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LAND MANAGEMENT SYSTEMS

Progress and Risks in Developing BLM's Land and Mineral Record System

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The Honorable Ralph Regula
Chairman
The Honorable Sidney R. Yates
Ranking Minority Member
Subcommittee on Interior
and Related Agencies
Committee on Appropriations
House of Representatives

This report presents the results of our assessment of the Bureau of Land Management's (BLM) Automated Land and Mineral Record System/Modernization (ALMRS/Modernization). This project, which is estimated to cost about $428 million, is intended to improve BLM's ability to record, maintain, and retrieve land description, ownership, and use information. As agreed with your offices, our objective was to ascertain BLM's progress in developing and implementing the ALMRS/Modernization, including identifying potential risks. Details on our scope and methodology are provided in appendix I.

Results in Brief

Although planning for ALMRS was initiated in the early 1980s, a contract was not awarded to develop and deploy the ALMRS/Modernization until 1993 because of numerous changes in project concept and scope. Thus far, BLM has been meeting most of the schedule milestones that were established in 1993; however, deployment of some equipment has been deferred to fiscal year 1996 due to a shortage of hardware funds. Other project costs are expected to increase $25.2 million in fiscal year 1996. This increase is primarily due to requirements that were added after BLM awarded the contract.

In the coming months, the ALMRS/Modernization work will become more difficult as BLM and the prime contractor endeavor to complete, integrate, and test the new software system and meet the current schedule. The Bureau has been taking action to maintain the project schedule, but slippages may yet occur because little time was allocated to deal with unanticipated problems.

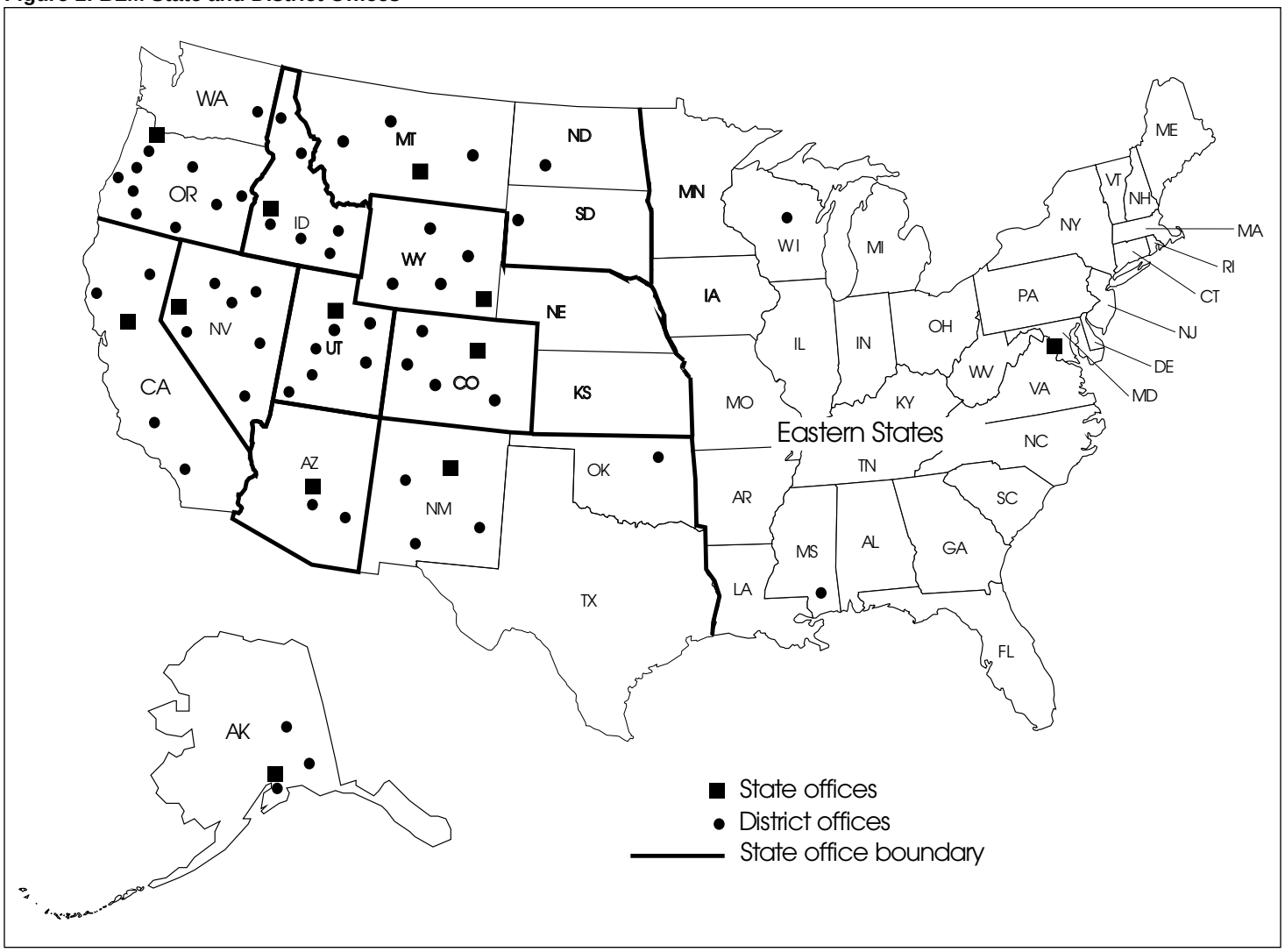
BLM recently took action to obtain independent verification and validation to help ensure that the new ALMRS software meets the Bureau's requirements. A key risk remains, however. BLM plans include stress

testing only a portion of the ALMRS/Modernization, rather than the entire project, to ensure that all systems and technology can successfully process workloads expected during peak operating periods. By limiting the stress test, BLM will deploy the ALMRS/Modernization information technology without knowing whether it can perform as intended during peak workloads.

Background

BLM's mission is to manage public lands and resources to best serve the needs of the American people. The Bureau, which is part of the Department of the Interior (DOI), has 210 state, district, and resource area offices that manage about 270 million acres of public lands located in 28 states, primarily in the West and Alaska (see figure 1). BLM's offices also manage another 300 million acres of subsurface mineral resources that underlie lands administered by other government agencies or are owned by private interests. BLM's fiscal year 1995 appropriation totaled $1.24 billion.

Figure 1: BLM State and District Offices



In fulfilling its mission, BLM develops land-use plans to balance multiple uses and competing demands, including ecosystem management, timber harvesting, mining, oil and gas production, watershed management, wildlife management, and recreation. It also designates and maintains land of critical environmental concern and is responsible for a major section of

the National Spatial Data Infrastructure.[1] In performing these functions, BLM maintains over 1 billion documents, including land surveys and surveyor notes, tract books, land patents, mining claims, oil and gas leases, and land and mineral case files. According to BLM, many of these paper documents are deteriorating, and some are illegible. Most of the documents are manually maintained and stored in a number of locations, although some have been entered into various databases since the 1970s.

Evolution of ALMRS/Modernization

During the early 1980s, BLM found it could not handle the case processing workload associated with a peak in the number of applications for oil and gas leases. BLM recognized that to keep up with the increased demand it needed to automate its manual records and case processing activities. Thus, the Bureau began planning to acquire an automated land and mineral case processing system (ALMRS). At that time, BLM estimated the life-cycle cost of such a case processing system would be about $240 million.

In 1988, BLM expanded the scope of ALMRS to include a land information system (LIS). This system was to provide automated information systems and geographic information systems technology (GIS)[2] support for other land management functions, such as land use and resource planning. BLM then combined the LIS with a project to modernize the Bureau's computer and telecommunications equipment. BLM estimated the total life-cycle cost of this combined project to be $880 million.

According to DOI and ALMRS project officials, the Office of Management and Budget (OMB) directed BLM to scale down the combined project in 1989 because of the projected high cost. The project, which was renamed ALMRS/Modernization, was reduced to three major components—the ALMRS Initial Operating Capability (ALMRS IOC), Geographic Coordinate Data Base (GCDB),[3] and modernization of BLM's computer and telecommunications infrastructure and rehost of selected management and administrative

[1]The Infrastructure is a cooperative effort of state and local governments, federal agencies, academia, and the private sector to collect and assemble geospatial data in ways that maximize the usefulness and accessibility of the data.

[2]Geographic information systems technology is the computer hardware and software that allow for the assembly, storage, manipulation, and display of geographically referenced data, (i.e., data that are associated with specific places on earth, such as the geographic location of a lake or oil well).

[3]We have previously reported significant cost overruns and milestone slippages on the GCDB component. See Land Management Systems: Extensive Cost Increases and Delays in BLM's Major Data Base Project, (GAO/IMTEC-91-55, Aug. 5, 1991).

systems.[4] Estimated life-cycle costs were cut to $575 million. In 1993, BLM reduced the ALMRS/Modernization 10-year life-cycle cost estimate from $575 million to $403 million, after the system development and deployment contract was awarded at a lower cost than had been anticipated.

Overview of the ALMRS/Modernization Project

BLM has designated the ALMRS/Modernization project as a mission-critical system to (1) automate land and mineral records and case processing activities and (2) provide information to support land and resource management activities. The project is a large-scale effort that is expected to provide an efficient means to record, maintain, and retrieve land description, ownership, and use information to support BLM, other federal programs, and interested parties. It is to accomplish this by (1) establishing a common information technology platform,[5] (2) increasing public access to BLM records through the Internet, (3) integrating multiple databases into a single geographically referenced database, (4) shortening the time to complete case processing activities, and (5) replacing costly manual records with automated records. Appendix II provides an overview of the planned ALMRS/Modernization architecture.

As noted above, the ALMRS/Modernization consists of three components—ALMRS IOC, GCDB, and technology modernization and rehost of selected systems. The ALMRS IOC component is to provide (1) support for case processing activities, including recording valid mining claims, processing mineral patents, and granting rights-of-way for roads and power corridors and (2) information for land and resource management activities, including timber sales and grazing leases. The GCDB component is the database that will contain geographic coordinates and survey information for land parcels. Other databases, such as those containing land and mineral records, will be integrated with GCDB. The information technology modernization and rehost component consists of installing computer and telecommunications equipment and converting selected management and administrative systems to a relational database system that will be used throughout the Bureau.

[4]BLM is converting selected management and administrative software from COBOL, a third generation programming language that uses flat data files, to INFORMIX, a fourth generation query language and relational database system.

[5]Information technology platform refers to an automated information systems environment that consists of interoperable hardware, systems software, and communications.

Status of Project Funding and Estimates

Between fiscal years 1983 and 1995, about $296.2 million had been appropriated for ALMRS/Modernization. According to project officials, obligations for ALMRS/Modernization totaled $262.8 million from 1983 through April 30, 1995. They expect obligations to equal appropriations by September 30, 1995.

In 1993, OMB and BLM agreed to annual funding limits for ALMRS/Modernization through fiscal year 2002. As agreed, total spending was not to exceed $403 million for fiscal years 1983 through 2002. However, to stay within the limit for fiscal year 1995, BLM delayed the initial hardware installation for the Alaska and Wyoming state, district, and resource area offices. Also, BLM estimates that it will exceed the fiscal year 1996 limit of $69.5 million by $25.2 million. BLM expects to obtain the $25.2 million from other parts of its operations.

According to ALMRS/Modernization project officials, the increase is attributable to several factors, but primarily because of requirements that were added after contract award. These requirements include system engineering studies for system architecture and system security issues, a requirement to integrate BLM's remaining older personal computers and local area networks with the new ALMRS/Modernization systems, changes to more easily accommodate land record automation requirements of other Interior bureaus and federal agencies, and more training for users and technical staff.

In addition, the ALMRS/Modernization project office now believes that operations and maintenance costs in fiscal years 1997 through 2002 will be more than the OMB and BLM funding agreement for that category. BLM is currently working on a new operations and maintenance estimate.

Progress on the Development and Implementation of ALMRS/ Modernization

BLM has completed most of the initial installation of computer and telecommunications equipment and has met most of its ALMRS IOC, GCDB, and rehost milestones thus far. As the ALMRS IOC development nears completion over the next several months, tasks will become more complex as the system is integrated and tested. BLM has taken action to maintain its tight development schedule, but slippages could still occur because there is little schedule time available to correct unanticipated problems. Also, BLM has recently taken action to obtain an independent assessment of the ALMRS IOC to help ensure that its requirements are met.

Status of Development and Implementation

BLM has been meeting most of its schedule milestones for the initial installation of ALMRS IOC and modernization computer and telecommunications hardware. Thus far, BLM has installed (1) a mix of ALMRS IOC, office automation, E-mail, GIS servers, and telecommunications equipment primarily in eight state offices and their subordinate district and resource area offices and (2) about 4,400 of the planned 6,073 workstations in these offices. The Bureau plans to install 730 more workstations and other equipment in fiscal year 1995 at the Idaho and Utah state offices, their subordinate offices, and a support office.

However, initial hardware installation for Alaska and Wyoming state and subordinate offices has been delayed because of a shortage of hardware funds in fiscal year 1995, according to ALMRS/Modernization project officials. BLM recently rescheduled the installation of servers and 951 workstations for these locations to fiscal year 1996.

The collection and validation of land and mineral data for ALMRS IOC are on schedule for all ten state offices. The land and mineral data files are to be converted to INFORMIX after the installation and testing of final hardware upgrades and ALMRS IOC software.

The development of ALMRS IOC software, which BLM divided into three phases or "builds," is currently on schedule. Build 1, which consists of about 46,000 lines of code, was developed and successfully tested on time. BLM and the prime contractor have been working on about 124,000 lines of code for build 2. They expect to complete the software integration test[6] for build 2 on September 12, 1995. BLM and the prime contractor estimate that about 120,000 lines of code will be developed in build 3 to complete the ALMRS IOC software. The software produced in builds 1, 2, and 3 will be integrated to form ALMRS IOC.

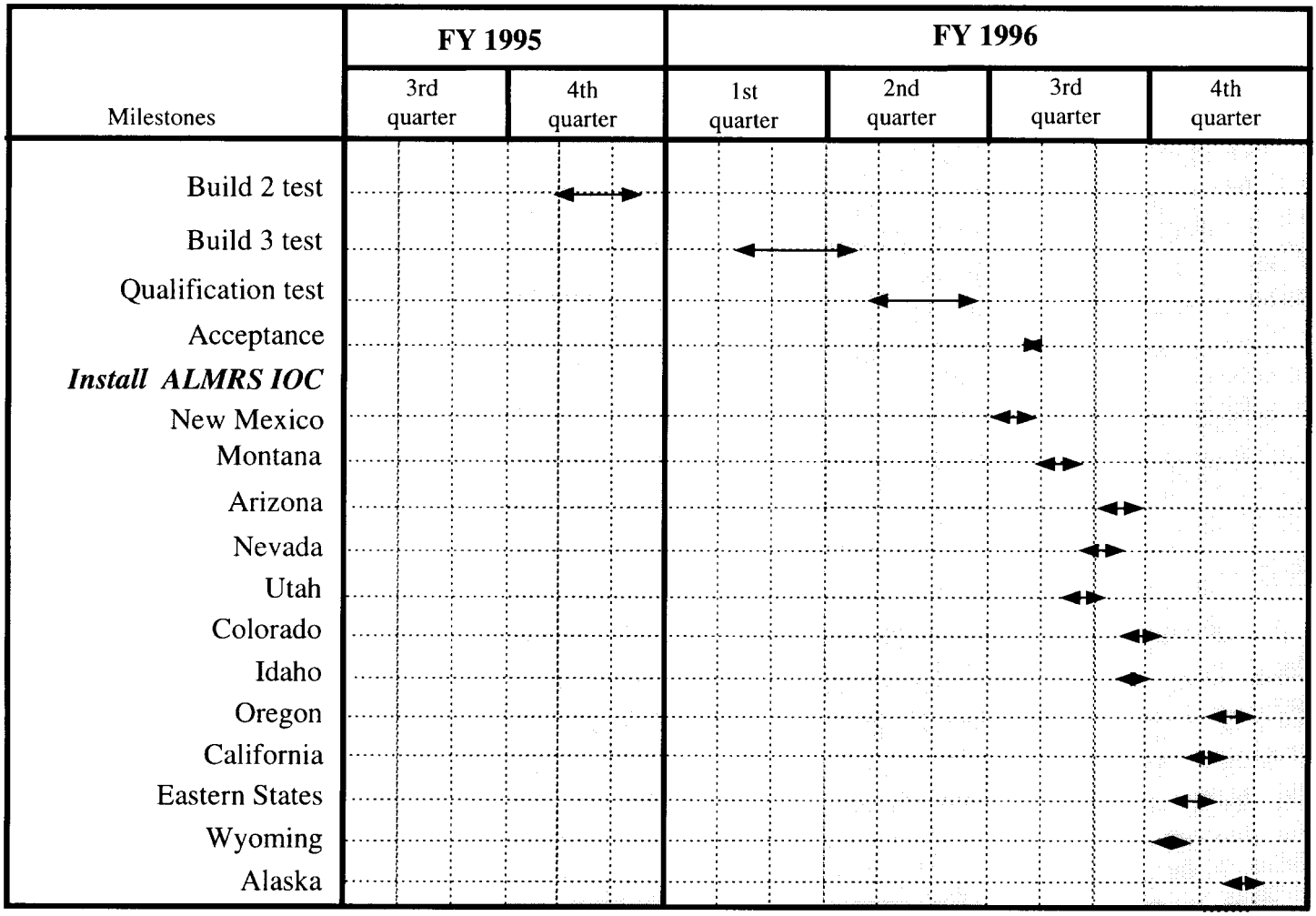
As to the GCDB component, nine state offices are meeting or are ahead of the data collection milestones set in 1993. One state office, Montana, is behind schedule. The final test of the software to convert existing data files to INFORMIX is scheduled to be completed by January 12, 1996. BLM plans to convert the GCDB data files when ALMRS IOC is deployed in each state office.

[6]A software integration test, which is typically conducted after software units have been successfully tested individually, is used to determine whether software units meet design specifications, properly interface with other software units, perform correctly under load, and respond correctly to user and data errors.

Finally, the administrative systems rehost effort is on schedule with all 13 of the planned software applications and related databases converted from COBOL to INFORMIX. Three of these applications have been rehosted to the ALMRS/ Modernization equipment and are operational, one is in the process of being rehosted, six have been tested and accepted and will be rehosted, and three have undergone testing and are expected to be accepted soon. According to the Deputy Project Manager, BLM plans to update the systems before deploying them to satisfy users' change requests that were held in abeyance while the systems were being converted to INFORMIX.

Figure 2 shows future milestones for the software integration tests of builds 2 and 3, qualification test for ALMRS IOC (functionality and integration), acceptance of ALMRS IOC, and final installation of ALMRS IOC hardware upgrades and software. As the ALMRS/Modernization nears the final testing and implementation stages, the project work will become more complex and the schedule more demanding. The final tests will include assessing the ALMRS IOC software to determine whether it meets design specifications, software units properly interface with other units, software responds correctly and consistently to users, and hardware and software operate as expected at pilot sites and under various levels of workload. As with all development efforts, the actual performance of the new software systems will not be known until they are completed, fully tested, and deployed.

Figure 2: ALMRS IOC Testing and Final Installation Milestones



Note: The milestones for final installation of ALMRS IOC were recently rescheduled by BLM to fiscal year 1997 because of an anticipated funding reduction for fiscal year 1996.

Status of ALMRS/Modernization Project Schedule

Developing realistic project schedules is critical to managing the successful development of large software systems. The General Services Administration has found that setting realistic project schedules is one of

the ten most important factors in successfully developing large, complex federal computer systems.[7]

ALMRS/Modernization project officials and an Interior Senior Technical Analyst stated that the milestones were not based on an assessment of the time and resources needed, but instead were based on the need to complete the project by the end of fiscal year 1996—the deadline established in the OMB and BLM agreement. Nevertheless, project officials said they have been committed to completing the development and deployment of ALMRS as scheduled.

Our analysis of the project schedule showed that several critical milestones are very close together with little recovery time available to deal with unanticipated problems that may be encountered. Therefore, slippages in the ALMRS/Modernization development and testing schedule could occur and impact project cost and completion plans. Similarly, slippages in the deployment of ALMRS IOC and database conversions could also impact project costs and completion plans because of the short installation periods scheduled for each state. As shown in table 1, BLM was allowing only 15 to 20 working days to perform the final installation of ALMRS IOC and convert databases in each state.

Table 1: ALMRS IOC Installation Schedule

IOC Installation Site	Scheduled Duration
New Mexico	20 days
Montana	15 days
Utah	15 days
Nevada	15 days
Arizona	15 days
Idaho	15 days
Colorado	15 days
Wyoming	15 days
Eastern States	15 days
Oregon	15 days
Alaska	15 days
California	15 days

ALMRS/Modernization project officials and an Interior Senior Technical Analyst agreed that both the development and testing milestones and deployment and database conversion milestones are very tight with little

[7]An Evaluation of the Grand Design Approach to Developing Computer Based Application Systems (U.S. General Services Administration, Information Resources Management Service, September 1988).

tolerance for slippages. Interior and BLM have been taking a number of actions to closely monitor the project status and schedule to avoid slippages. Interior Information Resources Management (IRM) officials have been conducting periodic oversight reviews and have required project officials to address project schedule issues. BLM has also established a consolidated project schedule that includes BLM's and the prime contractor's tasks to estimate and monitor the entire project schedule. Finally, BLM advanced the date for the software integration test for build 2 to provide additional time to deal with any unexpected problems.

BLM recently revised the installation schedule because of an anticipated reduction in funding for fiscal year 1996. Specifically, the Bureau rescheduled the final ALMRS IOC installation and database conversions from fiscal year 1996 to 1997.

Recent Action to Verify and Validate ALMRS IOC

Verification and validation of software is widely accepted and advocated by Federal Information Processing Standards Publication 132.[8] Verification and validation is a formal process to assess the products of each system's life-cycle phase, including concept, requirements, design, testing, implementation and installation, and operations and maintenance. Typically, the assessments are performed by someone not involved in developing the software to help ensure that the software meets the organization's requirements, that software development and maintenance costs will not escalate unexpectedly, and that software quality is acceptable.

Recently, project officials decided to obtain an independent verification and validation of ALMRS IOC software in response to direction from the House Committee on Appropriations. This action should help ensure that the software meets BLM's stated requirements and provides the support expected from this mission-critical system.

ALMRS/ Modernization Stress Test Plans Not Adequate

Stress testing automated systems before deploying them is a common industry practice. Such testing is done to ensure that the entire system will successfully process workloads expected during peak operating periods and determine the point at which major system resources (e.g., servers, workstations, storage devices, and local and wide area networks) will be exhausted.

[8]Federal Information Processing Standards Publication 132, Guideline for Software Verification and Validation Plans, National Bureau of Standards, Department of Commerce.

BLM plans to perform a 30-day acceptance test of the ALMRS IOC at pilot sites to assess functionality and performance in an operational setting. During this period, BLM also plans to stress test the ALMRS IOC (i.e., state and district office ALMRS IOC servers, terminals, and workstations) in a network environment. If ALMRS IOC performs successfully at the end of the test, BLM will accept and install it throughout all of its offices.

However, BLM's stress-test plans cover only the ALMRS IOC. The plans do not examine how the entire ALMRS/Modernization—including ALMRS IOC, office automation, E-mail, administrative systems, and various departmental, state, and district applications in a network environment—will perform under peak workload conditions. While ALMRS IOC is the largest and most significant component in the initial deployment of BLM's modernization effort, other systems and applications are expected to place considerable demand on the ALMRS/Modernization computer systems and communications networks. By limiting the stress testing to ALMRS IOC, BLM will deploy the ALMRS/Modernization nationwide without knowing whether it can perform as intended during peak workloads.

Conclusions

To date, the Bureau has been completing most of the project tasks according to the schedule milestones established in 1993. However, the project schedule could slip because there is little time available to deal with unexpected problems. Further, over the next several months, BLM and the prime contractor will be working on the more difficult tasks of completing, integrating, and testing ALMRS IOC.

BLM's recent action to obtain independent verification and validation of ALMRS IOC software should help ensure that BLM's requirements are met. However, the Bureau's plan to stress test the ALMRS IOC portion of the modernized system is not sufficient. Stress testing only a portion of the modernized system will not provide assurance that all of the systems and technology to be deployed can successfully process the workloads expected during peak operating periods.

Recommendation

We recommend that the Director, BLM, ensure that the entire ALMRS/Modernization is thoroughly stress tested before it is deployed throughout the Bureau.

Agency Comments

In commenting on a draft of this report, BLM stated that it agreed with our conclusions and recommendation. The Bureau said it now plans to stress test the entire ALMRS/ Modernization to ensure that all systems and technology can process the workloads expected during peak operating conditions. As previously noted, the Bureau said it has contracted for an independent verification and validation of the ALMRS IOC software in response to direction by the House Committee on Appropriations to perform a verification and validation test.

BLM also suggested some clarifications and provided additional information for our report. We have incorporated these suggestions and information as appropriate.

As arranged with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the date of this letter. At that time, we will provide copies to the Secretary of the Interior; the Director, Bureau of Land Management; the Director, Office of Management and Budget; and interested congressional committees. We will also make copies available to others upon request.

Please call me at (202) 512-6253 if you or your staff have any questions concerning this report. Other major contributors are listed in appendix III.

Joel C. Willemssen
Director, Information Resources
Management/Resources, Community,
and Economic Development

Contents

Abbreviations

ALMRS	Automated Land and Mineral Record System
ALMRS IOC	Automated Land and Mineral Record System Initial Operating Capability
BLM	Bureau of Land Management
COBOL	Common Business Oriented Language
DOI	Department of the Interior
GAO	General Accounting Office
GIS	geographic information system
GCDB	Geographic Coordinate Data Base
IRM	information resources management
LIS	land information system
OMB	Office of Management and Budget

Scope and Methodology

To ascertain BLM's progress in developing and implementing the ALMRS/Modernization, we reviewed ALMRS/Modernization project documents, DOI reports, a Department of the Treasury report, BLM studies on ALMRS/Modernization project development, General Services Administration IRM publications, Federal Information Processing Standards Publication 132, OMB Circular A-130, and GAO reports on large-scale systems development projects. We also attended departmental project reviews at the ALMRS/Modernization project office in Lakewood, Colorado, and reviewed the minutes of four prior project reviews.

We discussed the planned capabilities of the system, technical complexity, and development progress with prime contractor officials, a DOI Senior Technical Analyst, and ALMRS/Modernization project officials responsible for systems engineering, software development, and project management. We also discussed with ALMRS/Modernization project officials and BLM Headquarters officials the planning and development history of ALMRS/Modernization, testing plans, and efforts to follow industry practices. We analyzed project milestones against current progress, and reviewed the remaining tasks for their complexity.

We reviewed and analyzed ALMRS/Modernization project estimates and fiscal year 1996 budget justifications and documentation. We also compared BLM's fiscal year 1996 budget request for the ALMRS/Modernization with its cost estimate for fiscal year 1996. We reviewed BLM's options paper for ALMRS/Modernization operations and maintenance funding through fiscal year 2001 and discussed it with the ALMRS/Modernization Deputy Project Manager and the project budget analyst. We interviewed ALMRS/Modernization project officials and a Department Senior Technical Analyst on ALMRS/Modernization total project budget and milestones. Budget estimates were collected from the ALMRS/Modernization Deputy Project Manager, budget analysts, and other BLM Headquarters representatives. These estimates were confirmed by the Department's IRM office; however, we did not independently verify the accuracy of the estimates.

Our work was performed between March 1995 and August 1995, in accordance with generally accepted government auditing standards. We performed our work at the Department's IRM headquarters and BLM headquarters in Washington, D.C., and at the ALMRS/Modernization Project Office and prime contractor's office in Lakewood, Colorado.

We requested comments on a draft of this report from the Director, Bureau of Land Management. In response, we received comments from the Chief, Office of Information Resources Management/Modernization, Bureau of Land Management. We have incorporated these comments as appropriate.

ALMRS/Modernization Architecture Overview

The ALMRS/Modernization system—slated for deployment at approximately 200 BLM sites around the country—is to be implemented on a common information technology platform. The platform will be composed of servers, terminals, workstations, switching hubs, multiplexers, modems, and firewalls interconnected via local, state, and national-level networks. As planned, the ALMRS environment will initially support existing automated systems, including legacy local area networks and microcomputers.

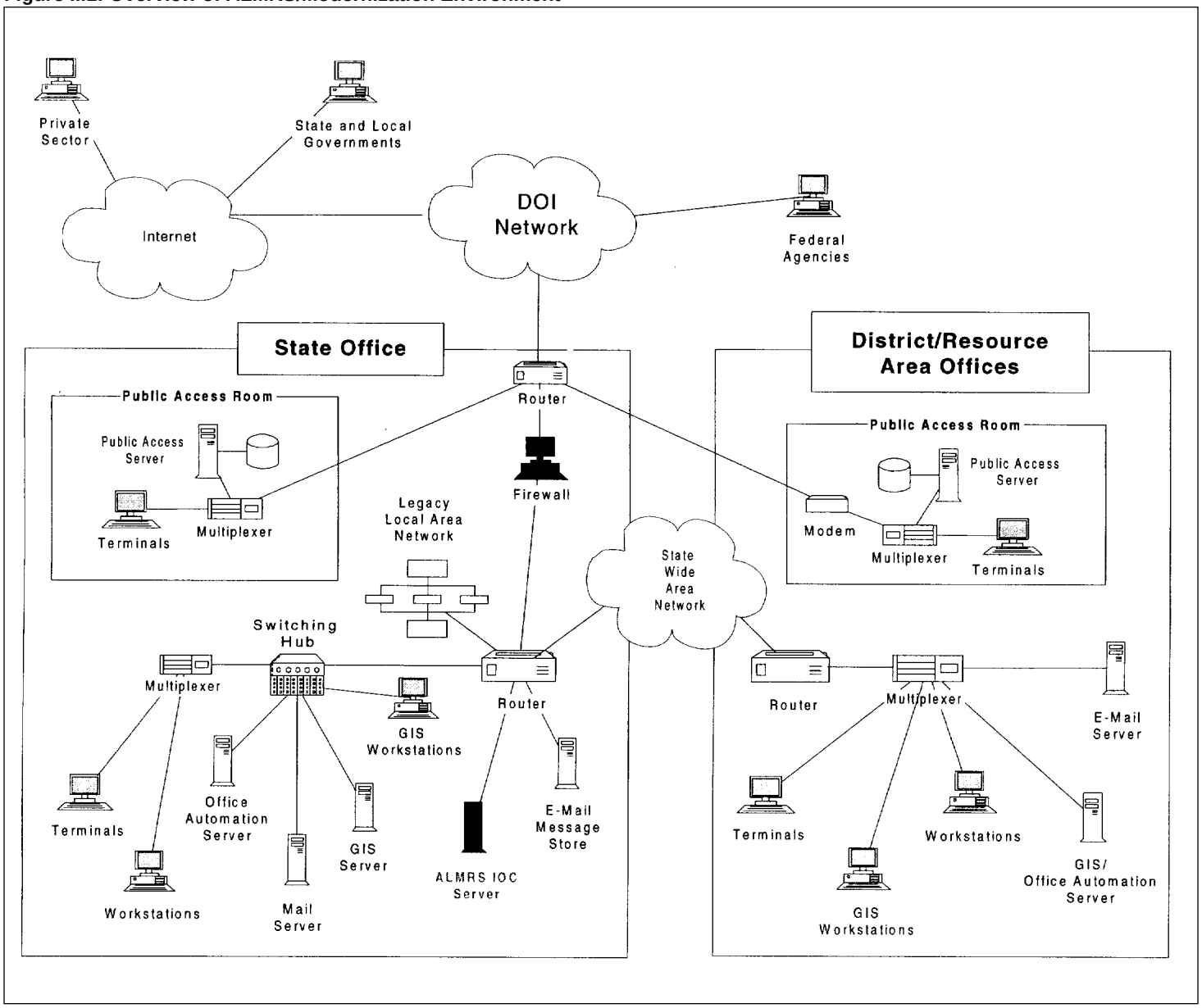
BLM expects that a typical state office installation will consist of several servers supporting major application groups—ALMRS IOC and related databases, office automation applications, GIS applications and related GCDB databases, and E-mail. A typical state office is to provide land and mineral resource data through the state ALMRS IOC server to district and resource area offices. State offices are to be interconnected via a Department of the Interior network. Each district or resource area office is to have its own GIS and office automation servers.

BLM users are to access applications via terminals and workstations interconnected through the local, state, and DOI networks. The public is to have access to selected ALMRS information in public access rooms equipped with stand-alone ALMRS IOC servers and terminals. The public access systems are expected to be isolated from the state and district office ALMRS IOC systems for security purposes.

BLM is also planning to provide connections to the Internet. The Bureau plans to protect each state office with a firewall system—a security device designed to protect the BLM systems from intrusion by hackers.

Figure II.1 shows a high-level overview of the ALMRS/Modernization environment.

Figure II.1: Overview of ALMRS/Modernization Environment



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