Geographic Information System
FY–90 Equipment
Configuration Proposal

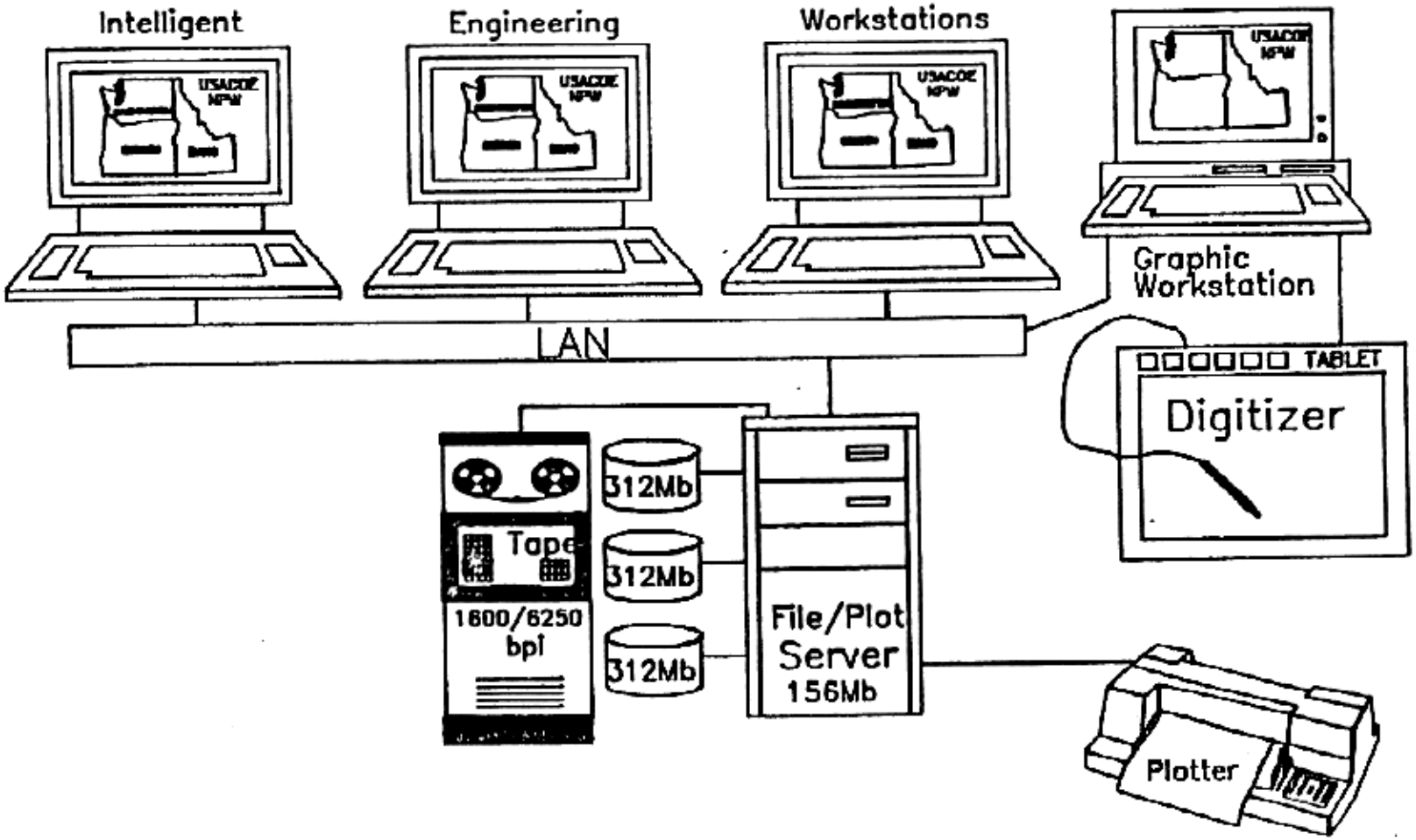


Chart 1.4

Geographic Information System
FY–91 Equipment
Configuration Proposal

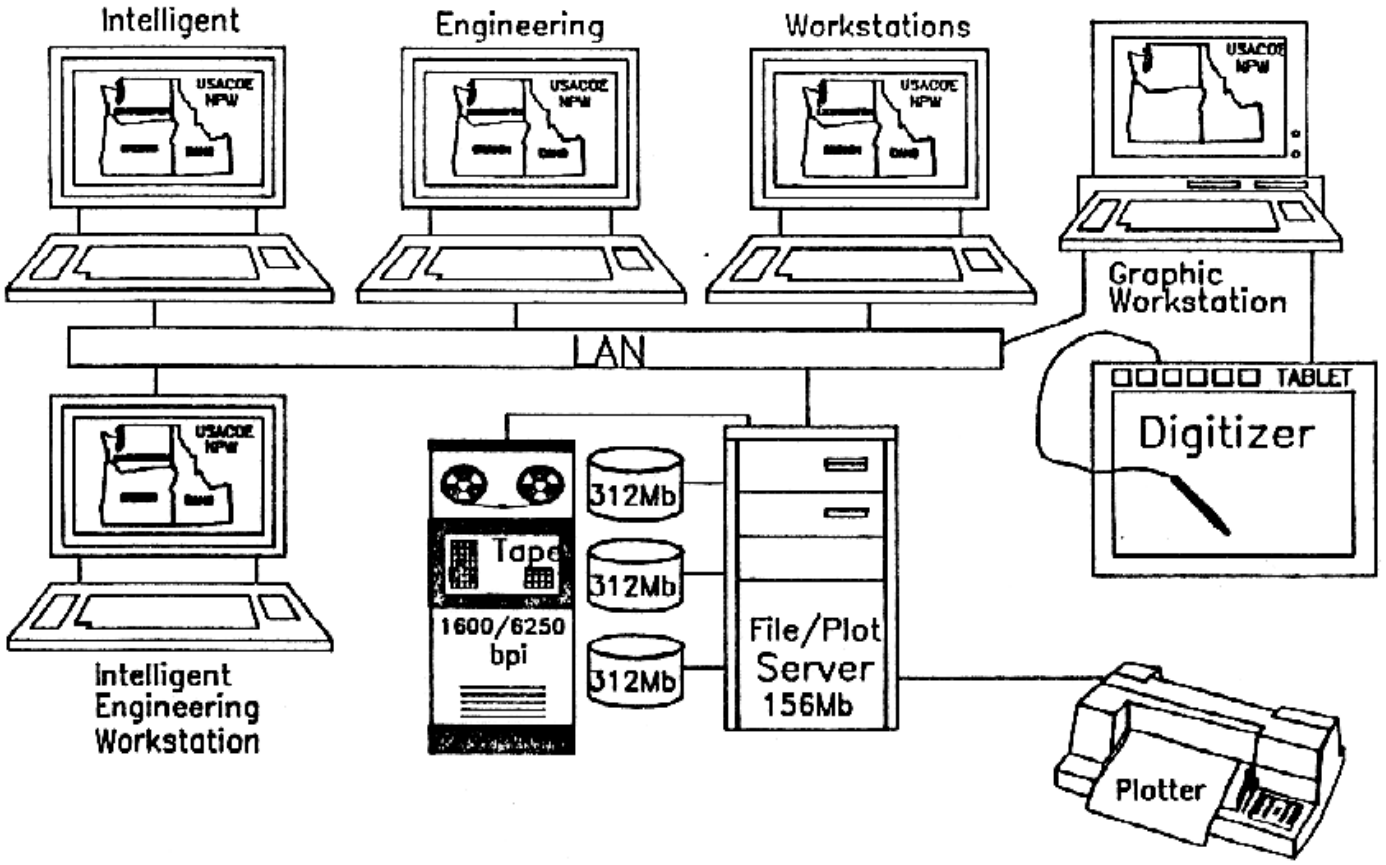
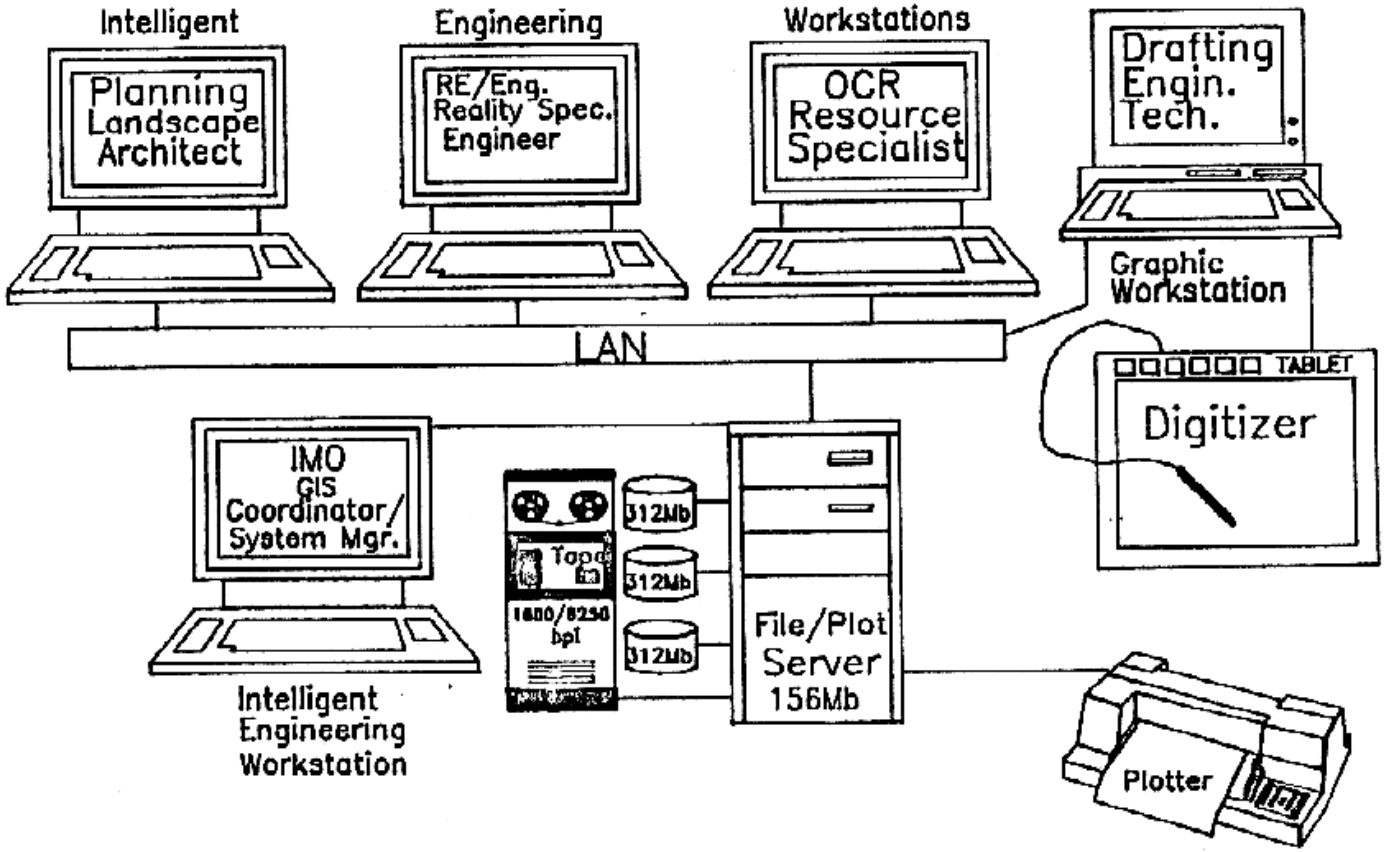


Chart 1.0

Geographic Information System Equipment–Primary User Configuration



– GEOGRAPHIC INFORMATION SYSTEM –

ECONOMIC ANALYSIS

- Basis
  - 7 Year Useful Life
  - Assessed GIS Workload
    - Currently being done
    - Currently not be done
- Analysis
  - Cost To Manually Complete Assessed Workload versus Cost
  - 5 Workstations To Complete Assessed Workload in 7 Years

Figure 1.1

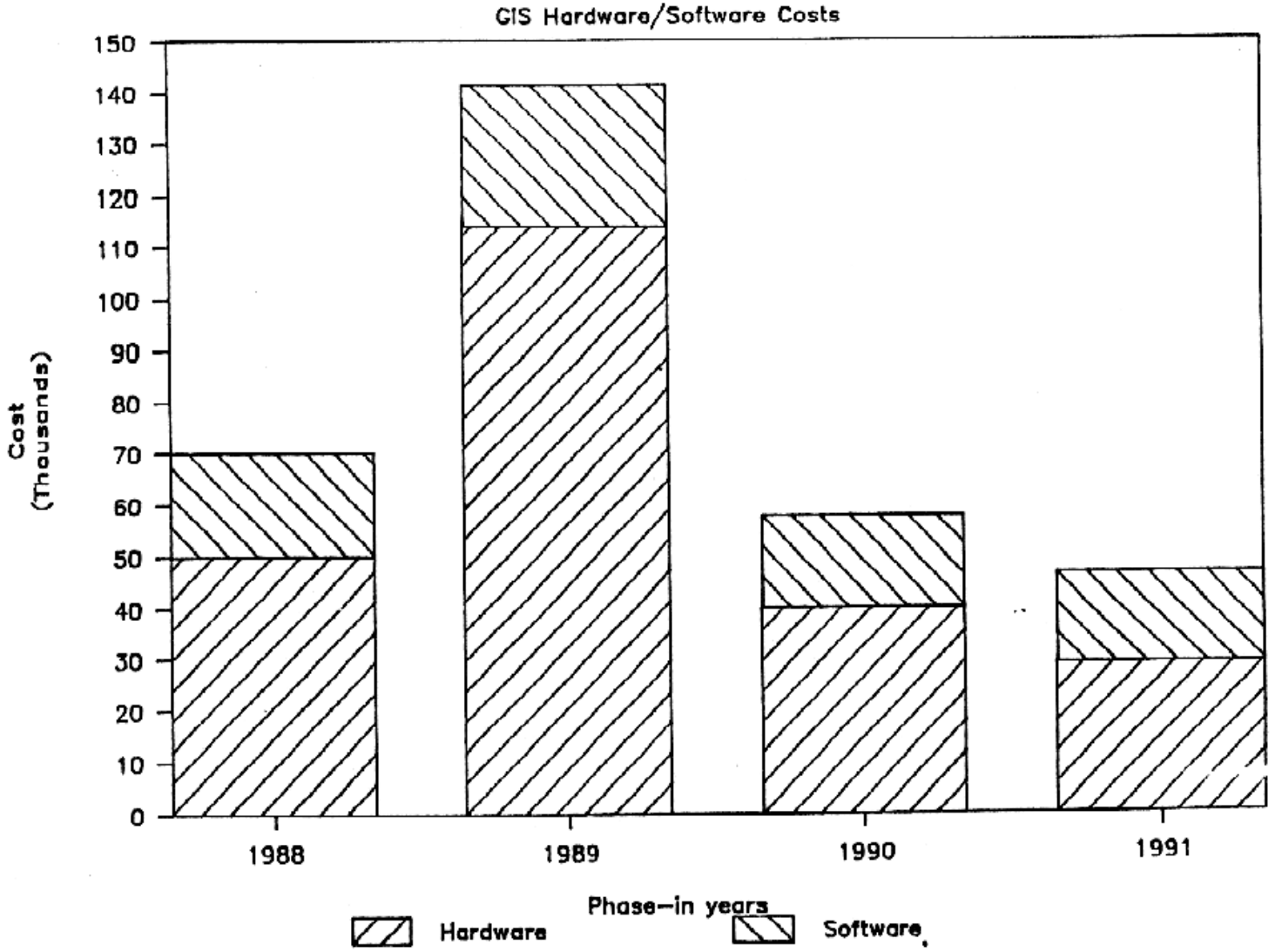
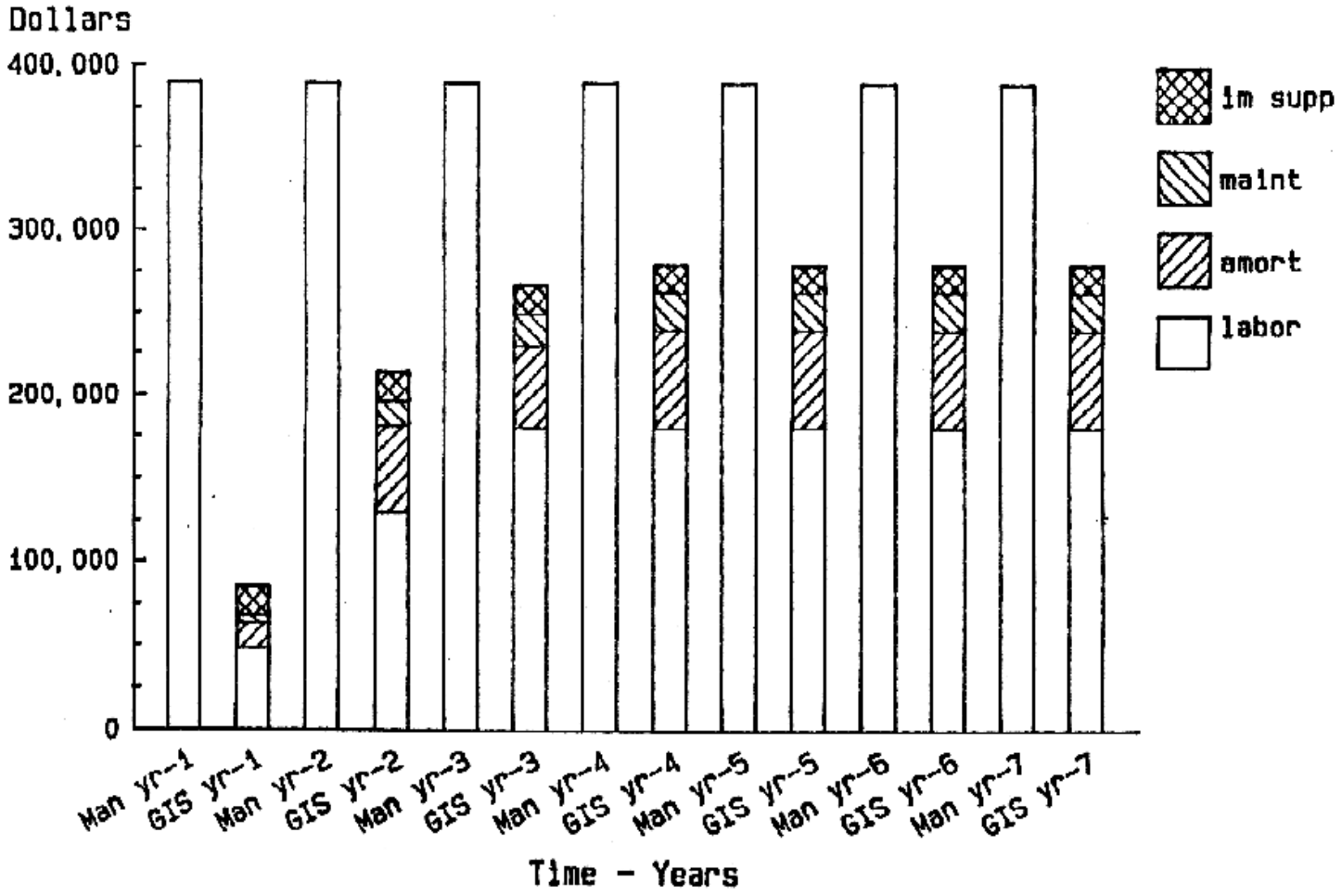

GIS Hardware/Software Costs
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Cost (Thousands)
1988
1989
1990
1991
Phase-in years
Hardware
Software

Figure 1.2
Annual Cost Comparison, GIS vs Manual
5 Station Configuration



3. GIS Software. Change to the original GIS software requirements was necessary to purchase the Master Plan program to process GIS from the mainframe CPU. The Master Plan version to process GIS independently at the workstation level is not yet available. The following table is the new approved software proposal:

GIS SOFTWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
FORTRAN	2,635				2,635
Master Plan	23,850				23,850
Plot Tape Output	3,000				3,000
GIS (Workstation)		30,000	15,000	15,000	60,000
Graphic (Workstation)		1,200	600	600	2,400
Interplot (Plot Server)		5,000			5,000
	29,485	36,200	15,600	15,600	96,885

ADDENDUM II
APRIL 1988

1. General. This addendum covers the discrepancies between the GIS hardware and software as proposed in Addendum I and the actual hardware and software purchased in FY 1988. The initial GIS equipment installed in July 1988 were the 8 mb CPU and one 337 mb system disk with an additional 8 mb memory, magnetic tape drive, two 337 mb data disk drives, two intelligent color workstations one with a large digitizing table, and equipment shared with CADD, a communication server, a plot server, and a leased electrostatic plotter, all connected to an Ethernet network. The 8 mb additional memory, the magnetic tape drive, one 337 mb data disk drive, and the communication server are additions to the proposal in Addendum I. The magnetic tape drive and the communication server, contrary to the original belief that it was included with the basic system, had to be purchased separately. The additional memory and the 337 mb data disk drive were required to process the memory and data extensive Master Plan program. Also the purchase of the plot server was accelerated from FY 1989 to FY l988 when it became available through modification to the Corps-wide contract. The plot server will act as a plot controller and allow the leasing of the electrostatic plotter without the plot controller until a decision on the type of plotter that best fit the needs of GIS and CADD is made. The purchase of a plotter is scheduled for FY 1989. Additional software include programs to translate data into the Intergraph data format and the Digital Terrain Modeling program which is a requirement of the Master Plan program. The following tables amends the GIS proposal of Addendum I:

GIS HARDWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
CPU and System Disk	52,471				52,471
8 MB Addnl Mem	2,832				2,832
Magnetic Tape	8,500				8,500
Comm Server	2,341				2,341
InterView WS	23,260				23,260
Digitizer	8,500				8,500
InterPro 220 WS	24,960	24,960	24,960	24,960	99,840
Disk Storage w/ File Processor	23,100				23,100
Disk Storage	7,500		11,200		18,700
Plot Server	7,020				7,020
Plotter		20,000			20,000
Disk Storage for Plot Server		5,500			5,500
Cabling	2,475	2,040			4,515
	162,959	52,500	36,160	24,960	276,579

GIS SOFTWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL	
FORTRAN	1,850				1,850	
IGES	1,300				1,300	
Master Plan	23,850				23,850	
DTM	4,000				4,000	
Plot Tape Output (Deleted)	0				0	
GIS (Workstation)		30,000	15,000	15,000	60,000	
Graphic (Workstation)			1,200	600	600	2,400
Interplot (Plot Server)	900				900	
USGS DLG-IN	3,000				3,000	
USGS DLG-OUT	3,000				3,000	
	37,900	31,200	15,600	15,600	100,300	

ADDENDUM III
FEBRUARY 1989

1. General. This addendum adjusts the FY 1989, FY 1990 and FY 1991 GIS hardware and software proposal. Due to the sooner than anticipated GIS activities within the District, the purchase of an additional disk storage was accelerated from FY 1990 to FY 1989. The workstation scheduled for FY 1991 was also accelerated to be purchased in FY 1990. However, the purchase of the plotter and the additional disk storage for the plot server scheduled for FY 1989 was deferred until FY 1990 and FY 1991 respectively. A 36 inch laser plotter to replace the leased electrostatic plotter is being studied. Software adjustment include the purchase of World Mapping program in FY 1989 which will translate coordinate systems within Master Plan. The workstation GIS Master Plan version is still in the testing stage and not yet released. The cost of the workstation GIS and graphic programs is anticipated to be higher than originally planned. The acquisition of those programs will be deferred until FY 1990 and FY 1991. Intergraph is continually modifying the Corps-wide CADD contract to include their latest products, thus when GIS required an additional disk storage for FY 1989, a 559 mb disk drive was available for purchase. However, the process of modifying the contract often is a lengthy procedure and the product requirement for a fiscal year may not yet be available on the contract. This was the case in FY 89 when purchasing the Planning Division's workstation which required additional features not offered on the original Corps-wide contract. Intergraph's first reaction was to offer their next higher 200 model workstation but since then have discontinued the sale of that model and is now in the process of offering one of their 300 models, the InterPro 340. Since the InterPro 340 workstation was not yet on the Corps-wide contract, it was purchased off the Intergraph - GSA contract. The need for the added features justified the higher cost of the workstation. Upgrading of the purchased InterPro 220 workstations to InterPro 240s is scheduled for FY 1991. The following tables are the adjusted GIS hardware and software proposals:

GIS HARDWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
CPU and System Disk	52,471				52,471
8 MB Addnl Mem	2,832				2,832
Magnetic Tape	8,500				8,500
Comm Server	2,341				2,341
InterView WS	23,260				23,260
Digitizer	8,500				8,500
InterPro 220 WS	24,960		24,960		49,920
InterPro 340 WS		33,922	37,587		71,509
Disk Storage w/ File Processor	23,100				23,100
Disk Storage	7,500	18,050			25,550
Plot Server	7,020				7,020
Plotter			15,000		15,000
Disk Storage for Plot Server				5,500	5,500
Workstation Upgrd				20,000	20,000
Cabling	2,475	2,374			4,849
	162,959	54,346	77,547	25,500	320,352

GIS SOFTWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
FORTRAN	1,850				1,850
IGES	1,300				1,300
Master Plan	23,850				23,850
DTM	4,000				4,000
World Mapping		12,000			12,000
GIS (Workstation)			20,000	60,000	80,000
Graphic (Workstation)			1,800	5,400	7,200
Interplot (Plot Server)	900				900
USGS DLG-IN	3,000				3,000
USGS DLG-OUT	3,000				3,000
ACTEM		312			312
	37,900	12,312	21,800	65,400	137,412

CENPW-IM-R (18-23) 27 November 1989

MEMORANDUM FOR Chief, Real Estate Division

SUBJECT: Review and Approval of FY 90 GIS Equipment

1. At our last GIS subcommittee meeting of 17 November 1989, we discussed three computer hardware items that need to be corrected or added to our GIS hardware systems. These items include a plotter, a CD-ROM reader and a dual-port disk controller. Each has been discussed at length by the subcommittee with CADD representation and the following recommendations are submitted for your review and approval:

a. Color Electrostatic Plotter (purchase price = $57,500, CADD shared cost = $30,000, GIS shard cost = $27,475). Our plotting system is a leased system that, according to the GIS acquisition and implementation and the CADD acquisition plans, was to be replaced in FY 90 with a better and more cost-effective alternative. This was to prevent excessive yearly lease costs and replace the B/W electrostatic plotter with better and more capable hardware not available at the time of original acquisition. PRIP funds were requested and approved for purchase of a CADD/GIS plotter in FY 90. Based upon the alternatives available, the subcommittee has decided to recommend the acquisition of a color electrostatic Verstec plotter. The benefits of acquiring a color plotter are as follows:

(1) More information per map plotted to reduce number of plates.

(2) Less plate development time due to less graphic differentiation of unique data themes required.

(3) Desktop Publishing - color output directly to Master Plan plate or other finished map for direct addition to the Master Plan. This could reduce the number of data plates prepared for a publisher by 500 to 1,000 mylar blackouts (color separations) per Master Plan or other published produce, and would be cost effective for the relatively small number of published plans.

(4) Less labor in defining graphic standards for any map.

(5) Versus a published plate, much easier to edit a plate for replot.

(6) Much more flexibility in developing maps for Master Plans, contracts, environmental analysis, etc.

(7) No disruption to CADD operations, B/W would still be a CADD standard. However, engineering would have color capabilities plus enhanced B/W shading alternatives.

(8) The subcommittee feels that the color option will also increase our chances for additional outside GIS work and possibly becoming a GIS center of expertise.

b. CD-ROM Reader (purchase price = $850, CADD shared cost = $425, GIS shared cost = $425). Our system and applications software for both the CADD and GIS will soon be delivered only on CD-ROM. We have a system requirement of adding one reader to our network that will service both the CADD and GIS systems. It will also reduce by several months the development to delivery time of software upgrades. It will greatly reduce the system managers workload for upgrading the systems. The benefits of this item can pay for it in one or two software installations.

c. Dual Port Controller (purchase price = $3,500, GIS cost = $3,500). The GIS system has one disk drive that has a single instead of a dual access controller. Now that all the disks are being fully utilized, it is important to upgrade this disk to improve access. The dual controller allows the GIS users to continue working by logging into the CADD CPC and crossing over to GIS data disks during system maintenance, GIS system failures, and system upgrades; and allows engineering users direct access to substantial downtimes (sometimes up to 3 days during system software upgrades), is extensive due to schedule interruptions. With the Dual-Port, all upgrades and system work can be done on regular time without disruptions to users.

2. The costs to GIS would be born according to the existing percentage breakdown as are existing plotting costs.

CENPW-IM-R
SUBJECT: Review and Approval of FY 90 GIS Equipment

Color Electrostatic Plotter:

PRIP Breakdown (GIS portion)

	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96
	$27,475	$23,550	$19,625	$15,700	$11,775	$7,850	$3,925
Depr.	3,925	3,925	3,925	3,925	3,925	3,925	3,925
Insur.	206	177	a47	118	88	59	30
Maint.	4,002	4,002	4,002	4,002	4,002	4,002	4,002
Plt. Inc.	1,374	1,442	1,514	1,590	1,670	1,753	1,841
Total	9,507	9,546	9,588	9,635	9,685	9,739	9,798

Lease cost including maintenance (thru FY 92):

GIS	6,570	6,673	6,788

PRIP Breakdown (CADD portion)

	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96
	$30,000	$25,714	$21,428	$17,142	$12,856	$8,570	$4,284
Depr.	4,286	4,286	4,286	4,286	4,286	4,286	4,286
Insur.	225	193	161	129	96	64	32
Maint.	4,002	4,002	4,002	4,002	4,002	4,002	4,002
Plt. Inc.	1,500	1,575	1,654	1,737	1,824	1,915	2,011
Total	10,013	10,056	10,103	10,154	10,208	10,267	10,331

Lease cost including maintenance (thru FY 92):

CADD	13,338	13,547	13,781

FY 90 Cost by Organization

		Color $	B/W $
Plotter:			
CADD:		$10,013	$13,338
GIS:			
Org	%	Color $	B/W $
Planning	.6145	$5,842	$4,448
Operations	.2292	$2,179	$1,547
Real Estate	.1042	$991	$703
Engineering	.0521	$495	$352
GIS Total		$9,507	$6,750

CENPW-IM-R
SUBJECT: Review and Approval of FY 90 GIS Equipment

CD-ROM:

Planning	.6145	x	$425	=	$261
Operations	.2292	x	$425	=	$97
Real Estate	.1042	x	$425	=	$44
Engineering	.0521	x	$425	=	$23
Total					$425

Dual-Port Upgrade:

Planning	.6145	x	$3,500	=	$2,151
Operations	.2292	x	$3,500	=	$802
Real Estate	.1042	x	$3,500	=	$365
Engineering	.0521	x	$3,500	=	$182
Total					$3,500

3. Request that each organization review the above proposed GIS hardware acquisitions and return their answer NLT 30 November 1989. Following approval, IMO will order. Any questions should be directed to your GIS coordinator or Tom Seiner at ext. 6421.

WILLIAM F. HOLMES
Chief, Information Management

CENPW-OP (CENPW-IM-R/27 Nov 89) (18-23) 1st End
SUBJECT: Review and Approval of FY 90 GIS Equipment

Planning Division

FOR Chief, Information Management Office

x Concur with proposed color plotter acquisition.

o Do not concur with proposed color plotter acquisition.

x Concur with proposed CD-ROM acquisition.

o Do not concur with proposed CD-ROM acquisition.

x Concur with proposed Dual-Port Upgrade.

o Do not concur with proposed Dual-Port Upgrade.

Comments:

L.V. ARMACOST
Chief, Planning Division

CENPW-OP (CENPW-IM-R/27 Nov 89) (18-23) 1st End
SUBJECT: Review and Approval of FY 90 GIS Equipment

Real Estate Division

FOR Chief, Information Management Office

x Concur with proposed color plotter acquisition.

o Do not concur with proposed color plotter acquisition.

x Concur with proposed CD-ROM acquisition.

o Do not concur with proposed CD-ROM acquisition.

x Concur with proposed Dual-Port Upgrade.

o Do not concur with proposed Dual-Port Upgrade.

Comments:

RICHARD CARLTON
Chief, Real Estate Division

CENPW-OP (CENPW-IM-R/27 Nov 89) (18-23) 1st End
SUBJECT: Review and Approval of FY 90 GIS Equipment

Engineering Division

FOR Chief, Information Management Office

x Concur with proposed color plotter acquisition.

o Do not concur with proposed color plotter acquisition.

x Concur with proposed CD-ROM acquisition.

o Do not concur with proposed CD-ROM acquisition.

x Concur with proposed Dual-Port Upgrade.

o Do not concur with proposed Dual-Port Upgrade.

Comments:

MARVIN C. BRAMMER
Chief, Engineering Division

CENPW-OP (CENPW-IM-R/27 Nov 89) (18-23) 1st End
SUBJECT: Review and Approval of FY 90 GIS Equipment

Operation Division

FOR Chief, Information Management Office

x Concur with proposed color plotter acquisition.

o Do not concur with proposed color plotter acquisition.

x Concur with proposed CD-ROM acquisition.

o Do not concur with proposed CD-ROM acquisition.

x Concur with proposed Dual-Port Upgrade.

o Do not concur with proposed Dual-Port Upgrade.

Comments:

PAUL F. WINBORG
Chief, Operation Division

JUSTIFICATION & ACQUISITION PLAN
FOR WALLA WALLA DISTRICT
GEOGRAPHIC INFORMATION SYSTEM
COMPUTERIZED MAP & RESOURCE ANALYSIS

ADDENDUM I
OCTOBER 1987

1. General. This addendum covers the changes made to the original GIS plan. The change with the greatest impact was the decision to purchase the GIS in conjunction with the CADD system through the Corps-wide CADD Contract DACW87-87-D-0092 awarded to the Intergraph Corporation on September of 1987. This eliminated the RFP process thus accelerating the GIS installation date by several months. The CADD/GIS system is a dual CPU, one CPU for the CADD and the other CPU for GIS, each with its own disk drives and magnetic tape drive, and a common ethernet network with intelligent workstations and a plotter attached to it. The dual system eliminates any compatibility problem between CADD and GIS. The Zeiss stereoplotter output can also be translated into Intergraph format, thus assuring the Zeiss of being an integral part of GIS.

2. GIS Hardware. The items in the Corps-wide contract may be purchased at any time within the first five years of the contract which is basically the same as the original four-year GIS plan. However, the order of purchase of certain items have been accelerated from the original plan and the original file server replaced by a mainframe CPU. The following table is the new approved GIS hardware proposal:

GIS HARDWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
CPU	52,471				52,471
InterView WS	23,260				23,260
Digitizer	8,500				8,500
InterPro 220 WS	24,960	24,969	24,960	24,960	99,840
Disk Storage w/ File Processor	23,100				23,100
Disk Storage			11,200		11,200
Plot Server		22,000			22,000
Disk Storage for Plot Server		5,500			5,500
	132,291	52,460	36,160	24,960	245,871

3. GIS Software. Change to the original GIS software requirements was necessary to purchase the Master Plan program to process GIS from the mainframe CPU. The standalone GIS is not as yet available. The following table is the new approved software proposal:

GIS SOFTWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
FORTRAN	2,635				2,635
Master Plan	23,850				23,850
Plot Tape Output	3,000				3,000
GIS (Workstation)		30,000	15,000	15,000	60,000
Graphic (Workstation)		1,200	600	600	2,400
Interplot (Plot Server)		5,000			5,000
	29,485	36,200	15,600	15,600	96,885

ADDENDUM II
APRIL 1988

1. General. This addendum covers the discrepancies between the GIS hardware and software as proposed in Addendum I and the actual hardware and software purchased in FY 1988. The initial GIS equipment installed in July 1988 were the 8 mb CPU with an additional 8 mb memory, magnetic tape drive, three 337 mb disk drives, two intelligent color workstations - one with a large digitizing table, and equipment shared with CADD, a communication server, a plot server, and a leased electrostatic plotter, all connected to an Ethernet network. The 8 mb additional memory, the magnetic tape drive, one of the three 337 mb disk drives, and the communication server are additions to the proposal in Addendum I. Also the plot server was accelerated from FY 1989 to FY 1988. The electrostatic plotter was leased until a decision i8 made on the type of plotter we want to purchase. Additional software include programs to translate data into the Intergraph data format and the Digital Terrain Modeling program which is a requirement of the Master Plan program. The following tables amends the GIS proposal of Addendum I:

GIS HARDWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
CPU	52,471				52,471
8 MB Addnl Mem	2,832				2,832
Magnetic Tare	8,500				8,500
Comm Serve.	2,341				2,341
InterView WS	23,260				23,260
Digitizer	8,500				8,500
InterPro 220 WS	24,960	24,960	24,960	24,960	99,840
Disk Storage w/ File Processor	23,100				23,100
Disk Storage	7,500		11,200		18,700
Plot Server	7,020				7,020
Plotter		20,000			20,000
Disk Storage for Plot Server		5,500			5,500
Cabling	2,475	2,040			4,515
	162,959	52,500	36,160	24,960	276,579

GIS SOFTWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
FORTRAN	1,850				1,850
IGES	1,300				1,300
Master Plan	23,850				23,850
DTM	4,000				4,000
Plot Tape Output (Deleted)	0				0
GIS (Workstation)		30,000	15,000	15,000	60,000
Graphic (Workstation)		1,200	600	600	2,400
Interplot (Plot Server)	900				900
USGS DLG-IN	3,000				3,000
USGS DLG-OUT	3,000				3,000
	37,900	31,200	15,600	15,600	100,300

ADDENDUM III
FEBRUARY 1989

1. General. This addendum adjusts the FY 1989, FY 1990 and FY 1991 GIS hardware and software proposal. The purchase of an additional disk storage was accelerated from FY 1990 to FY 1989. The workstation scheduled for FY 1991 was also accelerated to be purchased in FY 1990. However, the purchase of the plotter and the additional disk storage for the plot server scheduled for FY 1989 was deferred until FY 1990 and FY 1991 respectively. Software adjustment include the purchase of World Mapping program in FY 1989 which will translate coordinate system within Master Plan. The GIS standalone programs are still in the testing stage and not yet released. The cost of the standalone GIS and graphic programs will be higher than originally planned. The acquisition of those programs will be deferred until FY 1990 and FY 1991. Intergraph is continually modifying the Corps-wide CADD contract to include their latest products, thus when GIS required an additional disk storage for FY 1989, a 559 mb disk drive was available for purchase. However, the process of modifying the contract often is a lengthy procedure and the product requirement for a fiscal year may not yet be available on the contract. This was the case in FY 89 when purchasing the Planning Division's work-station. Since the workstation with the required added features was not yet on the Corps-wide con-tract, it was purchased off the Intergraph GSA contract. The following tables are the adjusted GIS hardware and software proposals:

GIS HARDWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
CPU	52,471				52,471
8 MB Addnl Mem	2,832				2,832
Magnetic Tape	8,500				8,500
Comm Server	2,341				2,341
InterView WS	23,260				23,260
Digitizer	8,500				8,500
InterPro 220 WS	24,960		24,960		49,920
InterPro 340 WS		33,922	37,587		71,509
Disk Storage w/ File Processor	23,100				23,100
Disk Storage	7,500	18,050			25,550
Plot Server	7,020				7,020
Plotter			15,000		15,000
Disk Storage for Plot Server				5,500	5,500
Workstation Upgrade				20,000	20,000
Cabling	2,475	2,374			4,849
	162,959	54,346	77,547	25,500	320,352

GIS SOFTWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
FORTRAN	1,850				1,850
IGES	1,300				1,300
Master Plan	23,850				23,850
DTM	4 000				4 000
World Mapping		12,000			12,000
GIS (Workstation)			20,000	60,000	80,000
Graphic (Workstation)			1,800	5,400	7,200
Interplot (Plot Server)	900				900
USGS DLG-IN	3,000				3,000
USGS DLG-OUT	3,000				3,000
ACTEM		312			
	37,900	12,312	21,800	65,400	137,412

Figure 1.3

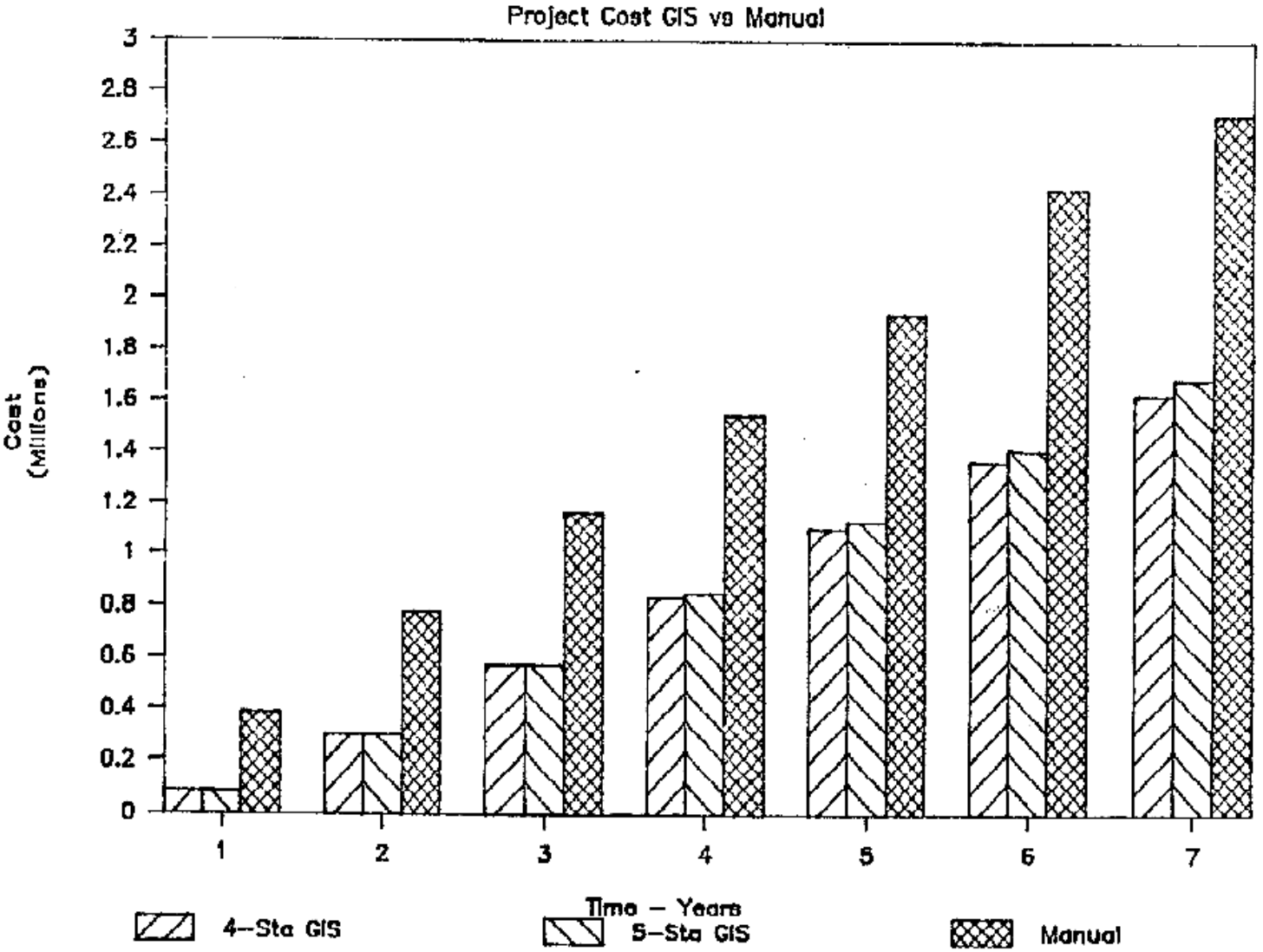
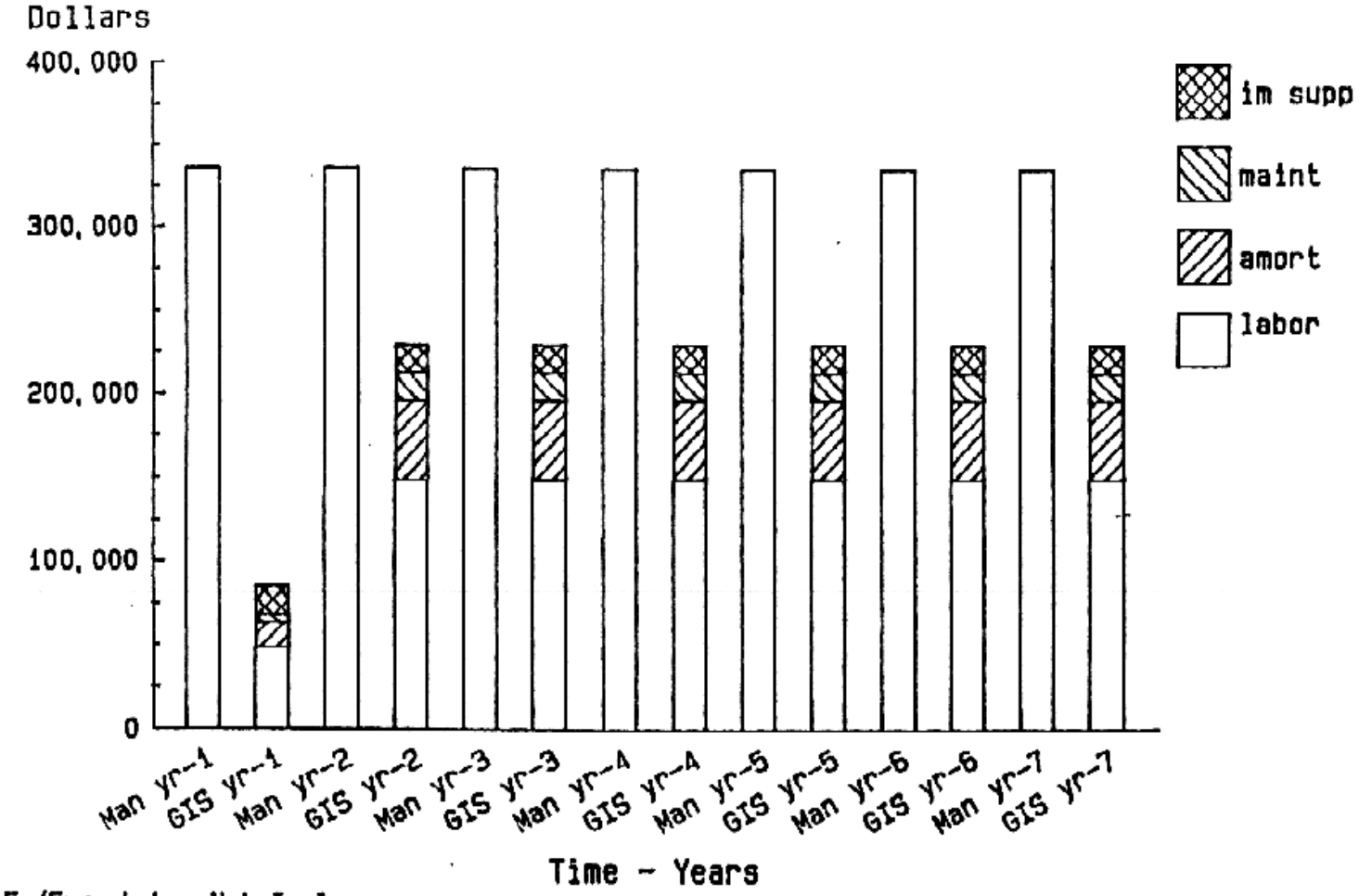
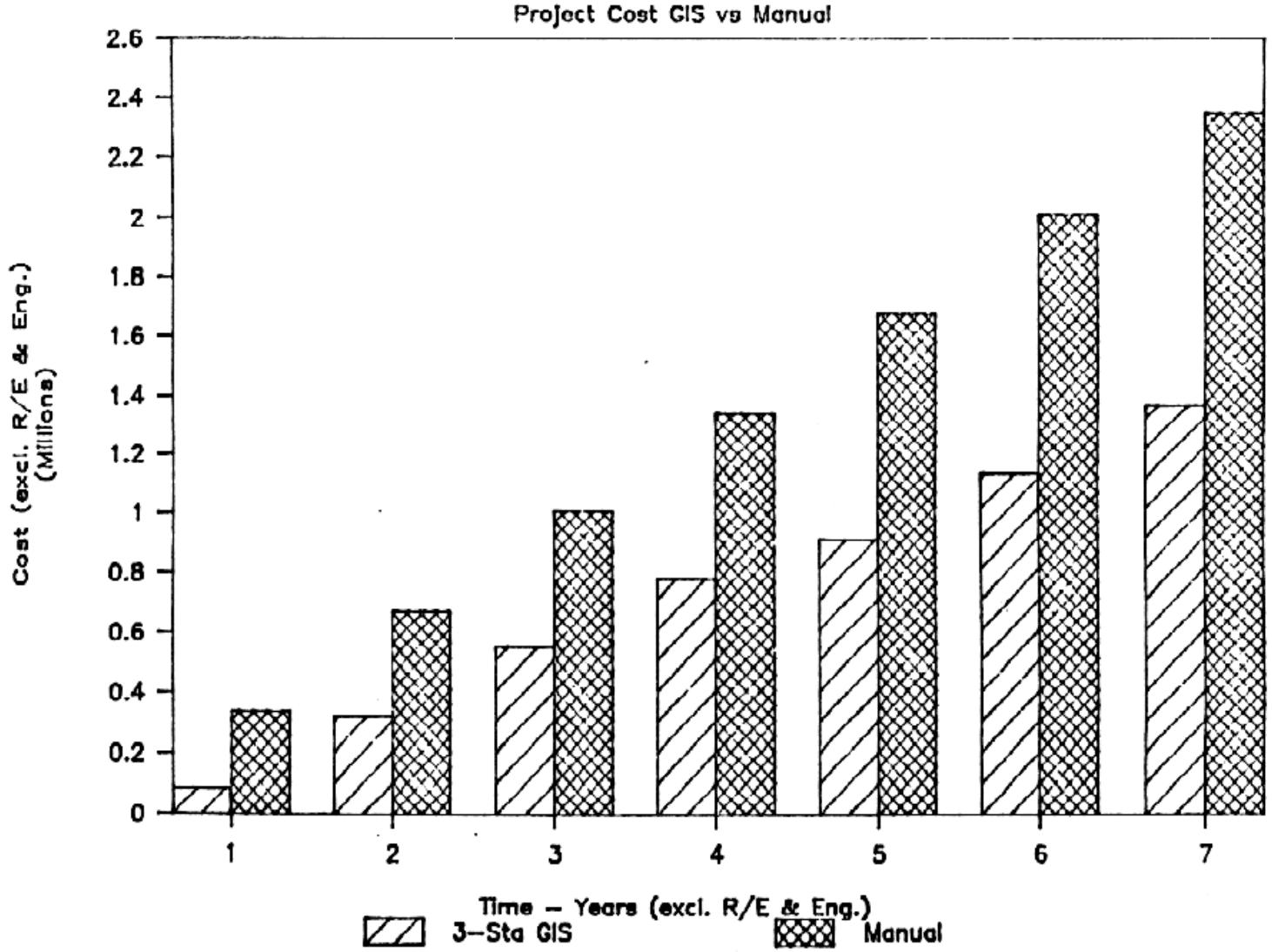

Project Cost GIS vs Manual
Cost (Millions)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
Time – Years
4–Sta GIS
5–Sta GIS
Manual

Figure 1.4
Annual Cost Comparison, GIS vs Manual
3 Station Configuration



R.E./Eng. Labor Not Incl.

Figure 1.5


Project Cost GIS vs Manual
Cost (excl. R/E & Eng.)
(Millions)
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
Time – Years (excl. R/E & Eng.)
3-Sta GIS
Manual

– GEOGRAPHIC INFORMATION SYSTEM –

REMARKS

PLUS	MINUS
More work completed	Added cost
More timely	No manpower savings
Higher quality	
Better managed	
Outside work	

IS IT WORTH THE COST TO ACCOMPLISH THE PLUSES?

GIS PRIP (Hardware) Costs

Item	FY-88	FY-89	FY-90	FY-91	FY-92	Total
CPU	52,471					52,471
Workstation/ Digitizer	23,260					23,260
Digitizer	8,500					8,500
Workstation	24,960	24,960	24,960	24,960		99,840
Disk Storage/ File Server	23,100					23,100
Disk Storage			11,200			11,200
Plot Server		22,000				22,000
Disk Storage/ Plot Server		5,500				5,500
Total	132,291	52,460	36,160	24,960		245,871

GIS Software Costs

Item	FY-88	FY-89	FY-90	FY-91	FY-92	Total
Fortran	2,635					2,635
Master Plan	23,850					23,850
Plot Tape Output	3,000					3,000
GIS (Workstation)		30,000	15,000	15,000		60,000
Graphic (Wrkstn)		1,200	600	600		2,400
Plot (Plot Server)		5,000				5,000
Total	29,485	36,200	15,600	15,600		96,885

JUSTIFICATION & ACQUISITION PLAN
FOR WALLA WALLA DISTRICT
GEOGRAPHIC INFORMATION SYSTEM
COMPUTERIZED MAP & RESOURCE ANALYSIS

ADDENDUM I
OCTOBER 1987

1. General. This addendum covers the changes made to the original GIS plan. The change with the greatest impact was the decision to purchase the GIS in conjunction with the CADD system through the Corps-wide CADD Contract DACW87-87-D-0092 awarded to the Intergraph Corporation on September of 1987. This eliminated the RFP process thus accelerating the GIS installation date by several months. The CADD/GIS system is a dual CPU, one CPU for the CADD and the other CPU for GIS, each with its own disk drives and magnetic tape drive, and a common Ethernet network with intelligent workstations and a plotter attached to it. The dual system eliminates any compatibility problem between CADD and GIS. The Zeiss stereoplotter output can also be translated into Intergraph format, thus assuring the Zeiss of being an integral part of GIS.

2. GIS Hardware. The items in the Corps-wide contract may be purchased at any time within the first five years of the contract which is basically the same as the original four-year GIS plan. However, the order of purchase of certain items have been accelerated from the original plan and the original file server to serve multiple workstations, each capable of processing GIS independently, have been replaced by a mainframe CPU that allows the workstations the option of either processing GIS interactively on the CPU or downloading data on to the workstation to process GIS independently. The dual CPU concept allows accessing data files on either the GIS or CADD system. The following table is the new approved GIS hardware proposal:

GIS HARDWARE COSTS

ITEM	FY-88	FY-89	FY-90	FY-91	TOTAL
CPU and System Disk	52,471				52,471
InterView WS	23,260				23,260
Digitizer	8,500				8,500
InterPro 220 WS	24,960	24,969	24,960	24,960	99,840
Disk Storage w/ File Processor	23,100				23,100
Disk Storage 11,200				11,200	
Plot Server		22,000			22,000
Disk Storage for Plot Server		5,500			5,500
	132,291	52,460	36,160	24,960	245,871

S: 18 August 1989

CENPW-IM-R (18) 19 July 1989

MEMORANDUM FOR Chief, Operation Division

SUBJECT: Geographic Information System (GIS) Planning for FY 92-94

1. Enclosed is Addendum IV to the Justification and Acquisition Plan for the Walla Walla District Geographic Information System. The addendum covers additional GIS hardware and software for the Dworshak, Ice Harbor, and McNary Projects, and Clarkston Resource Office. The addendum was prepared by the District's GIS Subcommittee.

2. Request the addendum be staffed for review and comments. The GIS Subcommittee will incorporate any changes into a final plan. That plan will be provided to Operations Division for their approval then presented to the Information Management Steering Committee for District approval.

3. Review comments should be provided to the Information Management Office, ATTN: Jim Krussel, NLT 18 August 1989.

Encl

WILLIAM F. HOLMES
Chief, Information Mgt Ofc

Krussel/IM/emd

Holmes/IM

CF:
IM-I (Seiner)

IM/Files

JUSTIFICATION & ACQUISITION PLAN
FOR WALLA WALLA DISTRICT
GEOGRAPHIC INFORMATION SYSTEM
COMPUTERIZED MAP & RESOURCE ANALYSIS

ADDENDUM IV
JULY 1989

1. General. This addendum proposes additions to the original GIS acquisition plan during the period FY 92 - FY 94. The current plan with addenda covers the GIS hardware and software needs through FY 91. After FY 91, additional Engineering Workstations will be needed at four project sites: Dworshak, Ice Harbor, Clarkston Resource Office, and McNary.

At this time, substantial digital geographic information systems will have been constructed for Dworshak and the Lower Snake River system. The Project Master Plans will be mostly complete and the GIS system will be utilized by the Project Offices and the Operations Division for Operational Management Plans (database and map coordination between Project and Operations Division), Environmental Analysis, and to support Project resource management operations (HMU analysis and management, fire prevention, forest inventory maintenance and management, cultural inventories, recreation management, and construction site analysis).

The Projects have supplied data requirements (data resolutions, entities, and attributes) to the database structure and most GIS data themes have been constructed with the use of the Project Offices in mind. The Operations Division has coordinated with Project Resource Managers on development of the data. Many of the data themes have a long life cycle and maintenance of the more dynamic data themes will be coordinated directly through the Project Workstations and on-site data managers. The District host will still provide digitizing support, database management support, mass storage, backup security, hardware, software, analytical support, system and data conversion, and large format plotting support.

The master databases for each Project will still reside on the Host VAX system in the District. The additional stand-alone Workstations will reduce the time-sharing CPU load on the VAX, but will increase file serving functions such as, communications server hookup to the Projects for file transfers, disk I/O, and tape transfers of Project files. Increased mass storage on the Project Workstations should offset the need for an additional Host disk drive in the FY 92 - FY 94 period. The Projects will also utilize floppy disk drives for design file backups offsystem and transferring files for plots that are not time critical.

2. GIS Hardware. The hardware needed to support the Project offices includes 4 Engineering Workstations of moderate to high level capability: 3 - 220 InterPro, 1 - 340 InterPro class machines. The 340 class machine should be acquired for the Dworshak Project to support additional software requirements needed to handle high-resolution, high color definition satellite imagery for vegetation monitoring. All Workstations will have a 1.2 MB floppy disk drive and should also have a minimum of 300 MB disk storage. The Workstations will be stand-alone at each Project site with a standard telecommunications linkage to the District VAX file-server. Files can also be transferred through the mail by floppy. Local plotting requirements are for small to medium format color. All Workstations will have a small/medium format color plotter for work plots. Large format plotting will still be done at the District Office.

GIS HARDWARE COSTS

Proj	ITEM	FY-92	FY-93	FY-94	TOTAL
Dworshak	340 InterPro	40,000			40,000
	Plotter	3,500			3,500
Clarkston	220 InterPro		30,000		30,000
	Plotter		3,500		3,500
Ice Harbor	220 InterPro			30,000	30,000
	Plotter			3,500	3,500
McNary	220 InterPro			30,000	30,000
	Plotter			3,500	3,500
		43,500	33,500	67,000	144,000

3. GIS Software. Software for the Project site GIS Workstations must include the stand-alone MicroStation 32, MicroStation GIS (includes the needed plot drivers), and relational database products. Satellite image processing software for Dworshak is expected to be the GRASS software provided by CERL. Data will continue to be prepared, organized, and archived at the District VAX minicomputer. Project data will be electronically transferred to the Project and utilized for management and local planning.

GIS SOFTWARE COSTS
All Projects

ITEM	FY-92	FY-93	FY-94	TOTAL
MicroStation 32	$1,600	$1,600	$3,200	$6,400
Relational Database	8,600	8,600	17,200	34,400
MicroStation GIS	8,000	8,000	16,000	32,000
	$18,200	$18,200	$36,400	$72,800

Walla Walla District
Geographic Information System (GIS)
Information Request per Frank McDonald NPD 1/30/90

Enclosed is the CAD/GIS cost report prepared in December 1989.

The Active Project List currently includes:

Mill Creek Master Plan data preparation*, analysis, project plates
Regional/District Database acquisition, analysis, plates for Mill Creek, Dworshak, Lower Granite-Little Goose, Ice Harbor-McNary Master Plans
Dworshak Master Plan data acquisition*, conversion, analysis, project plates.
Dworshak Project Road 1989 Inventory data conversion, maps.
Dworshak Project Forest Inventory project layout, site preselection for stand inventory.
Dworshak Project Hydrography database preparation, conversion.
Jackson Hole, Wyoming Flood Control Project vegetation cover analysis by year (1956,1974,1986).
Lower Snake River HEP Study data preparation, analysis, reports.

* See Data Theme List

The Project Proposals include:

Lower Granite, Little Goose, Ice Harbor, Lower Monumental, McNary Project Master Plans.
Dworshak HEP study.
Lower Granite In-Water Disposal Test.
Real Estate database for Lower Granite Project as a model for District Real Estate operations.
Emergency Management model project applications for Boise, Idaho flood control and Gowen Field.
Regulatory Functions model project of a portion of Idaho for map and database preparation and analysis.

The personnel using GIS hardware/software include:

1 full-time	data preparation
1 part-time	data preparation
1 full-time	project development, database design, analysis, training, applications management.
3 part-time	Planning Environmental Analysis
1 part-time	Real Estate
1 part-time	Operations
1 part-time	Surveying, mapping

Data Theme List

Master Plans:

Theme	Extent: Project	Extent: District/Regional
boundaries		
Project	x	x
State		x
County		x
City	x	x
Elevation zones	x	
Slope zones	x	
Aspect zones	x	
Buildings	x	
Fences	x	
Habitat structures	x	
Water structures	x	x
Hydrography	x	x
Outgrants	x	
Disposals	x	
Tracts	x	
Management Units	x	
Zoning	x	
Roads	x	x
Trails/Walks	x	
Soils	x	
Vegetation	x	
Archaeology	x	
Wildlife Ranges	x	x
Endangered Species	x	x
Utilities/Transmission Lines	x	
Signs	x	
Recreation Areas	x	x
Forest Stands	x	
Wildfire	x	
Vegetation Plantings	x	

INSTRUCTIONS FOR COMPUTING CAD/GIS ANNUAL COSTS

1. General. A Lotus 1-2-3 spreadsheet of the Intergraph CAD/GIS equipment and software with separate CADD and GIS purchase and maintenance costs from FY 88 through FY 94 has been written and saved under the filename CADGIS.WK1. Separate CADD and GIS annual costs, updated automatically as items are added, modified or purchased to the CADD/GIS system, are also part of the spreadsheet. CADD annual cost is charged entirely to Engineering Division; GIS annual cost is distributed to Planning, Operations, Real Estate, and Engineering divisions. GIS organizational costs for depreciation, plant increment, insurance, maintenance, and software are also part of the spreadsheet.

2. Annual Cost. The annual cost for FY 88 through FY 94 includes depreciation, plant increment, insurance, maintenance, software, site preparation, training, and IMO support.

Depreciation. PRIP hardware items are depreciated in 7 years. Software costing $5,000 or greater are depreciated in 2 years.

Plant Increment. Plant increment is a equipment replacement amount set aside each year until a PRIP equipment is surplused. Plant increment for a year is computed at 5% of the price of any equipment purchased under PRIP during the year plus 105% of the previous year's plant increment. Plant increment for software $5,000 or greater is computed only until the item is depreciated.

Insurance. Insurance is computed each year at .75% of the nondepreciated amount of PRIP hardware item.

Maintenance. Maintenance for a year is the hardware maintenance and the software support costs for the all items.

Software. Software costs are for software costing less than $5,000 purchased during the year.

Hardware. Hardware costs are for hardware costing less than $5,000 purchased during the year and not under PRIP.

Site Preparation, Training, and IMO Support. Self explanatory.

3. GIS Organizational Costs. The above GIS costs are distributed to Planning, Operations, Real Estate, and Engineering divisions. All shared item costs are distributed as follows:

Planning 61.45%

Operations 22.92%

Real Estate 10.42%

Engineering 5.21%

Since Real Estate and Engineering will share a workstation, all item costs pertaining to their workstation will be split 66.6% Real Estate and 33.4% Engineering.

The workstation GIS software packages will be installed on the GIS Manager’s InterPro 340 in FY-90 and on the Planning InterPro 340, the InterView 32C, and on the Operations Interpro 220 in FY-91. The cost of the four packages will be split 50% Planning and 50% Operations.

4. Printing the Spreadsheet. The spreadsheet has been programmed to print the item description and the unit cost of the item (cols. A-E) on every printout page thus range of the printout will begin at col. F. The spreadsheet of the equipment and software purchases from FY88 through FY-94 is too large column wise to print on a single 11 X 14 paper. After setting the setup option to compressed type (\015) for the Epson LQ-1000, print FY-88 through FY-90 (cols. F-U) on the first sheet, FY-91 through FY-93 (cols. V-AM) on second sheet, and FY-94 (cols. AN-AS) on the third sheet. The CADD and GIS annual costs can be printed on the HP LaserJet printer by setting the setup option to compressed type (\027E\027(s16.66H), remembering that columns A-E automatically gets printed.

CAD ANNUAL COST

NOVEMBER 1989

	HARDWARE		SOFTWARE									
FY	DEPREC	PLT INC	DEPREC	PLT INC	INS	MAINT	SITE PR	TRAIN	IMO SUP	SOFTW	HARDW	TOTAL
88	0	0	0	0	0	0	2000	5000	5000	31670	0	43670
89	45066	15773	0	0	2366	36570	0	0	17000	0	10475	127250
90	49352	18062	0	0	2253	35775	0	0	17000	0	9658	132099
91	49352	18965	0	0	1883	37854	0	0	17000	0	0	125053
92	49352	19913	0	0	1513	37856	0	0	17000	0	0	125631
93	49352	20909	0	0	1143	37854	0	0	17000	0	0	126257
94	49352	21954	0	0	772	37854	0	0	17000	0	0	126932
												806892

GIS ANNUAL COST

NOVEMBER 1989

	HARDWARE		SOFTWARE									
FY	DEPREC	PLT INC	DEPREC	PLT INC	INS	MAINT	SITE PR	TRAIN	IMO SUP	SOFTW	HARDW	TOTAL
88	0	0	0	0	0	0	2000	12000	5000	37900	0	56900
89	30755	10764	6000	600	1615	25624	0	0	17000	2812	1058	102228
90	44317	16049	6000	630	2096	33416	0	0	17000	13810	6806	140124
91	47174	17852	0	0	1914	49740	0	0	17000	34950	7400	176029
92	47174	18744	0	0	1560	57342	0	0	17000	0	0	141820
93	47174	19681	0	0	1206	57342	0	0	17000	0	0	142404
94	47174	20665	0	0	852	57342	0	0	17000	0	0	143034
												902539

GIS ORGANIZATIONAL COSTS

SUMMARY

ORG	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	TOTAL
PLANNING	34965	63731	84965	98756	80714	81045	81403	525579
OPERATIONS	13041	26934	34431	52806	36450	36590	36742	236994
REAL ESTATE	5929	7708	13815	16304	16430	16505	16585	93277
ENGINEERING	2964	3854	6913	8163	8226	8264	8304	46689
	56900	102228	140124	176029	141820	142404	143034	902539

GIS ORGANIZATIONAL COSTS
SUMMARY

ORG	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	TOTAL
PLANNING	34965	63731	84965	98756	80714	81045	81403	525579
OPERATIONS	13041	26934	34431	52806	36450	36590	36742	236994
REAL ESTATE	5929	7708	13815	16304	16430	16505	16585	93277
ENGINEERING	2964	3854	6913	8163	8226	8264	8304	46689
	56900	102228	140124	176029	141820	142404	143034	902539

GIS ORGANIZATIONAL COSTS
DEPRECIATION

ORG	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	TOTAL
PLANNING	0	23969	30112	26425	26425	26425	26425	159781
OPERATIONS	0	9048	11339	11392	11392	11392	11392	65955
REAL ESTATE	0	2492	5909	6235	6235	6235	6235	33340
ENGINEERING	0	1246	2958	3122	3122	3122	3122	16693
	0	36755	50317	47174	47174	47174	47174	275768

GIS ORGANIZATIONAL COSTS
PLANT INCREMENT

ORG	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	TOTAL
PLANNING	0	7467	9991	10084	10588	11117	11673	60921
OPERATIONS	0	2823	3766	4303	4518	4744	4981	25133
REAL ESTATE	0	716	1947	2309	2424	2546	2673	12615
ENGINEERING	0	358	975	1156	1214	1275	1339	6317
	0	11364	16679	17852	18744	19681	20665	104986

GIS ORGANIZATIONAL COSTS
INSURANCE

ORG	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	TOTAL
PLANNING	0	1065	1235	1037	839	641	442	5259
OPERATIONS	0	403	466	466	380	295	209	2219
REAL ESTATE	0	98	263	274	227	180	133	1176
ENGINEERING	0	49	132	137	114	90	67	589
	0	1615	2096	1914	1560	1206	852	9242

GIS ORGANIZATIONAL COSTS
MAINTENANCE

ORG	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	TOTAL
PLANNING	0	16056	21657	29322	32416	32416	32416	164283
OPERATIONS	0	6744	7531	12615	16263	16263	16263	75679
REAL ESTATE	0	1882	2818	5200	5773	5773	5773	27218
ENGINEERING	0	941	1410	2603	2891	2891	2891	13626
	0	25624	33416	49740	57342	57342	57342	280806

GIS ORGANIZATIONAL COSTS
SOFTWARE

ORG	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	TOTAL
PLANNING	23290	1848	7341	18042	0	0	0	50521
OPERATIONS	8687	573	5873	16135	0	0	0	31267
REAL ESTATE	3949	261	397	516	0	0	0	5122
ENGINEERING	1975	130	199	258	0	0	0	2561
	37900	2812	13810	34950	0	0	0	89472

GIS ORGANIZATIONAL COSTS
HARDWARE

ORG	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94	TOTAL
PLANNING	0	2878	4182	3400	0	0	0	10461
OPERATIONS	0	3448	1560	4000	0	0	0	9008
REAL ESTATE	0	488	709	0	0	0	0	1197
ENGINEERING	0	244	355	0	0	0	0	599
	0	7058	6806	7400	0	0	0	21264