EOD SYSTEMS AND FACILITIES WORKLOAD REQUIREMENTS FORECAST

Job Order 71-625

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Houston, Texas

Contract NAS 9-15200

For

EARTH OBSERVATIONS DIVISION

SPACE AND LIFE SCIENCES DIRECTORATE

National Aeronautics and Space Administration

LYNDON B. JOHNSON SPACE CENTER

Houston, Texas

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BACKGROUND

The Earth Observations Division (EOD) is responsible for developing the techniques and associated technology needed to conduct monitoring and management applications for programs and projects specified by the Earth Resources Program Office (ERPO).

Figure 1-1 gives a project workflow model. This model depicts the various stages through which a typical science program passes from concept through operations.

To fulfill these EOD responsibilities requires that specific support services be provided. The Systems and Facilities Branch has been established to provide a comprehensive range of data processing support services for both general processing needs and technological development. These support services comprise: the design, development, implementation and operation of computational hardware/software systems, the generation of a variety of scientific and managerial output products, and the development of highly technical tools and techniques as aids to earth sciences studies.

In this accommodating role the EOD operational environment should be reliable, flexible, and expandable. Its posture should be one that can effectively respond to changing emphasis in either technological development support and traditional processing.

The EOD environment does not at this time have all these desired qualities. Excessively large volumes of data and high utilization of the available resources impair to varying degree SFB ability to satisfy all needs.

This situation is currently exemplified by the impact created with heavy involvement in the LACIE program. In this case, the bulk of EOD resources are being expended on LACIE requirements, seriously limiting techniques and technological development support services.

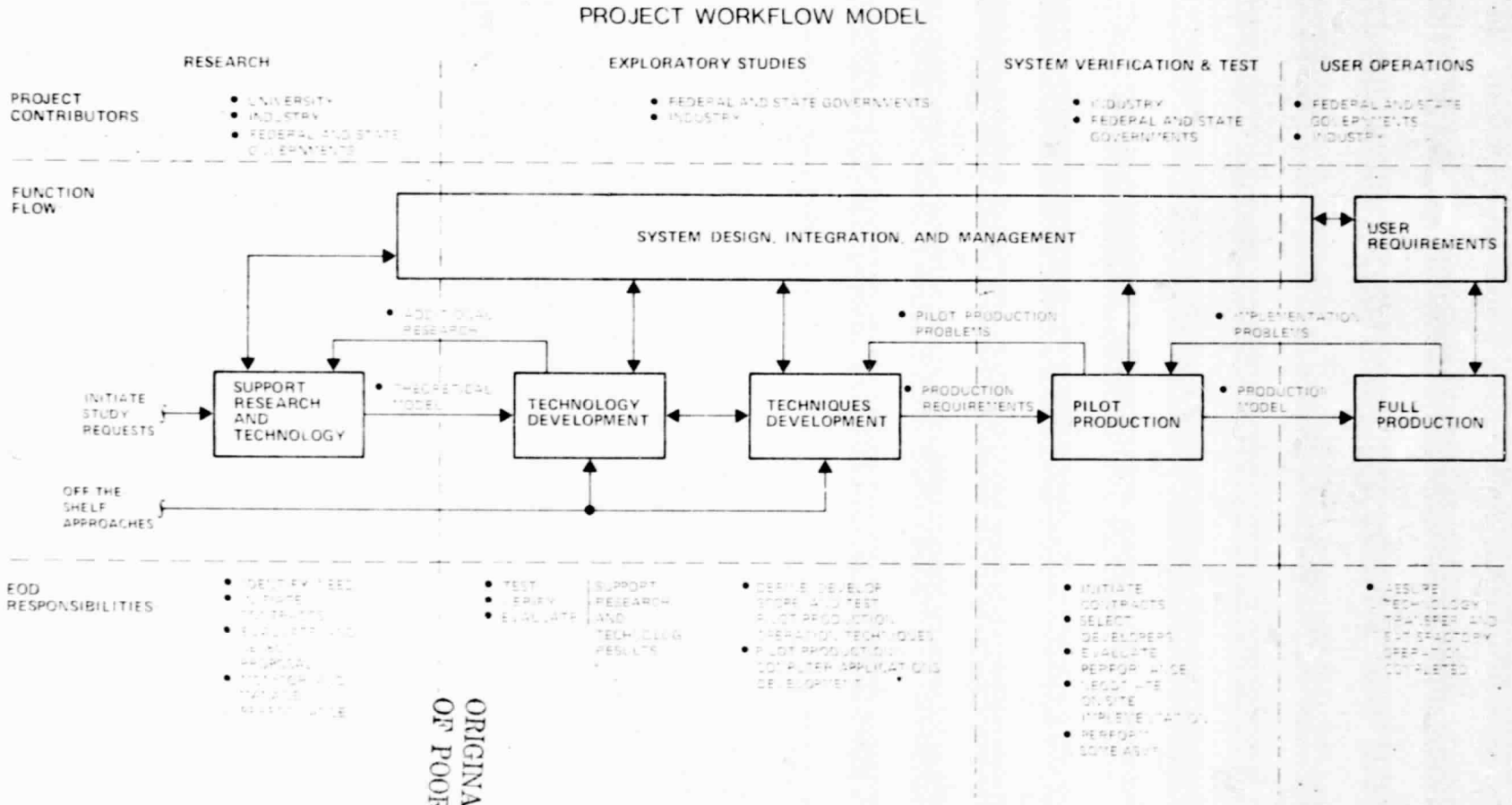

FIGURE i-1

PROJECT WORKFLOW MODEL

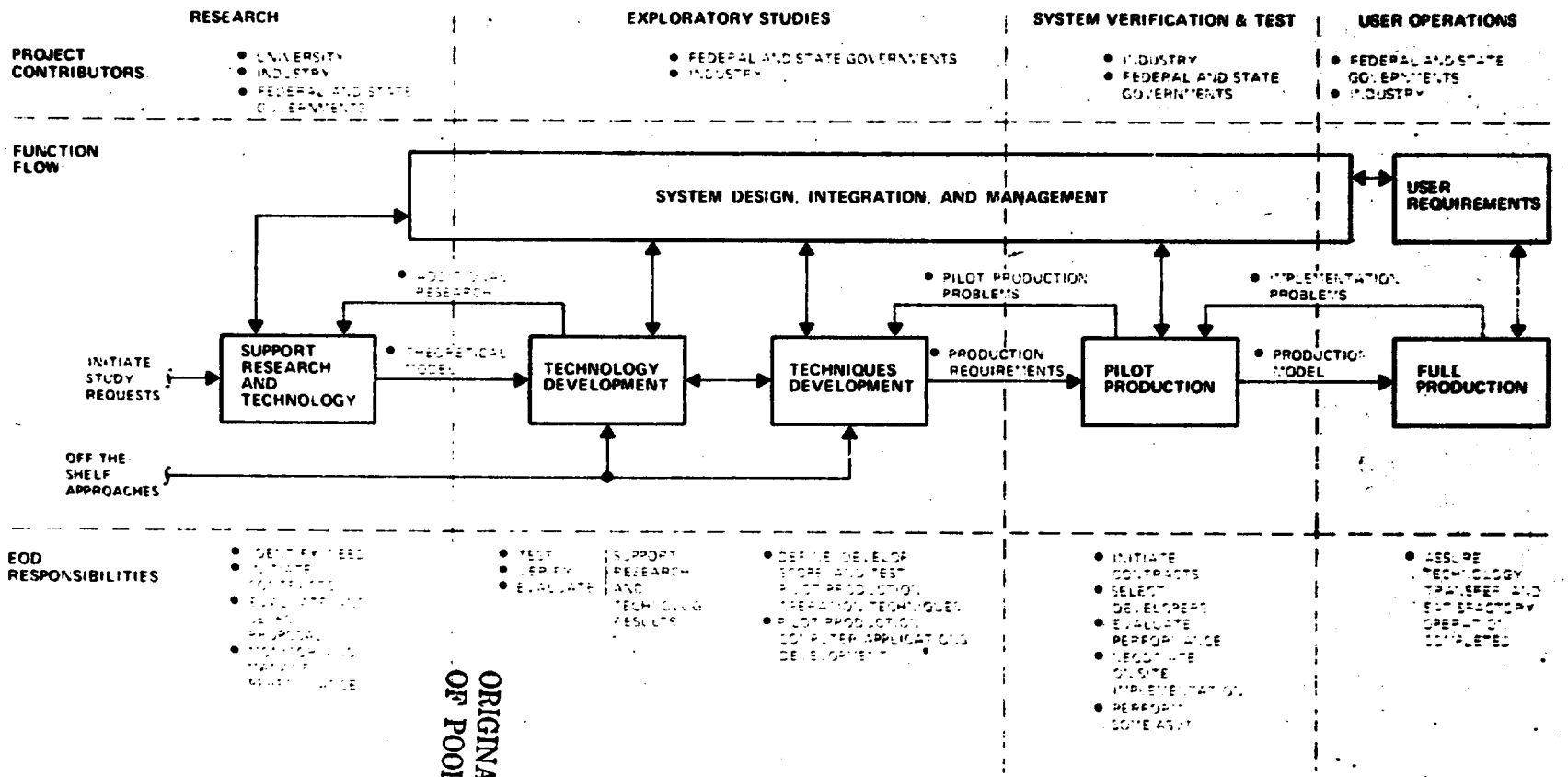

FIGURE i-1

This workload forecast document is one vital informational element in a total plan approach to resolve or at least minimize this situation and other potentially problematic conditions.

The EOD functions and roles are currently being reassessed to determine its position relative to:

- What the total potential workload is
- What portion of the workload must be processed
- What are EOD existing capabilities and capacities
- What EOD can do within the limits of technical capabilities and available funding.

The significance of this document is that it is fundamental to all follow-on planning activities.

PREFACE

Job Order 71-625, ERPSS Planning and Systems Engineering was created for the purpose of performing various investigatory and analysis studies for the Earth Observations Division/Systems and Facilities Branch.

Under this job order, a Long Range Planning team (LRP team) was established specifically to perform planning support functions. The major activities of this team were to:

- Support immediate need for EOD/JSC forecast of budgetary requirements.
- Define a plan to develop long range EOD/Systems and Facilities resource requirements.
- Investigate the EOD/JSC operations and environment to identify present and near future conditions which would affect Systems and Facilities resource development.
- Forecast an EOD workload which would be a fundamental document in support of near and long term planning activities.
- Develop a long range plan which will create an operational posture with adequate resource capabilities and capacities to assure the satisfactory performance of Systems and Facilities functions.

CONTENTS

FIGURES

ACRONYMS

AEM	Applications Explorer Mission
ASVT	Application System Verification and Test
BEG	Bureau of Economic Geology
BLM	Bureau of Land Management
B/W	Black and White
CAS	Crop Assessment Subsystem
COM	Computer on Microfiche
CPU	Central Processing Unit
CRT	Cathod-ray Tube
DOI	Department of Interior
DRC	Data Reduction Center
EI	Exploratory Investigation
EOD	Earth Observations Division
ERDS	Earth Resources Data System
ERDSS	Earth Resources Data System Study
ERIPS	Earth Resources Interactive Processing System
ERPO	Earth Resources Program Office
ES	Exploratory Studies
FAP	Forestry Applications Program
FML	Field Measurements Laboratory
FMP	Food Multicrop Program
FRRAS	Forest and Rangelands Resource Assessment System
GDSD	Ground Data Systems Division
GFFP	Global Food and Fiber Program

GSFC	Goddard Space Flight Center
I-100	GE Image 100 System
IDSD	Institutional Data Systems Division
ITS	Intensive Test Site
JSC	Johnson Space Center
JSME	Joint Soil Moisture Experiment
LACIE	Large Area Crop Inventory Experiment
LACIE X	LACIE Transition
LARS	Laboratory for Applications of Remote Sensing
LRP	Long Range Planning
MET	Meteorological
PDP 11/45	Program Data Processor, Model 11/45
PFC	Production Film Convention
Photo/Carto	Photogrammetric/Cartographic
PMIS/DAS	Passive Microwave Imaging System/Data Analysis Station
PTD	Photographic Technology Division
PTL	Photographic Technology Laboratory
Radar/Ag	Radar Agriculture Project
RAP	Regional Applications Program
RT&E	Research, Test and Evaluation
S&T	Status and Tracking
SFB	Systems and Facilities Branch
SIR	Shuttle Imaging Radar
SR&T	Supporting Research and Technology
SUP	Standard Univ of Processing
SVT	System Verification and Test

T&E	Test and Evaluation
U1100	Univac 1100 Series Computer System
USA COE	USA Corp. of Engineers
USDA	U.S. Department of Agriculture
WSFC	Water Shed Flood Control
WVRI	Wildland Vegetation and Recreation Resources Inventory
360/75	GDSD's IBM 360/75 Earth Resources Processing System

1. INTRODUCTION

This Workload Requirements Forecast document identifies and describes a projected 5 year EOD/Systems and Facilities Branch workload. It defines processing categories, develops processing loads and quantifies projected processing volumes for each program identified. Program processing requirements are then integrated and summarized by processing support services categories for ease of dissemination (Section 2).

Data sources and workload processing requirements are derived from programs and projects identified as most probable future EOD activities. Analysis of these projects yield common parameters such as sites, acquisitions, pixels, missions, resolution factors, etc. These can be quantified as data volumes.

Further, analysis of the support service processing necessary to acquire the desired information, yields: volumes of data to be stored, equipment used, number of rolls of film exposed, amounts of data to be physically handled, etc. These are translatable into processing parameters such as hours of equipment utilization, material comsumption and manpower considerations.

A process of delinearing support services into categories which would facilitate collection and planning techniques was employed. These categories are:

1. Computational Processing
2. Interactive Imagery Display
3. Photogrammetric - Cartographic
4. Field Measurements
5. Film Generation
6. Film Processing
7. Non-Electronic Data Storage/Management

These categories relate directly to specific functional activities performed by the Earth Observation Division.

Section 3, Methodology, defines these categories, describes fully parameter relationships, and the analysis process used.

Section 4, Projects/Program Requirements, develops workload requirements and the corresponding processing requirements by project.

1.1 PURPOSE

The purpose of this document is to describe an EOD workload forecast to support EOD Systems and Facilities resource planning activities.

1.2 SCOPE

This document identifies all known programs and projects which comprise the EOD workload over the next 5 years; and determines the volume and composition of the processing resources needed to accommodate that workload.

1.3 CONSIDERATIONS

The planning activities to which this document will be fundamental, prescribes that some content be exhaustively treated. For this reason an overview or synopsis will, when considered appropriate, preceed lengthy and detailed content. Additionally, to establish the framework within which this document was written, the following developmental guidelines are given.

It is assumed that at least one program will be developed fully through and including systems verification and testing.

Each project and program contributing to the workload forecast was analyzed for technical and fiscal reasonableness in regard to processing requirements and data volumes. Therefore, load estimates are not necessary based on the users maximum projections.

With instances of functional duplication, similar products, etc., consolidation and standardization techniques are used to reduce resource needs.

Physical handling volumes and other personnel staffing considerations are included, however no estimates of manpower requirements are made.

Equipment and processing procedures currently employed are used to serve as a standard reference in both the determination and understanding of the workload. Equipment and processing procedures will change with time. The workload descriptions contained herein must be therefore reassessed with respect to new equipment and technology.

"The purpose of this document is to describe a workload forecast to support (future) resource planning activities." As with any forecast or prediction based upon history, current conditions, and interpretations of data and trends; experienced judgement must be used to bridge the gap between data, facts, and the unknown. For this reason the primary value of this forecast document is visibility, suitability, reasonability, and utility to other planning activities.

2. REQUIREMENTS SUMMARY

2.1 OVERVIEW

This section summarizes the total workload requirements forecast by resource category.

Rather than a simple accumulation, this summary integrates schedules and milestones information, applies load balancing techniques and performs other adjustment efforts to arrive at a sensible workload requirements forecast which is feasible.

Delineation by resource category (described in Section 3, Methodology) is maintained so that the details of an informational element(s) can be found in the text of Section 4 where requirements are generated for each program uniquely.

FY76 utilization has been included to provide a baseline reference.

The information has been extracted, abstracted and presented in optional formats. This approach hopefully facilitates reader comprehension and enhance utility to the various planning activities to follow.

An appendix has been organized containing a considerable amount of supplemental information. Within the text of this section there will appear references to the appendix where the reader will find explicit source information, formuli, and other analysis processes used in determining results.

Selection of the particular method of illustration (tabulation, histrograms, or curve) is made on the basis of its ability to most comprehensively convey information.

2.2 FORECAST NUMBER OF ELECTRONIC DATA ELEMENTS

Figure 2-1 through 2-4 tabulates the estimated number of sites, acquisitions, intensive test sites and blind sites contributed by the various projects over the FY77 through FY82 time frame. Appendix A1 details how these estimates were computed.

2.2.1 TREND ANALYSIS

In FY76 approximately 11000 acquisitions were processed. The bulk of these, 9300, were used in LACIE - Phase II development. As can be seen in figure 2-2, LACIE Phase III development again attributes over 90 percent of all FY77 acquisitions. LACIE extension will continue as the primary contributor of future workloads over the near term. As LACIE extension subsides, the GFFP program accelerates in development to become the primary workload contributor at more than twice the level experienced with LACIE extension.

2.2.2 DATA VOLUME

Estimates of the number of sites, acquisitions, intensive test sites and blind sites, by project, were a necessary exercise in order to determine resources and capacities required for project development.

For the purposes of planning, acquisitions from all sources were converted to numbers of eight-bit bytes of data. Figure 2-5 is a tabulation of the forecast number of bytes to be stored and processed by EOD systems. In addition to calculating bytes = pixels/acquisitions type, estimates of other generated files are included. (Fields, history, ancillary, results, statistics, overhead, etc.) Details on the derivation of these estimates are found in A2.

FORECAST EQUIVALENT LACIE SITE REQUIREMENTS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FYS1	FY82
LACIE	1633	3047					
LACIE TRANSITION			2504	2703	1202	1000	
FAP *	10	10	10	10	125	125	125
RAP *	140	140	140	350	350	350	350
FMP				3047	3047	(a) 5333	7618
JSME **	3	3	291	632	634	1000	1403
MISC. SUPPORT	5	17	29	75	160	270	270
TOTAL	1838	3214	2683	6185	4884	7078	9203

* NOT EQUIVALENT LACIE SITES BUT RATHER PROGRAM ORIENTED SITES.

** SELECTED FROM SUPPORT PROGRAM SITES - NOT INCLUDED IN TOTAL

FIGURE 2-1

(a) AVERAGE OF PROCEEDING AND SUCCEEDING YEARS.

FORECAST EQUIVALENT LACIE ACQUISITION REQUIREMENTS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	9300	16,900					
LACIE TRANSITION			15,024	16,218	7212	6000	
FAP	600	600	600	600	7500	7500	7500
RAP	1526	1526	1526	3815	3815	3815	3815
FMP				16,900	16,900	29,575 (a)	42,250
JSME *	6	6	582	1264	1268	2120 (a)	2806
MISC. SUPPORT	28	100	175	450	950	1600	1600
TOTAL	11,460	19,132	23,307	38,019	39,409	47,960	54,259

* SELECTED FROM SUPPORT PROGRAM ACQUISITIONS - FOR PROCESSING PURPOSES THIS IS INCLUDED IN THE TOTAL.

FIGURE 2-2

2-4

(a)

FORECAST EQUIVALENT LACIE ITS REQUIREMENTS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	30	30					
LACIE TRANSITION			27	29	13	11	
FAP		4	4	4	50	50	50
RAP	5	5	5	12	12	12	12
FMP				30	30	(a) 53	75
JSME *	3	3	12	12	12	12	12
MISC. SUPPORT	-	1	1	2	3	5	5
TOTAL	38	43	49	89	120	143	154

* ITSs SELECTED FOR RT&E PURPOSES ONLY.

FIGURE 2-3

(a) 2-5

FORECAST EQUIVALENT LACIE BLIND SITE REQUIREMENTS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	170	250					
LACIE TRANSITION			223	240	108	90	
FAP		9	9	9	113	113	113
RAP	23	23	23	58	58	58	58
FMP				250	250	438 (a)	525
JSME*	-	-	-	-	-	-	-
MISC. SUPPORT	-	2	3	8	16	27	27
TOTAL	193	284	258	565	545	726	823

* USES ITSs FOR BLIND SITES.

FIGURE 2-4

(a)

FORECAST STORAGE REQUIREMENTS (MEGABYTES)
8 BIT BYTES

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	850	16					
LACIE TRANSITION			1770	2030	351	708	
FAP	28	28	34	34	430	430	2880
RAP	140	140	175	440	440	3540	3540
FMP				1940	1940	(a) 21,120	40,300
JSME	1	2	2	2	2	(a) 76	151
MISC. SUPPORT	10	10	20	52	100	(a) 300	408
TOTAL	1029	196	2001	4498	3772	45,354	47,360

(a)

FIGURE 2-5

The FY76 main storage requirement was given to furnish a frame of reference. Currently,data volumes are stored and used on-line (immediately accessible by the computer processing system). Apparently, current mass storage capacity will accommodate FY77 and FY78 data volumes. In the future, additional storage devices and/or techniques may be required. It is not within the scope of this document to address solutions to real or potential problems but to provide information applicable to studies which may be initiated as part of the planning function. And for that reason, this information is documented.

2.3 FORECAST COMPUTATIONAL PROCESSING REQUIREMENTS

2.3.1 OVERVIEW

For the purposes for which this document is intended, usage estimates are summed in the standard units of the processing systems. (CPU hours, SUPS, etc.)

Usage in all cases includes all applications development and productional processing. Excluded are interactive imagery processing and operating systems development and maintenance. The former is summarized in a unique category (subsection 2.4); the latter is a consideration when determining the available capacity of a system (not covered in this document). Details on the derivation of these estimates are found in A3. A3 includes both baseline assumptions and forecast estimate calculations.

2.3.2 USAGE SUMMARY BY COMPUTATIONAL SYSTEM

2.3.2.1 EOD Support Processor

Figure 2-6 is the forecast utilization of EOD Support Processor (PDP 11/45) usage in the Building 17 facility. The PDP 11/45 operating system, RSX-11D, is a multi-tasking system permitting more than one job to execute concurrently. There is no accounting of system resources used by one or another job during execution. Therefore, execution time is only measureable as the elapsed time from the start of a job

FORECAST COMPUTATIONAL PROCESSING REQUIREMENTS
EOD SUPPORT PROCESSOR REQUIREMENTS (HOURS/WEEK)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	71.0	97.4	(a) 48.7				
LACIE TRANSITION			86.9	93.5	41.6	35.1	
FAP	-	3.5	3.5	3.5	43.2	43.2	
RAP	-	1.0	1.3	3.1	3.1	20.8	20.8
FMP				71.0	71.0	(a) 125.0	178.9
JSME	-	2.0	4.5	9.7	9.7	(a) 16.2	21.4
MISC. SUPPORT	-	13.0	17.2	27.6	40.1	52.0	52.0
TOTAL	71.0	116.9	162.1	198.4	208.7	312.3	272.2

(a)

FIGURE 2-6

to its finish; with no accountability for inactive (wait) periods during which other jobs may be executing. These estimates are then in wall clock hours of elapsed time, not CPU hours.

2.3.2.2 GDSD Facility - IBM 360/75

Figure 2-7 is a summary of the estimate average usage in 360/75 CPU hours/week. Notice the estimate forecasts full shift utilization in FY77. In fact, this implies more than one shift/day considering six hours/week for systems maintenance and monthly,quarterly, and year-end peak loads, etc.

2.3.2.3 IDSD Facility - Univac 1100 Series

Distinction between the Exec 2, Exec 8, and the Exec 8 demand operating systems were maintained in preparing this summary. Indications are that the Exec 2 will not be made available in the near future and that all processing will be performed using the more efficient Exec 8 multi-programming operating system. As in the case of IBM 360/75, usage increases are significant; the question whether the IDSD Building 12 facility will provide these levels of support services in future should be seriously considered. See figure 2-8.

2.3.2.4 Purdue/LARS - IBM 360/65

The Purdue University facility maintains a sophisticated suite of mathematical models frequently accessed via terminals by EOD analysts.

Although these programs are portable (can be executed on the 360/75 in Building 30), they are to some degree proprietory. These programs are considered essential to EOD users. Figure 2-9 gives the forecast Purdue/LARS usage.

Imagery processing is not included in these estimates. Estimates for imagery are covered in the following subsection 2.4.

FORECAST COMPUTATIONAL PROCESSING REQUIREMENTS
GDSD FACILITY - 360/75 EQUIVALENT (CPU HOURS/WEEK)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	22.0	30.0	(a) 15.0				
LACIE TRANSITION			26.7	28.8	12.9	10.8	
FAP	-	1.1	1.1	1.1	13.3	13.3	13.3
RAP	-	-	-	-	-	-	-
FMP				30.0	30.0	(a) 53	75.0
JSME	-	-	-	-	-	-	-
MISC. SUPPORT	-	-	-	-	-	-	-
TOTAL	22.0	31.1	42.8	59.9	56.2	77.1	88.3

(a)

FIGURE 2-7

FORECAST COMPUTATIONAL PROCESSING REQUIREMENTS
IDSD FACILITY - U1100 SERIES EQUIVALENT (SUP HOURS/WEEK)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	2 -7.9 8 -7.0 8d-2.3	2 -7.9 8 -7.0 8d-2.3					
LACIE TRANSITION			2 -7.0 8 -6.2 8d-2.1	2 -7.6 8 -6.7 8d-2.2	2 -3.4 8 -3.0 8d-1.0	2 -2.8 8 -2.5 8d-0.9	
FAP	2 -0.3 8 -0.2 8d-0.1	2 -0.3 8 -0.2 8d-0.1	2 -0.3 8 -0.2 8d-0.1	2 -0.3 8 -0.2 8d-0.1	2 -3.5 8 -3.1 8d-0.1	2 -3.5 8 -3.1 8d-0.1	2 -3.5 8 -3.1 8d-0.1
RAP	2 -0.4 8 -1.0 8d-0.9	2 -0.4 8 -1.0 8d-0.9	2 -0.5 8 -1.3 8d-1.1	2 -1.3 8 -3.1 8d-2.8	2 -1.3 8 -3.1 8d-2.8	2 -8.4 8 -20.8 8d-18.8	2 -8.4 8 -20.8 8d-18.8
FMP				2 -7.9 8 -7.0 8d-2.3	2 -7.9 8 -7.0 8d-2.3	(a) 2 -13.9 8 -12.3 8d-4.1	2 -19.8 8 -17.5 8d-5.8
JSME	2 -0.4 8 -0.1 8d -	2 -0.5 8 -0.4 8d-0.1	2 -0.5 8 -0.4 8d-0.1	2 -1.1 8 -1.0 8d-0.3	2 -1.1 8 -1.0 8d-0.3	(a) 2 -1.8 8 -1.6 8d-0.5	2 -2.4 8 -2.1 8d-0.7
MISC. SUPPORT	2 -2.8 8 - 8d -	2 -1.5 8 -2.0 8d-1.8	2 -2.0 8 -2.6 8d-2.4	2 -3.2 8 -4.2 8d-3.8	2 -4.6 8 -6.2 8d-5.5	2 -6.0 8 -8.0 8d-7.2	2 -6.0 8 -8.0 8d-7.2
TOTAL	2 -11.8 8 -8.3 8d-3.3	2 -10.6 8 -10.6 8d-5.2	2 -11.3 8 -10.7 8d-5.8	2 -21.3 8 -22.2 8d-11.5	2 -21.8 8 -23.4 8d-12.9	2 -36.9 8 -48.3 8d-32.5	2 -30.1 8 -51.5 8d-33.5

(a)

2 - EXEC 2
8 - EXEC 8
8D - EXEC 8 DEMAND

FIGURE 2-8

FORECAST COMPUTATIONAL PROCESSING REQUIREMENTS
PURDUE/LARS 360/75 EQUIVALENT (CPU HOURS/WEEK)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	4.6	4.6	(a) 2.3				
LACIE TRANSITION			4.1	4.4	2.0	1.0	
FAP	-	-	-	-	-	-	-
RAP	1.0	1.0	1.3	3.1	3.1	20.8	20.8
FMP				4.6	4.6	11.5	11.5
JSME	-	-	-	-	-	-	-
MISC. SUPPORT	-	-	-	-	-	-	-
TOTAL	5.6	5.6	7.7	12.1	9.7	33.9	32.3

(a)

FIGURE 2-9

2.3.3 SUMMARY CONCLUSIONS/IMPLICATIONS

Developing the computatipnal processing requirements for each processing system uniquely, was determined to be the better way of communicating this intelligence to the reader. This approach is more easily defended by the supportive material in the appendix; and individual loading estimates support workload redistribution analysis which in all probability will be a consideration in satisfying requirements.

Estimate computational processing requirements for each system or facility increased. To construe that systems will be augmented or facility utilization increased to accommodate the estimated increases would be erroneous. For reasons of economies and/or efficiencies and/or management some consolidation and standardization will take place thus reducing dependence upon one or another support facility. By distinquishing each system and/or support facility, those who will be responsible for resource development planning can better determine how requirements can be satisfied most effectively and economically.

2.4 FORECAST INTERACTIVE IMAGERY DISPLAY REQUIREMENTS

2.4.1 OVERVIEW

Interactive imagery display requirements were developed for both the ERIPS and I-100 systems.

Because of its sophitication and exclusive use as an investigative aid, the PMIS/DAS was not considered as a suitable resource upon which a system could be developed.

Current baseline usage was collected (reference A4) and provided. This was done so that actual usage together with the estimates of the imagery processing workloads would best illustrate the severity of the workload impact upon one or the other systems. This is of particular importance in the FY77-78 time frame when it may not be possible to increase capacity.

Information detailing how imagery display estimates were derived can be found in A4.

ERIPS imagery requirements are in IBM 360/75 CPU hours per week; and, as stated previously, this usage is not part of computational time.

The ERIPS system as part of the IBM 360/75 system is such that when the two terminals are operating no other background workload can be processed. Actual central processor utilization is something less than capability, however, the CPU for our purposes, is considered fully utilized. The hours given represent two terminals operating simultaneously.

Operation of the I-100 imagery system does permit some degree of background processing on the PDP 11/45 system. However, since there is no internal accounting of CPU or other PDP 11/45 system resources, I-100 usage, as user elapsed time in wall clock hours, is a suitable measure of utilization.

2.4.2 ERIPS FACILITY - IBM 360/75

Figure 2-10 is a tabulation by project of all ERIPS imagery display usage estimates in hours/week.

Usage increases are seen to be rather linear over the FY77-82 time frame with a slight tail off. This is a result of applying scheduling information and by deferring some small amounts of workload for later or earlier processing.

Attempts to apply balancing efforts (transferring of portions of the workload between ERIPS and I-100) will be discussed later in this subsection. (2.4.4).

FORECAST IMAGERY DISPLAY REQUIREMENTS
ERIPS TYPE (IBM CPU HOURS/WEEK)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	30.0	23	(a) 12.0				
LACIE TRANSITION			20.5	22.0	9.7	8.3	
FAP	1.5	1.5	1.5	1.5	15.0	15.0	15.0
RAP	-	1.0	1.3	3.1	3.1	3.1	3.1
FMP				17.1	17.1	(a) 17.7	18.3
JSME	-	-	2.8	6.1	6.1	(a) 9.7	13.5
MISC. SUPPORT	-	0.5	0.7	1.1	1.1	1.5	2.0
TOTAL	30.0	26.0	38.8	50.9	52.3	55.3	51.9

(a)

FIGURE 2-10

approach which can satisfy the total various project needs prior to development of the Earth Resources Data System (ERDS). One candidate substitute for imagery display requirements is the PMIS/DAS system. Use of the PMIS/DAS alone, however, cannot satisfy interactive image display user needs entirely. Pre or post PMIS/DAS usage would require processing by some other support processor(s). Should this method be used to satisfy user needs it would, of necessity, be short term because of the many manual steps of physical data handling involved and the extended output product development times resulting therefrom.

Apparently providing solutions to the aforementioned problems in this one resource category is a task of considerable efforts.

Whatever actions are taken, the available lead time to implement change is brief; and the corrective actions taken, to be economical, must be of lasting benefit.

2.5 FORECAST PHOTOGRAMMETRIC-CARTOGRAPHIC REQUIREMENTS

2.5.1 SUMMARY REQUIREMENTS

Figure 2-12 is a tabulation of the quantity of photogrammetric-cartographic products estimated to be requested collectively by all projects between 1977 and FY82. These products were not tabulated by project as are the other support service requests because it would have resulted in the addition of differing kinds of elements which has little meaning, and would tend to confuse rather than clarify requirements.

The quantity of acquisitions nearly doubles from FY76 to FY77. This large increase is not reflected in the photogrammetric-cartographic product quantities because a majority of these products are LACIE updates and not generated newly from scratch. The first large growth step which is of major significance will take place in FY79. In FY79 an increase of almost twice the number of products will be required. A majority of these products are generated from data acquired at new locations. The number of output products continues to grow till FY81.

2.4.3 EOD IMAGE PROCESSOR

Figure 2-11 tabulates in hours per week the I-100 (PDP 11/45) usage by project.

Note the nearly twofold increase in the estimate for I-100 usage in FY77. This resulted even with some significant deferral of LACIE - Phase III workload into FY78. Similar adjustment was also made with the Food Multicrop Program (FMP), the Joint Soil Moisture Experiment (JSME), and other workloads. In no way, however, were known schedule start/finish dates violated.

2.4.4 SUMMARY CONCLUSIONS/IMPLICATIONS

The following comments are made to uncover the not so obvious severity of the forecast workload estimates. And perhaps in some way support management and personnel in their efforts to resolve the existing and potential problems affecting EOD support services.

It would appear that ERIPS requirements could be satisfied by simply extending the operational periods incrementally to a full seven-day three-shift operation in FY82. This is <u>not</u> however possible.

The IBM 360/75, in addition to 'driving' the ERIPS system, also provides a substantial amount of needed computational processing support.

Adding the estimated FY78 GDSD facility computational support to the FY78 ERIPS support totals 81.6 hours. Add to this scheduled and unscheduled maintenance, processing priorities, operating and applications systems maintenance, etc., and it becomes questionable whether the 360/75 system usage for FY78 can be satisfied.

FORECAST IMAGERY DISPLAY REQUIREMENTS
EOD IMAGE PROCESSOR (I-100 TYPE - HOURS/WEEK)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	20.0	100.0	(a) 53.0				
LACIE TRANSITION			94.3	101.8	45.0	38.2	
FAP	10.0	10.0	10.0	10.0	47.0	47.0	47.0
RAP	4.0	3.7	5.0	12.5	12.5	12.5	12.5
FMP				34.1	34.1	(a) 35.3	36.1
JSME	-	-	22.4	48.6	48.6	(a) 91.5	107.9
MISC. SUPPORT	30.0	20.0	26.5	42.0	42.0	61.6	80.0
TOTAL	10.0	139.7	211.2	249.0	229.8	276.1	283.5

(a)

FIGURE 2-11

Several of the following options, or combinations of, were considered.

- Off-load a portion of the computational workload to an alternate processor.
- Off-load a portion of the ERIPS to the I-100 system.
- Enhance the ERIPS hardware/software to permit background processing.
- Expand I-100 capacity.
- Off-load a portion of the I-100 workload onto the PMIS/DAS.
- Acquire additional imagery system.
- Allocate stringently all available resources.
- Reduce requirements.

It is technically feasible to off-load some ERIPS activities to the I-100 and conversely (balance workloads). However, the high usage estimates for both imagery systems exceed the sum total of all current imagery capacity.

Allocation of the available resources on the basis of priority would be severely detremental to other projects. The LACIE extension program alone, to which EOD is firmly committed, would use almost all image display capacity.

Off-loading computational workloads raises the question, "where to?". Additional computational support, currently provided by non-EOD facilities, may be difficult to obtain.

Hardware/software augmentation and/or acquisition would have to expand image processing capability as well as image and computational processing capacities to permit workload redistribution.

Current combined requirements for interactive imagery display exceeds available times on the ERIPS and I-100 terminals. To alleviate this resource conflict, effort is being directed toward finding an optional

FORECAST PHOTOGRAMMETRIC-CARTOGRAPHIC PRODUCT REQUIREMENTS

PRODUCTS	FY76	FY77	FY78	FY79	FY80	FY81	FY82
SITE LOCATION/RELOCATION (SEGMENT)	1670	2242	2980	4302	5306	6229	3246
ITS UPDATES	36	18	36	74	73	84	40
PHOTOMOSAICS	167	227	315	525	554	685	336
APEA MEASUREMENTS (SITES)	184	151	322	579	307	597	226
BOUNDARY DETECTION (OVERLAYS)	0	785	1046	1738	1848	2183	1215
PARTITIONING (OVERLAYS)	12	1802	2870	4744	1643	5203	2175
ORTHOPHOTO	0	46	23	46	325	129	116
CHANGE DETECTION (OVERLAYS)	36	46	15	41	383	130	130
DIGITAL IMAGERY REGISTPATION (LANDSAT IMAGES)	0	117	158	263	283	323	169
SOIL MOISTURE CONTENT MAP	-	111	156	172	238	318	147
PERCENT SOIL MOISTURE CONTOUR MAP	-	9	12	14	19	25	12
SOIL MOISTURE DEPTH PROFILES	-	8	12	15	12	29	10

FIGURE 2-12

Figure 2-13 is a summary tabulation of the revised list of photogrammetric-cartographic products. Detailed estimates, by project, for the first nine standard output products are available in the appendix (A5-6,-14). The three new products are attributed to JSME ancillary data necessary in support of major projects. Estimates for these are based upon the JSME acquisition estimates. (See reference A5-4,5) for details of volume determinations.)

2.5.2 SUMMARY CONCLUSIONS/IMPLICATIONS

The quantity of acquisitions increase twofold from FY76 to FY77. This increase will be largely offset by the fact that a majority of photo-carto products are LACIE updates and not generated from source data. (Data had been previously processed and/or products generated.) The first large growth step which is of major significance will take place in FY79. An increase of almost twice the number of products will be required in FY79 as a majority of the data will be from new locations. The number of output products continues to grow till FY81.

Despite efforts to temper photogrammetric-cartographic product types and volumes, the increases from the FY76 actuals are significant.

Photo-carto personnel and the LRP team concluded that the success or failure of accomplishing the goals of future earth science programs most probably rests upon the development and the automation of mapping sciences output products. It is not just a matter of large increases of output requirements but mainly in identification, isolation and application of automated processes for rapid imagery analysis and evaluation. Large data bases of digitized partitioned parameters, e.g. rainfall, soil type, temperature gradients, etc., would have to be developed and maintained to facilitate processing functions as computer registering, area measurements, rectification, and correlation.

PHOTO/CARTO PRODUCTS

B&W MOSAICS
- UNCONTROLLED
- CONTROLLED

THEMATIC MAPS FOR ITS

LANDSAT GROUND TRACK WITH SCENE CENTERS

SAMPLE SEGMENT LOCATION MAP OVERLAYS

METEOROLOGICAL STATION POSITIONAL PLOTS

METEOROLOGICAL DATA PLOTS

VARIOUS SPECIAL THEMATIC MAPS

AREA MEASUREMENT CALCULATIONS

STRIP MOSAICS FOR EACH BIOPHASE FOR EACH REGION

CROP REPORTING DISTRICT BOUNDARY BASE MAPS

SIGNATURE EXTENSION PARAMETER IDENTIFICATION

SOIL MAPS

FIGURE 2-13

2.6 FORECAST FIELD MEASUREMENT REQUIREMENTS

2.6.1 SUMMARY REQUIREMENTS

Field measurement requirement workloads are shown in terms of missions taken by meteorological/ground truth teams and truck teams. Many of these missions will be performed by state universities and USDA county personnel. Instrument calibrations, and data quality and validity must largely be done at JSC.

2.6.2 SUMMARY CONCLUSIONS/IMPLICATIONS

A summary of field measurement requirements is shown in figure 2-14. Field measurement support will continue to grow till the latter phases of Global Food and Fiber Program (GFFP), i.e., FY81. Missions for both meteorological and truck teams will more than double by FY79. A rather stable condition will be reached at that time and remain until FY82.

FORECAST FIELD MEASUREMENT REQUIREMENTS (MISSIONS)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	13T 24M	13T 24M	7T 12M	-	-	-	-
LACIE TRANSITION	-	-	6T 12M	13T 24M	7T 12M	7T 12M	-
FAP	2M	4M	4M	4M	8M	8M	8M
RAP	-	5M	5M	10M	10M	10M	10M
FMP	-	-	-	23T 28M	27T 34M	27T 34M	23T 28M
JSME	6T	12T	12T	12T	12T	12T	12T
MISC. SUPPORT	-	1T 1M	1T 1M	1T 2M	3T 3M	4T 6M	4T 6M
TOTAL	19T 26M	26T 34M	26T 34M	40T 68M	49T 67M	50T 70M	39T 52M

T - TRUCK TEAMS
M - METEOROLOGICAL/GROUND TRUTH TEAM

FIGURE 2-14

2.7 FORECAST FILM GENERATION REQUIREMENTS

2.7.1 SUMMARY REQUIREMENTS

The film generation requirement is a summarization of those determined for each project identified in the workload forecast. No alternations were made to these volumes excepting a 25% overhead determined as the average time utilized for COM processing. (Processing of source imagery data to produce specialized film products.)

Figure 2-15 is a summary tabulation of the film generations forecast for FY77 through FY82 in FR80 processing hours per week. Details on the derivation of these estimates are found in appendix A7.

2.7.2 SUMMARY CONCLUSIONS/IMPLICATIONS

Although the FY77 estimate is significantly greater than FY76 utilization, the one shift per week average is considered operationally manageable.

Film generation in the 1980's will obviously exceed the capacity of an FR80 processor. Currently, this support is provided by the GDSD facility Building 30 which has an FR80 servicing several users in addition to EOD. The IDSD facility Building 12 also has a similarly configured FY80. Current sum utilization of both these systems is not known however, requirements, including those of other users (i.e. SHUTTLE DRC), are known to be increasing. It can reasonably be assumed therefore, that capacity will be provided as needed to accommodate requirements for FY80 products.

FORECAST FILM GENERATION* REQUIREMENTS (HOURS/WEEK)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	14.9	18.1	(a) 9.0				
LACIE TRANSITION			26.1	27.8	12.5	10.4	
FAP	-	1.0	1.25	1.25	15.6	15.6	15.6
RAP	-	0.2	0.25	0.8	0.8	6.4	6.4
FMP				30.6	38.6	(a) 73.2	109.8
JSME	-	1.0	1.8	3.3	3.3	7.1	6.6
MISC. SUPPORT	-	0.2	0.3	0.8	1.0	3.0	3.0
TOTAL	14.9	20.5	38.7	70.6	60.3	115.7	141.4

* 25% OVERHEAD INCLUDED TO COVER COM PRODUCT GENERATION

(a)

FIGURE 2-15

2.8 FORECAST FILM PROCESSING REQUIREMENTS

2.8.1 FILM PROCESSING SUMMARY

Processing volumes are extrapolated directly from film generation estimates. Figure 2-16 tabulates the forecast film processing in rolls per week of both color and black and white film. Scheduling adjustments were applied to accommodate an inordinate volume increase attributed to LACIE Phase III workloads which would exceed current Building 8 film processing capacity. A portion of that LACIE workload was deferred to FY78.

Processing volumes for the 1980's grossly exceed the current capacity of Building 8 facilities. Details on the derivation of these estimates are found in Appendix A8.

FORECAST FILM PROCESSING REQUIREMENTS (ROLLS/WEEK)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	B 4.9 C 1.6	B 5.9 C 2.0	B 3.0 C 1.0				
LACIE TRANSITION			B 9.2 C 2.6	B 9.9 C 2.8	B 4.4 C 1.3	B 3.7 C 1.0	
FAP	B - C -	B 0.3 C 0.1	B 0.4 C 0.1	B 0.4 C 0.1	B 3.8 C 1.3	B 3.8 C 1.3	B 3.8 C 1.3
RAP	B - C -	B 0.1 C -	B 0.1 C -	B 0.2 C 0.1	B 0.2 C 0.1	B 1.5 C 0.4	B 1.5 C 0.4
FMP				B 10.3 C 3.0	B 10.3 C 3.0	B 29.5 C 7.4	B 29.5 C 7.4
JSME	B - C -	B 0.3 C 0.1	B 0.6 C 0.2	B 1.0 C 0.3	B 0.9 C 0.3	B 1.9 C 0.5	B 1.7 C 0.5
MISC. SUPPORT	B - C -	B - C -	B 0.1 C -	B 0.3 C 0.1	B 0.6 C 0.2	B 1.1 C 0.3	B 1.1 C 0.3
TOTAL	B 4.9 C 1.6	B 6.6 C 2.2	B 13.4 C 3.9	B 22.1 C 6.4	B 20.2 C 6.2	B 41.5 C 10.9	B 37.6 C 9.9

B - BLACK AND WHITE FILM IMAGERY
C - COLOR FILM IMAGERY

FIGURE 2-16

NOTE: PTL THROUGHPUT CAPACITY IS 5 TO 6 ROLLS/24 HOUR PERIOD

2.9 FORECAST NON-ELECTRONIC DATA STORAGE/MANAGEMENT REQUIREMENTS

2.9.1 SUMMARY REQUIREMENTS

Figure 2-17 tabulates the volume estimates of data packets to be maintained annually. Packets are synonymous with sites covering areas as small as a few hundred acres to tens of hundreds of square miles. The volume or bulk of information contained in a packet is similarly variable from a few sheets to eight or ten inches of computer listing, film products, typed copy, etc. Details on the derivation of these estimates are found in Appendix A9.

Note all annual estimates exceed the FY76 actual.

2.9.2 SUMMARY CONCLUSIONS/IMPLICATIONS

The physical handling of non-electronic data packets pose a perplexing problem to EOD/SFB facility planning personnel. The maintenance of these data elements and the generation of Photogrammetric-Cartographic products are the two most problematic support service categories which require effective and economic long term solutions.

FORECAST NON-ELECTRONIC DATA REQUIREMENTS
(PACKET EQUIVALENTS)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	2188	3961					
LACIE TRANSITION			3255	3514	1563	1300	
FAP	26	26	26	26	325	325	325
RAP	182	182	182	455	455	455	455
FMP				3961	3961	(a) 6932	9903
JSME	8	8	421	421	421	(a) 516	611
MISC. SUPPORT	17	22	38	96	208	351	351
TOTAL	2421	4199	3922	8473	6933	9869	11635

(a)

FIGURE 2-17

3. METHODOLOGY

3.1 OVERVIEW

In describing an EOD workload, each program and project scheduled by the Earth Resources Program Office was individually evaluated.

These were assessed with regard to prior commitment, emphasis, priority, dependency, development schedule, complexity and magnitude to determine what the workload would be, and the degree of EOD involvement in the development phase of each program and project.

The source data volumes and minimal machine processing requirements necessary to meet program objectives were determined from the analysis of the workload processing phases.

Overall requirements were obtained by analysis of prior experience, derived assumptions, imposed constraints, given direction and those scheduling adjustments necessary to allocate resources effectively with minimal impact to any individual program or project.

3.2 DETERMINATION OF DATA SOURCES AND VOLUMES

The total volume of data flowing within EOD is the summation of the data generated by the individual Earth Resource projects. Project data volume can be estimated based on sensor characteristics, project acquisition requirements, and processing requirements for each subset of selected acquisitions. The acquisition was selected as the parameter of reference through which support service workloads for future programs may be assessed relative to currently imposed support service workloads on existing programs.

The acquisition is defined as the total data acquired by a single sensor platform from a selected site. Other variables which were considered within the number of acquisitions included: the number of frequency bands taken, the number of pixels recorded, the number

of acquisitions selected for work and/or rework, the number of crops in review, the number of acquisitions per biophase, and the number of days in each growing season. In each case these acquisition variables were considered individually as they tend to affect support service requirements such as processing time, storage space, image display time and general data handling volumes.

3.3 SUPPORT SERVICES CATEGORIES DEFINITION

Support of EOD activities in the development of methodology and its associated technology requires a variety of specialized processing services. These processing services include those of a manual nature as well as those provided by computer of other specialized automated systems facilities. A study of the processing operations was performed to better comprehend methods, equipment and personnel utilization in satisfying user requirements. The resultant was a technique by which processing support services could be partitioned into the following seven major categories.

a. Computational Processing

b. Interactive Imagery Display

c. Photogrammetric/Cartographic

d. Field Measurements

e. Film Generation

f. Film Processing

g. Non-Electronic Data Storage/Management

3.3.1 COMPUTATIONAL PROCESSING

This classification applies to demand/batch computational processing and associated support functions as is being performed by the Ground Data Systems Division (GDSD), Institutional Data Systems Division (IDSD), and Purdue as well as by EOD. The machines used include the IBM 360 series, Univac 1100 series, and Digital PDP 11/45. Units to express processor utilization are CPU hours, SUP hours, CCU hours, and elapsed

clock hours. Other informational elements such as on/off-line storage volumes, terminal connect time, etc., are collected as subsets of this category.

3.3.2 INTERACTIVE IMAGERY DISPLAY

This is a category which includes the interactive processing, analysis and display of imagery data. It is currently performed on the ERIPS terminal system (which uses the IBM 360/75 computer) and the GE Image-100 system (using the PDP 11/45 computer). It includes the capability to process and investigate digital imagery data which is projected onto a CRT screen for analysis. Utilization of these systems is expressed in hours of terminal time. Both image systems are driven by a digital processor. But only those processor resources needed to display imagery are included in this category.

3.3.3 PHOTOGRAMMETRIC/CARTOGRAPHIC

This category of support services applies to the generation of all unique mapping and mapping sciences products needed to satisfy Earth resources studies. It includes mapping compilation and aerial traiangulation; orthophotography; photomosaicing and thematic mapping; geometric image registration; mensuration and display; and sensor performance evaluation and calibration. Although this service is assisted by some automated devices, it is largely a manual function. For this reason support service requirement units are identified as the number of products as they relate to specific projects.

3.3.4 FIELD MEASUREMENTS

Field measurements support includes the instrumentation, preparation, acquisition and verification of earth resources ground truth data. Four trucks and one helicopter are appropriately equipped to obtain optical, meteorological, agronomic, air quality, water quality, field spectrometer and imaging data. The instruments associated with each of these systems is operated and maintained by the corresponding ground truth data teams at Purdue, University of Kansas, Texas A&M University and Johnson Space Center. Units of measure for support services are given as truck or helicopter ground truth team missions.

3.3.5 FILM GENERATION

Current earth resources technology relies heavily on the generation of photographic imagery of most acquisitions. This category of support services is provided by GDSD on the FR80 and associated production film conversion hardware and software. The products consist of both color and black and white film exposed with various types of processed and non-processed Aircraft and space vehicle imagery. Measurement of utilization of these equipments are given in hours.

3.3.6 FILM PROCESSING

Film processing is that category of support services in which the exposed film is chemically treated (developed), sleeved, cut and annotated. Resultant products are transparencies, proofs or prints of imagery information.

All film generated by the production film converter must be processed, developed and packaged for use by the analysts. This support is provided by the Photo Technology Laboratory in Building 8. Units of support are given in rolls of film processed.

3.3.7 NON-ELECTRONIC DATA STORAGE/MANAGEMENT

This category of support services includes the requesting, receiving, distribution, storage and reference retrieval of physical data products to and from the data user. Also included are the accountability, record maintenance and research assistance provided on these and other ancillary user reference data. Non-electronic data storage services are divided into two classes: Project and non-project related support. Project type of support will be covered in the discussion of individual program support requirements in section 4.0. Non-project type of support is covered in section 2.0.

The "site" is used as a unit of measure for deriving project related nonelectronic data storage workload requirements. A site is defined as an elemental area selected, by project, for investigation. As identified by each project, a defined amount of non-electronic data is required to support the analysis and evaluation of each site. The volume of this data was estimated for each project and summed. Non-project related support is estimated as a percentage of the project related support activities.

3.4 WORKLOAD ANALYSIS PROCESS

For each program, processing workloads were forecast employing the conventional approach of assessing inputs based upon program sensor source volumes and characteristics, and then determining what interim and end-item output products were needed to satisfy the program objectives. Input/output requirements were later modified to reflect program and source data (sensor) schedules and milestones. Where concurrently developing programs were in contention for the same resource category(s), further modifications were performed when summarizing requirements.

3.4.1 SOURCE DATA VOLUMES

3.4.1.1 Overview

The purpose of this section is to describe what was considered in deriving those data estimates and by example illustrate the analysis processes employed.

Estimates of future data processing volumes based solely on current volumes, without regard to sensor characteristics or individual project processing requirements, would be relatively easily calculated. These estimates would also represent totally unrealistic processing requirement levels. In this document forecast, analysis were performed on each element of data to be processed. The data source characteristics, project acquisition requirements, and other unique project

operating parameters were identified and evaluated to determine a most reasonable assessment of the workload requirements. The estimate volume of data input to specific resource categories was treated within the text of that category under discussion. This permitted analysis by category so that processing of source data, used by more than one program, was not tallied twice.

3.4.1.2 Processing Volume Assessment

Considerations such as non-linearity, necessary degree or extent of investigative study, science technology advancement, improved aids and tools, and more efficient processing systems were all applied to each project.

For example: the Landsat data presently used by LACIE consists of 4 spectral bands containing 117 by 196 pixels (bytes) in each acquisition. Based upon FY1976 workloads and making adjustment for more bands and differing number of pixels per acquisition, the workload for each processing function was calculated. In the early years these workloads were, in most cases, linearily extrapolated, however, when dealing with the 1979 through 1982 period, adjustments were made to lessen the workload because of improved methods and technology usages. For LACIE it was assumed that all acquisitions were used as training sites whereas in later programs (such as Multicrop) training acquisitions were reduced to only 20%. This assumed improved algorithms and more extensive use of automated equipment.

It was further discovered that system verification and test activities are primarily confined to standard LACIE sized Landsat sample segments, whereas exploratory studies use these plus both full frame Landsat and aircraft data. Exploratory studies also tend to work only a small portion of the overall number of acquisitions but to work them several times. This again contrasts with the mode of operation used by

systems verification and test personnel. The latter teams work nearly all of the standard, (117 X 196 pixels), LACIE Landsat sample segment acquisitions, but tend to work them only once. It should be noted that a majority of the acquisitions worked are common to both groups. These considerations were applied in the investigations of all resource categories for each individual program.

3.4.1.3 Pre and Post Processing Volume Assessment

It became apparent that data management and storage volumes estimates were essential input to other planning activities. Therefore, in deriving data volume estimates for the seven resource categories, project and non-project oriented management and storage volume requirements estimates were included as an integral part of the analysis in each applicable area.

3.4.2 WORKLOAD BASELINE INVESTIGATIONS

Support services provided during FY'76 to LACIE, FAP, RAP, JSME, other miscellaneous programs and RMOs were used as a reference baseline. The new processing requirements and data volumes were integrated with the baseline to estimate and determine forecast capacities and new capabilities. Available projections of resource requirements provided by EOD personnel were also assessed and, when applicable, used to modify initial estimates.

3.4.3 PROGRAM ASSUMPTIONS

As a matter of practicality for a smooth flow of data, balanced task workloads and avoiding potential scheduled milestone conflicts, it was necessary to make certain assumptions concerning the interrelationship of programs. The following is a list of these assumptions.

- Global Food and Fiber Program (GFFP) will be the major EOD involvement in future. Soon to be initiated, this work will overlap with the LACIE transition program.

- Forestry and Rangeland Renewable Resource Inventory (FRRRI) will be performed at only a slightly increased level above that used by FAP in FY77.
- Transferring of low cost technology to various, state and federal agencies, as currently done by RAP, will continue at about the current FY76 level.
- The principle work performed on the Joint Soil Moisture Experiment (JSME) will be in support of other programs which require soil moisture inputs as ancillary data. Only a small nucleus of effort will exist independent of other programs.
- Aircraft and ground truth data will continue to support new programs at much the same rate and level as is currently being provided.

3.5 WORKLOAD REQUIREMENTS CONVERSION TO SUPPORT SERVICES

Section 3.3 defined the support service categories and associated usage units. This section describes how these units were obtained and the implied interrelationship which exists between them.

As previously explained, the parameter "acquisition" is used to estimate future program source data volumes to support service workload requirements. A forecast of computational processing and image display usage requirements was based on the number of acquisitions required to develop, verify and test each program; the number of pixels (bytes) present in each acquisition; and the amount of processing time currently required by each computer to analyze each phase of the input data.

The transfer or assignment of workload (workload balancing efforts) was considered and employed when advantageous. In these cases capabilities, capacities and execution times of the various computing systems were adjusted to correspond to the specific type of task performed.

It was determined that users of the I-100 system require on the average, 2 hours of terminal time to process a single LACIE acquisition. Somewhat different kinds of processing are done on the ERIPS terminal system where the amounts of terminal time are dependent upon exactly what processing is performed. It should be noted, that the IBM 360/75 does not perform background processing while ERIPS is activated whereas the PDP 11/45 does perform auxillary processing while the I-100 is in use.

Each acquisition or collection of acquisitions dictates one or more specific mapping science output products. These vary according to the type output product, the geographic location of the acquisitions, the phase of the program, and the availability of existing similar products.

Field measurements provides a source for ground truth data. These data are taken at a selected set of Intensive Test Sites, blind sites and experimental farms during spring and fall seasons. A mission (or acquisition data take) represents a known amount of preparation, performance, post verification, and validation which was used to forecast field measurement support service workload requirements.

Support service categories, film generation and film processing, both process basically the same data. This data volume is one-for-one related to the number of acquisitions. Each acquisition defines a definite amount of images. This translates directly to film exposures (rolls) made which must be processed outside EOD. The extension of this volume of output products dictates the amount of equipment utilization requirements.

Non-electronic data are collected in site packets where a single site may have 9 acquisitions. However, the average number of acquisitions per site during LACIE Phase III was 5.5. Although some non-electronic data is handled on an acquisition by acquisition basis, for the most part these data are considered as being handled

on a site by site basis. These data consist of imagery, maps and multitudes of other ancillary data which aids the user in the evaluation of each selected site. The number of selected sites and acquisitions is determined on a program by program basis. This study assesses the non-electronic data storage/management based on the number of sites selected for work and the basic library research functions necessary to support the project.

4. PROJECTS/PROGRAM REQUIREMENTS

Figure 4-1 lists those projects which will comprise the EOD workload over the next five years. Figure 4-2 immediately following is an event schedule depicting project development start/end dates. The figure also shows the data sources availability schedule.

This section develops workload requirements and the corresponding processing requirements for each of the identified projects individually. Experience with completed and current on-going programs establishes a basis for the analysis process. Where applicable, program support services have been identified and assigned to either exploratory studies (ES) or systems verification and test (SVT) workloads. A traditional approach to workload requirements analysis was then taken where,

- Data sources are qualified and quantified,
- output and interim products identified, and
- resource capabilities and capacities are determined.

An abbreviated form of the spacecraft data sensor characteristics is listed in figure 4-3.

Supportive rationale appears where applicable within the text or conveniently referenced in a preceding part of the document to maintain continuity and enhance comprehensiveness. Detailed supportive material is to be found in the appendix, appropriately referenced.

CURRENT AND FORECAST PROJECTS

PROJECT	DESCRIPTION
LACIE	• INTERAGENCY EXPERIMENT USING EARTH RESOURCES INFORMATION TO DEMONSTRATE AN ECONOMICALLY IMPORTANT USE OF REPETITIVE MULTISPECTRAL REMOTE SENSING FROM SPACE AND TO PROVIDE TIMELY ESTIMATES OF WHEAT PRODUCTION.
LACIE TRANSITION	• TRANSFER LACIE DEVELOPMENT TECHNOLOGY TO USDA. VERIFY AND IMPROVE OPERATIONAL SYSTEM THROUGH REGULAR PRODUCTION ESTIMATES FOR VARIOUS WORLD REGIONS.
FAP	• INTERAGENCY EXPERIMENT TO MONITOR AND INVENTORY U.S. FOREST AND RANGELAND RENEWABLE RESOURCES VIA REMOTE SENSING (INCLUDING ST. REGIS SUPPORT)
RAP	• SUPPORT OF STATE AND REGIONAL AGENCY STUDY PROGRAMS, E.G., - COASTAL ZONE MANAGEMENT AND WATERSHED EVALUATION - WILDLIFE HABITAT MAPPING CAPABILITY FOR TEXAS PARKS AND WILDLIFE COMMISSION
JSME	• DEVELOP TECHNOLOGY FOR AGRICULTURE APPLICATIONS TO THE MEASUREMENT OF SOIL MOISTURE CONTENT UNDER VARYING EARTH SURFACE CONDITIONS USING MICROWAVE REMOTE SENSING
GFFP	• INTERAGENCY PROGRAM USING EARTH RESOURCES INFORMATION TO EXTEND DEVELOPMENT OF LACIE TYPE APPLICATIONS TO ADDITIONAL GLOBAL FOOD AND FIBER CROPS. (WILL INCLUDE FAP & AGRICULTURAL MULTICROP)
WVRI	• DEVELOP AND EXPLORE WILDLAND MINERAL, VEGETATION AND RECREATION RESOURCES WEST OF MISSISSIPPI USING REMOTE SENSING. PROJECT UNDER CONTROL OF BLM.
MISC. STUDIES	• INTERMITTENT PROCESSING OF AIRCRAFT, SEASAT, MET, AND LANDSAT DATA.

FIGURE 4-1

FORECAST PROJECTS EVENT SCHEDULE

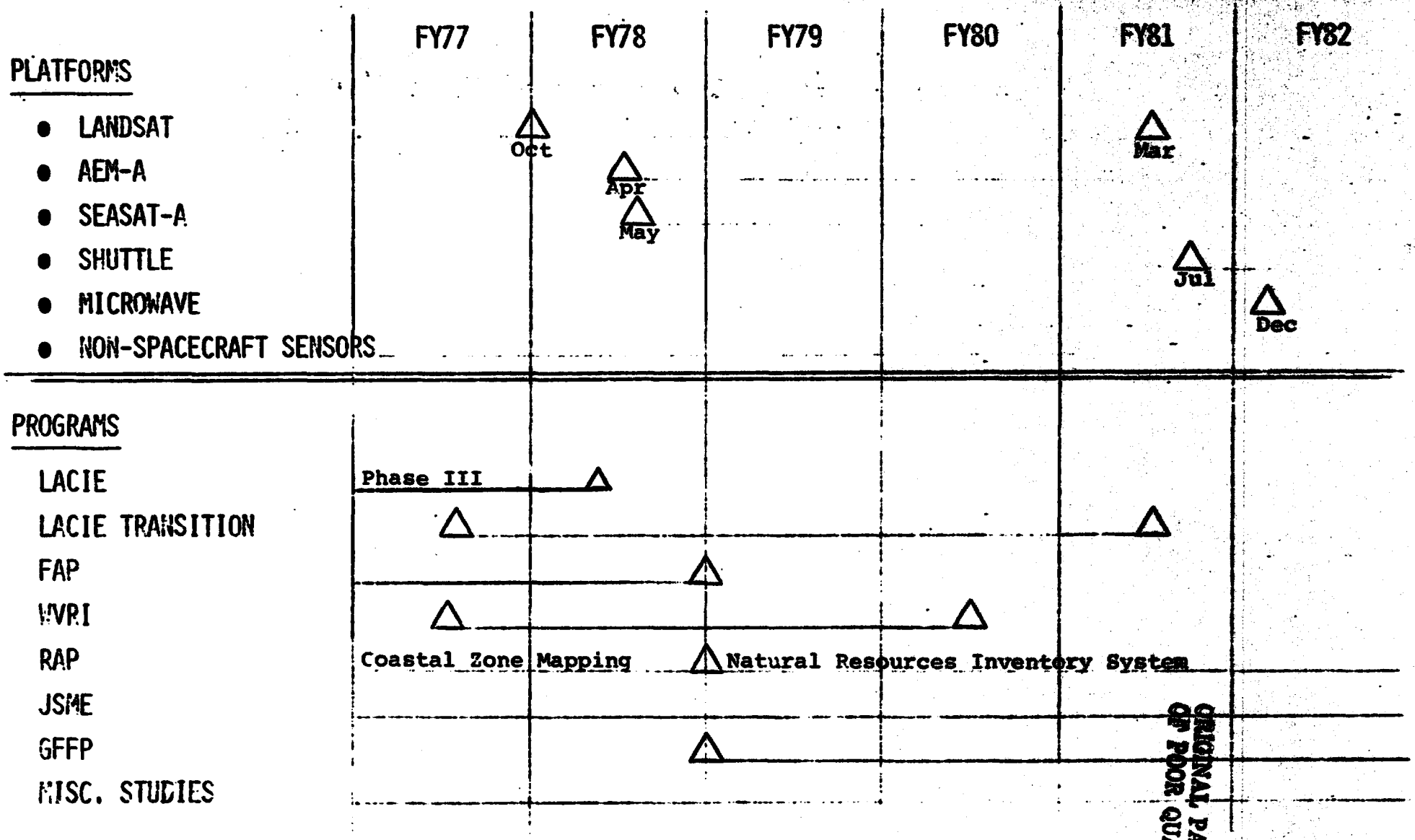

FIGURE 4-2

DATA SOURCE CHARACTERISTICS

VEHICLE	NO. OF BANDS	SWATH WIDTH	RESOLUTION
LANDSAT 2	4 REFLECTIVE	185 KM	79 M
LANDSAT-C	4 REFLECTIVE 1 THERMAL IR	185 KM	79 M
LANDSAT-D*	5 REFLECTIVE 1 THERMAL IR	185 KM	30 M
SEASAT-A	1 REFLECTIVE 1 THERMAL IR	2127 KM	2200 M 4200 M
AEM-A	1 REFLECTIVE 1 THERMAL IR	693 KM	518 M
SHUTTLE IMAGING RADAR (SIR)	1-X BAND 1-L BAND	85 KM	25 M

*2 SATELLITES WITH PARTIALLY OVERLAPPING BANDS MAY BE USED.

FIGURE 4-3

4.1 LACIE - PHASE III

4.1.1 OVERVIEW

LACIE is an interagency experiment which uses Earth Resources technology and meteorological information to: demonstrate an economically important application of repetitive multispectral remote sensing from space; and to test and validate technology which could provide timely estimates of wheat production.

To date the LACIE has developed and tested area, yield, and production estimate techniques over a limited region employing a quasi-operational system. Phase III development of the LACIE program involves the further refinement of spectral analysis techniques using all eight LACIE selected countries and the extended use of crop area, yield, and production estimates in at least six of these countries.

Currently a majority of EOD resources are being consumed in support of LACIE. There is no reason to assume that program emphasis will change until LACIE Phase III has been terminated in March 1978.

The predominance of EOD resources utilized by LACIE makes LACIE a natural first choice for workload analysis. The detail known about LACIE, as compared with the detail known about other future programs, has lead to more extensive treatment of its projected processing requirements than that of the other projects.

4.1.2 DATA

4.1.2.1 Sites, Acquisitions, ITSs and Blind Sites

From the LACIE RESULTS meeting it was determined that 3,047 perspective sites will be selected from Landsat 2 in conducting LACIE Phase III. This volume of data is represented by 16,900 equivalent LACIE acquisitions which will be received, processed, and analyzed by EOD during the 1977 crop year.

4.1.2.2 Bytes (8 Bit) Storage

A single equivalent Landsat acquisition consists of 4 bands (frequencies or channels) containing 3240 lines (rows) of 2240 pixels (columns). Equivalent LACIE acquisitions (sample segments) selected from the Landsat data are comprised of 196 lines of 117 pixels each. This means that a single LACIE sample segment is represented by 91,728 pixels of electronic radiance data.

On the basis of 16,900 acquisitions, a storage space of 1550×10^6 8-bit bytes would be required for the imagery data alone. Although additional storage space is necessary for the fields, history, ancillary, statistics, results and overhead data, they are relatively incidental (perhaps 2 or 3%) as compared to the imagery storage space requirements.

4.1.3 COMPUTATIONAL PROCESSING

4.1.3.1 Overview

This category is intended for all processing performed on digital computing systems used for applications, systems development and production, exclusive of interactive imagery processing and maintenance. Interactive imagery processing is covered in the "Interactive Imagery Display" category. All computational processing facilities used (EOD, GDSD, IDSD, COMSHARE and Purdue) are included in this category. Capacity utilization of each system is measured in units characteristic of that Processing System.

4.1.3.2 Current (Baseline) Resource Utilization

The following paragraphs are based on actual FY76 usages obtained from year end computer usage/cost summary.*

* LEC memo to T. H. Smith, Jr./TF, from W. E. Trump, dated 19 July 1976.
Subject: Summary IDSD Computer Usage/Cost for Month Ending 6/30/76

4.1.3.2.1 EOD Support Processing Facility

Use of the Building 17 Digital PDP 11/45 system for LACIE - Phase II computational processing averaged 71 clock hours/week. These were utilized as follows:

- TF3 LACIE Exploratory Studies (ES) - 2 hours
- TF4 Systems Validation Testing (SVT) - 29 hours
- CAS Crop Aggregation Subsystem - 40 hours

4.1.3.2.2 GDSD Building 30 Facility

The large mass storage of electronic data (i.e., images, fields, history, etc.) and its management is performed in Building 30. The updating, maintenance and control of this LACIE Phase II data, required (on the average) 22 IBM 360/75 CPU hours/week plus a substantial number of support personnel. Although some of this time was used for exploratory studies, the large majority was used for LACIE systems verification and test.

4.1.3.2.3 IDSD Building 12 Facility

The IDSD Univac 1100 Series computers were used during LACIE Phase II both for exploratory studies, and systems verification and test. It was used principally for operation of the LARSYS-EOD system. This system enables the users to generate classifications, histograms, graymaps, and a multitude of other statistical algorithms. Records show that weekly averages during FY76 were:

SYSTEM	EXPLORATORY STUDIES	SYSTEMS VERIFICATION & TEST
Exec 2 hours	7.0	0.9
Exec 8 SUP hours	2.4	4.6
Exec 8 demand SUP hours	1.6	0.7

Note that the serial processing operating system, Exec 2, measures utilization in hours of Central Processor Time (CPU). Exec 8, a multi-processing operating system, measures utilization in standard units of processing (SUP) , an accounting algorithm which include charges for other computational resources such as main memory, file storage volume, number of accesses to storage peripherals, etc., in addition to CPU. These units are not equatable. The capacity of an Exec 8 system can vary between .7 SUP /hour and 1.3 SUP /hour dependent upon hardware configuration and computational resources used.

Also note demand usage (access to the system via a terminal device) is measured in SUP. This is not a representative of Terminal Connect Time, the period spent working at the terminal. Connect time is in the order of 5 to as much as 30 times greater than SUP dependent upon what processing is being performed and the individual using the terminal.

4.1.3.2.4 COMSHARE

COMSHARE was used exclusively for LACIE Phase II operations status and tracking of acquisitions as they pass through different phases of analysis and interpretation. Based on the computer CPU charges submitted by COMSHARE, an average of 4.8 hours per week were used for status and tracking in FY76.

4.1.3.2.5 Purdue LARS

The LARS computer facility was used for a variety of LACIE Phase II tasks. Some of these tasks were similar to those performed on the IDSD facilities. FY76 records show an average of 4.6 CPU hours per week usage.

4.1.3.3 Forecast Resource Utilization

To initiate the development of LACIE - Phase III computational processing requirements, all LACIE - Phase II workload processing functions and resource utilizations were gathered and analyzed. In all cases estimates were derived by the Long Range Planning (LRP) team; and in some cases independent estimates were provided by the EOD user/analysts. From these, a Phase III workload and its processing requirements were constructed.

Schedules show that LACIE will be completed by the end of the second quarter FY78. The number of acquisitions taken is significantly larger for LACIE Phase III (16,900) than with Phase II (9,300). A simple ratio, of FY76 resource utilization/number of acquisitions using estimates for FY77, produced inordinate resource use levels. Investigation of most recent processing performance levels suggested the estimate FY77 usages will remain at their average FY76 levels. The rationale supporting a throughput increase with no increase in usage levels is based upon rates currently being encountered and satisfied, with little or no impact, equaling those forecast for FY77. This is due to 1) improved personnel technology and capability, 2) improved procedures, 3) reuse of products generated earlier in the program and 4) upgraded machine capability.

The performance improvements experienced are expected to continue; and upon analysis, some additional, though moderate, improvements can be anticipated in future.

4.1.3.3.1 EOD Support Processing Facility

EOD data users estimate LACIE Phase III data will require support processing an average of 21 hours per week during FY77 and 19.6 hours/week during the first half of FY78. In addition, CAS users have requested 40 hours/week for aggregation and report generation.

The LRP team estimates PDP 11/45 Support Processor usages of 75 hours/week (10 hours for exploratory studies, 20 hcurs for systems verification and test and 45 hours for CAS). This level of usage will be required by LACIE till its completion.

The LRP team estimates were determined after investigating FY76 PDP 11/45 usage during the several developmental stages of LACIE - Phase II. Usage was moderately low in the initial stages and rose to a peak during the last quarter of FY76. The peak level is more representative of the processing load anticipated with LACIE - Phase III development and was therefore used as a basis for projections.

4.1.3.3.2 GDSD Building 30 Facility

EOD analysts estimate IBM 360/75 usage will average 26.8 hours/week in FY77 and 20.0 hours/week in FY78. The LRP team estimates an increase to 30 hours/week (current usage rate) during the balance of the LACIE program. All of this time is dedicated to systems verification and test.

4.1.3.3.3 IDSD Building 12 Facility

EOD analysts estimate average weekly hours IDSD computer Exploratory Studies (ES) and Systems Verification and Test (SVT) usages as follows:

	FY77		1st half FY78	
	ES	SVT	ES	SVT
Exec 2 hours	11.6	2.0	11.6	2.0
Exec 8 SUP hours	2.4	8.1	2.4	3.6
Exec 8 demand SUP hours	0.6	1.8	0.6	1.7

The LRP team estimates average weekly usages as:

	FY77 and 1st half of FY78	
	ES	SVT
Exec 2 hours	7.0	0.9
Exec 8 SUP hours	2.4	4.6
Exec 8 demand SUP hours	1.6	0.7

As in the previous discussions (Re IBM 360/75 and PDP 11/45 usage), Building 12 Univac 1100 series last quarter FY76 usage was substantially higher than the FY76 average. Most likely this was what influenced the EOD analysts to increase their FY77, FY78 usage estimates. The LRP team reasoned that any increases in LACIE exploratory studies should be accountable to LACIE transition activities. Also, increased LACIE system verification and test workloads should be performed on the PDP 11/45 Support Processor. (The LRP team estimates accounted for this in their earlier calculations).

4.1.3.3.4 COMSHARE

Based on LACIE status and tracking costs incurred during the FY transition quarter, a forecast of 13.6 IBM 360/75 hours/week would be required for LACIE Phase III status and tracking. Starting with February 1, 1977, however, LACIE status and tracking was done on the PDP 11/45. Status and tracking usage of the 11/45 as compared to the 360/75 is estimated to run approximately 1.65 times as long. Thus, EOD Support Processing Facility for status and tracking processing is forecast at 22.4 CPU hours/week.

EOD status and tracking personnel are currently requesting 40 hours/week on the Support Processor. When the new disk is installed on the support processor the usage time should reduce to approximately 25 CPU hours/week. Heavy usages by other higher priority users can significantly increase the run times by a factor of three or four.

4.1.3.3.5 Purdue LARS

The EOD analysts estimated their average weekly LARS usage in terminal hours rather than CPU hours. These values were 41.1 hours for the balance of LACIE program. Forty-one hours of terminal time is essentially equivalent to the LRP team estimate of 4.6 CPU hours/week (1.2 for ES and 3.4 for SVT).

4.1.4 INTERACTIVE IMAGERY DISPLAY

This category is intended for all interactive processing, analysis and display of imagery data. Terminal time usages include applications and systems development as well as production. Interactive Imagery Display Processing is provided on the ERIPS/IBM 360/75 dual terminal system in Building 30 and on the Image-100/PDP 11/45 single terminal system in Building 17.

4.1.4.1 Current (Baseline) Resource Utilization

Actual FY76 usages were obtained from year-end terminal usage/cost summaries for the ERIPS and current terminal scheduled and used reports for the Image-100.

4.1.4.1.1 ERIPS Building 30 Facility

The ERIPS imagery terminal system provides interactive imagery processing and analysis capability with direct access to the entire LACIE data base. Its capabilities are costly in terms of computing system resources such as central processing unit, mass storage volume and accessability, etc. Two ERIPS terminals can be operated simultaneously but, when either terminal is in use, the 360/75 computer system cannot accommodate other workload. The average ERIPS terminal usage time during FY76 was 60 hours/week. Since two terminals are operated at the same time, actual utilization was 30 CPU hours of IBM 360/75, i.e., 12 hours for exploratory studies and 18 hours for systems verification and test.

4.1.4.1.2 EOD Image Processing Facility

The Image Processing System (I-100) has capabilities similar to but somewhat different than the ERIPS system. Together they provide a spectrum of capabilities neither one can fully satisfy, e.g., I-100 system does not have direct access to the large data base on the 360/75 system; ERIPS system is not suitable for the analysis of small areas.

The I-100 terminal in Building 17 was used 56 hours/week in the later LACIE Phase II training, analysis, and program development phases. This time is divided into 30 hours for systems verification and test training, and 26 hours for exploratory studies analysis.

4.1.4.2 Forecast Resource Utilization

Procedure 1 will be used for LACIE Phase III data analysis. No performance history exists by which the effects of Procedure 1 can be accessed. Discussions with responsible procedure 1 developers combine with actual FY76 usages established a reasonable basis from which user support service requirement workloads on interactive image display terminals were forecast.

The following paragraphs describe the interactive image display terminal time usage estimates.

4.1.4.2.1 ERIPS Building 30 Facility

During LACIE Phase III the ERIPS terminals will be used to analyze and evaluate yields in several areas throughout the world. LACIE systems analysts indicate that LACIE Phase III Procedure 1 will have minimal effect on existing LACIE Phase II techniques developed for use on ERIPS. To satisfy the major LACIE goals as identified in the LACIE Phase III operations plan, it is estimated that ERIPS terminal usage will continue during FY76.

The increased workload implied by the additional number of sites and acquisitions taken during FY77 and FY78 is offset by 1) working fewer countries, 2) improved technology and 3) improved procedures.

ERIPS dual console weekly average usage estimates are:

USERS

Exploratory Studies (ES)	12 hr
Systems Verification and Test (SVT)	22 hr
Total	34 hr

4.1.4.2.2 EOD Image Processing Facility

The I-100 terminal will be used to demonstrate and evaluate performance of the LACIE Procedure I Hybrid Image Analysis system. Since no performance history exists for this workload, the LACIE Phase III scope study report Image-100 options document was used as a reference. I-100 usage per week is estimated as follows:

USERS

Exploratory Studies (ES)	**26 hr**
Systems Verification and Test (SVT)	**80 hr**
Total	**106 hr**

4.1.5 PHOTOGRAMMETRIC/CARTOGRAPHIC

4.1.5.1 Overview

This resource category was established for those products produced by the Cartographic Technology Laboratory and EOD personnel collocated in Building 17.

The Photogrammetric/Cartographic requirements are unique among all of the support service categories. To the potential data user/ requestor it offers almost an infinite variety of output product types and sizes. This is a potential hazard, i.e., requests can quickly exceed manpower limits and yet not fully satisfy the requestors need.

To minimize this problem photogrammetric - cartographic personnel have selected a somewhat standardized group of current output products (reference A6) on which a forecast is made. As required, some non-standard products will be supplied on an individual request basis.

There are several processes used, some fully automated, some partially automated, and all requiring a significant degree of manual efforts. The forecast for this category is assessed relative to the semi-standardized types and quantities of each output product generated. Determination of equipment capabilities and capacities, and manpower staffing and skills levels will be addressed later by a resources development plan.

4.1.5.2 Current (Baseline) Resource Utilization

The following list identifies the types and quantity of output products generated in FY76 to support the LACIE Phase II program.

PRODUCTS	QUANTITY
• Sample Segment Location/Relocation (Segment)	1633
• ITS Update - Ground Truth (Sites)	36
• Photomosaics	160
• Area Measurements (Sites)	184
• Partitioning Overlays	12

4.1.5.3 Forecast Resource Utilization

LACIE Phase III output product estimates were made after analysis of project requirements and consultations with cognizant photogrammetric/cartographic personnel. Product quantities were not simply adjusted according to increases or decreases in the number of sites or acquisitions. Each product was examined from its individual utility and need in the development of the project. The use of partitioning 'overlays' developed in FY76 will be greatly expanded in FY77; in addition two new product types were added in FY77, viz., 'Boundary Detection Overlays' and 'Digital Imagery Registration'. Product quantities for FY78 are expected to run at about three fourths the FY77 level. A large number of these products will be produced in FY78 to support documentation for the wrap-up of LACIE activities. Estimate product types and volumes are:

PRODUCTS	FY77	FY78
• Sample Segment Location/Relocation (Segment)	1785	1339
• ITS update - Ground Truth (Sites)	8	6
• Photomosaics	179	134
• Area Measurements (Sites)	117	88
• Boundary Detection (Overlays)	595	446
• Partitioning Overlays	1785	1339
• Digital Imagery Registration (Landsat Images)	89	67

4.1.6 FIELD MEASUREMENTS

4.1.6.1 Overview

Up to four truck teams and one helicopter team have been assigned to perform field measurements tasks. The field measurements teams make various trips to the field to acquire ground truth and helicopter data in support of each project. A single team leaving its base location, traveling to a selected site(s), acquiring site data and returning to its base location, constitutes a mission. One mission may include the visitation and data acquisition of several sites.

Prior to each mission a team will maintain, test, calibrate and prepare the instrumentation for travel. During a mission the team will sample, read and record all approved data items applicable to each corresponding site. Post mission team activities involve the verification of proper sensor instrumentation performance, quality evaluation and calibration of the data collected. Estimates of the workload for this support service category is a function of the number of missions, type of the measurements to be taken, and complexity of each measurement.

Ground truth test sites are selected for these projects independently. Where possible, common test sites are used by more than one project. The projects identify the type, quantity and the seasonal or growing period needed from each site.

It is assumed that Field Measurement support services will be provided for all Research, Test and Evaluation (RT&E) projects in development.

4.1.6.2 Current (Baseline) Resource Utilization

During FY76 the Field Measurements teams conducted 13 truck missions and 24 helicopter meteorological/ground truth missions in support of LACIE Phase II. Measurements taken during these missions include: 1) Meteorological Data Collection, 2) Optical Depth Data Collection, 3) Field Spectrometer Data Collection, 4) Agronometric Data Collection, and 5) Soil Data Sample Collection.

4.1.6.3 Forecast Resource Utilization

After analysis of project requirements and consultations with cognizant personnel in the field measurements discipline, it was determined that LACIE would need the same number of missions (37) in FY77 as were conducted in FY76. Only half that many missions would be needed in FY78. In addition to the measurements currently taken, three new types will be acquired in FY77 and FY78, viz., air quality data, water quality data, and thematic mapper data collections.

Some amount of instrument augmentation will be required to collect these new data. Requirements in terms of specific equipment and/or manpower must default to the development of the Field Measurement Implementation Plan.

4.1.7 FILM GENERATION

4.1.7.1 Overview

GDSD provides a facility in Building 30 where electronic data recorded

on computer compatible tapes are converted to exposed film imagery. The facility is called the production film converter (PFC). Two types of film products are provided by this support service: 1) Landsat Photo Imagery and 2) Computer on Microfische (COM). The COM films contain tabulations and plots of the resultant processing analysis. Processing of the Landsat Photo Imagery, the development of film exposures, is performed by the Photo Technology Division (PTD) and is covered under the film processing support service category. (Reference Section 3.1.8) Processing of COM products is performed by GDSD and the corresponding workload assigned accordingly.

Five different Landsat imagery film products are currently being produced for LACIE.

Product 1 - Color infrared

2 - Enhanced color

4 - Black-and-white one image for each of the bands (channels)

8 - Black-and-white classification map

12 - Black-and-white field boundary overlay

4.1.7.2 Current (Baseline) Resource Utilization

The time required by the PFC to produce each LACIE film imagery product is as follows:

PRODUCT	MINUTES/ACQUISITION	TYPE OF FILM	QUANTITY/ACQUISITION
1	1.0	color	1
2	1.0	color	1
4	0.33	B&W	4
8	0.33	B&W	1
12	0.33	B&W	1

These times reflect: 1) recently updated processing times, 2) PFC setup and change over times and, 3) film load and unload times.

GDSD both generates and processes all COM film products. After review of the quantities and processing methods used to provide COM products, the LRP team estimated that a 25% workload increase must be added to compensate for COM product support service requirements.

4.1.7.3 Forecast Resource Utilization

The average amount of time required to generate exposed film for each acquisition of Landsat imagery is 4.0 minutes.

The 16,900 acquisitions to be taken during LACIE Phase III represent a workload in FY77 that will exceed the processing capacity of the PFC. Fortunately many of the film products are not critical to Phase III development activities so that periodic backlogs are tolerable. Film products would therefore be generated over an 18 month time frame extending into mid FY78. The workload volume estimate for FY78 is considerably less and would not be impacted.

The estimate average hours of PFC processing time required to generate the film, including a 25% overhead for COM products, is 18.1 hours per week through mid FY78.

4.1.8 FILM PROCESSING

4.1.8.1 Overview

Film processing is performed by the Photo Technology Division (commonly referred to as the Photo Technology Lab) in Building 8. Processing is done on a roll by roll basis.

The operations include the chemical treatment of each roll of exposed film to produce a transparency black and white and/or color roll of developed imagery. Image rolls are then sleeved, enclosed in plastic, as protection against scratching and smudging during handling. The rolls are then cut into segments of acquisition size to be used by the analysts. A film color or tone (in the case of black and white) reference chart accompanies each roll shipped to Building 17. In Building 17 groups of these products and other auxillary products are assembled into packet folders and issued to the analysts.

4.1.8.2 Forecast Resource Utilization

A single roll of film can contain up to 220 images. LACIE - Phase III acquisitions contain digital imagery data from which two color and six black and white image products are required to be generated. Sixteen thousand nine hundred acquisitions processed over an 18 month period is approximately 220 weekly. This would result in two rolls of color and six rolls of black and white film handled weekly.

In actual operations, however, film must be exposed to new imagery on a daily rather than weekly basis in order to stay in step with real time data acquisition rates. Partially exposed rolls of black and white and/or color film are sent to PTD daily. Partial exposed rolls require the same development time as fully exposed rolls. Therefore, on the average, one roll of black and white and 3 rolls of color film are processed daily by PTD.

4.1.9 NON-ELECTRONIC DATA STORAGE/MANAGEMENT

4.1.9.1 Overview

This category encompasses those activities associated with the collection, distribution, storage and accountability of all physical data such as magnetic tapes, photo imagery products, various maps, crop calendars, computer printouts, etc. A large part of the non-electronic data storage/management activities (operations) were determined from the number of sites and quantity of ancillary and documentation data required by the user/analyst. Research, reference documentation and ancillary data handling not associated with site volume correlation were added as a percentage of the operations support.

Due to the accumulative nature of earth resource projects the volume of non-electronic data continues to increase as the project matures. Even after the projects are completed large reference files must be stored, indexed and maintained for a considerable period of time.

4.1.9.2 Forecast Resource Utilization

The LACIE review meeting document states that for LACIE Phase III 3047 sites will be selected for acquisition. Each site will require separate non-electronic data accountability. Non-electronic data packet volume is estimated at 3047 packets. Non-operations support is forecast at 30% of the operations support or 910 packet equivalents.

The long range planning activities to follow in other documentation will determine the physical space, storage media, management techniques, personnel, etc., requirements needed to accommodate this volume of LACIE Phase III packets plus other packets to be created for other projects.

4.2 LACIE TRANSITION

4.2.1 OVERVIEW

LACIE Transition (herein referred to as LACIE X) is the project developed for transfer of operational technology from EOD to the U.S. Department of Agriculture. The transfer is divided into four phases during which time, production, area and yield estimation operations technology will be validated and implemented by the user advanced system, PAYES, operation.

4.2.2 DATA

4.2.2.1 Sites, Acquisitions, ITSs, and Blind Sites

Early estimates of LACIE X indicate that more than 2500 sites will be worked during the first two years and about 1000 sites will be analyzed during the second two years of LACIE transition. If we assume that the ratio of acquisitions per site for LACIE X remains approximately the same as in LACIE Phase II, and the number of intensive test sites and blind sites remain at the ratio of LACIE Phase III level, the following estimates can be made:

	FY78	FY79	FY80	FY81
Sites	2,504	2,703	1,202	1,000
Acquisitions	15,024	16,218	7,212	6,000
ITS	27	29	13	11
Blind Sites	223	240	108	90

4.2.2.2 Bytes (8 Bit) Storage

Acquisitions made during LACIE X will be five band Landsat C data type. From the acquisitions projected in the preceding paragraph the byte storage space requirements, given in megabytes are:

FY78	FY79	FY80	FY81
1,770	2,030	850	710

4.2.3 COMPUTATIONAL PROCESSING

4.2.3.1 Overview

This category includes computational processing required by LACIE X for technology development, operations, user advanced system development, and research, test and development.

Computational processing support services may not continue to be supplied by the same facilities which are currently providing these resources. For ease of understanding, the LRP team forecast future requirements, for this category, in terms of todays facilities. On this basis, LACIE X support services requirements are defined in terms of EOD, GDSD, IDSD, and Purdue as indicated below.

4.2.3.2 Forecast Resource Utilization

Because of the similarity which exists between LACIE and LACIE X, workloads for LACIE X are extrapolated/interpolated from past, present and forecast LACIE workloads.

Since status and tracking (S&T) is no longer being done on COMSHARE but rather on the PDP 11/45 Support Processor, it is included in the following estimates. These estimates are given in average hours per week.

Computational System	FY78	FY79	FY80	FY81
• EOD Support Processing Facility	86.9 hr	93.5 hr	41.6 hr	35.1 hr
• GDSD Building 30 Facility	26.7 hr	28.8 hr	12.9 hr	10.8 hr
• IDSD Building 12 Facility				
Exec 2	7.0 hr	7.6 hr	3.4 hr	2.8 hr
Exec 8	6.2 hr	6.7 hr	3.0 hr	2.5 hr
Exec 8 demand	2.1 hr	2.2 hr	1.0 hr	0.9 hr
• Purdue LARS	4.1 hr	4.4 hr	2.0 hr	1.6 hr

4.2.4 INTERACTIVE IMAGE DISPLAY

The usage times identified in the following paragraph are based on estimated analysis times projected for Procedure I Hybrid system during FY78 and FY79 and a forecast for a stand alone system during FY80 and FY81. The ERIPS is given in dual terminal usage time and the I-100 in single terminal usage time.

4.2.4.1 Baseline Resource Utilization

The Procedure I method of image display has no history of performance to use as a basis of forecast, therefore, technical analyst estimates are used. Although an attempt has been made to accurately access the mechanical steps involved in the Hybrid System Procedure 1 in terms of user terminal time required, further adjustments will be necessary when actual operation times become available.

4.2.4.2 Forecast Resource Utilization

The following LACIE X Interactive Display support requirement estimates were made on the same basis as were the LACIE Phase III estimates. Results are given in average hours per week (adjusted for dual console in the case of ERIPS).

IMAGE SYSTEM	FY78	FY79	FY80	FY81
ERIPS Building 30 Facility	30 hr	33 hr	15 hr	12 hr
EOD Image Processing Facility	94 hr	102 hr	46 hr	38 hr

4.2.5 PHOTOGRAMMETRIC/CARTOGRAPHIC

4.2.5.1 Forecast Resource Utilization

The types of mapping sciences products needed for LACIE X are the same as those needed for LACIE and are assumed to be proportionate in quantity.

PRODUCT	FY78	FY79	FY80	FY81
• Sample Segment Location/ Relocation (Segment)	1677	833	376	1000
• ITS update - Ground Truth (Sites)	18	9	4	11
• Photomosaics	168	83	38	100
• Area Measurements (Sites)	150	74	34	90
• Boundary Detection (Overlays)	559	278	125	333
• Partitioning Overlays	1677	833	376	1000
• Digital Imagery Registration (Landsat Images)	84	42	19	50

4.2.6 FIELD MEASUREMENTS

Field measurements will provide LACIE X support services similar to those requested for LACIE Phase III.

4.2.6.1 Forecast Resource Utilization

As in LACIE Phase III, air quality data, water quality data and thematic mapper data will be added to the currently required types of data. During FY78 and FY79 field measurement support requirements will continue at approximately the LACIE Phase III level, i.e., 35 to 37 missions per year. In FY80 and FY81 field measurements support is expected to decrease to about half that value. To a alrge degree these estimates were based on the relative number of acquisitions per year compared to LACIE Phase III.

4.2.7 FILM GENERATION

4.2.7.1 Baseline Resource Utilization

At this time there is no reason to assume that the number of types of film products will be any diff. nt than a proportionate amount of what is currently being forecast for LACIE Phase III. The additional band (channel) added to the four bands presently acquired by Landsat 2 will produce another product 4 (black-and-white) image. Each additional product 4 increases film generation time by 0.33 minutes per acquisition.

4.2.7.2 Forecast Resource Utilization

The following listing shows the forecast of film generation requirements for LACIE X during its four transition phases. A twenty five percent addition has been made to compensate for COM product generation. Generation time is given in hours per week.

FY78	FY79	FY80	FY81
26.1 hr	27.8 hr	12.5 hr	10.4 hr

4.2.8 FILM PROCESSING

4.2.8.1 Forecast Resource Utilization

Film processing requirements for color, and black and white film transparencies are estimated using the same acquisition numbers identified by paragraph 4.2.2.1 The weekly average number of rolls of film required for processing are:

	FY78	FY79	FY80	FY81
B&W (Rolls)	9.2	9.9	4.4	3.7
Color (Rolls)	2.6	2.8	1.3	1.0

It was assumed that daily rolls of film only partially filled with LACIE X imagery exposures will be used to generate imagery products required by concurrently operating EOD projects. Therefore, no adjustment must be made to the weekly average roll values.

4.2.9 NON-ELECTRONIC DATA STORAGE/MANAGEMENT

LACIE X non-electronic data storage workload estimates are based on the volume of sites selected for evaluation, and the quantity of ancillary and documentation data required by the LACIE analysts.

4.2.9.1 Forecast Resource Utilization

As in LACIE, so in LACIE X, non-site oriented efforts in this area are estimated at 30% of the site support requirements. Adjusted non-electronic data storage/management workload in terms of packet equivalents is given below.

FY78	FY79	FY80	FY81
3255	3514	1563	1300

4.3 FORESTRY APPLICATIONS PROGRAM (FAP)

4.3.1 OVERVIEW

The objective of the Forestry Applications Program (FAP) is to identify, develop, test, and evaluate remote sensing methods and techniques that may have significance for Forest Service goals.

The FAP began in August 1971 as a joint venture of NASA/JSC and the Southern Region of the Forest Service. Since then, the FAP has taken on a more national-scale interest, with expanded Forest Service cooperation and participation at the Headquarters level and Regional Offices. The FAP project consists of five major tasks. These tasks include:

- Classification and Area Determination
- Productivity and Yield
- Econometric
- Technology Assessment
- ASVT (Forest and Rangelands Resource Assessment System)

Best estimates currently show the Classification and Area Determination, now in progress, will be completed at the end of FY80. The Productivity and Yield Subsystem will be initiated early in FY78 with the vegetation/habitat vigor model and terminate at the end of FY82. The Technology Assessment, using Landsat telemetry for baseline, will commence in the first quarter FY79 and end, following the initial analysis of data from the Shuttle Imaging Radar, last quarter FY83. The Forest and Rangelands Resource Assessment System (FRRAS) will initiate its pilot project starting FY79, shift to full ASVT in FY80, and be completed with technology transfer in FY83. All FAP activities after the beginning of FY79 will be done within the confines of the Global Food and Fiber Program (GFFP). However, for the purposes of forecasting, the whole collection of EOD forestry applications projects will be covered in this section.

4.3.2 DATA

4.3.2.1 Sites, Acquisitions, ITSs, and Blind Sites

FAP exploratory studies currently analyze ten selected timber and grassland areas. Landsat 1, aircraft overflight, and ground truth data are acquired for each area for one spring and one fall acquisition. A typical area consists of a 30 by 30 mile area of approximately 30 equivalent LACIE acquisitions. In total the current FAP data volume is 600 equivalent LACIE acquisitions, 4 intensive test sites and 9 equivalent blind sites. This level is expected to be maintained until FY80. With the FRRAS ASVT initiation in FY80, approximately 125 areas will be analyzed increasing the data volume to 7500 equivalent LACIE acquisitions 50 ITSs and 113 blind sites per year.

In mid FY81 Landsat D data will be available and will supplant Landsat C data. With the increased resolution of Landsat D data, a pixel will be now representative of about .14 acres rather than the 1:1 as in the case of Landsat C. Taking into account the video display capabilities, the number of equivalent LACIE acquisitions will increase by 6.9 times that of Landsat C. This increase will be offset by either reduced user resolution or reducing the number of areas analyzed. The number of equivalent LACIE acquisitions will remain at 7500.

4.3.2.2 Bytes (8 Bit) Storage

Prior to FRRAS ASVT approximately 30 megabytes of storage per year will be required. During FY80 and 81, ASVT activity levels will increase byte storage requirements to 4300 megabytes per year. Further increases in storage requirements may occur as a result of the Landsat D's increased resolution. Storage requirements during this time (FY82-FY83) could jump to 28,880 megabytes per year.

Total mass storage requirements, selection of the storage media, determination of on/off-line needs, management, and other data handling considerations for this document pose a challenging problem to the follow-on planning activities.

4.3.3 COMPUTATIONAL PROCESSING

The computational processing required for FAP are provided by EOD, GDSD, and IDSD support services. No Computational Processing estimates were available from the EOD analysts. The LRP team made its estimates based on past and present support level requirements and the number of equivalent LACIE acquisitions being analyzed. It was assumed that current workload requirement levels would continue through the end of FY79. As the FRRAS ASVT becomes operational in FY80 and until it is completed, the support level would increase by twelve fold due to the increased number of areas to be analyzed. LACIE workload levels were used as a reference for workload forecasting. The following chart lists the average weekly processing usage estimates.

Computational System	FY77-FY78	FY80-FY83
EOD Support Processing Facility*	3.5 hr	43.2 hr
GDSD Building 30 Facility	1.1 hr	13.3 hr
IDSD Building 12 Facility		
Exec 2	0.28 hr	3.5 hr
Exec 8	0.24 hr	3.1 hr
Exec 8 demand	0.10 hr	1.0 hr

4.3.4 INTERACTIVE IMAGE DISPLAY

It is assumed that workloads will continue through FY79 at the current level. During FY80 through FY82 the workload is assumed to increase proportionally (according to equivalent LACIE acquisitions) to the LACIE Phase III workload requirements based on a stand alone type image processor.

The usage times identified below include applications and systems development and production. ERIPS estimates are given in dual terminal usage time per week and the I-100 in single terminal usage time per week.

* The EOD systems and facilities workload estimate includes operational status and tracking requirements.

IMAGE SYSTEM	FY77-FY79	FY80-FY82
ERIPS Building 30 Facility	1.5 hr	15.0 hr
EOD Image Processing Facility	10.0 hr	47.0 hr

Increasing demand for imagery resources are imposing more stringent allocations based on priorities. Currently, the FAP personnel are being requested to more utilize imagery resources available on the PMIS/DAS system. It is not known at this time how useful the PMIS/DAS will be and what impact this will have on the equipment workload estimates given.

4.3.5 PHOTOGRAMMETRIC/CARTOGRAPHIC

The following paragraphs identify the number and types of mapping science products necessary to support FAP and FRRAS. Estimates are based on the number of sites, acquisitions, and pixels required for each product generated. Volumes forecast were not based on FY76 quantities as much as on product need discussions with FAP and Photogrammetric/Cartographic personnel.

PRODUCTS	FY77	FY78-FY79	FY80	FY81-FY83
Sites Location/Relocation	300	75	3575	938
ITS Update - Ground Truth (sites)	4	1	47	13
Photomosaics	30	8	357	94
Area Measurements (sites)	9	2	106	28
Boundary Detection (overlays)	100	25	1192	313
Orthophotos	25	6	286	75
Change Detection (overlays)	30	8	358	94
Digital Imagery Registration (Landsat images)	15	4	179	47
Atlas Map Production	10	10	125	125

The last item shown above (Atlas Map Production) may not be required. If required, it will involve the generation of maps covering 125,000,000

acres of forest and grasslands. Based on techniques currently used this represents an inordinate amount of manpower. The description of what this entails, where it would be done, how it would be accomplished, and similar questions are left to be answered by later investigations.

4.3.6 FIELD MEASUREMENTS

Field Measurement support service requirements for FAP are forecast on the basis of the estimated number of intensive test sites (or equivalent type of site), the location of these sites, and requirements similar to those identified for LACIE ground truth data. It is estimated that the intensive test sites (ITS) will be clustered such that four helicopter team missions per year will be required in the FY77-FY79 time frame. Expansion of ITS for FY80 through FY83 will increase helicopter team missions to twice the FY77 level, viz. eight missions per year.

4.3.7 FILM GENERATION AND FILM PROCESSING

The estimates for these support services were calculated using the same relationships that were established in LACIE. Film generation estimates are as follows:

	FY77	FY78-FY79	FY80-FY83
Film Generation	1.0 hr/week	1.25 hr/week	15.6 hr/week
Film Processing:			
Black and White	0.3 rolls/wk	0.4 rolls/wk	3.8 rolls/wk
Color	0.1 rolls/wk	0.1 rolls/wk	1.3 rolls/wk

4.3.8 NON-ELECTRONIC DATA STORAGE/MANAGEMENT

In order to access a reasonable and consistent workload forecast for this category it was assumed that a level of support services required by FAP would be proportional to LACIE according to actual areas analyzed. To this amount, 30% was added to account for non-site related support requirements. The total non-electronic data storage/management

support requirements given in packet equivalents are shown below.

FY77-FY79	FY80-FY83
26	325

4.4 REGIONAL APPLICATIONS PROJECT (RAP)

4.4.1 OVERVIEW

The objective of the Regional Applications Project (RAP) is to test and document state-of-the-art procedures for the transfer of cost-effective, operational applications in remote sensing technology satisfying selected information needs of Texas, other states, and regional users. In response to needs for coastal zone management in Texas, and in conjunction with agencies in the State of Texas, the RAP has developed a variety of regional resource studies and applications. Some applications are:

- Coastal Zone Mapping
- Watershed Evaluation
- Land Classification
- Wildlife Habitat Mapping

In 1969, the Texas Bureau of Economic Geology (BEG) developed the Environmental Atlas. Since then, interest in the project has increased significantly. Recent events indicate that beginning as early as mid FY77 the State of Texas and the Earth Resources Program Office may jointly fund the RAP as an ASVT.

4.4.2 DATA

RAP data volumes are expected to remain at the current level till FY79. Program objectives imply that the data volume used for analysis beginning in FY79 will increase by two and one half times. This new level of data volume will continue through FY82. This volume increase will affect a corresponding increase in data products. The types of RAP products required to support an ASVT will differ somewhat from current RT&E products. Presently no facility exists or is planned to be developed outside EOD for providing the RAP products.

The current data source for RAP is Landsat 2. Landsat C and D data will be used as they become available.

4.4.2.1 Sites, Acquisitions, ITSs and Blind Sites

Consultations with RAP personnel disclosed that effectively 1500 equivalent LACIE acquisitions from Landsats 1 and 2, 5 equivalent intensive test sites and 23 equivalent blind sites were analyzed in FY76. This same level of data acquisition will continue through FY78. At that time the equivalent LACIE acquisition, equivalent ITS and equivalent blind site rates are expected to increase by a factor of 2.5 times. This rate will continue through the balance of the RAP ASVT.

4.4.2.2 Bytes (8 Bit) Storage

1500 equivalent LACIE acquisitions for Landsat 2 will require 140 megabytes of storage during FY77. With Landsat C becoming operational, FY78 storage requirements will increase slightly to 175 megabytes. Increased RAP activity beginning FY79 will force imagery storage requirements to jump to 440 megabytes per year through FY80. FY81 and FY82 will see further increases to 3500 megabytes per year due to the increased resolution and reflective band.

4.4.3 COMPUTATIONAL PROCESSING

Currently the RAP computational processing support is provided by EOD, IDSD, and Purdue type services. The LRP team estimates are based on previously stated program milestones and sensor operation schedules. In contrast with current LACIE operations, it was assumed that none of the RAP ASVT computations would be done by GDSD.

The listings below show a growth of 25% computational processing requirements between FY77 and FY78. This is the result of Landsat C becoming operational with its one thermal band of additional data. The computational processing requirement increase of two and one half times between FY78 and FY79 is caused by an estimated increase in the

number of sites needed to complete the second part of RAP ASVT. Introduction of Landsat D data with its much increased resolution and additional reflective band data will further increase computational processing requirements by almost 7 times between FY80 and FY81.

COMPUTATIONAL SYSTEM	FY77	FY78	FY79-FY80	FY81-FY82
EOD Support Processing Facility (hr/week)	1.0	1.25	3.1	20.8
IDSD Building 12 Facility				
Exec 2 (hr/week)	0.4	0.5	1.2	8.4
Exec 8 (hr/week)	1.0	1.25	3.1	20.8
Exec 8 demand (hr/wk)	0.9	1.1	2.8	18.8
Purdue LARS (hr/week)	1.0	1.25	3.1	20.8

4.4.4 INTERACTIVE IMAGERY DISPLAY

The RAP is a candidate project which might use the PMIS/DAS system to satisfy its interactive image display requirements. Because of the many unknown factors involved in substituting the PMIS/DAS for the I-100, it was decided to make the RAP interactive image display workload forecast in terms of the known ERIPS and I-100 type terminals only.

The RAP usage requirement times listed below includes applications and system development, and production. The LRP team assured the same loading effect as described in paragraph 4.4.3 except that Landsat D data would not cause an increase in image system usage. ERIPS is given in dual terminal usage time in hours per week and the I-100 in single terminal usage time in hours per week.

IMAGE SYSTEM	FY77	FY78	FY79-FY82
ERIPS Building 30 Facility (hr/week)	1	1.25	3.1
EOD Image Processing Facility (hr/week)	4	5	12.5

4.4.5 PHOTOGRAMMETRIC/CARTOGRAPHIC

The following lists the types and number of mapping science products required to support RAP through FY82. It is assumed that the use of Landsat C and Landsat D data will have minimal effect on the number of mapping science products required by RAP. The increased number of sites needed for the second part of RAP ASVT, however, will cause an increase of two and one half times the number of products between FY78 and FY79.

PRODUCTS	FY77	FY78	FY79	FY80-FY82
Site Location/Relocation	140	35	245	88
ITS Update - Ground Truth (Sites)	5	1	19	3
Photomosaics	14	4	25	9
Area Measurements (Sites)	23	6	41	15
Boundary Detection (Overlays)	47	12	82	30
Orthophotos	11	3	20	7
Change Detection (Overlays)	14	4	25	9
Digital Imagery Registration (Landsat images)	7	2	13	5

4.4.6 FIELD MEASUREMENTS

Consultation with RAP personnel indicate that a selection of 5 major site locations for study are a reasonable estimate for FY77 and FY78. During the FY79 through FY82 time frame due to increased efforts, an estimate of 10 sites were forecast.

The nature of the RAP programs and their objectives are such that on the average, one mission will be required for each intensive test site once a year. Data collected from these sites are a prime source of reliable reference information needed to satisfy RAP program objectives. Ground truth data obtained for RAP may differ significantly from that collected for LACIE type programs. This would imply that, although a mission would still collect data for more than one program, new disciplines and perhaps different equipment may be a requirement.

It is expected that one of the state universities will provide a major portion of the on-site field measurements data acquisition support effort. This will provide blind site evaluation data with independent objectivity as well as economical labor costs. Pre and post field measurement mission instrument test and calibration, and data quality evaluation and validation will be performed by JSC personnel.

4.4.7 FILM GENERATION AND FILM PROCESSING

The amounts of film generation support services (in hours per week) and film processing support services (in rolls per week) needed by RAP was estimated on a basis similar to LACIE. Increased sensor resolution resulting from Landsat D will correspondingly increase support services required during the FY81-82 time frame. The following estimates were forecast:

	FY77-FY78	FY79-FY80	FY81-FY82
Film Generation	0.2 hr/week	0.8 hr/week	6.4 hr/week
Film Processing			
Black and White	0.1 rolls/wk	0.2 rolls/wk	1.5 rolls/wk
Color	-	0.1 rolls/wk	0.4 rolls/wk

4.4.8 NON-ELECTRONIC DATA STORAGE/MANAGEMENT

It is assumed that the non-electronic data storage/management support services required by RAP during the ASVT phase will be proportionate to the LACIE requirements relative to the number of scene acquisitions. The following includes both site and non-site support requirements in terms of packet equivalents.

FY77-FY78	FY79-FY82
182	455

4.5 GLOBAL FOOD AND FIBER PROGRAM (GFFP)

4.5.1 OVERVIEW

The purpose of the Global Food and Fiber Program (GFFP) is to monitor from space the earth's changing potential to produce food, fiber, and water; and to aid mankind in more fully utilizing this production capability in meeting world wide demand for these resources. In fulfilling this objective, the GFFP will respond to the needs of the USDA, DCI, DOS, USACOE, appropriate state agencies, international organizations and private companies by defining, developing, and implementing observations program systems required to maintain world wide inventories. Special emphasis will be placed on world crops, national forest and grasslands. After successful transfer of the LACIE wheat assessment technology into the USDA, LACIE techniques will be extended to other major food and fiber crops as well as water resources. This collective program will constitute the GFFP.

Current plans show the GFFP being initiated in the first quarter FY79. At that time the Forestry Applications Program (FAP), the Food Multicrop Project (FMP), the Wild Land Vegetation and Recreation Resources Inventory (WVRI), Radar Agriculture Project (Radar Ag), and Water Shed Flood Control (WSFC) will comprise the Global Food and Fiber Program (GFFP). The GFFP is scheduled to run through the end of FY82. Since the FAP/FRRAS portion of GFFP was covered under the FAP section of this document, and the WVRI, Radar Ag and WSFC is covered under the Miscellaneous EOD Support Programs of this document, only the FMP will be discussed herein.

4.5.2 DATA

4.5.2.1 Sites, Acquisitions, ITSs, and Blind Sites

4.5.2.1.1 Baseline Resources Utilization

The FMP forecast was based on the LACIE program development experience. Multicrop techniques and technology will be developed using Landsat C and D type data.

4.5.2.1.2 Forecast Resource Utilization

The LRP Team assumed that 4 crops would be analyzed during the agricultural multicrop portion of GFFP. On the surface it would appear that analysis data for all four crops could be obtained during the same acquisition. To some degree this common data acquisition is possible, however, two circumstances prevent this from happening in all cases. First, crops have biophases which occur at different times during the year. Second, different crops are grown in different geographical regions. Because of these factors, the LRP team assumed that four crops would require the same number of acquisitions, ITSs, and blind sites during the initial phase of FMP (FY79&FY80) as were required for LACIE Phase III. It also assumed that the number of equivalent LACIE acquisitions would increase to two and one half times this many during the advanced phases of FMP (FY81 and FY82). These values are listed below:

	FY79-FY80	FY81-FY82
Sites	3,047	7,618
Acquisitions	16,900	42,250
ITS	30	75
Blindsites	250	625

These values tend to agree with earlier ERDSS estimates of 1,350 acquisitions per month during early years of the program but are significantly less than that predicted by ERDSS (7,000 acquisitions per month) in the fully operational years of FMP.

4.5.2.2 Bytes (8 Bit) Storage

Acquisitions taken in FY79 and FY80 will be 5 band Landsat C data with 80 meter resolution. Acquisitions made in FY81 and FY82 will be six band Landsat D data which has 30 meter resolution. Based on the number of acquisitions projected above, the byte storage

space requirements, given in megabytes are:

FY79-FY80	FY81-FY82
1,940	40,300

4.5.3 COMPUTATIONAL PROCESSING

For the advanced phases of FMP, computational processing support services may not be supplied by the same facilities currently providing these resources. For ease of understanding, however, the LRP team forecast future requirements for this category in terms of todays facilities. On this basis, FMP support service requirements will be defined in terms of EOD, GDSD, IDSD, and Purdue.

4.5.3.1 Baseline Resource Utilization

Because of the similarity of experience factor which exists between LACIE Phase II ASVT activities and the early agricultural multicrop activities (FY79-FY80), their support service requirements are assumed to be equal, regardless of number of acquisitions. The program experience factors which exist for LACIE Phase III more nearly represent those expected during the latter part (FY81-FY82) of the FMP. During this time frame the support service requirements are assumed to be proportional to LACIE Phase III according to equivalent LACIE acquisitions.

4.5.3.2 Forecast Resources Utilization

The following agricultural multicrop computational processing support requirement estimates are given in average hours per week.

COMPUTATIONAL SYSTEM	FY79-FY80	FY81-FY82
EOD Support Processing Facility (hr/wk)	71	188
GDSD Building 30 Facility (hr/wk)	22	75
IDSD Building 12 Facility		
Exec 2 (hr/wk)	7.9	19.8
Exec 8 (hr/wk)	7.0	17.5
Exec 8 (hr/wk)	2.3	5.8
Purdue/LARS (hr/wk)	4.6	11.5

4.5.4 INTERACTIVE IMAGERY DISPLAY

The usage times identified in the following paragraphs include applications and systems development, and production. The ERIPS is given in dual terminal usage time and the I-100 in single terminal usage time.

4.5.4.1 Baseline Resource Utilization

The man-machine interactive element of image display does not allow these support services to be estimated linearly based on past usage as does computer processing. Instead this category of support services will be estimated on projected user involvement for each acquisition.

4.5.4.2 Forecast Resource Utilization

4.5.4.2.1 Early Agricultural Multicrop Activities (FY79-FY80)

Based on current trends evidenced by LACIE Phase III, about half of the image display workload for early agricultural multicrop activities will be done on ERIPS and the other half of the I-100. Of the 16,900 acquisitions estimated for early multicrop activities, 20% will be training and 80% ordinary. Five percent of the training and twenty-five percent of the ordinary acquisitions will require interactive imagery review.

Using projected LACIE Phase III usage times, terminal sessions are estimated to take about one hour per acquisition. It is assumed that the additional band of Landsat C data (five band) will have no impact on image analysis terminal time.

4.5.4.2.2 Later Agricultural Multicrop Activities (FY81-FY82)

These workloads will be split half on the ERIPS and half on the I-100. The percentage of training and ordinary acquisitions will remain at 20/80. Two additional assumptions were made in order to complete this estimate: 1) Procedure and skill increase would reduce the

number of acquisitions needed for interactive work to ten percent of the ordinary acquisitions from the earlier 25 percent, and 2) Increased resolution and number of bands from Landsat D will be offset by newly developed analysis techniques and/or reduced amount of data analyzed.

4.5.4.2.3 Resulting Forecast

The following Interactive Imagery Display support requirement estimates are given in average hours per week (adjusted for dual console in the case of ERIPS).

IMAGE SYSTEM	FY79-FY80	FY81-FY82
ERIPS Building 30 Facility (hr/week)	17.1	18.3
EOD Image Processing Facility (hr/week)	34.1	36.5

4.5.5 PHOTOGRAMMETRIC/CARTOGRAPHIC

4.5.5.1 Baseline Resource Utilization

Each mapping sciences product needed for FMP is based on sites, acquisitions, intensive test sites, blind sites, and products needed to satisfy a support requirement similar to that in LACIE.

4.5.5.2 Forecast Resource Utilization

The following quantities for each type product identified was estimated, based on similar requirements of LACIE. Two basic groupings of agricultural multicrop support efforts were defined: 1) early activities (FY79-FY80) and 2) later activities (FY81-FY82).

PRODUCTS	FY79	FY80	FY81	FY82
• Sample/Segment Location/ Relocation (Segment)	2285	762	4333	1950
• ITS Update - Ground Truth (Sites)	23	7	52	19

• Photomosaics	305	76	433	191
• Area Measurements (Sites)	188	62	437	156
• Boundary Detection (Overlays)	1018	254	1444	635
• Partitioning (Overlays)	3047	762	4333	1905
• Digital Imagery Registration (Landsat Images)	153	38	217	96

4.5.6 FIELD MEASUREMENTS

4.5.6.1 Baseline Resource Utilization

Field Measurements support requirements were estimated on the basis of LACIE FY76 usages.

4.5.6.2 Forecast Resource Utilization

As the early agricultural multicrop program develops and matures, the general types and amounts of data collected at each site will not change significantly from those collected for LACIE Phase III. However, the number of RT&E truck missions does increase to 27 due to the wide geographical coverage needed. The number of helicopter missions also increases to 34 for the same reason.

The following is the listing of the number of Field Measurement missions projected to the end of FY82.

MISSIONS	FY79	FY80	FY81	FY82
Truck	23	27	27	23
Helicopter	28	34	34	28

4.5.7 FILM GENERATION

4.5.7.1 Baseline Resource Utilization

It is assumed that the number of types of film products will be the same as is currently being forecast for LACIE Phase III. The added

resolution attained by the Landsat D reflective sensors will not affect the amount of film generated. However, each additional band (channel) added to the four bands presently acquired by Landsat 2 will produce another product 4 (black-and-white) image. Each additional product 4 increases film generation time by 0.33 minutes per acquisition.

4.5.7.2 Forecast Resource Utilization

The results of this estimate are shown in the following listing. Required time is given in average number of hours per week.

FY79-FY80	FY81-FY82
36.6 hr	109.8 hr

4.5.8 FILM PROCESSING

Film processing requirements for color, and black and white film transparencies were estimated using the same acquisition numbers identified by paragraph 4.5.7.2. The weekly average number of rolls of film required for processing are:

EOD USERS	FY79-FY80	FY81-FY82
• Black and White	10.3	29.5
• Color	3.0	7.4

4.5.9 NON-ELECTRONIC DATA STORAGE/MANAGEMENT

As forecast for all previous programs the non-electronic data storage/management support service requirements are a function of packet equivalents. Agricultural multicrop packet equivalents are equal to the number of forecast sites plus 30% for non-operational support. This amounts to 3,960 packet equivalents for FY79 and FY80 and 9,900 packet equivalents for FY81 and FY82.

4.6 JOINT SOIL MOISTURE EXPERIMENT (JSME)

4.6.1 OVERVIEW

The Joint Soil Moisture Experiment (JSME) is a combination of several smaller tasks designed to measure the moisture content of various soil types under varying earth surface conditions. JSME will use ground truth, aircraft, seasat, and shuttle microwave sensor data to develop soil moisture technology for agriculture applications. The major emphasis of the JSME experiment is to provide needed ancillary data to all plant growth/yield earth resources study and applications programs. Technology developed and proven by this experiment will be transferred to the user agencies along with each prime program application.

JSME exploratory studies have been conducted by EOD since July 1974. LACIE applications for JSME support have been identified and are currently in development. Until Seasat is launched and operating in May of 1978, JSME will rely on ground truth data taken by the field measurement teams and aircraft data gathered by the aircraft program. A large volume of JSME data will be provided by Shuttle microwave instrumentation in the early 1980's.

4.6.2 DATA

4.6.2.1 Sites, Acquisitions, ITSs and Blind Sites

4.6.2.1.1 Baseline Resource Utilization

During FY76, three sites were selected for JSME ground truth and aircraft data to be taken. A total of six truck missions were accomplished at these sites. During each of these missions, sensor data and soil samples were acquired and processed. Aircraft data were taken over only two of the sites during three of these missions.

4.6.2.1.2 Forecast Resource Utilization

During FY77 it is estimated that approximately 12 truck and aircraft acquisitions will be made. Much of this data will be used to develop ancillary support of LACIE. Projections for FY78, 79, 80 and first half of FY81 indicate that JSME data will be acquired twice per year at approximately 250 equivalent LACIE or GFFP blind sites and an estimated 75 intensive test sites. Preliminary Shuttle flight plans show multi-pass JSME data will be acquired at 470 selected sites in support of several earth resource inventory assessment programs. Total JSME equivalent LACIE acquisitions are estimated to be no less than two passes per site or 940 per year.

4.6.2.2 Bytes (8 Bit) Storage

4.6.2.2.1 Forecast Resource Utilization

Based on the minimal volume of truck and aircraft data acquired during the FY77 through mid FY78 time frame, storage requirements will approach 1.2×10^6 bytes. Seasat will be added as a data source starting mid FY78. Its poor resolution and limited spectral bands will constitute an increase of only 50% in data storage requirements through FY82. This brings the mid FY78 to mid FY91 (Pre-Shuttle operations) storage requirements to 1.8×10^6 bytes per year. During the shuttle program, JSME data volumes grow dramatically. The Shuttle thematic mapper will produce 1.5×10^8 bytes of data per year.

4.6.3 COMPUTATIONAL PROCESSING

4.6.3.1 Overview

JSME computational processing support requirements are divided into three differing program support activities: 1) FY77 to mid FY78, support of LACIE, 2) mid FY78 through mid FY81, support of LACIE transition prior to shuttle and 3) mid FY81 through FY82, support of GFFP, using shuttle data. The required support services will be provided by EOD and IDSD.

4.6.3.2 Current (Baseline) Resource Utilization

In FY76 the EOD JSME data analysts did not employ the PDP 11/45 systems. They did, however, avail themselves of IDSD 1100 series systems processing support, averaging:

Exec 2	0.3 hours/week
Exec 8	0.1 hours/week
Exec 8 demand	0.1 hours/week

4.6.3.3 Forecast Resource Utilization

4.6.3.3.1 LACIE Support (FY77 to mid FY78)

JSME data analysts have estimated the average weekly LACIE support level requirements to be as follows:

EOD Support Processing Facility	0.5 hours
IDSD Building 12 Facility	
Exec 2	0.5
Exec 8	0.3
Exec 8 demand	0.2

After further discussions with JSME analysts and LACIE personnel, the LRP team felt these estimates were too conservative relative to program objectives and schedules. Recent NASA project changes tends to substantiate these concerns. LRP team average weekly support requirements estimates are:

EOD Support Processing Facility	2.0 hr
IDSD Building 12 Facility	
Exec 2	1.2 hr
Exec 8	1.0 hr
Exec 8 demand	0.8 hr

4.6.3.3.2 Pre-Shuttle Support (Mid FY78 through Mid FY81)

As the JSME develops useful ancillary data for LACIE, the multi-program pre-shuttle support requirements will increase significantly.

Conservatively, the demand for JSME processing support is estimated at double the FY77 level. This increased demand is the result of participating in soil moisture content algorithms for approximately 250 blind sites and 75 ITS's. Estimates are:

EOD Support Processing Facility	4.0 hours/week
IDSD Building 12 Facility	
Exec 2	2.4 hours/week
Exec 8	2.0 hours/week
Exec 8 demand	1.6 hours/week

4.6.3.3.3 Shuttle Support (Mid FY81-FY82)

With the substantial increases of microwave sensor soil moisture data from shuttle, a requirement for data filtering prior to analysis and/or processing should be assumed. With some selective filtering of this data combined with increased personnel experience and upgraded computational system capability, computational processing support can be expected to increase, conservatively, by 100%. These values are:

EOD Support Processing Facility	8.0 hours/week
IDSD Building 12 Facility	
Exec 2	4.8 hours/week
Exec 8	4.0 hours/week
Exec 8 demand	3.2 hours/week

4.6.3.3.4 Other Support Workload

In addition to processing data, there are status and tracking support requirements. These are a part of and included in the individual programs being supported by JSME and not in JSME itself.

4.6.4 INTERACTIVE IMAGERY DISPLAY

4.6.4.1 Baseline Resource Utilization

No ERIPS or I-100 support was used or needed during FY76. All interactive image displays were done on the PMIS/DAS in Building 17. Estimates given in the following paragraphs consider the amount of

JSME support supplied by the PMIS DAS and the growth in JSME data activity identified in the preceeding paragraphs. It is assumed that the processing currently done on the PMIS DAS will be done on an I-100 type system after mid FY78. The ERIPS system would then be employed as a quick look facility to reduce site selection and registration with all other imagery display functions being performed on the I-100.

4.6.4.2 Forecast Resource Utilization

The following JSME interactive imagery display support requirement estimates are given in average hours per week (adjusted for dual consoles in the case of ERIPS).

4.6.4.2.1 Pre-Shuttle Support (Mid FY78 through Mid FY81)

Employing the ERIPS terminal as a quick look facility, assume site selection takes one half hour per acquisition. To work 250 blind sites and 75 ITS's will require 1.6 hours per week of ERIPS time. (Two terminals).

The I-100 would then be used extensively to perform the evaluation of ancillary data inputs to the multi-programs as seasonal soil moisture content estimates. Assuming terminal analysis evaluation time is 2 hours per site for the 325 sites, the I-100 would be used 12.5 hours per week.

4.6.4.2.2 Shuttle Support (Mid FY81-FY82)

The same rationale for growth rate is used here as was used in the computational processing section. Shuttle multi-program support is estimated to increase by 100%. It therefore follows that ERIPS usage time would be 3.2 hours per week and the I-100 terminal usage time would be 25.0 hours/week.

4.6.5 PHOTOGRAMMETRIC/CARTOGRAPHIC

4.6.5.1 Overview

In addition to the current types of mapping science products, several new types of products will be required by JSME. The following quantity and types of products are generated by the JSME program in support of other Earth resources programs. These mapping sciences products are in addition to the products developed by other projects or programs. The types and quantities of products were identified and estimated by analysis of JSME user requirements and current similar LACIE product requirements. This analysis was extended and applied to include other JSME supported projects.

4.6.5.2 Types of Mapping Sciences Products

The new or modified JSME products which will be required include:

- Photomosaics
- Area Measurements (sites)
- Boundary Detection
- Orthophotos
- Digital Imagery Registration
- Soil Moisture Content Map
- Percent Soil Moisture Contour Line Map
- Soil Moisture Depth Profiles

4.6.5.3 Quantities and Projects Using the Products

JSME will be supporting LACIE Phase III, LACIE X, FA[illegible], RAP and FMP. The quantity of JSME mapping sciences products required to support these programs is proportional to the number of Sites, ITSs and Blind Sites used by the programs. It was assumed that five percent of the data will require JSME ancillary products as follows:

PRODUCTS	FY77	FY78	FY79	FY80	FY81	FY82
Photomosaics	11	16	17	24	32	15
Boundary Detection (Overlays)	37	52	57	79	106	49
Orthophotos	9	12	14	19	25	12
Digital Imagery Registration (Landsat Images)	5	8	8	12	16	7
Soil Moisture Content	111	156	172	238	318	147
Percent Soil Moisture Contour Maps	11	16	17	24	32	15
Soil Moisture Depth Profiles	8	12	15	12	29	10

4.6.6 FIELD MEASUREMENTS

Just as was done for photogrammetric/cartographic support, combined field measurement requirement estimates are made for all JSME supporting programs. Best estimates indicate that the Texas A&M University and the University of Kansas ground truth truck teams will each make 6 JSME missions per year during the FY77 through FY82 period in support of the various earth resources programs.

4.6.7 FILM GENERATION AND FILM PROCESSING

JSME does not use the Landsat data, however, it is assumed that the type and quantity of photo imagery required to support the EOD programs will be 5% of the amount required to support the corresponding systems verification and test program. Below is shown the average number of hours per week required for film generation by the PFC and the average number of film rolls per week required to be processed.

	FILM GENERATION	FILM BLACK & WHITE	PROCESSING COLOR
FY77	1.0 hours	8.3 rolls	0.1 rolls
FY78	1.8 hours	0.6 rolls	0.2 rolls
FY79	3.3 hours	1.0 rolls	0.3 rolls
FY80	3.3 hours	0.9 rolls	0.3 rolls
FY81	7.1 hours	1.9 rolls	0.5 rolls
FY82	6.6 hours	1.7 rolls	0.5 rolls

4.6.8 NON-ELECTRONIC DATA STORAGE/MANAGEMENT

The JSME non-electronic data storage/management support service requirements are assumed to be proportionate to the LACIE requirements. The proportionality is directly related to the number equivalent LACIE sites. Both site and non-site support requirements are included in the following chart. The workload values are given in packet equivalents.

FY77	FY78-Mid FY81	Mid FY81-FY82
8	421	611

4.7 MISCELLANEOUS EOD SUPPORT PROGRAMS

4.7.1 OVERVIEW

This subsection is provided for all other programs and projects considered as candidates for EOD support services and about which little definition exists. It includes:

- **Wild Land Vegetation and Recreation Resources Inventory (WVRI)**
- **Radar Agriculture Project (Radar Ag)**
- **SEASAT Project (SEASAT)**
- **Applications Explorer Mission (AEM)**
- **Multi-Sensor Correlation and Application**
- **Water Shed Flood Control**
- **Tropical Area Monitor**
- **Land Area Subsidence**
- **Special Project Support**
- **General Project Support**

Some of these projects may develop into very large programs; others may be worked as a small project or integrated into an existing project or eliminated altogether.

4.7.2 DATA

Because of the unidentified sources and unknown quantities of data to be generated by each of these projects, it is unreasonable to forecast project data volumes individually. A forecast for the entire group, based upon historical development records of similar types of projects and the levels of support services utilized, would more closely approximate those which will be experienced in the future.

The sum workload contributed by these Miscellaneous EOD Support programs is considerably less than LACIE - Phase III, LACIE Transition or GFFP, however, it is significant enough to warrant inclusion. This workload together with the preceding workloads gives a total EOD workload forecast with which to plan and develop future support services.

4.7.2.1 Sites, Acquisitions, ITSs, and Blind Sites

Acquisitions for this group of programs would have little or no value unless placed in proper perspective. The current and projected values for the number of acquisitions are not necessarily real but they do represent a proportionally real amount of support services required to complete projected tasks. Estimates of the number of equivalent sites, acquisitions, intensive test sites and blind sites are as follows with the FY76 base given:

EQUIVALENT	FY76	FY77	FY78	FY79	FY80	FY81 and 82
Sites	5	17	29	75	160	270
Acquisitions	28	100	175	450	950	1,600
ITS	-	1	1	2	3	5
Blind Sites	-	2	3	8	16	27

4.7.2.2 Bytes (8 Bit) Storage

In deriving the storage estimate using the estimated number of acquisitions previously given, the following assumptions were made:

- The forecast acquisitions will be taken with Landsat 2-C-D, AEM, Seasat and Shuttle sensors during their corresponding scheduled operational periods.
- Each acquisition will contain the same number of pixels as the standard equivalent LACIE acquisition.
- Storage volume for aircraft data is trivial by comparison.

Therefore, based upon the acquisition estimates, data storage requirements, in megabytes, are:

FY77	FY78	FY79	FY80	FY81-FY82
10.4	21.2	52.8	110.1	498.0

4.7.3 COMPUTATIONAL PROCESSING

Computational processing for this group will require only EOD and IDSD type support services.

4.7.3.1 Baseline Resources Utilization

Experience has shown that the growth of computer processing requirements for programs such as those included here increases somewhat less than linearily with increases in the number of acquisitions analyzed. Personnel and machine technique and technology continue to improve. Improvement should be such that the ratio of support requirements of these projects would be proportioned to the square root of the ratio of the number of acquisitions for each project relative to current LACIE usages.

4.7.3.2 Forecast Resource Utilization

Since no PDP 11/45 data was available for FY76, FY77 was selected as the reference year. IDSD usage numbers for FY76 do exist and were adjusted to the reference year, FY77. EOD analyst estimates, where available, are included. Results of these projections in hours per week follow:

COMPUTATIONAL SYSTEM	EOD ANALYST FY77	LRP FY77	TEAM FY78	FY79	FY80	FY81-FY82
EOD Support Processing Facility (hours/week)	13.0	13.0	17.2	27.6	40.1	52.0
IDSD Building 12 Facility						
Exec 2 (hours/week)	2.8	1.5	2.0	3.2	4.6	6.0
Exec 8 (hours/week)	2.5	2.0	2.6	4.2	6.2	8.0
Exec 8 demand (hr/week)	0	1.8	2.4	3.8	5.5	7.2

4.7.4 INTERACTIVE IMAGERY DISPLAY

The same rationale as used in estimating computational processing support service requirements was used to develop estimates of imagery support services. The usage times include applications and systems development, and production. ERIPS is given in dual terminal usage time in hours per week and the I-100 in single terminal usage time in hours per week.

	EOD ANALYSTS		LRP TEAM				
IMAGE SYSTEM	FY77	FY78	FY77	FY78	FY79	FY80	FY81-FY82
ERIPS Building 30 Facility	0	0.3	0.5	0.7	1.1	1.5	2.0
EOD Image Processing Facility	52.0	50.5	20.0	26.5	42.0	61.6	80.0

The EOD image processor terminal user predictions, i.e., 52.0 and 50.5 hours per week during FY77 and FY78, respectively, is considered unrealistic. Other higher priority users as LACIE - Phase III most certainly will preempt this resource.

ERIPS will be used only to cluster and classify data from the large IBM 360/75 data base and configure it for work on the I-100. The I-100 terminal will be used extensively for image analysis rather than the ERIPS terminal due to the convenience of its location and the case with which users can make real time usage scheduling trades.

4.7.5 PHOTOGRAMMETRIC/CARTOGRAPHIC

Estimates of types and quantities of mapping science products are based on LACIE, FAP, and RAP workloads proportioned according to the relative number of sites and acquisitions for the comparative programs. It is estimated that one ground truth test site will be selected for every 100 acquisitions.

PRODUCTS	FY77	FY78	FY79	FY80	FY81-FY82
Site Location/Relocation	17	29	75	160	270
ITS Update - Ground Truth (Sites)	1	1	2	3	5
Photomosaics	2	3	8	16	27
Area Measurements (Sites)	2	3	8	16	27
Boundary Detection (Overlays)	6	10	25	53	90
Partitioning (Overlays)	17	29	75	160	270
Orthophotos	1	2	6	13	22
Change Detection (Overlays)	2	3	8	16	27
Digital Imagery Registration (Landsat Images)	1	2	4	8	14

4.7.6 FIELD MEASUREMENTS

The number of field measurement missions forecast is based on the estimated number of ground truth test sites identified in paragraph 4.7.5. These sites will be clustered such that each helicopter mission will include up to 3 sites and each truck mission will include up to 4 sites. The results of these estimates follow:

	FY77	FY78	FY79	FY80	FY81-FY82
Truck	1	1	1	3	4
Helicopter	1	1	2	3	6

4.7.7 FILM GENERATION AND FILM PROCESSING

Hours of film generation time and rolls of film processing support were estimated using the same relationship identified in LACIE. The resulting weekly average projections are given in the following list:

	FY77	FY78	FY79	FY80-Mid FY81	MidFY81-FY82
Film Generation (hours/week)	0.2	0.3	0.8	1.6	3.0
Film Processing: (rolls/week)					
Black & White	0.1	0.1	0.3	0.6	1.1
Color	-	-	0.1	0.2	0.3

4.7.8 NON-ELECTRONIC DATA STORAGE/MANAGEMENT

The number of packet equivalents necessary to support these program requirements is estimated by the number of equivalent sites. The estimate is based on ratios existant within the currently running programs. The following list shows the resultant number of packets per year.

FY77	FY78	FY79	FY80	FY81-FY82
22	38	96	208	351

APPENDIX A
SUPPLEMENTAL INFORMATION, EOD
SUPPORT SERVICE REQUIREMENTS FORECAST

APPENDIX A1

VOLUME OF DATA ACTIVITY

SITES, ACQUISITIONS, INTENSIVE TEST SITES AND BLIND SITES (PER YEAR)

LACIE: Source - LACIE Results Meeting Handout 1/26/77

#I - 692 sites, 2299 acquisitions, 6 ITS

#II - 1683 sites, 9300 acquisitions, 30 ITS, 170 blind sites

#III - 3047 sites, 16,900 acquisitions, 30 ITS, 250 blind sites

LACIE X SITES	FY77 LACIE #III REFERENCE	FY78	FY79	FY80	FY81
• USGP	600	600	600	600	-
• ITS	34	34	34	34	-
	164	164	164	164	-
• USSR	1949	-	-	-	-
• US	-	-	-	-	1000
• India	100	626	626	-	-
• Argentina	-	165	165	-	-
• Canada	105	105	-	-	-
• China	100	810	810	-	-
• Australia	-	-	257	257	-
• Brazil	-	-	47	47	-
• Exploratory	-	-	-	100	-
Total	3047	2504	2703	1202	1000
Acquisitions per site		X6	X6	X6	X6
Acquisitions		15,024	16,218	7,212	6,000
Assume proportional number of ITS and blind sites as LACIE.					
ITS		27	29	13	11
Blind Sites		223	240	108	90

FAP

Number of areas = $\frac{\text{Total Survey}}{\text{Area Size}} = \frac{125 \times 10^6 \text{ Acres}}{10^6 \text{ Acres}} = 125$ Areas

- FY77-FY79

  10 Areas = 10 sites

  $\frac{10 \text{ Areas} \times 2 \text{ times/year} \times 30 \text{ miles} \times 30 \text{ miles}}{\text{Equivalent LACIE Acquisition} = 5 \text{ miles} \times 6 \text{ miles}} = 600$ Equivalent LACIE Acquisitions

  ITS = 4; Blind sites = $250 \times \frac{600}{16{,}900} = 9$

- FY80-FY83

  125 Areas = 125 sites

  $600 \times \frac{125 \text{ Areas}}{10 \text{ Areas}} = 7500$ Equivalent LACIE Acquisition

  ITS = $4 \times \frac{125}{10} = 50$; Blind sites = $9 \times \frac{125}{10} = 113$

RAP

- FY76 - 140 Landsat scenes = 140 sites

  140 Landsat Scene acquisitions @ 250,000 pixels each

  LACIE Scene acquisition size = 117 X 196 = 22,932 pixels

  Equivalent LACIE acquisitions = $\frac{140 \times 250{,}000}{22{,}932} = 1526$

  Equivalent ITS = 5

  Equivalent Blind Sites = $250 \times \frac{1526}{16{,}900} = 23$

- FY77 - FY78 Same as FY76 = 1526 equivalent LACIE acquisitions; 5 equivalent ITS and 23 equivalent blind sites.

- FY79 - FY82 Effort increase by 2.5 times

  Sites = 140 X 2.5 = 350

  Equivalent LACIE acquisitions = 1526 X 2.5 = 3815

  Equivalent ITS = 5 X 2.5 = 12

  Equivalent blind sites = 23 X 2.5 = 58

FMP

Note: Assume 4 crops, with varying biophases and geological locations.
Early FMP uses Landsat C
Full operation FMP uses Landsat D

LACIE Ø III reference

Sites - 3047, Acquisitions - 16,900
ITS - 30, Blind Sites - 250

- -FY79-mid FY81 (Landsat C - Early FMP)
  Same as LACIE Phase III

- -mid FY81-FY82 (Landsat D-Full operational FMP)
  Sites = 3047 X 2½ = 7618
  Acquisitions = 16,900 X 2½ = 42,250
  ITS = 30 X 2½ = 75
  Blind sites = 250 X 2½ = 625

JSME

- FY76
  Sites - 3
  Acquisitions - 6
  ITS - 3 - all 3 sites were ITS's
  Blind Sites - uses ITSs for blind sites
- FY77
  Sites - Same as FY76 -3
  Acquisitions = 3 sites X 2 missions X 2 data takes/mission = 12

  ITS & blind sites - Same as FY76

- FY78 - FY82
  - Sites = Support Program ITSs + blind sites

	FY78	FY79	FY80	FY81	FY82
LACIE	250	269	121	101	
FAP	13	13	163	163	163
RAP	28	70	70	70	70
FMP	--	280	280	491	700
Subtotal	291	632	634	825	933
Shuttle*	--	--	--	235	470
Total	291	632	634	1060	1403

- Acquisitions = sites X 2 missions/year (2 seasons)
- ITSs = 12/year
- Blind Sites - use blind sites

*Shuttle has 470 selected microwave data take sites

MISCELLANEOUS PROGRAMS

- Estimates based on discussion with SR&T and T&E personnel relative to Paraguay historical data and future radar agriculture, SEASAT, and multi-sensor studies.

EQUIVALENT	FY76	FY77	FY78	FY79	FY80	FY81&FY82
Sites	5	17	29	75	160	270
Acquisitions	28	100	175	450	950	1600
ITS	-	1	1	2	3	5
Blind Sites	-	2	3	8	16	27

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APPENDIX A2

STORAGE REQUIREMENTS - 8-BIT BYTES

LACIE

- **Phase II:**

  Image

  117 X 196 (Pixels) X 4 bands X 9300 Acq. =
  22932 X 37200 = 8.5×10^8 bytes

  Fields

  1683 Sites X 50 fields X 5 verticies X 3 coordinate ID
  1683 X 750 = 1.3×10^6 bytes

  History, Ancillary, Results, Stats. and Overhead

  Estimate 1×10^6

  Total Image $\cong 8.5 \times 10^8$

- **Phase III:**

  22932 pixels X 4 bands 16,900 Acquisition = 15.5×10^8 bytes

LACIE X

22932 pixels X 5 bands X Acquisitions + 3% overhead =

	FY78	FY79	FY80	FY81
Acquisitions	14,994	16,218	7,212	6,000
Bytes	1.77×10^9	2.03×10^9	$.851 \times 10^9$	$.708 \times 10^9$

FAP

	FY77	FY78-FY79	FY80-81	FY82-83
Data Source	Landsat 1	Landsat C	Landsat C	Landsat D
Bands	4	5	5	6
Resolution Multiplier	1.0	1.0	1.0	6.7
Acquisition Multiplier	1.0	1.0	12.5	12.5

- FY76: 10 Areas X $\frac{30 \text{ miles X } 30 \text{ miles}}{5 \text{ miles X } 6 \text{ miles}}$ X 22932 X 4 bands + 3% overhead

  $= 0.275 \times 10^8$ bytes

- FY77: 0.275×10^8 Bytes

- FY78-79: 0.275 bytes X $\frac{5 \text{ bands}}{4 \text{ bands}} = 0.344 \times 10^8$ bytes

- FY80-81: 0.344×10^8 X $\frac{125 \text{ areas}}{10 \text{ areas}} = 4.3 \times 10^8$ bytes

- FY82-83: 9.0×10^6 X 6.7 resolution multiplier = 28.8×10^8 bytes

RAP

	FY77	FY78-FY81	FY82
Data Source	Landsat 2	Landsat C	Landsat D
Bands	4	5	6
Resolution Multiplier	1.0	1.0	6.7
Effort Multiplier	1.0	1.0/2.5	2.5

- FY76 - 140 Landsat Scenes X (500 X 500 pixels) X 4 Bands + 3% overhead =

  1.4×10^8 Bytes

- FY77 - Same as FY76 - 1.4×10^8 Bytes

- FY78 1.4×10^8 X $\frac{5 \text{ Bands}}{4 \text{ Bands}} = 1.75 \times 10^8$ Bytes

- FY79-FY80 - 1.75×10^8 X 2.5 effort multiplier = 4.4×10^8 Bytes

- FY81-FY82 - 4.4×10^8 X $\frac{6 \text{ Bands}}{5 \text{ Bands}}$ X 6.7 resolution multipler =

  35.4×10^8 Bytes

FMP

- FY79-FY80
  16,900 Acq. X 5 bands X 117 X 196 + 3% overhead = 19.4×10^8 bytes

- FY81-FY82
  42,250 X 6 bands X $\frac{(79 \text{ meters})^2}{(30 \text{ meters})^2}$ X 117 X 196 + 3% overhead =
  403×10^8 bytes

JSME

- FY77 (Aircraft Only)
  576,000 pixels/mission X 2 missions = 1.15×10^6 bytes

- FY78-mid FY81 (Aircraft & Seasat)
  $1.15 \times 10^6 + 0.6 \times 10^6$ pixels = 1.75×10^6 bytes

- Mid FY81-FY82 (Shuttle)
  Thematic mapper:
  940 Acquisitions X 22932 pixels/Acq. X 7 bands + 3% overhead =
  1.51×10^8 Bytes

MISCELLANEOUS PROGRAMS

- FY76 and 77
  Landsat 2: 117 X 196 X 4 bands X 100 acq. = 9.2×10^6 Bytes
  A.C.: 1.2×10^6 = 1.2×10^6
  Total = 10.4×10^6 Bytes

- FY78-1980
  Landsat C FY78: 117 X 196 X 5 X 175 = 20.0×10^6 Bytes
  FY79: 117 X 196 X 5 X 450 = 51.6×10^6 Bytes
  FY80: 117 X 196 X 5 X 950 = 108.9×10^6 Bytes
  A/C: = 1.2×10^6 Bytes

- FY81 and 82 (Landsat D (2/3) and Shuttle (1/3)

  Landsat D: $117 \times 196 \times 6 \times 1600 \times 2/3 = 137.6 \times 10^6$ Bytes

  Shuttle: 1/100 SIR and Thematic Mapper = 360×10^6

  Total = 498×10^6 Bytes

APPENDIX A3
COMPUTATIONAL PROCESSING REQUIREMENTS (HOURS/WEEK)

BASELINE RESOURCE UTILIZATION

Weekly applications development and productional computational hours (Exclusive of interactive imagery processing and operating system development).

FYT

- **EOD SUPPORT PROCESSING (PDP 11/45)**
  - LACIE

TF3 (ES)	2
TF4 (SVT)	29
CAS	40
Total	71

- GDSD BUILDING 30 FACILITY (360/75)
  - LACIE

TF3 (ES)	--
TF4 (SVT)	22
Total	22

- IDSD BUILDING 12 FACILITY (U1100 SERIES)
  - LACIE

TF3 (ES)	11.0
TF4 (SVT)	6.2
JSME, TF5 (ES)	0.5
RAP, TF5 (ES)	2.3
FAP, TF5 (ES)	0.6
Other, TF5 (ES)	2.8
Total	23.4

Conversion Constants

1.0 Exec 2 Hr = 0.7 Exec 8 Hr

1.0 Exec 8 Demand Hr = 2.0 Exec 8 Hr

1.0 Exec 8 Hr = 0.78 IBM 360/75 Hr

- Comshare
  - LACIE

FYT charges per month: Storage $1,800

Connect	1,100	
DBM	1,200	$2,200 Fullrate
Query	1,000	
Batch	6,900 - ½ rate	

$12,000 X 12 months = $144K/year

FYT Rate

Processing Costs

$2200 - full charge rate

6900 } ½ charge rate

6900 }

$\frac{\$16,000/\text{month X 12 months}}{52 \text{ weeks/year}} = \$3700/\text{week}$

COMSHARE computer charges are 10.5¢/CPU sec

$\frac{\$3700/\text{week}}{\$.105/\text{CPU sec X 60 sec/min X 60 min/hr}} = 9.766 \text{ hr/week}$

1976 Baseline = $\frac{70K}{144K}$ X 9.8 = 4.8 hr/week

- Purdue/LARS

  $5300/month @ $265/hr = 20 hr/month

  Hours usage per week = $\frac{20 \text{ X } 12}{52}$ = 4.6 hr/week

ACTUAL FY76 IDSD COMPUTATIONAL PROCESSING USAGE*, HOURS (BY PROJECT)

USER	EXEC 2	EXEC 8	EXEC 8D	TOTAL
TF3 (LACIE, ES)	365.43	119.54	83.88	568.85
TF4 (LACIE, SVT)	46.89	248.44	24.11	319.44
TF5 (JSME, ES)	14.81	4.63	1.06	20.50
TF5 (FAP, ES)	--	1.16	--	1.16
TF5 (RAP, ES)	1.03	47.40	71.17	119.60
TF5 (Other, ES)	21.18	109.67	13.52	144.37
TF6 (MISC)	7.89	0.05	--	7.94
TF12 (Support)**	43.70	19.91	2.95	66.56
Total	500.93	550.80	196.69	1,248.42

** Photo/Carto, Data Research and Control, and Field Measurements Support Processing for Specific Projects

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LARS (PURDUE TERMINAL)

CPU HR/MO ≙ 20

$/CPU HR = $265

Average Cost/Mo ≙ $5300

Cost/Yr ≙ $63,600

Average connect time/mo ≙ 224 Hr

Connect time/Yr ≙ 2928 Hrs

FORECAST RESOURCE UTILIZATION

LACIE Phase III - Based on LACIE Phase II values

- **EOD Support Processing Facility (PDP 11/45)**

  - LRP Estimates

TF3	10 hr.
TF4	20 hr.
CAS	45 hr.
	75 hr./week

  - EOD Estimates*

FY77-TF3 and 4	21.0 hr.
CAS	40.0 hr.
Total	61.0 hr./week

½ FY78-TF3 and 4	19.6 hr.
CAS	40.0 hr.
Total	59.6 hr./week

- GSDS Building 30 Facility (360/75)
  - LRP Estimates (No TF3 usage)

    Same as LACIE ØII maximum, i.e., 30 hr./week

  - EOD Estimates*

FY77	26.8
FY78	20.0

* EOD Long Range Computer Time Estimates. Branch Requirements and Project Requirements.
July 1, 1976 - July 1, 1978; Revised June 28, 1976

- IDSD Building 12 Facility (U1100 Series)
  - LRP Estimates

	FY77 and 78		
	ES	SVT	TOTAL
Exec 2	7.0	0.9	7.9
Exec 8	2.4	4.6	7.0
EX8D	1.6	0.7	2.3

  - EOD Estimates*

FY77	ES	SVT	TOTAL
Exec 2	11.6	2.0	13.6
Exec 8	2.4	8.1	10.5
Exec 8D	0.6	1.8	2.4

FY78			
Exec 2	11.6	2.0	13.6
Exec 8	2.4	3.6	6.0
Exec 8D	0.6	1.7	2.3

- COMSHARE - Based on FYT Usages and number of Acquisitions for SVT only.
  - LRP Estimates - EOD Support Processing Facility (11/45)

    $\frac{200K}{144K}$ X 9.8 = 13.6 hr./week X 1.65 (11/45 multiplier) = 22.4 hr/week

- Purdue/LARS
  - LRP Estimates

    4.6 hr/week

- EOD Estimates*

  41.1 hr./week (Terminal time)

LACIE X

	REF	FY78	FY79	FY80	FY81
% Acquisitions relative to LACIE ØIII	1.0	.89	.96	.43	.36

The following usage requirements are given in hours/week.

• EOD Support Processing Facility (PDP 11/45)					
-TF3	10.0	8.9	9.6	4.3	3.6
-TF4	20.0	17.8	19.3	8.6	7.2
-CAS	45.0	40.0	43.2	19.4	16.2
-S&T	22.4	20.2	21.5	9.3	8.1
-Total	97.4	86.9	93.5	41.6	35.1
• GDSD Building 30 Facility (IBM 360/75)					
-All ASVT usage	30.0	26.7	28.8	12.9	10.8
• IDSD Building 12 Facility (U1100 Series)					
- Exec 2 hours					
ES	7.0	6.2	6.7	3.0	2.5
SVT	0.9	0.8	0.9	0.4	0.3
Total	7.9	7.0	7.6	3.4	2.8
- Exec 8 SUP hours					
ES	2.4	2.1	2.3	1.0	0.9
SVT	4.6	4.1	4.4	2.0	1.6
Total	7.0	6.2	6.7	3.0	2.5
- Exec 8 demand SUP hours					
ES	1.6	1.4	1.5	0.7	0.6
SVT	0.7	0.7	0.7	0.3	0.3
Total	2.3	2.1	2.2	1.0	0.9

- **Purdue/LARS**

ES	1.2	1.1	1.1	0.5	0.4
SVT	3.4	3.0	3.3	1.5	1.2
Total	4.6	4.1	4.4	2.0	1.6

FAP

- **EOD Support Processing Facility (PDP 11/45)**

  FY77-FY79

  $\frac{600}{16,900}$ X [75 + 22.4 (s&t)] = 3.5 hr./week

  FY80-FY82

  $\frac{7500}{16,900}$ X 97.4 hr/week = 43.2 hr/week

- **GDSD Building 30 Facility (IRM 360/75)**

  FY77-FY79

  $\frac{600}{16,900}$ X 30 hr/week = 1.1 hr/week

  FY80-FY82

  $\frac{7500}{16,900}$ X 30 hr/week = 13.3 hr/week

- **IDSD Building 12 Facility (U1100 Series)**

  FY77-FY79

  Exec 2 $\frac{600}{16,900}$ X 7.9 = .28 hr/week

  Exec 8 " " X 7.0 = .24 hr/week

  Exec 8D " " X 2.3 = .10 hr/week

  FY80-FY83

  Exec 2 $\frac{7500}{16,900}$ X 7.9 = 3.5 hr/week

  Exec 8 " " X 7.0 = 3.1 hr/week

  Exec 8D " " X 2.3 = 1.0 hr/week

RAP

Notes: FY77 - Landsat 2 - Same as now.

FY78 - Landsat C (5 bands in place of 4 for Landsat 2)

FY79-FY80 - 2.5 times increase in effort

FY81-FY82 - Landsat D (30 meter resolution and 6 bands)

	FY76	FY77	FY78	FY79-80	FY81-82
EOD Support Proc Facility (PDP 11/45)	0	1.0	1.25	3.1	20.8
IDSD Building 12 Support (U1100 Series)					
Exec 2	0.4	0.4	0.5	1.25	8.4
Exec 8	1.0	1.0	1.25	3.1	20.8
Exec 8D	0.9	0.9	1.13	2.8	18.8
Purdue LARS	1.0	1.0	1.25	3.1	20.8

FMP (Food Multicrop Program) - Agricultural Multicrop

- FY79-Mid FY81 (early phase)

  FMP Support = LACIE Phase II Support

- EOD Support Processing Facility (PDP 11/45) - 71 hr/week
- GDSD (Bldg. 30) Facility (IBM 360/75) - 22 hr/week
- IDSD (Bldg. 12) Facility (U1100 Series)
  - Exec 2 7.9 hr/week
  - Exec 8 7.0 hr/week
  - Exec 8D 2.3 hr/week
- Purdue 4.6 hr/week

- Mid FY81-FY82 (later phase)

  FMP Support - 2.5 X LACIE Phase III Support

- EOD Support Processing Facility = 2.5 X 71 = 178 hr/week
- GDSD (Bldg. 30) Facility = 2.5 X 30 = 75 hr/week

- IDSD (Bldg. 12) Facility
  - Exec 2 = 2.5 X 7.9 = 19.8 hr/week
  - Exec 8 = 2.5 X 7.0 = 17.5 hr/week
  - Exec 8D = 2.5 X 2.3 = 5.8 hr/week
- Purdue/LARS = 2.5 X 4.6 = 11.5 hr/week

JSME

FY77- (LACIE Support & T & E)

- EOD Support Processing Facility (PDP 11/45)

EOD Estimates*	LRP Estimates
0.5 hr/week	2 hr/week

- GDSD (Bldg. 30) Facility (360/75)

None None

- IDSD (Bldg. 12) Facility (U1100 Series)

Exec 2	0.5 hr/week	0.5 hr/week
Exec 8	0.3 hr/week	0.4 hr/week
Exec 8D	0.2 hr/week	0.1 hr/week

FY78 - FY82	Ref	FY78	FY79	FY80	FY81	FY82
% Acquisition relative to LACIE Ø II (9300 Acq)	1.0	.063	.136	.136	.228	.302
• EOD Support Processing Facility (PDP 11/45)	71	4.5	9.7	9.7	16.2	21.4
• IDSD (Bldg 12) Facility (U1100 Series)						
Exec 2	7.9	0.5	1.1	1.1	1.8	2.4
Exec 8	7.0	0.4	1.0	1.0	1.6	2.1
Exec 8D	2.3	0.1	0.3	0.3	0.5	0.7

* EOD Long Range Computer Time Estimates. Branch Requirements and Project Requirements. July 1, 1976-July 1, 1978; Revised June 28, 1976

MISCELLANEOUS PROGRAMS

Includes Radar Ag., Water shed flood control centers, tropical area monitor, land area subsidance, multi-sensor correlations and applications, special project support, general project support, etc.

- **EOD Support Processing Facility (PDP 11/45)**

LRP ESTIMATES	EOD ESTIMATES**
1977 - 13 hr/week	13.0 hr/week
78 1.32 X 12 = 17.2	
79 2.12 X 13 = 27.6	
80 3.08 X 13 = 4.01	
81 & 82 4 X 13 = 52.0	

- GDSD (Bldg. 30) Facility (IBM 360/75)
  None

- IDSD (Bldg. 30) Facility (U1100 Series)
  1976 - Exec 2-2.8 hr/week
  Baseline:

1977 -	Exec 2	1.5	Exec 2	2.8
	Exec 8	2.0	Exec 8	2.5
	Exec 8D	1.8	Exec 8D	0
	Total	5.3 hr/week		

  1978 - Exec 2 -1.32 X 1.5 = 2.0 hr/week
  Exec 8 - 1.32 X 2.0 = 2.6 hr/week
  Exec 8D - 1.32 X 1.8 = 2.4 hr/week

* Estimates based on the square root of increases in number of acquisitions over the FY77 to FY82 time frame. (Representing increased personnel technology and upgraded procedures).
$\frac{175}{100} = 1.32$; $\frac{450}{100} = 2.1$; $\frac{950}{100} = 3.08$ and $\frac{1600}{100} = 4.0$

** EOD Long Range Computer Time Estimates. Branch Requirements and Project Requirements. July 1, 1976 - July 1, 1978; Revised June 28, 1976.

LRP

1979 - 2.1 X 1.5 = 3.2 hr/week
2.1 X 2.0 = 4.2 hr/week
2.1 X 1.8 = 3.8 hr/week

1980 - 3.08 X 1.5 = 4.6 hr/week
3.08 X 2.0 = 6.2 hr/week
3.08 X 1.8 = 5.5 hr/week

1981 & 1982
4X 1.5 = 6.0 hr/week
4X 2.0 = 8.0 hr/week
4X 1.8 = 7.2 hr/week

APPENDIX A4

INTERACTIVE IMAGERY DISPLAY REQUIREMENTS (HOURS/WEEK)

BASELINE RESOURCE UTILIZATION

Weekly Interactive Imagery Display and Applications Development terminal time† (exclusive of Maintenance and Operations System Development).

FY76 USER	I-100	Applications Prog. Dev. I-100	ERIPS*
LACIE TF3 (ES)			
Requested	24	10	12
Scheduled	16	10	12
Used	16	10	12
LACIE TF4 (SVT)			
Requested	13	26	18**
Scheduled	10	20	18
Used	10	20	18
FAP TF5 (ES)			
Requested	14	-	-
Scheduled	10	-	-
Used	10	-	-
RAP TF5 (ES)			
Requested	4	-	-
Scheduled	4	-	-
Used	4	-	-
Subtotal	40	30	30
Misc. (PM, SISO, LEC DRs and Disk Preserve)			
Requested	45.5		
Scheduled	42.5		
Used	42.5		
Total			
Requested	136.5	36	30
Available	120.0	30	30
Used	112.5	30	30

* Two terminals are operated at same time.
** Two hours more used by MPAD for Ops.
† Based on 2nd week August PDP 11/45 requests/schedule/use on I-100 and ERIPS

FORECAST RESOURCE UTILIZATION

LACIE PHASE III

- ERIPS
  - LRP Estimates - Based on discussions with LACIE Ops Team

    TF3 (ES)

    LACIE Phase II = 12 hr/week

    TF4 (SVT)

    Assume 10% of Acq. will be reworked

    Total Acq. - I-100 Acq. = ERIP Acq. work

    (16,900 - 5500) 10% = $\frac{1140 \text{ Acq.} \times 1 \text{ hr/Acq.}}{52 \text{ weeks/yr} \times 2 \text{ consoles}}$ = 11 hr/week

    Total 23 hr/week

  -EOD Estimates*

TF3 (ES)	15 hr/week
TF4 (SVT)	35 hr/week
Total	50 hr/week

- I-100
  - LRP Estimates - Based on discussions with LACIE Ops Team

  TF3 (ES) - Assume all full frame Landsat images will be worked on ERIPS and all data segment images will be worked I-100.

  - Assume workload will continue at LACIE Phase II level, i.e., 16 + 10 = 26 hr/week

  TF4 (SVT) - Based on LACIE Phase III, I-100 Usage Study

  $\frac{4160 \text{ Acq.} \times 2 \text{ hr/Acq.}}{52 \text{ week/yr}}$ = 80 hr/week

  Total 106 hr/week

* EOD Long Range Computer Time Estimates. Branch Requirements and Project Requirements. July 1, 1976 - July 1, 1978; Revised June 28, 1976.

LACIE X	LACIE ØIII BASE	FY78	FY79	FY80	FY81
%	100	89	96	43	36
• ERIPS	23	20.5	22.0	9.9	8.3
• I-100	106	94.3	101.8	45.6	38.2

FAP

- FY76
  - ERIPS 1.5 hr/week
  - I-100 10 hr/week
- FY77 through FY79 - Same as FY76 i.e.
- FY80-FY82
  - ERIPS

    $\frac{7500}{16,900} \times 34 = 15$ hr/week
  - I-100

    $\frac{7500}{16,900} \times 106 = 47$ hr/week

RAP

	LRP Estimate	EOD Estimate
• FY77		
- ERIPS	$\frac{2 \text{ hr/week}}{2 \text{ consoles}} = 1$ hr/week	0
- I-100 current level - 4 hr/week		$\frac{48 \text{ hr/qtr} \times 4}{52} = 3.7$ hr/week

- FY78 (Landsat C - 5 bands)
  - ERIPS 1.25 hr/week
  - I-100 5 hr/week

- FY79-82 (Task increase by 2.5 times - Increased resolution of Landsat D assumed to be no effect).
  - ERIPS 3.1 hr/week
  - I-100 12.5 hr/week

FMP

- FY79-Mid FY81

  Assume - 50% of work on ERIPS and 50% on I-100
  - 20% training and 80% ordinary segments
  - 5% of training must be reworked
  - 25% of ordinary must be reworked
  - Reworks require 1 hour each on a terminal

  16,900 X 20% (Training) X 5% reworked = 170 Acquisitions

  16,900 X 80% (ordinary) X 25% reworked = 3380 Acquisitions

  3550 Acquisitions

  - ERIPS: $\frac{3550 \text{ Acq.} \times 1 \text{ hr} \times 50\%}{52 \text{ weeks/yr} \times 2 \text{ consoles}}$ = 17.1 hr/week
  - I-100: $\frac{3550 \text{ Acq.} \times 1 \text{ hr} \times 50\%}{52 \times 1 \text{ console}}$ = 34.1 hr/week

- Mid FY81-FY82

  Assume - 50% or work on ERIPS and 50% on I-100
  - 20% training and 80% ordinary segments
  - 5% training must be reworked
  - 10% ordinary must be reworked (Increase skill and procedures)
  - Reworks require 1 hour each on a terminal

  42250 X 20% X 5% reworked = 420 Acquisition

  42250 X 80% X 10% reworked = 3380 Acquisition

  3800 Acquisition

  - ERIPS: $\frac{3800 \times 1 \times 50\%}{52 \times 2}$ = 18.3 hr/week
  - I-100: $\frac{3800 \times 1 \times 50\%}{52 \times 1}$ = 36.5 hr/week

JSME

- **FY76-FY77**
  Uses PMIS/DAS

- **FY78**
  - **ERIPS** $\dfrac{582 \text{ Acquisitions} \times \frac{1}{2} \text{ hours/Acquisition}}{52 \text{ weeks/yr} \times 2 \text{ consoles}} = 2.8 \text{ hr/week}$

  - I100 $\dfrac{582 \text{ Acq} \times 2 \text{ hr/Acq}}{53 \text{ weeks/yr}} = 22.4 \text{ hr/week}$

- **FY79**
  - ERIPS $\dfrac{1264 \text{ Acq} \times \frac{1}{2} \text{ hr/Acq}}{52 \text{ weeks/yr} \times 2 \text{ consoles}} = 6.1 \text{ hr/week}$

  - I-100 $\dfrac{1264 \text{ Acq} \times 2 \text{ hr/Acq}}{52 \text{ weeks/yr}} = 48.6 \text{ hr/week}$

- **FY80 - Same as FY79**

- **FY81**
  - ERIPS $\dfrac{2120 \text{ Acq} \times \frac{1}{2} \text{ hr/Acq}}{52 \text{ weeks/yr} \times 2 \text{ consoles}} = 9.7 \text{ hr/week}$

  - I-100 $\dfrac{2120 \text{ Acq} \times 2 \text{ hr/Acq}}{52 \text{ weeks/yr}} = 81.5 \text{ hr/week}$

- **FY82**
  - ERIPS $\dfrac{2806 \text{ Acq} \times \frac{1}{2} \text{ hr/Acq}}{52 \text{ wks/yr} \times 2 \text{ consoles}} = 13.5 \text{ hr/week}$

  - I-100 $\dfrac{2806 \text{ Acq} \times 2 \text{ hr/Acq}}{52 \text{ wks/yr}} = 107.9 \text{ hr/week}$

MISCELLANEOUS PROGRAM

Includes Radar Ag., water shed flood control studies, tropical area monitor, land area subsidance, multi-sensor correlations and applications special project, support, general project support, etc.

- **Estimates based on the square root of increases in number of acquisitions over the FY77 to FY82 frame. (Representing increased personnel technology and upgraded procedures).**

- **ERIPS**
  - **LRP Estimate'**

    FY77 - $\frac{1 \text{ hr/week}}{2 \text{ consoles}}$ = 0.5 hr/week

    FY78 - 0.5 X 1.32 = 0.65 hr/week

    FY79 and 80 - 0.5 X 2.1 = 1.05 hr/week

    FY81 - 0.5 X 3.08 = 1.54 hr/week

    FY82 = 0.5 X 4.0 = 2.0 hr/week

  - **EOD Estimates****

    1977 - None
    1978 - 0.3 hr/week
    1979-1982 = No estimate

- **I-100**
  - **LRP Estimate'**

    1977 - 20.0 hr/week

    1978 - 20.0 X 1.32 = 26.5 hr/week

    FY79 and 80 - 20.0 X 2.1 = 42.0 hr/week

    FY81 - 20.0 X 3.08 = 61.6 hr/week

    FY82 - 20.0 X 4.0 = 80.0 hr/week

* $\frac{175}{100}$ = 1.32; $\frac{450}{100}$ = 2.1; $\frac{950}{100}$ = 3.08; $\frac{1600}{100}$ = 4.0

Estimates based on the square root of increases in number of acquisitions over the FY77 to FY82 time frame. (Representing increased personnel technology and upgraded procedures).

- EOD Estimates**

	1977	1978
General:	1654/52 = 31.8 hr/week	30.2 hr/week
Special:	260 X 4/53 = 20.0 hr/week	20.0 hr/week
Multi-Sensor:	= .20 hr/week	.3 hr/week
Total	= 52.0 hr/week	50.5 hr/week

1979 through 1982 - No Estimate

Programming Development for Applications

- Currently we are using 30 hr per week I-100 time for program development.
- Assume constant level of this program development will be required on the I-100 or equivalent for the various T&E and pilot production projects.
- In addition starting in FY77 ERIPS will require program development applications of 5 hr/week and increasing to 10 hr/week from FY79 through FY82.
- The hour usages here are based on current, well known types of equipment, i.e., I-100 and ERIPS terminal usages. However, as ERIPS replacement comes on, probably the I-100 time will be used on the ERIPS replacement.

** EOD Long Range Computer Time Estimates. Branch Requirements and Project Requirements. July 1, 1976 - July 1, 1978; Revised June 28, 1976.

APPENDIX A5

PHOTOGRAMMETRIC/CARTOGRAPHIC REQUIREMENTS

BASELINE

- Site Location/Relocation = New Sites + 25% rework old sites
- ITS Updates = New ITS + 25% rework ITS
- Photomosaics = 10 sites/mosaic (New and rework sites only)
- Area Measurements = New blind sites + 25% rework old sites
- Boundary overlays = 3 sites/boundary overlay (New and rework sites only)
- Partitioning Overlays = Site Location/relocation
- Digital Imagery Registration = 5% of total sites
- Orthophotos = 8% of sites
- Change detection = 10% of sites
- Atlas Map production = one per area

	Sites	Equivalent ITSs	Blind sites
LACIE-FY76	1683	30	170
LACIE Phase III			
• FY77	3047	30	250
FY76	(1683)	(30)	(177)
New	1364	0	73
25% rework	421	8	44
Balance for FY77	1785	8	117
• FY78 (75% of FY77)	1339	6	88

LACIE X

• FY78	2504	27	223
Repeats*	(1103)	(12)	(98)
New	1401	15	125
25% rework	276	3	25
Balance for FY78	1677	18	150
• FY79	2703	29	240
Repeats*	(2494)	(27)	(221)
New	209	2	19
25% rework	624	7	55
Balance for FY79	833	9	74
• FY80	1202	13	118
Repeats*	(1102)	(12)	(99)
New	100	1	9
25% rework	276	3	25
Balance for FY80	376	4	34
• FY81 All New	1000	11	90

* See LACIE X Site Location on Forecast Acquisition Sheets

FAP	Sites	Equivalent TTSs	Blind Sites
• FY77	300	4	9
• FY78-FY79 (FY77 level)	300	4	9
Rework (25%)	75	1	2
• FY80	3750	50	113
FY77 (Repeats)	(300)	(4)	(9)
New	3450	46	104
25% Rework	75	1	2
Balance for FY80	3525	47	106
• FY81-FY83 (FY80)	3750	50	113
25% Rework	938	13	28
RAP			
• FY77	140	5	23
• FY78 (25% rework)	35	1	6
• FY79	350	13	58
FY77 (Repeats)	(140)	(5)	(23)
New	210	8	35
25% rework	35	1	6
Balance for FY79	245	9	41
FY80-FY82 (FY79)	350	13	58
25% rework	88	3	15
FMP			
• FY79	3047	30	250
25% overlay with LACIE	(762)	(7)	(62)
New	2285	23	188

	Sites	Equivalent ITSs	Blind Sites
• FY80	3047	30	250
25% rework	762	7	62
• FY81	7618	75	625
FY80 (Repeats)	(3047)	(30)	(250)
New	3571	45	375
25% rework	762	7	62
Balance for FY81	4333	52	437
• FY82 25% rework	1905	19	156

JSME

	FY77	FY78	FY79	FY80	FY81	FY82
• Sites						
LACIE	1785	1339	-	-	-	-
LACIE X	-	1677	833	376	1000	-
FAP	300	75	75	3525	938	938
RAP	140	35	245	88	88	88
FMP	-	-	2285	762	4333	1905
Total	2225	3116	3438	4751	6359	2931
5% for JSME	111	156	172	238	318	147
• ITS						
LACIE	8	6	-	-	-	-
LACIE X	-	18	9	4	11	-
FAP	4	1	1	47	13	13
RAP	5	1	9	3	3	3
FMP	-	-	23	7	52	19
Total	17	26	42	61	79	35
5% for JSME	1	1	2	3	4	2

	FY77	FY78	FY79	FY80	FY81	FY82
• Blind Sites						
LACIE	117	88	-	-	-	-
LACIE X	-	150	74	34	90	-
FAP	9	2	2	106	28	28
RAP	23	6	41	15	15	15
AMP	-	-	188	62	437	156
Total	149	246	305	247	570	199
5% for JSME	8	12	15	12	29	10

Miscellaneous Programs

Assumed all Miscellaneous Program products are new each year.

Worked	FY77	FY78	FY79	FY80	FY81-FY82
Sites	17	29	75	160	270
ITS	1	1	2	3	5
Blind Sites	2	3	8	16	27

SITE LOCATION/RELOCATION

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	1633	1785	1339				
LACIE TRANSITION			1502	1622	721	600	
FAP	15	300	75	75	3575	938	938
RAP	15	140	35	245	88	88	88
FMP				2285	762	4333	1950
JSME	-	-	-	-	-	-	-
MISC. SUPPORT	7	17	29	75	160	270	270
TOTAL	1670	2242	2980	4302	5306	6229	3246

ITS UPDATES

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	30	8	6				
LACIE TRANSITION			27	29	13	11	
FAP	1	4	1	1	47	13	13
RAP	5	5	1	19	3	3	3
FMP				23	7	52	19
JSME	-	-	-	-	-	-	-
MISC. SUPPORT	-	1	1	2	3	5	5
TOTAL	36	18	36	74	73	84	40

PHOTOMOSAICS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	160	179	134				
LACIE TRANSITION			150	162	72	60	
FAP	2	30	8	8	357	94	94
RAP	5	5	4	25	9	9	9
FMP				305	76	433	191
JSME	-	11	16	17	24	32	15
MISC. SUPPORT	-	2	3	8	16	27	27
TOTAL	167	227	315	525	554	685	336

AREA MEASUREMENTS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	177	117	88				
LACIE TRANSITION			223	240	108	90	
FAP	2	9	7	2	106	28	28
RAP	5	23	6	41	15	15	15
FMP				188	62	437	156
JSME	-	-	-	-	-	-	-
MISC. SUPPORT	-	2	3	8	16	27	27
TOTAL	184	151	322	579	307	597	226

BOUNDARY DETECTION
(OVERLAYS)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	-	595	446				
LACIE TRANSITION			501	541	240	200	
FAP	-	100	25	25	1192	313	313
RAP		47	12	82	30	30	30
FMP				1018	254	1444	635
JSME	-	37	52	57	79	106	147
MISC. SUPPORT	-	6	10	25	53	90	90
TOTAL	0	785	1046	1738	1848	2183	1215

PARTITIONING OVERLAYS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	12	1785	1339				
LACIE TRANSITION			1502	1622	721	600	
FAP	-	-	-	-	-	-	-
RAP	-	-	-	-	-	-	-
FMP				3047	762	4333	1905
JSME	-	-	-	-	-	-	-
MISC. SUPPORT	-	17	29	75	160	270	270
TOTAL	12	1802	2870	4744	1643	5203	2175

ORTHOPHOTOS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	–	–	–				
LACIE TRANSITION			–	–	–	–	
FAP	-	25	6	6	286	75	75
RAP		11	3	20	7	7	7
FMP					–	–	–
JSME	–	9	12	14	19	25	12
MISC. SUPPORT	–	1	?	6	13	22	22
TOTAL	0	46	23	46	325	129	116

CHANGE DETECTION
(OVERLAYS)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	-	-	-				
LACIE TRANSITION			-	-	-	-	
FAP	18	30	8	8	358	94	94
RAP	18	14	4	25	9	9	9
FMP				-	-	-	-
JSME	-	-	-	-	-	-	-
MISC. SUPPORT	-	2	3	8	16	27	27
TOTAL	36	46	15	41	383	130	130

DIGITAL IMAGE REGISTRATION
(LANDSAT IMAGES)

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE		89	67				
LACIE TRANSITION			75	81	36	30	
FAP	-	15	4	4	179	47	47
RAP		7	2	13	5	5	5
FMP				153	38	217	96
JSME	-	5	8	8	12	16	7
MISC. SUPPORT	-	1	2	4	8	9	14
TOTAL	0	117	158	263	283	323	169

APPENDIX A6

FIELD MEASUREMENT REQUIREMENTS

PROGRAM	FY76	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	13T 24M	13T 24M	7T 12M				
LACIE TRANSITION			6T 12M	13T 24M	7T 12M	7T 12M	
FAP	2M	4M	4M	4M	8M	8M	8M
RAP	-	5M	5M	10M	10M	10M	10M
FMP				23T 28M	27T 34M	27T 34M	23T 28M
JSME	6T	12T	12T	12T	12T	12T	12T
MISC. SUPPORT	-	1T 1M	1T 1M	1T 2M	3T 3M	4T 6M	4T 6M
TOTAL	19T 26M	26T 34M	26T 34M	49T 68M	49T 67M	50T 70M	39T 32M

T - TRUCK TEAMS
M - METEOROLOGICAL/GROUND TRUTH TEAM

APPENDIX A7
FILM GENERATION REQUIREMENTS

Product # 1	Time Req to Generate	1.0 min.
2		1.0
4	.33 X 4 images	1.33
8		.33
12		.33
	Total Landsat 2 Time per Acq.	4.00 min.
	Landsat C 5 bands	.33
		4.33 min.
	Landsat D 6 bands	.33
		4.66 min.

LACIE ØII

$$\frac{4 \text{ min/Acq} \times 9300 \text{ Acq}}{60 \text{ min/hr} \times 52 \text{ wk/yr}} \times 1.25 \text{ overhead} = 14.9 \text{ hr/week}$$

LACIE ØIII

- FY77-Mid FY78 $\frac{4 \times 16{,}900}{60 \times 78 \text{ wk}/1\frac{1}{2} \text{ years}} \times 1.25 = 18.1$ hr

LACIE X

- FY78 = $\frac{4.33 \text{ min/Acq} \times 15{,}024 \text{ Acq}}{60 \text{ min/hr} \times 52 \text{ weeks/year}}$ + 25% overhead
  = 20.9 X 1.25 = 26.1 hr/week
- FY79 = $\frac{\text{FY79 Acq}}{\text{FY78 Acq}} \times$ FY78 workload
  = $\frac{16{,}218}{15{,}024} \times 26.1 = 27.8$ hr/week
- FY80 $\frac{7212}{15{,}024} \times 26.1 = 12.5$ hr/week
- FY81 $\frac{6000}{15{,}024} \times 26.1 = 10.4$ hr/week

FAP

- FY77

  $\frac{4.33 \text{ Min/Acq} \times 600 \text{ Acq}}{60 \text{ min/hr} \times 52 \text{ weeks}} \times 1.25 \text{ (overhead)} = 1.0 \text{ hr/week}$

- FY78-79

  $.8 \times \frac{5 \text{ bands}}{4 \text{ bands}} \times 1.25 \text{ (overhead)} = 1.25 \text{ hr/week}$

- FY80-FY83

  $1.0 \times \frac{125 \text{ Areas}}{10 \text{ Areas}} \times 1.25 \text{ (overhead)} = 15.6 \text{ hr/week}$

RAP

- FY77

  $\frac{4.33 \text{ Min/Acq} \times 140 \text{ Acq}}{60 \text{ min/hr} \times 52 \text{ weeks}} = 0.2 \text{ hr/week}$

- FY78 (Landsat C - 5 bands)

  $.2 \text{ hr/week} \times \frac{5 \text{ bands}}{4 \text{ bands}} = .25 \text{ hr/week}$

- FY79-FY80 (Increased effort)

  $.25 \text{ hr/week} \times 2.5 + 25\% \text{ overhead} = 0.8 \text{ hr/week}$

- FY81-FY82 (Landsat D - 6 bands and 6.7 times resolution)

  $0.8 \text{ hr/week} \times \frac{6 \text{ bands}}{5 \text{ bands}} \times 6.7 = 6.4 \text{ hr/week}$

PMP

- FY79-Mid FY81

  $\frac{4.33 \text{ Min/Acq} \times 16{,}900 \text{ Acq}}{60 \text{ min/hr} \times 52 \text{ weeks}} \times \frac{5 \text{ bands}}{4 \text{ bands}} + 25\% \text{ overhead} = 36.6 \text{ hr/week}$

- Mid FY81-FY82

  36.6 hr/week X $\frac{\text{6 bands}}{\text{5 bands}}$ X $\frac{\text{42,250}}{\text{16,900}}$ = 109.8 hr/week

JSME	FY77	FY78	FY79	FY80	FY81	FY82
LACIE	18.1	9.0	-	-	-	-
LACIE X	-	26.1	27.8	12.5	10.4	-
FAP	1.0	1.25	1.25	15.6	15.6	15.6
RAP	0.2	0.25	0.8	0.8	6.4	6.4
FMP	-	-	36.6	36.6	109.8	109.8
Total	19.3	36.6	66.25	65.5	142.2	131.8
5% for JSME	1.0	1.8	3.3	3.3	7.1	6.6

OTHER

- Landsat 2

- FY76 $\frac{\text{4 Min/Acq X 28 Acq X 1.25}}{\text{60 Min/hr X 52 weeks/year}}$ (overhead) = 0.04 hr/week

- FY77 $\frac{\text{4 X 100 X 1.25}}{\text{60 X 52}}$ = 0.16 hr/week

- Landsat C

- FY78 $\frac{\text{4.33 X 175 X 1.25}}{\text{60 X 52}}$ = 0.3 hr/week

- FY79 $\frac{\text{4.33 X 450 X 1.25}}{\text{60 X 52}}$ = 0.8 hr/week

- FY80 $\frac{\text{4.33 X 950 X 1.25}}{\text{60 X 52}}$ = 1.6 hr/week

- FY81-82 $\frac{\text{4.66 X 1600 X 1.25}}{\text{60 X 52}}$ = 3.0 hr/week

APPENDIX A8
FILM PROCESSING REQUIREMENTS

General: Product #		Color	B & W
1		1	
2		1	
4			4
8			1
12			1
Landsat 2		2	6
Landsat C	5 bands	0	1
		2	7
Landsat D	6 bands	0	1
		2	8

$$\text{\# of rolls} = \frac{\text{\# of Acq X \# of Images/Acq}}{\text{52 wk/yr X 220 Images/Roll}}$$

LACIE ØII

$$\text{B\&W } \frac{9300 \text{ Acq X 6 images}}{52 \text{ X } 220} = 4.9 \text{ rolls}$$

$$\text{Color } \frac{9300 \text{ X } 2}{52 \text{ X } 220} = 1.6 \text{ rolls/week}$$

LACIE ØIII

- FY77-Mid FY78

$$\text{B\&W } \frac{16{,}900}{52 \text{ X } 220} \text{ X 6 images X } \frac{12 \text{ mos}}{18 \text{ mos}} = 5.9 \text{ rolls/week}$$

$$\text{Color } \frac{16{,}900 \text{ X } 2}{52 \text{ X } 220} \text{ X } \frac{12 \text{ mos}}{18 \text{ mos}} = 2 \text{ rolls/week}$$

LACIE X

- FY78

  B&W $\frac{15,024 \text{ X } 7 \text{ images}}{52 \text{ X } 220}$ = 9.2 rolls/week

  Color $\frac{15,024 \text{ X } 2 \text{ images}}{52 \text{ X } 220}$ = 2.6 rolls/week

- FY79

  B&W $\frac{16,218}{15,024}$ X 9.2 = 9.9 rolls/week

  Color $\frac{16,218}{15,024}$ X 2.6 = 2.8 rolls/week

- FY80

  B&W $\frac{7212}{15,024}$ X 9.2 = 4.4 rolls/week

  Color $\frac{7212}{15,024}$ X 2.6 = 1.25 rolls/week

- FY81

  B&W $\frac{6000}{15,024}$ X 9.2 = 3.7 rolls/week

  Color $\frac{6000}{15,024}$ X 2.6 = 1.0 rolls/week

FAP

- FY77

  B&W $\frac{600 \text{ Acq X } 6 \text{ B\&W images}}{220 \text{ images/roll X } 52 \text{ wk/yr}}$ = 0.3 rolls/week

  Color $\frac{600 \text{ X } 2 \text{ color images}}{220 \text{ X } 52}$ = 0.1 rolls/week

- FY78-FY79

  B&W $\frac{600 \text{ X } 7 \text{ B\&W images}}{222 \text{ X } 52}$ = 0.37 rolls/week

  Color = Same as FY77 = 0.1 rolls/week

- FY80-FY83

  B&W FY78 Quantity X 12.5 = 0.3 X 12.5 = 3.75 rolls/week

  Color = 0.1 X 12.5 = 1.25 rolls/week

RAP

- FY77

  B&W $\frac{140 \text{ Acq X } 6 \text{ B\&W images}}{220 \text{ Images/roll X } 52 \text{ weeks/year}}$ = .07 rolls/week

  Color $\frac{140 \text{ Acq X } 2 \text{ color images}}{220 \text{ images/roll X } 52 \text{ wk/yr}}$ = .02 rolls/week

- FY78 (Landsat C)

  B&W $\frac{140 \text{ X } 7}{220 \text{ X } 52}$ = .08 rolls/week

  Color $\frac{140 \text{ X } 2}{220 \text{ X } 50}$ = .02 rolls/week

- FY79-80 (2.5 times effort)

  B&W .08 X 2.5 = 0.2 rolls B&W/week

  Color .02 X 2.5 = 0.06 rolls/week

- FY81-82 (Landsat D)

  B&W 0.20 X $\frac{8 \text{ B\&W images}}{7 \text{ B\&W images}}$ X 6.7 = 1.5 rolls/week

  Color 0.06 X 6.7 = 0.4 rolls/week

FMP

- FY79-FY80

  B&W $\frac{16{,}900 \text{ Acq X } 7 \text{ B\&W images}}{220 \text{ images/roll X } 52 \text{ wk/yr}}$ = 10.3 rolls/week

  Color $\frac{16{,}900 \text{ Acq X } 2 \text{ Color Images}}{220 \text{ X } 52}$ = 3.0 rolls/week

- FY81-FY82

  B&W $\frac{42,250 \times 8}{220 \times 52}$ = 29.5 rolls/week

  Color $\frac{42,250 \times 2}{220 \times 52}$ = 7.4 rolls/week

JSME

	FY77	FY78	FY79	FY80	FY81	FY82
• B&W						
LACIE	5.9	3.0	-	-	-	-
LACIE X	-	9.2	9.9	4.4	3.7	-
FAP	0.3	0.4	0.4	3.8	3.8	3.8
RAP	0.1	0.1	0.2	0.2	1.5	1.5
MCP	-	-	10.3	10.3	29.5	29.5
Total	6.3	12.7	20.8	18.7	38.5	34.8
5% for JSME	0.3	0.6	1.0	0.9	1.9	1.7
• Color						
LACIE	2.0	1.0	-	-	-	-
LACIE X	-	2.7	2.9	1.3	1.1	-
FAP	0.1	0.1	0.1	1.3	1.3	1.3
RAP	-	-	0.1	0.1	0.4	0.4
MCP	-	-	3.0	3.0	7.4	7.4
Total	2.1	3.8	6.1	5.7	10.2	9.1
5% for JSME	0.1	0.2	0.3	0.3	0.5	0.5

OTHER

Landsat 2	Rolls B&W	Rolls Color
• FY76 $\frac{28 \times 6}{52 \times 220}$	= 0.015	0.005
• FY77 $\frac{100 \times 6}{52 \times 220}$	= 0.05	0.017

Landsat C

- **FY78** $\frac{175 \times 7}{52 \times 220} = 0.1$ — 0.03
- **FY79** $\frac{450 \times 7}{52 \times 220} = 0.3$ — 0.08
- **FY80** $\frac{950 \times 7}{52 \times 220} = 0.6$ — 0.2

Landsat D

- **FY81-FY82** $\frac{1600 \times 8}{52 \times 220} = 1.1$ — 0.3

APPENDIX A9
NON-ELECTRONIC DATA REQUIREMENTS

- Total equivalent non-electronic data packets = (operational + non-operational) equivalent non-electronic data packets
- Equivalent operational non-electronic data packets = number of sites (or areas) under investigation
- Equivalent non-operational non-electronic data packets = 30% of equivalent operational non-electronic data products

LACIE Phase III

- FY77-Mid FY78
  - Operational 3047
  - Non-operational = 3047 X .3 914

  Equivalent non-electronic data packets 3061

LACIE X

- FY78
  - Operational 2504
  - Non-operational = 2504 X 0.3 751

  Equivalent packets 3255
- FY79
  - Operational 2703
  - Non-operational = 2703 X 0.3 811

  Equivalent packets 3514
- FY80
  - Operational 1202
  - Non-operational = 1202 X 0.3 361

  1563

- **FY81**
  - Operational 1000
  - Non-operational = 1000 X 0.3 300
    Equivalent packets 1300

FAP

- **FY77-FY79**
  - Operational 10 areas X 2 times/year 20
  - Non-operational = 20 X 0.3 6
    Equivalent packets 26
- **FY80-FY83**
  - Operational 125 X 2 times 250
  - Non-operational 250 X 0.3 75
    Equivalent packets 325

RAP

- **FY77-FY78**
  - Operational 140
  - Non-operational 140 X 0.3 42
    Equivalent packets 182
- **FY79-FY82**
  - Operational 350
  - Non-operational 350 X 0.3 105
    Equivalent packets 455

FMP

- **FY79-FY80**
  - Operational 3047
  - Non-operational = 3042 X 0.3 914
    Equivalent packets 3961

- FY81-FY82
  - Operational 7618
  - Non-operational = 7618 X 0.3 2285

  Equivalent packets 9903

JSME (RT&E only)

- FY77
  - Operational 6
  - Non-operational 6 X 0.3 2

  Equivalent packets 8
- FY78-Mid FY81
  - Operational 325
  - Non-operational 325 X 0.3 96

  Equivalent packets 421
- Mid FY81-FY82
  - Operational 470
  - Non-operational 470 X 0.3 141

  Equivalent packets 611

MISCELLANEOUS PROGRAMS

- FY77 17 X 1.3 = 22 equivalent packets
- FY78 29 X 1.3 = 38 equivalent packets
- FY79 75 X 1.3 = 96 equivalent packets
- FY80 160 X 1.3 = 208 equivalent packets
- FY81-FY82 270 X 1.3 = 351 equivalent packets