AGRICULTURAL BASE MAPPING PROJECT

SRI LANKA

1977-1982

Report of a Project Evaluation

Best Available Copy

MAY 1982

AGRICULTURAL BASE MAPPING PROJECT

SRI LANKA

1977-1982

Report of a Project Evaluation

Conducted By:

A. Norman Brew, Co-Team Leader
Chief, Branch of Contract Management
U.S. Geological Survey, National Mapping Division
Reston, Virginia

Richard D. Kidwell
Cartographer, Office of Research
U.S. Geological Survey, National Mapping Division
Reston, Virginia

Randle W. Olsen
Chief, Branch of Geometronics
U.S. Geological Survey, National Mapping Division
Menlo Park, California

Paul Prentice, Co-Team Leader
Consultant in Planning, Design & Evaluation
Development Associates, Inc.
Arlington, Virginia

April 20 - May 22, 1982

U.S. Agency for International Development

Washington, D.C. and Colombo, Sri Lanka

May 1982

This Evaluation Report represents the considered, professional opinion of the Evaluation Team based essentially on emprirical judgement. The findings, conclusions and recommendations do not necessarily represent the opinions of either the Survey Department or the USAID. Some issues may have been overlooked by the Evaluation Team, given the short period of time available for research, data collection, interviews, meetings and observation trips. Similarly, some of the data or information, particularly that contained in the appendices, may be found to be incomplete or even inaccurate. Readers are invited to submit any divergence of opinion or suggest corrections in data by corresponding directly with USAID/Colombo.

The Evaluation Team expresses its appreciation for the very cordial welcome and cooperation afforded by the Survey Department, at all levels. Without the full cooperation of management and the heads of production units and staff, the Evaluation Team would not have been able to complete its assignment. Discussions were candid and friendly. The Team was able to proceed with its scope of work with a minimum of organizational detail and orientation.

Needless to say, the support of USAID was indispensible for the Team to perform the tasks assigned to it. This was given, fully and cheerfully, The Team expresses its gratitude to all members of

ABMP EVALUATION REPORT

TABLE OF CONTENTS

PART I

Section I: EXECUTIVE SUMMARY 1

Basic Project Identification Data 4

Section II: CONCLUSIONS AND RECOMMENDATIONS 5

Major Conclusions and Recommendations 6
Other Conclusions and Recommendations 8

PART II

Section III: THE SRI LANKA CONTEXT 13

Section IV: DEVELOPMENT OF THE AGRICULTURAL BASE MAPPING PROJECT 16

Section V: DISCUSSION OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS 19

1.0 INTRODUCTION 19

2.0 OPERATIONS ANALYSIS 22

2.1: Map Requirements 22

2.2: Production Capacity 23

2.3: Review of Proposed Plans 23

2.4: Analysis of Alternatives 25

2.5: Implementation Plan 28

3.0 MAP PRODUCTION PROCESS 30

3.1: Aircraft 30

3.2: Photo Acquistion 32

3.3: Air Surveys Laboratory 33

3.4: Field Control 35

3.5: Aerial Triangulation 37

3.6: Photogrammetric Compilation 38

3.7: Field Edit 39

3.8: Scribing 41

3.9: Lettering 42

3.10: Map Production Laboratory 44

3.11: Plate making 45

3.12: Printing 47

4. FACILITIES 48

5. EQUIPMENT 51

6. MATERIALS 52

7. TECHNICAL ASSISTANCE AND TRAINING 57

8. ORGANIZATION AND MANAGEMENT 60

9. USER ASSISTANCE CENTER

PART III

Section VI: APPENDICES

A. PRODUCTION CAPACITY
B. SURVEY DEPARTMENT PLAN - APRIL 1982
C. SCHEDULE FOR 1:10,000-SCALE MAPPING
D. SCHEDULE FOR 1:50,000-SCALE MAPPING
E. SCHEDULE FOR PROCESSING 1:50,000-SCALE FROM 1:10,000-SCALE
F. AIRCRAFT MAINTENANCE AGREEMENT - SLAF/SD
G. ALTERNATIVE PROCEDURE - SCRIBING BY PHOTOGRAMMETRY
H. ALTERNATIVE PROCEDURE - FIELD EDIT BEFORE PHOTOGRAMMETRY
I. ABMP FLOW CHART 1:10,000-SCALE GOALS
J. ALTERNATIVE PROCEDURE: SINGLE COLOR LETTERING
K. EQUIPMENT - LOAN FUNDS
L. EQUIPMENT NEEDS
N. MATERIALS - 2 YEAR NEEDS
M. INVENTORY OF MAP PRODUCTION MATERIALS
O. SCHEDULE OF TRAINING PROVIDED
P. TECHNICAL ASSISTANCE PROVIDED
Q. TRAINING DESIRED BY SD
R. PP PROPOSED ORGANIZATION CHART
S. CURRENT SD ORGANIZATION CHART
T. LIST OF MAP PUBLICATIONS FOR SALE IN MAP SALES OFFICE
U. EVALUATION SCOPE, TEAM COMPOSITION, METHODOLOGY, CONTACTS

EVALUATION REPORT

AGRICULTURAL BASE MAPPING PROJECT

SRI LANKA

MAY 1982

PART I

Section I: EXECUTIVE SUMMARY

Basic Project Identification Data

Section II: CONCLUSIONS AND RECOMMENDATIONS

6

Project Purpose: meet the mapping requirements rural development in Sri Lanka.

Purpose of this Evaluation:

1. determine if the project is still necessary to meet the project's purpose;

2. determine if the project can be completed in approximately two years; and

3. if this is not possible, determine means for completing the project in alternative time spans and resources necessary for the Survey Department to sustain and complete the project taking into account modifications in the project that may be necessary.

Summary of Findings:

The project was originally designed to assist the Survey Department (SD) of Sri Lanka in acquiring the necessary equipment and technology to meet the demands on it for the provision of up-to-date maps and related data, on a priority basis, to be utilized in rural development project planning and implementation. Current maps were out-dated or did not contain sufficient back-up, detailed data to meet the needs of anticipated accelerated rural development activities of key Government of Sri Lanka (GSL) departments and ministries as well as international development and donor agencies.

The Evaluation Team (ET) found that the pressure on SD for this type of service is even greater now than when the project was first conceived and planned. The pace of development activities, particularly in rural areas, has quickened in response to current GSL policies and plans. The project remains a priority of the Minsitry of Lands and Land Development receiving the personal attention of the Secretary of the Ministry of Finance and Planning.

While the purpose of the project is officially reiterated, there have been three major revisions of the project plan, particularly the implementation plan and schedule which alter certain key aspects of the project as originally planned and iterated in the Project Paper (PP). The most important change has been the timeframe. It was estimated at the time the PP was prepared that the two major outputs of the project (a 1:10,000 and a 1:50,000 scale map) could be completed by the planned expiration of AID participation in the project (November 1983). Because of late project start-up, delays* in equipment, supplies and materials procurement, and problems in contracting for facilities renovation, SD revised its plans to suggest new completion dates for the two map series. These extended beyond the AID Project Activity Completion Date (PACD).

The other outputs were not significantly affected by the new SD plans: provision of specific, detailed maps and data on a priority development project and area basis; trained pilots and photographers; trained SD and User Assistance Center staff; a functioning User Assistance Center (UAC).

*due, in part, to inaccurate source, origin and cost estimates provided by the AID-financed feasibility and design contractor and, in part, to unforeseen cost escalation for certain items and unforeseen procurement problems which extended the time originally alloted for procurement.

significant assistance from a Swiss-funded remote sensing project. It is the intention of the SD that, in fact, the CRS will perform the role of the UAC and that UAC functions rather than its actual establishment be viewed as a project output.

The ET found the latest (April 1981) SD plan, prepared prior to ET arrival, to be feasible, with few modifications, in terms of dealing with the production of the two map series. Priority has been assigned to the completion of the 1:50,000-scale map series in a three-to-four year time span with no specific date assigned for the completion of the 1:10,000-scale map series, other than to estimate that it will probably take at least ten years. The specific need for greater detail maps and data can be handled by SD on an assigned priority basis for specific development projects and areas, without causing undue violence to the production schedule of the 1:50,000-scale map. It was felt, and the ET concurred, that this map would provide sufficient detail for most user agencies and that specific requests could be entertained for greater detail.

To meet this new plan and production schedule, SD has indicated additional needs which it wishes to meet, utilizing some of the balance in the AID loan. These are for additional equipment, materials, supplies, training and some short-term technical assistance. The Evaluation Team has reviewed these various lists with SD and has segregated out for recommendation those which are urgently needed, should and can be procured during the remaining life-of-project and will significantly contribute to meeting the project purpose. These total approximately $750,000 (including some pipeline items and contingencies) out of a current loan balance of $1,350,000.

The ET believes that the SD has just about reached the point where smooth production of the anticipated major outputs, from photo acquisition through final map production, can be realized. SD is aware of the major bottlenecks and is taking steps to correct them. Specific ET recommendations address this situation. ET believes that, given the reason detailed in the body of the report, the project, while technically three years behind schedule, has actually only recently entered what could be designated as production implementation. Most activities up till mid-1981 were of a preparatory nature, i.e., procurement, facilities renovation, technical assistance and training. If the SD is able to keep to its recent plan, reviewed and commented on by the ET, the ET believes that the project purpose basically will be met within the revised timeframe. The original schedule, even if no procurement and related problems had been encountered, was grossly optimistic under any circumstances.

The fact that the project is managed by a Deputy Surveyor-General, the second rung of authority within the SD, is indicative of the priority the project is accorded within the Department. SD management was found to be capable, active, enthusiastic and hard working. Both SD staff and management are and have been aware of the major problems faced in the project and have shown flexibility both in dealing with and in taking appropriate steps to correct these problems. These were discussed with considerable candor.

The ET found that USAID Mission staff was aware of the status and problems of major facets of the project, sensitive to the SD's requirements, and maintains excellent rapport with departmental personnel.

1. The SD should initiate production of the 1:50,000-scale map series immediately, using their proposed approach, with completion goal of three to four years. Limited production of greater detail maps should be done simultaneously only for designated high priority projects and areas.

2. SD should avail itself of the planned USGS technical assistance and immediately implement aerial triangulation capability.

3. SD should initiate procurement of critically needed additional equipment, supplies and materials, the latter to provide it with a two-year inventory.

4. SD should review its critical training needs and begin scheduling training for key individuals as well as key operational units as soon as feasibly possible.

BASIC PROJECT IDENTIFICATION DATA

1. Country: Sri Lanka

2. Project Title: Agricultural Base Mapping Project

3. Project Number: 383-T-0045; Loan Number: 383-T-20

4. Project Dates:

   a. First Project Agreement: February 28,1978
   b. Final Obligation: February 28, 1978
   c. Project Activity Completion Date (PACD): November 30, 1983

5. Project Funding:

a.	A.I.D. bilateral funding (loan):	$4,500,000
b.	Host Country Contribution:	$1,918,000 (equiv.)
	Total Project:	$6,418,000

6. Mode of Implementation:

   a. Direct procurement by the Survey Department with A.I.D. assistance: equipment, supplies, materials and technical services, including training.

7. Project Design: A.I.D. and Resource Development Associates

8. Responsible Mission Officials:

   a. Mission Director: Thomas Arndt, A.I.D. Representative, 1976-1978;
      Sarah Jane Littlefield, Mission Director, 1979 - present.

   b. Project Officer: Jeffrey W. Evans, 1977 - present.

9. Previous Evaluation and Reviews:

   None, other than informal USAID/Survey Departtment reviews.

10. Cost of Present Evaluation: (Budget figures only)

a.	USGS Contract:	$40,000
b.	Development Associates, Inc. Contract:	$17,962
	Total	$57,962

SECTION II: CONCLUSIONS AND RECOMMENDATIONS

The major findings and conclusions of this evaluation are summarized here, each followed immediately by one or more recommendations that derive from the respective conclusion or "finding". Where appropriate, references are given to Part II, Section V, indicating sub-sections upon which those conclusions or findings are based.

PP: Project Paper

SD: Survey Department of Sri Lanka

ET: Evaluation Team

ABMP: Agricultural Base Mapping Program

USGS: United States Geological Survey

1. Operation Analysis

The PP described an operational approach, schedule, and resources required for the SD to produce nationwide coverage of two ABMP map series' within a six-year time frame. The ABMP has suffered significant delays due primarily to long procurement cycles for aircraft, equipment, materials and initial technical assistance, and to labor management constraints resulting in poor worker motivation, high turnover, and restriction to single shifts. The schedule proposed in the PP, based on an AID-financed feasibility study, was clearly over-optimistic with respect to staffing requirements, productivity, and procurement scheduling. The SD has continuously reacted to delays by readjusting schedules and implementing operational procedures necessary to begin production. Now that most of the resources required are in place, the SD has proposed a schedule for a 4-year completion of 1:50,000-scale maps and limited production of 1:10,000-scale maps in priority areas. The ET feels that this plan, with minor variations, is the best approach with respect to requirements by user agencies, reasonable workflow estimates, effective use of available capacity, and budget considerations. Part II, Sect.V, ss 2.5).

Recommendations:

The SD should initiate production of the 1:50,000-scale series immediately, using their proposed approach, with a completion goal of 3 to 4 years. Limited production of 1:10,000-scale maps should be done simultaneously for identified high priority areas, as planned,using capacity not critically needed to complete the 1:50,000-scale series. The SD should gear up smooth workflow for consistent long term 1:10,000-scale production of about 200 maps per year, once the 1:50,000-scale series is completed. Efficient procedures and unit costs should take precedence over a target completion date for the 1:10,000-scale series.

2. Map Production Process:

An evaluation of the map production processes, phase-by-phase, has indicated that the SD has implemented an effective technical approach. Generally, procedures are consistent with those recommended by the PP. Deviations from the PP are, in most cases, warranted. The initial problems with aircraft and acquisition of aerial photos have been corrected. The aircraft is operational and the flight and maintenance agreement made with the Sri Lanka Air Force is very adequate to meet future needs. (Ref. Sec.V, ss 3.1.3). Remaining procedural problem areas are in aerial triangulation (ref. 3.4.3 and 3.5.3 d)lettering (3.9.3), and printing (ref. 3.12.3). In most cases, deficiencies had been already identified by the SD with appropriate plans for improvement.

Recommendations:

The current agreement with the Sri Lanka Air Force should be continued to complete high altitude photo coverage in 1983 followed by systematic lower altitude coverage for the 1:10,000-scale series. Aerial triangulation capability should be implemented immediately with the technical assistance which SD has requested from USGS. The lettering operation should be improved by immediate procurement of a photo-typesetter and by a map design change consolidating all lettering into a single black color. The third printing press should be installed and necessary training in printing and ink technology should be initiated to avoid a printing bottleneck. As planned by the SD, the number of printed copies per edition should be considerably reduced from the PP plans.

3. Facilities:

The SD has recently completed (about three years behind schedule) most of the facilities changes recommended by the PP The electrical system still suffers occasional voltage fluctuations and community-wide "brownouts", not considered serious to the ABMP. The air-conditioning system is functional, although generally turned off during non-working hours to reduce electricity costs. This has caused unstable temperature and humidity over a 24-hour period which adversely affects stability of materials. The PP recommendation to consolidate the two photo labs has not been done and is deemed unnecessary by the SD. (Ref. Sec.V, 4.3).

Recommendations:

The SD should maintain consistent temperature and humidity in the platemaking and printing facility over a 24-hour period. This might be done by relocating platemaking into the printing facility and by keeping the airconditioning continuously on or continuously off. Consolidation of the two photo labs is not necessary. Light leaks in the map finishing lab should be sealed. Photographic materials requiring refrigeration should be stored in cold storeage, requiring more effective use of the cold storage facility.

4. Equipment:

Most of the equipment recommended by the PP has been installed and is operational. Due to underestimation of equipment costs by the PP, based on the feasibility study, and to inflation and procurement delays, many items were considerably more expensive than estimated and caused scheduling delays. Approximately $1,880,000 has been expended for equipment using loan funds: $119,025 over budget. Many recommended items were deleted by the SD which were considered unnecessary or of a lower priority to avoid further cost overruns. Some items planned for AID loan funding were financed instead under a Swiss project. Some additional equipment, totalling about $110,500, is still required for effective implementation of the ABMP. Equipment maintenance continues to be a problem due to the complexity of new systems, especially in electronics, and the inability to bring in American or European factory representatives on an on-call basis. (Ref. Sec.V, ss 5.1.3 and 5.2.3).

Recommendations:

Loan funds totalling about $110,500 should be used immediately to procure equipment vital to ABMP. Major items include a photo-typesetter and related processor; accessories for photo-lab cameras; and spare parts for aircraft, photographic processors and the printing presses. In-house equipment maintenance capability should be improved by additional factory training in photogrammetric, photographic, and printing equipment.

5. Materials:

As with equipment, estimated cost of materials was grossly underestimated in the PP. In addition, the amount of materials required per map were underestimated. There has also been an enormous escalation in price for most materials. The SD has used a combination of loan and SD funds to build up a modest inventory. The ET feels that this inventory is not sufficient to meet the needs of the proposed operational plan for the next several years. Specific material needs for a two-year program have been identified, totalling an estimated $300,000 in expenditures. Maintenance of an adequate supply of materials for a 200-map per year level of production in the future will will require an additional $175,000 per year, plus inflation. Within the SD, inventory and procurement planning methods have a tendency to be short-sighted which could cause significant delays preventing smooth workflow or meeting planned schedules. (Ref.Sec.V, ss.6.3).

Recommendations:

Materials, totalling about $300,000, required for the next two years should be ordered now in order to meet the needs of the recommended short-term operational plan. The SD should plan to procure additional materials costing $175,000 plus inflation for at least eight years beyond 1983. The following actions should be initiated to reduce materials costs: (a) single-color lettering; (b) reduced number of colors (i.e. eliminate yellow); (c) reduced edition size per map; and (d) switch to diazo coated press plates instead of pre-sensitized plates. The SD should improve long term planning and monitoring of materials used or needed, possibly by centralizing the supervision of these functions.

6. Technical Assistance and Training

Technical assitance has not been utilized to the extent envisioned in the PP. The SD contracted with a U.S. firm to provide up to 36 months services of a long-term technical advisor, up to six months of services of a photo-pilot instructor and other miscellaneous short-term advisory services on as needed and optional basis. The photo-pilot services were provided in a three-month period. The long-term technical advisor provided effective services, including on-the-job training, the conducting of some training course and the preparation of a manual on cartographic procedures. His services were terminated after a stay of eighteen months in-country, due to his medical evacuation and subsequent death.

short term consultants and technicians. Additional loan-financed technical assistance has been requested for aerial triangulation work and is scheduled to begin late this month or early June.

Substantial effective technical assistance for the Center for Remote Sensing (which incorporates many of the functions originally planned for the User Assistance Center) has been provided under a Swiss-funded remote sensing project.

Funds were designated in the PP budget for five areas of training: (1) remote sensing training course/seminar in Sri Lanka; (2) USGS training courses in the US; (3) international study fellowships; (4) equipment familiarization, and (5) international conference attendance, (the later designated for management-level personnel).

The remote sensing training course was underway during this evaluation and conforms with original plans, but is not financed by AID.

Equipment familiarization courses have been held, financed from training funds in the ABMP loan budget as well as in conjunction with equipment procurement costs. The latter have not always been totally satisfactory, particularly the training given in conjunction with the acquisiton of the new printing presses.

A major change in the utilization of training funds has been to substitute technical training in India for the broader international exposure envisioned in the PP for senior staff as well as for technical staff. This change enabled SD to train more technical staff at a considerable savings, thus accounting for the large balance of unexpended remaining in the training component of the budget.

Additional training needs have been identified by the SD and the ET has responded to the suggested list in preparing its recommendation (Ref.Sec.V, ss7.4).

Recommendation:

The ET agrees with the SD that long-term technical assistance is not required and that the only short-term technical assistance needed at this time is for assistance in solving some aerial triangulation problems.

The request for this assistance was made by the SD before the ET arrived in-country, and the ET endorses this request feeling that such assistance is critical to the solution of a major bottleneck in photogrammetry operations.

The ET recommends that the SD should make immediate plans to secure specific training to improve current deficiencies which have been identified elsewhere in this report. The cost of this training is estimated at $50,000 (Ref. Sec.V, ss 7.4). Identified training needs include management exposure to other mapping agencies, such as USGS; analytical photogrammetry, printing and ink technology, half-tone photography, airplane mechanics, equipment maintenance and operation, and routine technician training.

performance of relatively complex job duties. There is a tendency for trained or highly motivated workers to leave the government service, attracted by substantially higher salaries offered elsewhere. This is a systemic problem with government service universally, but seems especially serious in the context of this project in Sri Lanka. It was quite underestimated or overlooked in the PP. To carry out the proposed production plan, the SD proposes increased staffing, especially in the drawing office. Staffing capacity requirements projected by the ET confirm a critical shortage for those map finishing phases performed in the drawing office. The method of production management used by the SD tends to be crisis-oriented, lacking centralized monitoring of workflow, cost accounting, and resource planning. (Ref. Sect.V, ss 8.3).

Recommendation:

The SD should plan on salary support for 250 technical staff exclusive of management and laborers, to meet the proposed operational plan. Two critical positions, Chief Photogrammetrist and head of the printing room, should be immediately filled with technically qualified people. Three or four photogrammetric technicians should also be immediately recruited. By 1983, over 100 draftsmen should be assigned for the Preparation and Drawing Office units. To meet the proposed schedule, the SD should institute incentive pay to reward productivity. It is not recommended that SD initiate a double shift, given the current labor management constraints. The SD should centralize a plans and production management staff function to improve workflow monitoring, maintain production costs, and perform short and long range resource planning.

8. User Assistance Center:

A self-contained User Assistance Center as proposed by the PP has not been implemented. However, most of the original objectives are being met through the SD Center for Remote Sensing (CRS) or other user-oriented services of the SD. A Swiss grant, providing equipment and over six man-years of technical assistance, has provided the means to develop the CRS to be quite responsive to the needs of user agencies concerned with resource planning. The emphasis of the CRS is on use of both satellite imagery and conventional photography for resource applications. Other units within the SD carry out map sales, photo sales, and special surveying or mapping projects which are user-specific. Other Sri Lanka government agencies as well as implementing agencies for various rural development projects are generally satisfied with the level of support and assistance provided by the SD. (Sect.V, ss.9.3, and 9.4).

Recommendation:

The SD should maintain the Center for Remote Sensing as an operational user assistance center sensitive to applications of this technology for resource agencies. The CRS should be self-supporting by grants or pay-for-services. The SD should also continue the current level of map and photo public sales and support surveying or cartographic special projects within available capacity. It is not recommended, at this time, to form a User Assistance Center as originally designed. It is not recommended to procure additional remote sensing equipment with loan funds.

9. Intermediate Scale Land-Use Mapping:

The SD has planned to include the same land-use categories proposed for the 1:10,000-scale series for the 1:50,000-scale series. The land-use mapping is a time-intensive activity for photo interpretation, scribing, and color separation processing. Concurrently, for a number of districts, the Center for Remote Sensing (CRS) is producing land-use maps at 1:100,000-scale using old 1:63,360 maps for the planimetric base. This is an apparent duplication of effort aimed at the same user agencies who need land-use categories for resource planning or monitoring. (Ref.Sect.V, ss.2.5.2).

Recommendation:

The SD should consider elimination of land-use categories on 1:50,000-scale maps, resulting in the potential to shorten the target completion by over a year. Compiled and edited 1:50,000-scale bases should be supplied to the CRS for 1:100,000-scale landuse mapping on an up-to-date base. Ultimately, after initial publication of 1:50,000-scale topographic maps, the 1:100,000-scale copy could be enlarged to 1:50,000-scale for a land-use overlay if user agencies identify such a requirement.

This is a suggestive recommendation, which SD has taken under advisement. SD was not prepared to adopt such a recommendation when the ET made it.

10. Alternative Procedures for 1:10,000-Scale Mapping

Basically, as identified in conclusion No.2 above, current SD procedures are adequate for ABMP operations. There are a number of phases, however, which are using outdated or inefficient methods. While it is recognized that dramatic changes of procedure are disruptive in the short-term, some changes are worthy of consideration for the benefit of long-term efficiency and low unit costs. (Ref. Sec.V, ss 2.5.3).

Recommendation:

The SD should consider the following procedural changes for long-term 1:10,000-scale mapping after completion of the 1:50,000-scale series: (a) use of up-to-date low altitude (i.e., 1:10,000 feet) interpretation photos for up-to-date feature classification; (b) field classification before photogrammetry using photo-interpretation and annotation methods with low altitude photos; (c) scribing instead of pencil copy for photogrammetric manuscripts; (d) increased use of computer software to aid photogrammetry; (e) single color lettering; (f) elimination of yellow color; (g) use of rectified or orthophoto imagery at 1:10,000-scale for a short term, low cost temporary product.

In most cases, training or visitation of operational managers to agencies such as USGS would be recommended before implementation.

11. Additional Equipment:

Equipment needs vital to ABMP have been identified in conclusion No.4 above. However, to improve flexibility or capability, the SD has identified additional equipment deemed desirable. The ET has also

identified some desirable options depending on the operational approach and SD budget support. (Ref. Sec.V, ss.5.1.3).

Recommendation:

The SD should procure additional equipment which improves capability to meet user needs other than that defined by the ABMP if alternative funds are available. About $329,000 in equipment has been identified by the ET deemed worthy of consideration, including a new aerial camera, roll film and paper processors, surveying equipment, a digitized coordinatograph, and an orthophoto attachment to an existing photogrammetric plotter.

110,500 Equip ABMP
300,000 Materials
50,000 Training
329,000 Additional Equip.
789

EVALUATION REPORT

AGRICULTURAL BASE MAPPING PROJECT

SRI LANKA

MAY 1982

PART II

Section III: THE SRI LANKA CONTEXT

Section IV: DEVELOPMENT OF THE AGRICULTURAL BASE MAPPING PROJECT

Section V: DISCUSSION OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

PART II

Section III: THE SRI LANKA CONTEXT

1.0: Government of Sri Lanka Development Plans and Strategy - 1977

At the time this project was first conceptualized, as well as when the AID loan was authorized, a conrnerstone of the Government of Sri Lanka's (GSL) development policy was the attainment of food self-sufficiency. This was to be achieved through the inter-linking of various rural and agricultural development schemes, programs and projects. A major tool to be utilized in planning and implementing these various activities and endeavors was identified: accurate up-to-date maps and related data both for the country as a whole and, in more specific detail, for priority development areas or projects.

Cognizant of the fact that the maps and data available in the various ministries and departments charged with the implementation of this policy were insufficient or out-dated, the GSL assigned the task of producing this material to the Survey Department (then a department of Ministry of Agriculture and Lands). The manner in which the Survey Department (SD) responded to this challenge is the topic of the next section (IV).

2.0: USAID Strategy - 1977

In reviewing GSL development plans and strategy, and in conjuntion with discussions with various GSL officials, USAID focused its development assistance strategy on providing assistance to the GSL in developing projects which would address the question of achieving food self-sufficiency by increasing domestic food production. Early in the development of its program, USAID became convinced that one essential tool would be the provision of accurate maps and related data. It agreed with the self-assessment of the Survey Department that it lacked certain key equipment and advanced technologies associated with the utilization of that equipment. It was felt that if AID could assist in financing the acquisition of this equipment (including an aircraft), the installation and instruction on utilization of the equipment as well as specific training and advisory services in new technologies, this would provide not only the GSL but donor organizations (including AID itself) with an essential planning and implementation tool. These considerations led to the development of the Agricultural Base Mapping Project, which is discussed in greater detail in the next section, (IV).

3.0: GSL Development Plans and Strategy - Current

The current government was elected in 1977, assuming office in 1978. It not only reiterated the concern of the previous government that Sri Lanka should become self-sufficient in food production, thus eliminating the drain on foreign exchange to pay for food imports, but it clearly stated this as a major priority and instructed the various ministries concerned with rural and agricultural development to pursue a vigorous program to accelerate achievement of this goal. The pace

and the intensity of development activities have accelerated markedly in the interim, particularly in the last four years. While the list of potential and actual GSL clients for the services of the Survey Department remains essentially the same as that described in the Project Paper (e.g. ministries with portfolios in national planning, agriculture, irrigation, power and highways and the Mahaweli Development Board) the demand for services has intensified. The clients now include almost all of the major donor agencies operating in Sri Lanka (UN agencies, EEC, ADB, IBRD, CIDA, Australian High Commision, as well as AID). The Survey Department finds it necessary to provide certain data and/or aerial surveys and aerial photoprints for specific, priority projects in advance of completing the planned 1:10,000 and 1:50,000-scale maps.

The Survey Department, therefore, finds an even greater demand for the type of servies the project was designed to assist it in providing. Concurrently it finds that the priority originally accorded this project and its major outputs is, at least potentially, in competition with the priority assigned certain projects which the GSL feels are essential to meeting its developmental goals.

4.0: USAID Development Strategy - Current

In 1978 USAID was accorded full mission status and a new Mission Director appointed in August 1978. The pace of project identification, planning, as well as implementation, has accelerated with major assistance concentrated in three categories: Mahaweli Basin Development, Food Production and Natural Resource Management, and Human Productivity and Well-Being. The first two categories directly impact on the GSL priority of achieving food self-sufficiency and are supplementary and complementary to other donor projects and host government programs designed to achieve the national goal.

The need for the services of the Survey Department is even more critical to the current AID program than when the project was planned and authorized. USAID continues to stress the importance of completing the ABMP within the shortest time-frame feasible. It has been cognizant of the delays in meeting project activity targets and the reasons for these dealys. It is open to suggestions as to how the project could be improved, particularly from an operational standpoint.

It is in keeping with this desire to assist the Survey Department that the USAID scheduled the current evaluation. One of the areas which the Evaluation Team was instructed to study was SD operations from the standpoint of capacity, requirements and scheduling, and to make recommendations on alternative approaches to completing map production. As a prelude to the evaluation, SD prepared a newly-revised operations plan for the ABMP. This is discussed in detail in Section V.

Section IV: DEVELOPMENT OF THE AGRICULTURAL BASE MAPPING PROJECT

1.0: With the assignment of providing up-to-date maps and related data to ministries charged with the implementation of GSL development policies, the Survey Department made a determination that it would have to introduce new technologies requiring some rather substantial outlays for equipment, including the probable acquisition of a replacement aircraft. The one it had at the time was inoperative.

The actual conceptualization of the project began in 1975, when the Ministry of Agriculture and Lands requested the Surveyor General to attend a FAO/UNDP planning session in which the components of a proposed $32,000,000 UN allocation were to be discussed. The Survey Department had prepared a summary paper for a proposed "National Map Service and Aerial Photography" project which was then estimated to cost $2.3 million.

UNDP took this preliminary project proposal under advisement and the Survey Department prepared a more detailed proposal in October 1975, followed by a formal project proposal document entitled: "Agricultural Base Mapping Project; subtitled: Project Request for Production of National Map Series, Photography of the Island, Strengthening of Geodetic Control." This was prepared by the Survey Department with assistance from the Agricultural Programme Preparation Unit in the Ministry of Agriculture and Lands, and was dated January 1976. The required foreign exchange financing was estimated at £1,431,528 (approximately $2.5 million) with the bulk of procurement to be made in the U.K. with the remainder in Switzerland and West Germany.

In October 1976 the Survey Department was officially advised that, due to cash-flow problems, the UNDP could not undertake to finance the project and recommended that the parent ministry (Agriculture and Lands) seek financing through the then Overseas Development Ministry of the U.K.

The Survey Department had, however, been alerted to this possibility a few months previously and had been advised by ODM that it could not consider this request in its current assistance planning for Sri Lanka. Overtures were then made to the AID Representative in Colombo who secured AID approval and financing for a consulting firm to conduct a feasibility study of the potential project.

AID selected the firm of Resource Development Associates (RDA) of Los Altos, California for this study. The RDA Team spent most of the month of October in Sri Lanka and prepared its report: "Agricultural Resources Inventory and Base Mapping in Sri Lanka: A Program Assessment and Evaluation", in November 1976.

Based on this report, AID prepared a Project Review Paper (PRD), also in November 1976. The foreign exchange requirements of the project (proposed AID contribution) were estimated at $3.3 million with the following components: Commodities - $2,390,000; Training $50,000; Technical Assistance $50,000; Contingencies - $810,000. The project purpose was stated as being "to develop the Survey Department's capability to meet current and continuing national photogrammetric and cartographic needs." The major anticipated output was the production of a 1/10,000-scale base map with selected, specialized larger scale maps specifically designed for priority projects or regions. The institutional outputs were identified as the improvement and expansion of the SD Air Survey and Map Production Units.

The Survey Department gave its approval of the PRP in November 1976 and it was reviewed in the same month by APAC in Washington. The PRP was approved and the approval message was transmitted to the field in January 1977. This message contained certain issues which were to be addressed in designing the project and in the preparation of the Project Paper.

AID again contracted with RDA to perform the project design study, which was completed in April 1977. This study recommended an expansion of the scope of activities to be covered in the project while still focusing on the basic purpose -- the production of an agricultural base map. For instance, the creation of a "Survey Research Center" discussed in the earlier feasibility study, was further discussed in this report under the concept of a combined remote sensing and survey research center. The output of a nationwide 1:10,000 map was still the first priority of the project, which was anticipated to be feasibly accomplished in five years. The suggested AID contribution was for a total of $3,125,000 with a commodity (equipment, materials and supplies) component of $2,258,200; technical training of $110,000; technical assistance of $315,000 (a two-year full-time technical advisor and 13 person-months of short-term technical advisory services); and the balance ($541,800) for contingencies and inflation factor.

Following various reviews of this document and exchange of correspondence between AID/Washington and USAID/Colombo and between USAID and the Survey Department, a Project Paper was finalized in August 1977 which incorporated both the RDA study of April 1977, mentioned above, and an addendum to that study which was prepared at the request of AID to address certain issues that had come up during the review process.

The PP suggested a price tag of $6,418,000 for the total life of project (a six-year period). The GSL contribution to the project was estimated at $1,918,000 and the AID contribution, a loan, was proposed at a total of $4.5 million with the following components: commodities - $2,710,000; technical training - $254,000; technical assistance - $503,000; contingencies and inflation factor - $1,033,000. Revision of cost estimates for equipment and materials (particularly equipment for photo acquisition, aircraft, field control and edit) accounted for the increase in

estimated costs in this component. The technical assistance and training components were increased since the anticipated project output now included a nationwide 1:50,000-scale map series. During the review process in Washington it was recommended that, given the inclusion of this map which it was estimated could be completed in two years, the long-term advisor should be assigned for a period of up to three years and that the person-months of short-term advisory services be increased proportionately.

Final review of the Project Paper was held in Washington in August with representatives from USGS, AID, USAID/Colombo and the Survey Department participating. The Survey Department notified USAID that it accepted the Project Paper and it was presented to the AID Development Loan Committee in late September. The loan was authorized on 30 September 1977 and the GSL was officially notified of this approval on 4 October 1977.

Project chronology following AID loan approval is discussed in Section V below.

Section V: DISCUSSION OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

1.0 INTRODUCTION

1.1 Description of Contents

This section constitutes the analytical section of the Evaluation Report. Findings and conclusions of the Evaluation Team are discussed under various sub-headings with cross-references to more detailed discussion and data in the appendices. With few exceptions, these discussions are concluded by listing the specific recommendations of the Evaluation Team.

1.2 Methodology

The detailed scope of work for the evaluation, including the purpose and the general as well as specific topics to be explored, is reproduced in Appendix U. The composition of the Evaluation Team, the methodology it employed, the contacts it made, and a summary of materials it reviewed are also described in that Appendix. To assist the reader, the major outline of the evaluation scope of work is listed here since the sub-sections which follow directly address these points.

1.2.1 Review operations from the standpoint of capacity, requirements, and scheduling to recommend alternative approaches to completing map production.

1.2.2 Review process steps from the standpoint of workflow, staffing, productivity, equipment, and facilities and make recommendations. Process steps include aircraft, photo acquisition, air surveys lab, field control, aerial triangulation, photogrammetric compilation, field edit, scribing, lettering, map production laboratory, platemaking, and printing.

1.2.3 Review plans for the operation of a user assistance center and comment on viability of such plans.

1.3 Arrangement and Sequence of Material

The Evaluation Team felt that the sequence of topics discussed was the best manner to present its findings and conclusions to accommodate both the lay as well as the technical reader. Since most readers will either not be acquainted with the basic project doucments or have access to them, each sub-section first addresses the recommendations and project plan contained in the Project Paper, which is generally designated "PP". The actions of the Survey Department (designated "SD") in following or adapting the plan are then summarized. Finally, the findings, conclusions and recommendations of the Evaluation Team are presented, usually prefixed with the designated "ET". (Some findings are mentioned under the SD headings, since they came to light in various meetings and interviews with SD staff.)

1.4 General Observations

1.4.1 The first, major problem confronting the Evaluation Team was the fact that the project is running far behind schedule. This was documented both in various communications and reports as well as in the several briefings the ET received in Washington and in Colombo. This was a "given" in the evaluation process requiring no extensive research for corroboration.

The Evaluation Team did, however, research the probable causes for the apparently serious discrepancy between planned completion of target activities and their actual current status. The ET found seven areas which contributed to the time lag. Most of these are further discussed in the appropriate subsections:

(a) Following loan authorization September 1977 there were three major actions which were required to get implementation underway: (1) signing of the loan agreement, (2) meeting the Conditions Precedent, and (3) contracting for the technical advisory services, which was excluded from the CP as the only procurement function permissible prior to satisfying the C.P.'s. (This was to allow the SD to have a technical advisor on board early on to assist in procurement.) The planned and actual dates are:

	Planned	Actual
Loan authorized	Sept./77	Sept./77
Loan agreement signed	Nov./77	Feb./78
CP's met	Jan./78	Nov./78
TA contracted	Dec./77	Sept./78

These delays alone set the actual implementaton of the project back by at least nine months.

(b) The procurement and delivery of the aircraft were to have been accomplished by November 1978 with simultaneous arrival of the photo pilot instructor. This actually took place in March 1980, too late in the season to begin the aerial photography, which had been scheduled to begin in December 1978. Project aerial photography did not begin until early 1981. This delay resulted from procurement of an aircraft for more complex than envisioned.

(c) Procurement of initial equipment requirements, while also experiencing similar delays due to delayed start-up of the project, faced a far more serious constraint in that the recommended equipment list (including specificatons and pricing provided by the feasibility and project design contractor) was in many instances totally inaccurate, both as to prices and source. It is possible to assume that out-dated catalogues had been used in compiling the equipment list.

(d) Renovation of facilities suffered scheduling setbacks both from the initial project delay already noted as well as problems connected with the procurement of services of a local contractor. No flexibility for the latter was included in the PP suggested implementation schedule. Facilities renovation was scheduled for November 1978. It has only recently been completed.

(e) Follow-up equipment procurement and procurement of initially required materials and supplies also suffered setbacks for reasons identified in (c) above, particularly inaccurate listing of recommended sources and prices.

(f) While all of the above were critical to meeting the PP suggested production schedule, even if they had all been accomplished as planned or with only a minimum of delay so that full production could have been initiated on time, the ET has determined that the production schedule recommended in the feasibility and project design studies, on which the PP was based had serious deficiencies and was quite unrealistic, particularly in some phases of production. These findings are discussed more fully in the subsections which follow. They are noted here since they collectively contributed to the factor already identified: the project is significantly behind planned schedule.

1.4.2. It should be noted that the SD was cognizant of these delays and took them into consideration in preparing three new plans (revisions of the original plan contained in the PP): one in April 1979, a second in October 1981 and a third in April 1982. These are discussed below in subsection 2. Beginning with the first plan, it was conceded that the dates for completing the two nationwide maps (1:10,000 and 1:50,000) would not be met by November 1983, as suggested in the PP. In fact, SD began talking about completion dates in the 1990's. This is covered in the next subsection.

1.4.3. It is apparent to the Evaluation Team that the revisions of overall plan for the ABMP alter certain key aspects of the originally designed project, particularly the time-frame, but the project purpose remains inviolate: to meet the mapping requirements of rural development in Sri Lanka. The major project outputs are still stated as valid and are included in the latest plan: (1) two nationwide maps series at 1:10,000 and 1:50,000-scale (2) greater detail maps on a priority development project and area basis; (3) a functioning User Assistance Center; (4) trained pilots and photographers; (5) trained staff for SD and user agencies. (These are discussed in subsequent subsections.

1.4.4. What remains a subject for policy consideration, definition, and refinement is what the final version of the actual agricultural base map will be, i.e. what specific details will be included, how the 1:50,000 and the 1:100,000 scale maps are rationalized. (This is further discussed in the subsections which follow.)

1.4.5. Finally, it should be stated that, given the factors indicated above and discussed in more detail below, the project, in terms of SD participation and implementation, will extend well beyond the currently planned expiration of AID participation, i.e. November 1983. The ET gives more explicit details below, but it is essential to note that the budget implications for continuing this project activity beyond November 1983 are that at least $200,000 annually in foreign exchange alone will be required to keep the project going and meet its ultimate objectives.

2. OPERATIONS ANALYSIS

2.1 Map Requirements

2.1.1 1:10,000-Scale (Maps)

This is a metric scale map of a resolution of one millimeter representing 10 meters on the ground. At this scale, most roads, buildings, trails, small parcels and local boundaries can be adequately portrayed without clutter. The map is printed in six colors and includes detailed land use categories such as rice paddies, coconut, tea, etc. Contour intervals vary from 2 meters to 20 meters, depending on terrain. 5 meter contours are the smallest interval photogrammetrically compiled. Most of the map is compiled from aerial photography flown at 25,000 feet above terrain. Stated accuracy standards meet U.S. National Map Accuracy Standards, where 90% of map points are within 1 mm horizontally and ½ contour interval vertically. Production on the 1:10,000-scale series has been ongoing for several years with 17 maps completed through printing.

The 1:10,000-scale map series meets most of the base mapping requirements of user agencies and developmental projects. Considerably more detail can be mapped at this large scale than on a 1:50,000-scale map, such as precise location of structures, complete road and trail networks, a smaller contour interval necessary for irrigation and engineering uses, and depiction of parcel sizes down to 2 acres for census and land-use requirements. There is some feeling that since fairly high-altitude photography is being used for both map series, some of the requirements for large-scale accuracy and content are being compromised. This argument tends to justify completion of 1:50,000-scale series first and then reconsider using a more appropriate photo scale for large scale mapping based on updated requirements at the time. It is the opinion of most Survey Department staff that completion of the 1:50,000-scale series has higher priority requirements than the 1:10,000-scale series except in localized cases.

2.1.2 1:50,000-Scale Maps

This is a metric scale map of a resolution of one millimeter representing 50 meters on the ground, or 2 centimeters per kilometer. At this scale, many built up areas are to be generalized with a tint rather than portraying all buildings. Land-use categories, if mapped, would be similar to 1:10,000-scale maps, although delineation would be more generalized and small parcels not shown. The map is intended to replace the current 1 inch to 1 mile map series considerably out-of-date. Contour intervals would typically be about 20 meters. Horizontal and vertical accuracy may not meet U.S. National Map Accuracy Standards in many areas, especially if old source data is salvaged to expedite map production. This series has not yet begun production, although design of the collar and symbology has been done. Aerial photography for 50% of the country, acquired in 1981, will be used to begin the mapping.

At the suggestion of USGS, the PP proposed production of a 1:50,000-scale base mapping series to be compiled by the Preparation Unit by photo-reducing compiled and edited 1:10,000-scale manuscripts. Thus, a nationwide intermediate-scale map series could be produced without serious impact on field and photogrammetry phases. There seems to be a considerable justification for such a series on a number of fronts:

a) User agencies need a resource planning map to replace badly out-of-date 1:63,360-scale, one inch to the mile maps.

b) Only 92 maps would provide nationwide coverage as compared to over 1800 1:10,000-scale maps, reducing cartographic finishing and printing impact.

c) If produced as a by-product of 1:10,000-scale compilation overall cost and capacity requirements are minimal.

d) If produced first, long-term costs are increased due to some duplication of effort and 1:10,000-scale mapping is delayed, although nationwide coverage of up-to-date maps is feasible within a 3-5 year time-frame.

d) Complete coverage of a popular map series in a short time is an asset which aids in budget support and visibility of the Survey Department capability.

2.2. Production Capacity

In order to analyze an operational approach, scheduling and workflow must take productivity and capacity into account as constraints. Based on observations by the Evaluation Team (ET), some certain and others estimates, production capacity has been re-evaluated and tabulated in Appendix A. A phase-by-phase breakdown is shown for three separate production schemes: (a) production of 1:10,000-scale maps; (b) production of 1:50,000-scale maps; and (c) production of 1:50,000-scale maps from already compiled and edited 1:10,000-scale manuscripts. The figures are, in some cases, different than the PP estimates. Capacity units, for ease in determing schedules, are in maps per man-year. In some cases maximum maps per year are indicated if there is an equipment or staffing limitation.

2.3. Review of Proposed Plans

2.3.1 PP:

The PP proposed production of both 1:10,000-scale and 1:50,000-scale map series to be completed in a six-year time frame. There was considerable ambiguity, however, in the proposed scheduling and production impact. Much of the PP analysis was concerned with only 1:10,000-scale production. The 1:50,000-scale mapping was added at the end after USGS review. The ET feels that the real impact of producing both series simultaneously was grossly underestimated by PP. Misleading scheduling and ambiguities are demonstrated with

the following example:

a) endorsement of USGS suggestion to produce 1:50,000-scale maps from reduced compiled 1:10,000-scale manuscripts, thereby not adversely affecting photography, surveys, or photogrammetry (see Project Paper, Vol.II, sec 2.0).

b) proposed schedule implies production of 1:50,000-scale maps first, to be completed in 2 years, delaying 1:10,000 -scale completion by one year (see PP, Vol.I) pages 5,11, 49 and 50).

The production impact of producing 1:50,000-scale mapping in a two-year time frame was not estimated in sections dealing with capacity, staffing, and workflow.

2.3.2 Survey Department Plan - April 1979

The SD published an informal document in April, 1979 revising the Project Paper implementation schedule due to a one-year delay that had already occurred. The delay was attributable to underestimation of the time required for equipment procurement and to problems with acquiring aerial photography. Two deviations in procedure were proposed:

a) Utilize scribing rather than subtractive filtration to produce color separated plates, justified by improved operational procedures suggested by Technical Advisor.

b) Produce 1:50,000-scale maps <u>from</u> reduced 1:10,000-scale maps due to capacity problems in photogrammetric compilation.

The revised schedule delayed completion of 1:10,000-scale series until 1986 and implied completion of 1:50,000-scale series in 1987.

2.3.3 Survey Department Plan - October 1981

An informal SD document was prepared in October 1981 which dramatically altered the April 1979 schedule. By this time, significant delays had occurred, especially concerning facilities renovation and procurements. The original 10-month plan for facilities and procurement had stretched over 3½ years. The aerial photography was initially flown in 1981, beginning the map production process that was originally scheduled several years before. Budgetary reductions also constrained staffing levels. Labor factors made the feasibility of double-shift operations unlikely. A new schedule was developed with new productivity estimates based on single-shift operations. This schedule resulted in estimated completion of 1:10,000-scale mapping in 1991 and 1:50,000-scale mapping in 1992. An alternative was recommended to go back to the original PP plan to complete the 1:50,000-scale mapping first, then begin systematic production of the 1:10,000-scale. This resulted in a projected completion of the 1:50,000-scale in 5 years with single shift operations (i.e. 1986) and completion of 1:10,000-scale in 9 additional years (i.e. 1995).

2.3.4 Survey Department Plan - April 1982

The SD is now endorsing a modification of the October 1981 plan to provide nationwide coverage of 1:50,000-scale mapping in a compressed time frame with limited 1:10,000-scale production in selected priority areas. An April 1982 document has been prepared with a specific plan requiring about four years and is included in Appendix B.

Two major strategies in this plan are:

a) Compromise level of content, accuracy of base, and contour interval of 1:50,000-scale maps to improve workflow and productivity and to enable flexible use of current production capacity. For example, considerable amount of salvaging of contours from older sources is proposed rather than new photogrammetric contouring. Compilation from rectified imagery is proposed to substitute photogrammetric plotting on many of the maps. Horizontal control would be provided by scaling to the old 1:63,360 maps instead of acquiring new control and doing aerial triangulation. Generally, the strategy is to reduce the workload in the current photogrammetric bottleneck.

b) Gain budget support on the justification of completing a major series in a short time frame. Additional staffing and incentive pay schemes to improve productivity require such support.

A reduction of 1:50,000-scale completion from 4 or 5 years to 2 years has been mentioned verbally, although a specific plan to accomplish that goal has not been done yet. Even with incentive pay, a four-year total time frame seems overly optimistic.

2.4 Analysis of Alternatives

2.4.1 1:10,000-scale mapping only

To project a capacity, staffing level, and schedule for completion of a major map series, some assumptions are made. In this case, after ET analysis of technical and management constraints, the following assumptions are used for 1:10,000-scale mapping:

a) Photogrammetric compilation is the major pacing phase, limited to about 240 maps per year per instrument shift.

b) Incentive Pay will be available to photogrammetric technicians as well as field revision surveyors.

c) Double shifting is probably not feasible due to labor management constraints.

d) The maps meet all accuracy and content specifications.

A schedule is shown in Appendix C. To dedicate production capacity to only 1:10,000-scale mapping, considerable increase in staffing of drafting personnel (scribing and lettering) would be necessary. The series would be completed in 1993. A total of 250 people would be required for ABMP salary support. It should be noted that the PP estimated 152 people for a five year time frame - a gross underestimation of productivity and workflow constraints. Part of this is attributable to the original assumption that double shifting would be used and cartographic scribing would not be used. Especially underestimated were the cartographic phases of preparation and lettering. It is the opinion of the ET that a ten year timeframe for a major large scale series is not unreasonable. Concentration should be made on operational efficiency and workflow management instead of target series completion dates.

2.4.2 1:50,000-scale mapping only

A similar analysis is presented for concentrating effort on completion of 1:50,000-scale mapping. Using similar assumptions as for the 1:10,000-scale mapping, a schedule has been developed and is shown in Appendix D. While no major recruiting would be necessary, most of the photogrammetric and field capacity currently available would be required. To complete the series in 1989, a total of 90 people would be required. The PP estimate of completing such a series in two years after photography was quite unrealistic. The only way to accelerate production would be double-shifting photogrammetry and doubling field surveyors involved in field revision. Another alternative is to reduce level of effort in various phases by further compromising accuracy or content.

2.4.3 1:50,000-scale mapping derived from 1:10,000-scale manuscripts.

Appendix E presents a schedule for producing the 1:50,000 scale series as a by-product of the 1:10,000-scale effort described in 2.4.1. Once the field revision phase is complete, the edited manuscripts are photo-reduced to 1:50,000 and paneled together to form a new manuscript and scribe guides. Since cartographic finishing would be much less effort to complete this series, the 1:50,000-scale series would actually be completed several years before the 1:10,000-scale series. 19 draftsmen in addition to the staffing required for 1:10,000-scale would be required.

2.4.4 Survey Department Plan

The current SD Plan described in 2.3.4 and Appendix B also been analyzed by the ET. Several points which alter productivity assumptions are:

a) time per map is reduced in some phases due to cutback of map accuracy or map content. For example, if the accuracy of the horizontal datum is tied to the 1:63,360 maps, field control and aerial triangulation are not necessary. Eliminating symbology categories or use of more generalization techniques reduces time in all cartographic operations.

b) new activities such as compiling planimetry from rectified imagery results in a new production rate and capacity considerations in the Preparation Unit.

c) some phases work on both map series' simultaneously, complicating a breakdown of costs per map series.

d) productivity estimates are too low in the SD plan compared to current productivity, requiring increased staffing in the Drafting Units.

It is the opinion of the ET that this plan is feasible and would complete a 1:50,000-scale series in about 4-5 years. Verbal goals of two years expressed by some seem clearly unrealistic. Incentive pay would be critical to meeting the schedule, especially for photogrammetry and field revision, the 2 probable bottleneck areas. Dramatically increased staffing in the Drafting Unit would also be critical. Most users of intermediate scale maps do not have strong requirements for accuracy or detailed map content. Rather, it is a planning tool useful as a base for more detailed operations later. Another advantage of this plan is that a fairly significant start could be made on the 1:10,000-scale series to meet requirements in priority localized areas. It seems logical that the 1:10,000-scale series would generally follow the schedule proposed in 2.4.1, although delayed by several years at least. Once the 1:50,000-scale series is completed, the primary goal for the 10,000-scale maps should be low cost per unit and a consistent production level per year (i.e. smooth workflow). The target completion date becomes secondary.

2.4.5 Photo Image Maps

Another alternative which deserves consideration and further requirements studies is the concept of a photo image map. In this case, for example 1:10,000-scale, an aerial photograph is rectified (about 5 time enlargement with tilt deformation removed) and registered to a map grid and collar. Additional overlays which are reasonably easy to generate may be added, such as existing contours or names and boundaries. Such a product can be made in one year with about 10% of the level of effort that a topographic map requires. It can meet some (obviously not all) of the user agency requirements for the 5 or 10 year interval it takes to produce a proper Agricultural Base Map. Rectified imagery can be used only in flat areas. In the hills, contour maps are better, although photo image maps can be made by procurement of an orthophoto scanning system, usually consisting of a photogrammetric plotter and a scanning printer. The PP recommended retrofitting a Wild PPO-8 printer onto an existing Wild A8 plotter (about $80,000 now). Although this procurement was cancelled by the SD, it should be reconsidered if there is any serious effort to produce photoimage maps. More expensive, but a state-of-the-art quality orthophoto system, would be an off-line printing device such as the Wild OR-1. This requires retrofitting an A-8 or B-8 plotter with digital profiling capability. Total cost is estimated at $300,000. The relatively low number of mountainous maps (about 30%) may not justify this expense.

2.5 Implementation Plan

2.5.1 General Recommendation

The ET recommends, as an implementation strategy, a variation of some of the plans and alternatives already analyzed. Basically, the ET endorses the current SD Plan for expedited completion of the 1:50,000-scale series and limited production of 1:10,000-scale maps in priority areas. In the long term, the 1:10,000-scale mapping would become the primary effort, but with an extended target completion into the 1990's. The advantages of this strategy are stated in 2.4.4 and need not be repeated.

2.5.2 Standards and Specifications

2.5.2.1 Accuracy

The 1:50,000-scale series may not require strict conformance to Map Accuracy Standards. The short term schedule is dramatically enhanced by liberal use of scaling new content to the 1:63,360 map base. The 1:63,360 maps are remarkably accurate, considering their vintage, although they probably do not meet modern accuracy standards for the scale. If it is convenient to control 1:50,000-scale with aerial triangulation, that should be used. However, as in the SD Plan, mapping from rectified prints and salvaging of old contours enables operations other than photogrammetry to begin, avoiding a bottleneck in production. Compromise of 1:10,000-scale map accuracy is not recommended.

2.5.2.2 Content

Three major compromises in 1:50,000 map content are suggested which would permit completion in 3-4 years instead of 4-5 years:

a) Liberal use of generalization techniques such as "built-up" tint instead of plotting individual buildings in concentrated settlement area.

b) Elimination of land-use categories on the base series, to be replaced by the 100,000-scale land-use maps prepared by the Center for Remote Sensing. The CRS would use the 1:50,000 edited manuscripts, reduced to 1;10,000, for the land-use map base. Eventually the land-use overlays could be added to the 1:50,000 scale series if the need existed.

c) Lettering in a single color (i.e. Black) to reduce materials cost and photo-lab processing time.

For the 1:10,000-scale series, complete mapping of all planned categories is recommended without compromise.

2.5.3 Procedures

Basically, current procedures are adequate to begin this operational strategy, especially for 1:50,000-scale mapping. Some suggestions for alternative procedures for 1:10,000-scale mapping are

not required for the ABMP, but deserve consideration for long-term procedural efficiency. Some of these recommendations are:

a) use of up-to-date low-altitude interpretation photography to increase productivity and accuracy of feature classification.

b) field classification before photogrammetry using photo interpretation and annotation methods with low-altitude interpretation photos.

c) scribing instead of pencil copy for photogrammetric manuscripts.

d) increased use of computer software to aid operational phases (i.e. numerical computation of stereo-plotter settings and rectifier orientation).

e) single-color lettering (i.e. black) to reduce materials cost and photo lab processing.

f) more streamlined scribing and lettering procedures to reduce time per map.

It would probably be desirable for several Survey Department production managers to observe such technicques in a mapping agency successfuly using them. There is always a risk in changing operational procedures which basically are functional. On the other hand, agencies should not fall into the trap of relying on outdated tradition in tight budget times when more efficient techniques are possible.

2.5.4 Schedule

The schedule proposed by the SD for this plan is quite complex and is not easily summarized. Generally, most of the operational units can begin one series or the other, some doing salvage work and others using originally planned procedures. The 1:50,000-scale series, if shortcuts are used, could be completed in three to four years if initiated immediately and if incentive pay is made available, geared to productivity. The schedule for 1:10,000-scale mapping, in the long run, should be geared to about 200 maps per year, completing the series in the 1990's.

2.5.5 Staffing

The staffing level to meet this plan would be simlar to Appendix C describing 1:10,000-scale mapping only. This totaled to 250 technicians requiring Survey Department budgetary support for salaries. Most of the increases over current staffing are in the Preparation Unit and the Drawing Office. Most of the increases would not be required until 1983.

3. MAP PRODUCTION PROCESS

3.1 Aircraft

3.1.1 PP:

The recommended plan in the Project Paper (PP) was to purchase a twin-engine, pressurized aircraft for delivery in November 1978. The plane was to be modified for aerial photography and capable of sustained flight operations with five crew members and camera for four hours at an altitude of 28,000 ft. The minimum operational service ceiling was to be 30,000 ft. In addition the aircraft was to be equipped with certain minimum instrumentation and safety equipment.

The aerial photography modification required a port large enough for an RC-8 or RC-10 camera and equipped with a glass window meeting group M specifications. Provision for a drift sight and a viewfinder was to be included. Three aircrafts were recommended as meeting the specifications and requirements:

Cessna 421C
Piper PA-31P
Beech King Air C-90

The PP recommended that the Survey Department (SD) enter into an agreement with the Sri Lanka Air Force (SLAF) whereby SLAF would furnish photo pilots at no cost to the Agricultural Base Mapping Project (ABMP) and have the aircraft available to SLAF for training purposes. SD would furnish funds for fuel, equipment and maintenance. Maintenance was to be performed by SLAF technicians. One week of orientation/training was estimated for both the pilots and mechanics. The PP also recommended that technical assistance and training be arranged for in the form of a photo pilot and photographer/photogrammetrist.

3.1.2 SD:

Early in 1980 SD acquired a Cessna 421C aircraft from Heli-Orient, the Cessna representative in Singapore. By the time the aircraft had been modified for aerial photography and the orientation and training had been completed the 1980 winter/spring photo season had passed.

Starting early in 1981, SD undertook photo operations with a 4 man crew, pilot, co-pilot, navigator and photographer. Because of space limitations the drift sight was not installed thus reducing the planned photo crew by one man.

In accordance with a maintenance agreement dated April 6, 1978 between SD and SLAF, the Air Force furnishes the pilots and SD furnishes the navigator and photographer to man the aircraft. SD also pays for fuel, parts and maintenance SD has assigned the responsibility of monitoring the maintenance agreement to the Supdt. of Surveys (Air Surveys). Such action is appropriate and important. See Appendix F for a copy of the agreement.

3.1.3 ET:

The Evaluation Team (ET) viewed the SD aircraft at the SLAF base at Katunayake. The Cessna 421C is a very adequate photo aircraft. The omission of the drift sight should present no problems at all and in fact lightens the load to be carried. The load can be further lightened occasionally to gain more altitude or range by temporarily removing the co-pilot and/or the navigator. This would be at the discretion of SD Air Surveys Branch. This aircraft and crew delivered 12 rolls of aerial film in 1981 for ABMP and other requirements. The annual capacity of a plane of this type far exceeds the 1981 production. Therefore it is likely that the SD aircraft can meet most or all of the photo requirements of all user agencies in Sri Lanka for several years to come. This excess capacity or unused time on the aircraft will be discussed below in considering future use of the aircraft.

Technical assistance was contracted for a photo pilot instructor for a period of three months. Training was provided for four Air Force officers at Heli-Orient in Singapore. SLAF informed us that Heli-Orient has cancelled all of their training programs for 1982 thus delaying the continuing SLAF training program. They did not mention any serious consequences at present. Nevertheless, additional training requirements were discussed and are listed in sub-section 7 below, and Appendix P.

The ET was invited to the monthly SD-SLAF coordination meeting on 20 April relating to the maintenance agreement between the two agencies. This agreement appears to be working well and is a reasonable solution to the decision to maintain an in-country aerial photo capability. Normal items of maintenance and repair were discussed. SLAF follows the manufacturer's specifications for maintenance and adds some of its own. Also mentioned were the turnover of trained technicians and the cutbacks in manufacturer training classes.

SD will soon want to make some plans and decisions on the future care and use of their aircraft. Most important will be the maintenance of the plane. Their present maintenance agreement calls for a review after three years. Since their present arrangement appears to be working satisfactorily it seems desirable to extend it for a period of time.

In many situations the presence of a photo aircraft is a "necessary evil" in that it is necessary for organizational operations but is either over-utilized or under-utilized. That is why photo acquisition is frequently contracted out when the service is readily available at a reasonable cost. This service is not available in Sri Lanka so that in-country capability within SD seems to be a logical approach to photo acquisition.

For the ABMP alone the aircraft will be definitely under-utilized. The most logical additional use is one that is already underway, the acquisition of aerial imagery for other government agencies. It is basically a management decision as to where to seek funds to pay for this additional work. It could be handled as a repay program or as a line item in the department budget but provision must be made to provide for all operational and maintenance costs on the aircraft. A considerable load of other agency photo requirements can be handled before scheduling becomes a problem.

ET understands that the matter of requests for non-photographic use of the aircraft has arisen already. Perhaps the most attractive aspect of other use is the prospect of rental income for SD to apply to the program. However, experience has shown that multi-use of a photo aircraft is usually detrimental to the photo program. Photographic weather must be taken advantage of as it occurs. To have the aircraft down for a 100-hour check because of other uses of the plane or to have the plane away on another assignment when it is needed is weather lost that cannot be recovered. Another obvious drawback is the additional wear and tear on the plane itself. In general the ET does not recommend multi-use of a photo aircraft.

3.2 Photo Acquisition

3.2.1 PP:

The final PP called for aerial photo operations to start in December 1978, and to be completed by September 1979. The project design called for 56 east-west flights at 25,000 feet above ground. The film was to be black and white panchromatic Kodak type 2402. Film processing and evaluation was to be done in the SD Air Survey Branch.

3.2.2. SD:

The aircraft was not actually available until March 1980 so that no productive operations were possible in the 1980 season. In the 1981 photo operation approximately 51% of the nation was covered by acceptable photography. The area is the central and west-central part of the country. More coverage might have been possible but some delays were encountered in attempting to place signals on their ground control stations.

For the 1981 season, flight design and flight map preparation were carried out in the SD Map Preparation Section in order to better distribute the workload. Following the photo mission the film processing and the preparation of contact inspection prints are carried out in the SD Air Surveys lab. Following this the mission evaluation, the titling of inspection prints and titling of the original negative is all done in Map Preparation Section. Line indexes are also prepared here after evaluation. The original film is then returned to the Air Surveys lab for diapositive preparation and then on to the library where it is available for filling outside orders for reproductions.

3.2.3 ET:

The aerial photo acquisition process of SD seems is quite straightforward and practical. Their flight planning and project evaluation steps follow standard techniques. More elaborate procedures are not really needed until they start acquiring other than their standard black and white panchromatic aerial film.

The ET understands that SD is preparing to move the photo acquisition steps now done by the Map Preparation Section into the Air Survey Branch. Organizationally and technically the ET believes this is a positive step. In general, all of the required elements - equipment, maintenance agreement and personnel - are in place for photo acquisition. The key point remaining is to further develop and maintain both efficiency and proficiency.

3.3. Air Surveys Laboratory

3.3.1 PP:

The following actions were recommended:

a) Both photo lab areas should be centrally air conditioned;

b) A single wet lab should be established to serve all processing needs and should be separate from optical equipment;

c) Film and paper supplies should be stored separately from wet and dry chemicals with cold storage for aerial film and other shortshelf life film supplies;

d) A chemical tank farm should be installed on the upper floor, along with plumbing, to store the chemicals and then pipe them to processors and trays as needed;

e) A Kodak Model 11-C-M Versamat roll film processor should be purchased to permit more quality control and to allow for greater volume of work;

f) A Log-E Mark IV printer should be purchased for more and better print and diapositive production;

g) A roll print processor and/or a sheet film processor should be installed to permit greater volume and better quality control;

h) A MAFI processor should be acquired for orthoprinting;

i) Transmission/reflection densitometers should be acquired for quality control in film processing.

Eleven people would be required to staff the SD Air Surveys laboratory.

3.3.2 SD:

The following is the status of action taken to date:

a) Both labs are now centrally air conditioned with reasonably good conditions.

b) The Air Surveys lab and the Map Production lab are two separate wet labs. There is some printing equipment, such as contact printers, in the same room with developing trays but this is common practice in some labs.

c) Paper and chemical supplies are neatly stored in one room. Again this is the practice in some labs. Cold storage for aerial film is being installed.

d) There is no tank farm to pipe chemicals to the photo labs.

e) The Kodak 11C-M Versamat roll film processor has not been purchased.

f) The Log-E Mark IV printer has been purchased and installed. It is not used much at present. Most contact prints are made on an old Morse-type printer.

g) SD has no roll paper processor nor any equipment on which to expose roll prints. The cut film and paper processor equipment is in the Map Production lab. Contact prints are processed in trays in the Air Surveys lab.

h) The MAFI processor has not been purchased.

i) Very sutiable transmission/reflectance densitometers are in place.

The Air Surveys lab was authorized ten people - 1 navigator, 9 aerial photographers. At present they have 1 navigator, 5 photographers, 2 trainees, and 2 vacancies.

3.3.3 ET:

The Air Surveys photo lab appears to have adequate equipment and capacity to meet their needs for the next two years. Some of their equipment is new-much of it is quite old. Based on the expectation that the mapping program will develop and accelerate in the next few years some problem areas could develop. The ET believes that the photo lab should be part of a management plan of deliberate annual upgrading activities.

The following is a random list of comments pertaining to the Air Surveys photo lab and equipment:

a) The air conditioning appears to be adequate.

b) Automatic aerial film processing equipment may be needed in a few years.

c) A new aerial camera with universal lens, fast shutter, and f4 aperture should be considered to meet the requirements for low altitude photography and color film emulsions.

d) Facilities for cold storage for film should be completed.

e) Personnel should be restored at least to authorized. strength. In due time the workload of flight operations and lab processing may require additional personnel.

f) The film library is organized and maintained in a neat and orderly fashion starting with 1956 photography.

g) As controls and film emulsions become more critical and sensitive, consideration should be given to more light proofing in the lab. At present, with slower emulsion, light leakage is not as serious as it will become.

i) Chemical disposal may become a problem area in the future.

j) Water filtration for the processors should be considered.

To restate the ET suggestion, it would be well to develop a plan for improving or upgrading some phase of the laboratory facilities and/or equipment each year.

3.4. Field Control

3.4.1 PP:

The PP recommended that conventional surveying methods be used to derive geodetic positions and elevations for points identified on aerial photographs required for aerial triangulation control. The same crews selected for ABMP field edit would do necessary surveys as required in addition to field edit responsibilities. About 1150 points would be required. Control requirements for 1:50,000 - scale mapping were not addressed, but the implication was that the same basic control and aerial triangulation would be used for both map scales. Doppler satellite surveys were suggested to strengthen the overall geodetic datum, especially for future requirements of large scale mapping or engineering surveys.

3.4.2 SD:

The SD proposes to use the PP method when aerial triangulation is operable. For control surveys, each surveyor has a 20-second theodolite and a precision level. Most horizontal surveys are traverses and vertical surveys are level lines. Occasionally, vertical angles and measured distances are used to establish elevations. Currently, for 1:10,000-scale mapping, use of 1956 photo-identified control without new field control or aerial triangulation is the common practice. For 1:50,000-scale mapping, the short-term proposal is to scale to old 1:63,360-scale maps and level to 1956 control using 1956 photography for contouring. Doppler surveys are not planned for ABMP.

3.4.3 ET:

Evaluation of survey methods and accuracy by the ET is difficult due to the current situation of no surveys in progress and inoperable aerial triangulation. The ET is relying on SD opinion that surveyed coordinates are sufficiently accurate, generally within one-meter, and are properly photo-identified. It is the opinion of the ET that the distribution of vertical control planned for aerial triangulation is too sparse to meet accuracy requirements for 5-meter contour intervals. Point spacing of 5 to 6 models in interior sidelaps should be reduced to 2 or 3 models, increasing the nubmer of required field elevations by about 60%. Current stopgap approach of salvaging old maps or 1956 control instead of aerial triangulation is marginally acceptable for accuracy, but causes inefficiency in photogrammetric procedures. A datum error would likely result between map scales if the 1:50,000-scale mapping is controlled by old maps and 1:10,000-scale mapping is controlled by new surveys. Ideally, the aerial triangulation method planned by the PP should be used for both map scales regardless of the sequence.

The PP estimated production rate of 10 days per control point seems too high. While capacity seems to be no problem, the SD should consider more modern surveying methods, especially in the hill country where long-distance visibility is good. For example, each District Office should have some electronic distance measuring (EDM) equipment or the new "total station" devices which measure angles and distances and provide readout displays of distances or changes in elevation. It would not be recommended to provide such equipment to every surveyor because the cost would be prohibitive.

3.5 Aerial Triangulation

3.5.1 PP:

The PP recommended that the existing Wild A-7 digitized plotter be complemented with a Kern MK-2 comparator, two Kern PG-2-AT plotters, and an IBM card punch. Depending on the measuring equipment, a block adjustment would be computed using either semi-analytical (plotter data) or fully-analytical (comparator data) methods. A new Hewlett-Packard 3060 computer or equivalent would be acquired for computational processing. Point marking, software, and sequential procedures were not addressed. Estimated production rate was 2 models per instrument shift.

3.5.2 SD:

A Wild A-10 digitized stereoplotter and a Kern CPM-1 comparator/point-marking device were acquired with appropriate encoded digitizers for display of coordinates. The A-10 was purchased with SD funds. Two Kern PG-2-AT's were also acquired, with Swiss funds, but are used for photogrammetric compilation. An ICL 2903/40 Minicomputer, a shared SD resource operated by the Computer Unit, performs the adjustment after measurements are entered onto terminals. Currently, only one software program is installed on the computer, a USGS-supplied program written by G.S. Schut (NRC-Canada) to assemble models into strips and adjust strips to the ground control using polynomial equations. This software can only handle model input (i.e. Wild A-10) and is not working properly. There is no program installed to adjust comparator data. A sufficient number of technicians are trained to measure data, although expertise to solve software problems and to interpret printouts is lacking. As a result, aerial triangulation is essentially non-operational at this time. The equipment is sometimes used for compilation tasks but is generally under-utilized. Estimated production rates cannot be verified due to limited experience.

3.5.3 ET:

The inability of SD to perform aerial triangulation is a major factor creating a photogrammetric bottleneck. The SD has recognized this and has taken steps to bring in technical assistance to solve the problem. Current procedures circumvent aerial triangulation by using field control with poor distribution with respect to new photography, causing inefficient photogrammetric compilation procedures. While this stopgap procedure could be used for 1:50,000-scale mapping, it is not recommended for continued 1:10,000-scale mapping. The equipment is more than adequate to meet the needs of ABMP. The ET ag es that there is a strong requirement for technical assistance to install computer programs to handle either plotter or comparator measurements and to train operational personnel techniques of data input, editing, and verification of output to satisfy accuracy requirements. The computer may not be large enough for sophisticated programs such as independent model or bundle-type simultaneous adjustments. Increasing the memory size is recommended for such programs. However, at a minimum, comparator data can be converted into analytical models and

subsequently processed similarly to plotter data using polynomial adjustment methods. The PP estimated production rate of 2 models per day is probably valid, resulting in a 5-year time frame for dedicated use of a single instrument on a single shift. The availability of two instruments could reduce the time-frame to 2.5 years, although both instruments are frequently used for other tasks. In any event, the aerial triangulation should be able to maintain the pace of photogrammetric compilation, once operational.

3.6 Photogrammetric Compilation

3.6.1 PP:

The PP recommended that compilation be done on a single manuscript with planimetry (i.e. roads, buildings, etc.), contours, and land-use categories. Eight existing Wild A-8 or B-8 stereoplotting instruments were to be used with two technicians working as a team on each of two shifts. The operator would orient the stereo models to control, interpret the photo imagery, and trace the map features using pencils on an attached pantograph. The second technician would clean up the raw copy, also using pencils. Three difference color pencils would be used to segregate categories of content. Estimated productivity was 5 days per model per shift, or about 3 years time to compile using two shifts (32 technicians). Compilation would be at 1:10,000 scale. The 1:50,000 series would be produced cartographically by photo-reducing the compiled manuscript, thereby not adversely affecting compilation scheduling or capacity. Recommended equipment procurement included 4 Wild Aviotab pantograph units, an orthophoto plotter, and some miscellaneous items.

3.6.2 SD:

Compilation procedure is consistent with PP approach, although contours are compiled onto a separate manuscript to improve readability. Productivity for 1:10,000 manuscript is about 8 days/model. A second shift has not been instituted due to labor compilations and training problems. Slower productivity is attributed by SD mostly to low motivation of workers due to low salary. Another factor is excessive model orientation time required to resolve control problems since aerial triangulation has not been done. SD recommendation is to institute incentive pay (i.e. reward high productivity) to approach the 5 days per model rate. Also, SD proposes compiling 1:50,000-scale directly in some areas in addition to limited 1:10,000-scale compilation to expedite completion of the 1:50,000 series. Two PG-2-AT plotters purchased with Swiss funds, originally recommended by PP for aerial triangulation, are also being used for compilation, increasing instrumentation to 10 units. Eight of the plotters are dedicated to ABMP and two to special purpose non-ABMP photogrammetric mapping. Three Aviotab pantographs have been procured with USAID loan funds and an additional one with Swiss funds. The orthophoto plotter procurement was cancelled due to lack of justification.

3.6.3 ET:

With current procedures and constraints, the 8 days per model rate appears to be realistic, and may often approach 10 days. This would be improved by a combination of factors:

a) aerial triangulation as planned;

b) provide approximate instrument settings to compilers to speed up model orientation (part of aerial triangulation software)

c) incentive pay - there is no question that compilers seem underpaid (in comparison to private sector pay scales for similar skilled labor) for a highly complex activity requiring concentration and constant judgement;

d) provide compilers with previously photo-annotated land-use categories done by trained photo-interpreters;

e) more operational training.

f) plot base sheets with a designated technician and a digitized coordinatograph.

There seem to be valid arguments against initiating a second shift, although this option should be considered if the labor/salary issue improves. A procedural change that should be considered (or at least tried) is direct scribing onto coated mylar instead of pencil compilation, providing more readable copy for subsequent phases. Materials cost would be somewhat higher, but savings in subsequent phases should be considerable. See Appendix G for several options that might be tried. The SD suggestion to initiate direct 1:50,000 scale compilation in some areas is recommended if, in fact, the 1:50,000-scale series completion in several years is the first priority. Compilers should be trained in generalization techniques and avoid unnecessary compilation of buildings in areas which would ultimately be a "built-up" tint.

3.7 Field Edit

3.7.1 PP:

The PP recommended that field edit be done by changing, adding, or deleting map content compiled by photogrammetry. The original manuscript would be converted to ozalid copies onto which field annotations would be made. Recommended procurement included 40 four-wheel-drive jeep-type vehicles required for 38 surveyors. A team of one vehicle, one surveyor, and 10 laborers would be assigned a map. Estimated productivity was 20 days per map, requiring 38 teams for a 5-year time-frame or 64 teams for a three-year time frame.

3.7.2 SD:

Field edit functions have been split into office preparation and on-site field revision. The office technicians print the photogrammetric copy onto a cronaflex positive from which three ozalid prints are made. On one, boundaries and names are compiled from existing sources. Unresolved items or controversies are noted for field completion. On another copy, content items unresolved by photogrammetry are noted for field completion. In addition, land-use categories are color coded to aid the readability of the map in the field. The third ozalid is for field revisions. The materials are sent to the surveyor, who arranges local housing and hires laborers. Procedures include completing unresolved names, boundaries, and planimetric content, classifying roads, spot-checking photogrammetric interpretation, and performing limited accuracy testing. Materials are returned to office preparation where the revisions are compiled onto the cronaflex to be used for scribe guides. For 1:10,000-scale mapping, office technicians require about 20 days per sheet per person for preparation. Field surveyors with 3 to 6 laborers each require about 15 days per sheet per surveyor for field revision. No 1:50,000-scale mapping has been done yet except for experimental compilation by the Preparation Unit from enlarged rectified photographs, averaging about 10 days per photo (250 days per 1:50,000-scale map). About 150 days per 1:50,000-scale map is estimated for field revision.

3.7.3 ET:

Procedures used for office preparation and field revision appear to be appropriate. The PP report underestimated the time required by not addressing required office support (i.e. Preparation Unit). The time required to field revise 1:50,000-scale mapping seems high. The sample 1:50,000-scale compilation done from rectified imagery was quite complex, although ET questioned the lack of generalization appropriate for that scale of mapping. For example, considerable time was expended to plot individual buildings which should have been a built-up tint.

The 1:50,000-scale photography is probably too small a scale for effective use of photo-interpretation and plotting without the benefit of stereo-plotter viewing. On the other hand, this procedure alleviates the production bottleneck in photogrammetry, justifying some inefficiency for the benefit of flexible use of capacity to shorten the time schedules. Both preparation and field revision personnel had difficulty with the poor quality of photogrammetric copy due to pencil plotting. A procedure which might be considered for 1:10,000-scale mapping is field classification on low altitude photography before photogrammetry. This is standard procedure at USGS and has proven to be considerably more efficient than field revision after photogrammetry. Field surveyors would work with photographs rather than map manuscripts and would need training in photo-interpretation. See Appendix H for more specific details.

3.8 Scribing

3.8.1 PP:

The PP estimated that map finishing operations, including scribing, lettering, and related photo lab support, would require about 4 months per technician for each 1:10,000-scale map. This would require 256 people in the Map Production Office, a considerable increase over the 35 technicians in that office at that time. The PP posed an alternative requiring much less capacity - color filtration of photogrammetric for final manuscripts without scribing. In that case, the 35 technicians would be adequate, although final map quality would be much less desirable. In either case, three manuscripts (color separates) were proposed: (a) contours; (b) drainage features; (c) cultural features and boundaries. A composite would be made for final editing and review. 1:50,000-scale procedures or capacity requirements were not addressed.

3.8.2 SD:

The Technical Advisor recommended use of color separation scribing rather than the color filtration method. Techniques and new symbology were introduced which were intended to improve the operational procedure and reduce the staffing requirement. Appendix I shows the procedural steps and productivity goals for scribing and lettering operations. In actuality, production rates are currently about double the goals for 1:10,000-scale, averaging about 65 days per technician per map. Realistic estimates for 1:50,000-scale scribing are about 100 days per map. Slow rates are attributed to inadequate training,difficulty in interpreting copy,and poor incentive.

In addition to the three manuscripts recommended in PP, there are additional separates for vegetation limits, urban fill and relief features for a total of six colors. Peelcoats are etched in the photolab using scribed delineations. Screen tints and patterns are added by the photolab. Patterns, symbols or screens covering small areas are applied to plastic overlay sheets using adhesive stripfilm copies. Approximately 15 total manuscripts including a standard border with marginal information and grid are composited for the six printing separation colors. These separations are edited and corrected individually and again edited and corrected as composited film positives. Six photolab steps interlace with 17 scribing steps to add 7 days of labor. The editing involved in the scribing phase involves check off of 150 items that include register, patterns, screens, line symbols, placement, quality and border match. All separations are punch registered on the new punch equipment procured by A.I.D. in the drafting and photographic lab.

3.8.3 ET:

Productivity rates for scribing seem very high compared to U.S.G.S. Experience of personnel is a factor, as the SD suffers about 30% turnover per year. Constant training reduces productivity as experienced technicians are used as trainers. Many errors are made, requiring frequent reviews and multiple corrections. Quality of the final map, however, looks good, comparable to USGS in linework quality and symbology.

Scribe copy seems difficult for scribers to follow due to compilation practice of a pencil manuscript on a composite sheet. Many lines fail to copy on scribe guides and are complicated to follow. Major savingsin time could result from compilation on separate punch registered plastic sheets. At the USGS, the use of scribed manuscripts on separate sheets results in excellent guide copy and in some cases are useable copy for final reproduction. Other savings may result:

a) by use of water filters in the photolab,

b) blue filters by the scribers to limit opaquing of minor pin-holes on negatives and

c) use of new K&E wipe-on dye back on etched peelcoats.

3.8.4 Sri Lanka Map Emblem

It is the opinion of the ET that the location and colors used for the Sri Lanka emblem appear to have a design problem. The best register is along the gripper edge of the press on the map explanation and punch register side of the map. On the opposite side of the sheet, the Sri Lanka emblem is located in four colors. One of the colors is yellow. Yellow is only used for rice paddies, secondary road fill and the emblem. Some sheets may be run exclusively for the small amount of yellow in the emblem—a cost and labor consideration. The road fill could be made dashed red and the paddies a solid green. This design change would save a peelcoat, a press plate and a press run multiplied by as much as 1800 for the ABMP by elimination of the yellow. Location of the emblem on the explanation side would solve the register problem, (as would omission of color in the emblem). The potential savings in the project is about $80,000 for omitting yellow on the 1800 mpas.

3.9 Lettering

3.9.1 PP:

The lettering phase of production was not addressed in the PP other than recommending that type be set manually while scribing is in progress for place names. Three sets would be made, one for each

language required and the names located on an overlay.

3.9.2 SD:

Lettering is a major production activity requiring 80 average days of labor for 1:10,000 sheets and approximately 120 days estimated for 1:50,000 sheets. Again, actual rates are about double the goals indicated in Appendix I. The activity involves handset letters and printing on paper. A camera negative is made and strip film positives are contact printed from the negative. About 8 days labor are required for type set. Scribers write the type order, apply the waxed strip film lettering to plastic sheet overlays and then separate on three negatives by opaquing the lettering into three separate printing negatives--black, blue and red. These steps are repeated for each of the three languages. A total of 9 negatives are produced.

3.9.3 ET:

The hand set lettering is of poor quality and requires extensive opaquing and touch-up on the negatives. Approximately 28 days of labor could be saved in opaquing and negative work by printing the the lettering in BLACK only with a resulting 3 negatives, one for each language. This suggested design change would reduce press plate and printing by 4 plates and 4 press runs for each of the near 2000 maps in the two publication scales. Printing would be reduced by 30% with 8 plates rather than 12 plates. See Appendix J for more details.

A phototypesetter has not been purchased yet since manufacturers investigated by SD have not offered Sinhala and Tamil type fonts. Mergenthaler and Addressograph-Multilith Corp are two firms that may offer these fonts for a charge of about $5000 each. An alternative is to purchase an Itek typesetter for about $15,000 for English-only and continue to handset other languages. The Itek is perhaps the easiest machine to operate and maintain; however, all the new equipment is solid state electronics with few moving parts and requires an air conditioned facility of about 144 ft. square for equipment and personnel. One machine would increase productivity by several times or more with substantial improvement in quality. Use of Agfa Gevert diffusion transfer film (processor $1,000) and film about $1 per 8 X 10 inch sheet is an alternative to strip film. The transfer film has an adhesive and can be copied directly in a daylight room from the phototypesetter film positive output, thereby avoiding the photolab. A phototype film processor is also needed at a cost of of about $5,000.

3.10 Map Production Laboratory (Studio)

3.10.1 PP:

The photographic laboratory (Studio) was not addressed in the PP for the scribing or production process other than to comment that composites or separation negatives, proofs, etc. are made.

3.10.2 SD:

During the map production process a total of 32 days are used in photographic processing of negatives, positives, scribe, peel, and photographic wipe-on color proofs. A substantial amount of camera work is required for the 1:50,000 utilization of salvaged 1:63,360 map materials, estimated at 64 days per map. Color proofing by photographic process rather than by PP suggested press proof is a significant improvement from a cost viewpoint. Dupont 44-inch rapid access film processors financed by AID loan funds are installed. A pump problem prevents the Dupont process from being operational.

3.10.3 ET:

Water filters are needed for the processors and chemicals for cleaning. The only halftone screen is glass on the old Lanston 40-inch camera that does not have a vacuum back. A camera vacuum back and halftone contact screens are needed if aerial photographs and/or landsat scenes are to be offset printed. A single corner register sheet would save considerable time in scribing,photographic, and platemaking activities by eliminating need to scribe or draft corner marks on each sheet now that punch register is used. Training in halftone photography is needed.

3.11 **Platemaking**

3.11.1 PP:

This phase was not considered in PP capacity calculations. The operation suggested was to make three plates for printing. The plates were to be marble grained, coated in a whirler and exposed to sunlight on the building rooftop where platemaking facility is located. An additional three plates would be made for the language placenames.

3.11.2 SD:

Twelve (12) composite negatives are used to expose images on pre-sensitized metal plates using metal-halide lamps. A new fliptop vacuum frame with metal-halide printing lamps is in place but not operational for lack of electric power. The plates are developed, washed and gummed by hand. Approximately 1.5 days are required to prepare the 12 plates for printing.

3.11.3 ET:

Film negatives may change dimensions in a short period of time without temperature and humidity control. Reigster problems on the press may be attributed to this factor. No plates were processed during the inspection but printing results show satisfactory results; however, register problems were being experienced. The pre-sensitized plates are the most expensive plates made for offset printing. USGS uses Western jet grained roller coated diazo plates at about ½ the cost or less. Consideration should be given to

to the airconditioned lithoroom. Old presses make room. This would improve workflow.

a in the PP to have no bottlenecks and was ing capacity. Each of the three plates were ngle color sheet-feed press and proofed in final edit. Minor corrections would be made new negative and plate required if major . After corrections, the plates would be offset press for runs of 3,000 copies for runs would be required for each map sheet place names in three colors. The map sheets trimmed for distribution.

3.12.2 SD:

Six u s are run on the 11 year-old single-color press and 30 two-color press for the three language edition, averag pies per 1:10,000-scale map. 1:50,000-scale product oposed 3500 sheet edition size. Two of the new AID purchased presses are operational but are underutilized due to lack of operators trained in maintenance and operation. The third new press is not operational due to rust in shipment. Also, parts were salvaged by the installer to make the other two presses operational. Efforts are in progress for training and repair of the third press. The head of the Litho office position has been vacant since 1981. This is a critical position requiring expertise in all phases of printing. The Litho Printing room has 34 employees. There are also 7 other presses of single-color proof class from 11 to 40 years old.

3.12.3 ET:

The ET concurs with SD that the head of the Litho Office position should be filled as soon as possible with a person knowledgeable in varous aspects of printing. Technical guidance for printers and leadership seem to be needed. Use of black-only for lettering would increase capacity of the press room by 50% (8 plates rather than 12 plates) or 360 maps annual. Reduction in edition size for each map (a USGS edition for topographic base maps is 2,000 for population of 220 million people) to a variable amount from 500 to 2000 depending upon expected need would further increase capacity and lower cost. Perhaps the Sinhala and Tamil language editions could even be further reduced for greater savings and less used storage space in map sales office.

Ink is purchased in the USA and used in the SD as received. Change in color or printing characterisitcs--drying, tack, etc are not normally done due to lack of training in ink technology. Press operations and printing results would likely improve by having training in ink chemistry. The practice of turning the air conditioning off during non-working hours affects the register of paper. It may be better to leave the air conditioner off than to change conditions for working hours only.

Best Available Copy

At USGS, the standard production for a single-color on color presses is 30 minutes per color at 76 sheets per minute. Wash-up normally is 24 minutes and 30 minutes when going from dark to light colors. Press preparation is 24 minutes. An edition of 2280 sheets would take 1 hour and 24 minutes. Four to five colors would be printed in an average day. An estimate of 4 days in SD is about equal to USGS for edition of 6,500 copies in 12 colors. However, this would be for a press staff of one man per press. For the 2-color press, time is only increased by 18 minutes and production is doubled. Two-color presses for multi-color work as suggested in PP would have increased productivity.

4.0. FACILITIES

4.1. PP

The main facilities problem identified by the PP was lack of temperature and humidity control. A lesser problem was lack of a centralized photolab. Photogrammetry had an inadequate air conditioning system with two carrier units in the room taking valuable floor space. The Drafting Office, film, paper, and chemicals were not in air conditioned space. There were four darkrooms with chemical open-tray processing and delicate photo-optical equipment in close proximity. Voltage fluctuations were apparent but not known.

4.2. SD:

In March 1982, about three years after plan, the air conditioning was completed. The two photolabs, one for aerial photography and one for map production, continue to be separate facilities. However, the work is specialized and no production or operational problems appear to be caused by this arrangement. All photographic, chemical, and 80% of printing paper stock is in air conditioned space, although air conditioning is turned off after working hours. Voltage fluctuations and failure do occur but are not serious to the program.

4.3. ET:

The lack of uniform temperature and humidity control during non-working hours probably contributes to registration problems. The pressroom for example may be better for printing in a relatively constant high temperature and humidity than a variable one created by off and on air conditioning. Refrigeration and freezers are needed for color photography materials and for long storage of other photographic material. Light leaks in the darkrooms should be sealed. Film moved from air-conditoned space to non air-conditioned work areas such as the platemaking unit on the roof probably causes dimensional changes in the film, adding to registration problems on press runs. It is suggested to move platemaking to the press room for better work flow in addition to a more stable environment. It is more critical, and strongly recommended, to maintain a constant environment in the press room over a 24-hour period.

5.0. EQUIPMENT

5.1 Equipment Acquisition

5.1.1 PP:

The PP indicated that the ABMP would impose greater than normal demands on production capacity and add equipment acquisition requirements. See Appendix K for a comparison of PP equipment recommendations with actual procurement status.

5.1.2 SD:

Among the six aircraft and accessories items, the driftsight, statoscope and camera renovation were deleted from the list. An additional item for aircraft ferrying added $13,500 to cost. In field control and edit, 35 of the 40 recommended Jeeps were purchased for $34,642, under estimate for this item. For triangulation, the Swiss purchased two Kern PG2-AT plotters and AID funds procured a Kern CPM-1 comparator (instead of an MK-2). Two IBM card punches were deleted as not needed. Four Aviotab TA coordinatographs were recommended and three purchased for $120,746. A fourth was acquired with Swiss funds. The other four photogrammetric items recommended were deleted as not needed. In the photolab out of 16 items, 5 were deleted . This included roll film and paper processors, whirler coating machine and three graining machines. The present hand operated film roll processor is adequate for current need and presensitized plates make the whirler and graining equipment unnecessary. A map reproduction machine (duplicator) was also considered unnecessary. For map production, only the photocomposer remains pending as equipment could not be identified with Sinhala and Tamil type faces. A vacuum back for the old camera could not be procured so this item is also pending in the photographic lab. In Litho, three single-color presses were purchased rather than one two-color press. The guillotine paper cutter is in shipment. None of the User Assistance Center equipment was procured with ABMP loan funds, although separate AID funds were used for a B & L stereomicroscope and a minicomputer. The Swiss procured several items and the others have been judged unnecessary. The doppler geodesy equipment lease was also found unnecessary. In total, $119,025 over budget has been used from loan funds for equipment.

5.1.3 ET:

Appendix L lists the remaining equipment needs considered vital to the ABMP, totalling $110,000. The phototypesetter is pending, awaiting identification of equipment with the needed language fonts to replace handset type. A press-plate roller coater can reduce future cost of pressplates by 50% or more. Varimat attachment for the camera can thin lines that are enlarged in converting from

1:63360 scale to 1:50,000 scale. A vacuum back for the old camera is needed to hold film. A number of smaller miscellaneous items required include a phototype processor and testing and maintenance tools. Aircraft maintenance and parts are vital to continuing aerial photographic capability, estimated at $30,000.

Some other items should be considered in the long-term to improve efficiency or capability, but are not currently vital to the ABMP.

They include:

(a) If greater volume of film and more quality control are required a roll film processor such as Kodak 11C-M Versamat would be required. Approximate cost $30,000.

(b) In order to fly low altitudes under 4500 feet and use other emulsions, such as color infra-red, a new camera with a universal lens and a rotary shutter would be almost a necessity. Price is approximately $125,000.

(c) The contact printer workload might soon require a roll paper printer and/or processor.

(d) Update field surveying instrumentation with electronic distance measuring capability ($8,000 each, suggest one or two per hill country district)

(e) Improve base sheet plotting efficiency with a digitized coordinatograph ($10,000)

(f) If photo-image mapping becomes common, an orthophoto scanner would be required ($80,000 attachment to Wild A-8 for Wild PPO-8 system or $300,000 for state-of-the-art off-line Wild OR-1 printer with digital profiling retrofit to an existing Wild plotter.

5.2 Equipment Maintenance

5.2.1 PP

The PP discussed the importance of equipment maintenance within the map production process. Maintenance recommendations include functions of preventing or minimizing failure, making repair when failures occur and performing calibration tests and adjustments on schedule. Maintenance was divided into two categories: that which should be performed by the SD and that which should be done by the manufacturer.

5.2.2 SD

There is a capability in the SD to perform the task described in the PP.

5.2.3 ET

Maintenance remains a serious problem as parts are difficult to procure and manufacturers' representatives may be only available once a year on routine visits. The ET strongly urges the SD to take corrective measures to insure that maintenance requirements are included in all budget considerations and allocations and that maintenance be included in the periodic review and planning exercises

6.0 MATERIALS

6.1 PP

The PP estimated the need for large quantities of a variety of expendable supplies for the ARMP. In fact, these supplies accounted for the second largest dollar volume of funds ($848,700). Both the range of items and quantities were identified so that adequate stock would be maintained. The PP noted that in the past there had been difficulty in obtaining materials due to problems of familiarity, availability, and and an unresponsive procurement system.

6.2 SD:

The cost of expendable items was appreciably underestimated in the PP with extreme increases required for aviation fuel (Rs.15.91 per US gallon to Rs. 100.00 at present) and with silver film estimated at $3 per 24 x 30 inch sheet and now requiring 26 x 36 inch sheets at $7.50 each. A total of 14,000 sheets of litho film were estimated for the entire project. It is now estimated that 10% of the project requires about 8000 sheets. Similarly, peelcoat quantity of 6000 estimated for the project is now 3000 actually needed for 10% of the project with unit cost up from estimated $1.50 to $12.00. Another major item, printing paper, increased from $250,000 for the project to $179,200 for 300 maps, after dramatic reduction in edition sizes. Appendix M lists the current inventory of expendable materials. The procurement of these items remains a fairly long time period including as much as three months processing within the Survey Department.

6.3 ET:

Expendable supplies required for the ARMP program during the next two years, based on production of 92 1:50,000 scale maps and 200 1:10,000 scale maps, are listed in Appendix N. The list includes contact screens for photo-image maps and color landsat maps that could become production items in the near term. After an initial purchase of $300,000 for two years' supply, expendable supplies will be approximately $175,000 per year plus inflation factor over the long term. A modified purchase procedure is needed to procure expendable items in less time. Also, a smooth inventory monitoring system is strongly recommended to provide the means for effective advance planning.

7. TECHNICAL ASSISTANCE AND TRAINING

Technical assistance and training are treated together under one subheading since they were and are inter-related, i.e. their need was predicated on the conditions created by the introduction of new sophisticated equipment and advanced technology in the Survey Department. There was also some fusing of the two functions, both in the PP as well as in practice: eg. the long-term technical advisor taught courses; the photo pilot instructor, recruited under the technical assistance contract, provided training.

7.1 PP

The PP stated that the project would not impose a "requirment for training new personnel" on the SD since the project would not require additional personnel. It indicated, however, that personnel already in the Department who would be involved in the implementation of the ABMP would need certain "on-the-job training and practice with new techniques." The PP budgeted $ 254,000 for five areas of technical training: (1) remote sensing training course/seminar in Sri Lanka, (2) USGS training course in the U.S., (3) international study fellowships, (4) equipment familiarization, (5) international conference attendance.(The latter was specifically designated for management level personnel). The PP also recommended that, as a general rule, equipment purchases include a clause for installation and training.

It was felt that this would satisfy the training needs of the technical-level staff. The PP concluded that no specialized technical training was needed at the management level, since "the management personnel of the Survey Department have almost all received excellent training in the technical fields necessary for map making. They are well read and current in their knowledge of the technical aspects....(the Survey Department) is staffed by a group of well-educated professionals in key position."

The PP did take account of the fact that the proposed ABMP represented a large and complex operation by any standard, requiring considerable technical as well as managerial skill to sustain a "continuous high level of effort which will impose managerial problems not now being encountered." Therefore, the PP determined that in certain key areas of project management, (particularly in developing a modus operandi involving new technology in the affected production units and in rationalizing all of the functions leading up to final map production) management-level staff might need some reinforcement. It was felt that some assistance would be essential in the early critical years of the project when the equipment was being procured, organizational and procedural changes were being introduced and staff was receiving both formal technical as well as on-the-job training. In addition to the attendance at international technical seminars and conferences (designated for management under the training budget), the PP established a budget of $503,000 for technical assistance covering up to three years of a long-term technical advisor who could assist in the procurement process and in on-the-job training supplemented by the inputs of short-term advisors on an as-needed basis. (This included the proposed utilization of a photo pilot instructor.)

7.2 SD

Appendix O lists the training which has been provided to date under the project budget allocation, and the total expenditures which have been made. In summary it consisted of:

a) thirteen draftsmen, trained in cartography and scribing at the Survey Training Institute, Hyderabad, India;

b) one draftsman, trained in map production at the same institute;

c) two officers, trained in repair and maintenance of theodolites and photogrammetric equipment at Kern plant in Switzerland:

d) four SLAF technicians, trained at Heli Orient in Singapore.

Additionally, the photo pilot instructor provided training during his three-month assignment in Sri Lanka. The long-term advisor gave training courses in map finishing operations, provided on-the-job training and prepared a manual on cartographic procedures for 1:10,000 scale maps. One trip to an international conference was funded under the project, although this does not appear in the listing in Appendix O. A number of equipment familiarization courses have been held, primarilily in conjunction with procurement of new equipment.

The SD determined that fully satisfactory technical training could be secured in India for some elements of the planned training program at a substantial savings to the project, thus permitting the training of more technical personnel than originally planned. It had sought unsuccessfully to secure USGS training courses for some of its technical staff.

The SD contracted with the U.S. California-based engineering consulting firm, Resources Development Associates (RDA) to provide up to 36 months of services of a long-term technical advisor, up to six months of a photo pilot instructor's services and other miscellaneous but optional short-term technical services on an as needed basis. The long-term advisor was expected to provide technical advisory services in the following areas: program management; map production; photographic laboratory; air survey; geodetic survey; remote sensing/survey research center - later referred to as user assistance center.

The long-term consultant completed the first eighteen months of his service when he was medically evacuated and subsequently died in the U.S. Following his death, SD reassessed its technical assistance requirements and determined that it would be preferable to fill specific, identified needs in timely manner with short-term advisory services rather than to recruit a new long-term advisor. (See Appendix P)

Late in 1981 the SD requested USAID approval to finance up to a three-month technical services of an advisor to assist in solving computer problems related to aerotriangulation, and USAID assistance in securing these services from USGS.

7.3 ET:

The Evaluation has taken note of the substantial balances left in the budget for the two project components of technical assistance and training: technical assistance - $254,840 compared to budget allocation of $503,000; training - $210,878 compared to budget allocation of $254,000. It has also noted the reasons given for the balances; the savings realized by utilizing training facilities in India; the savings realized by the training provided by the long-term technical advisor; the decision not to extend long-term technical advisory services to the full, budgeted total of thirty-six months once the services of the long-term advisor were no longer available. Some of the training listed in the PP was suggestive, most of the short-term technical advisory services was optional. In addition, the ET found that substantial and effective training and technical assistance has been provided by Swiss advisors under a Swiss-funded remote sensing project. Underway when the ET arrived in Sri Lanka was a remote sensing training course with Swiss and FAO involvement. This conforms to suggestions for this type of training contained in the original project plans, but is not funded under the ABMP AID loan.

The ET feels that what has been expended for training under the project was fully justified and that the training that was provided was essential to the project and is being applied effectively. Had the long-term technical advisor survived, it is apparent that he would have served out most if not all of the suggested thirty-six months, specified in the technical assistance contract. He was highly respected and his recommendations and suggestions were welcome. The training he provided apparently contributed significantly to meeting some of the training needs of the SD. It is impossible for the ET to assess the impact of his inputs, other than to note the high level of respect which he is still accorded, both in the Department and in USAID. Unfortunately, his contract did not require preparation of quarterly or other regular reports, so it is not possible to do a file search on his efforts.

The Evaluation Team feels that it would be inappropriate to comment on the contractual arrangements and relationships that existed between SD and the firm -- Resources Development Associates (RDA) -- with whom it contracted for the provision of the long-term technical advisor and the photo pilot instructor since the ET was not in a position to interview any representatives of that firm. That certain critical problems arose which clouded the relationship between RDA and the Department is a matter of record and the ET has been briefed on these matters by all parties as well as has had access to the relevant files in SD as well as USAID.

The one comment which the ET could make is that these problems, of themselves, do not seem to have constituted a major constraint to the implementation of the project. In determining not to contract or procure any further technical assistance, other than the advisory services of a technical advisor to assist in solving some computer problems (which was noted above), the SD appears to have exercised options and discretion which were available to it. The language of the PP was not mandatory -- it was suggested or recommended that certain types of technical advisory services might be useful in achieving the project purpose. Apart from the long-term advisor and the photo pilot instructor, (whose length of service was qualified by the prefix "up to (x) months"), the RDA contract indicated that other short-term services might be requested at the option of the SD.

7.4 The ET agrees with the SD that long-term technical assistance is not required and that the only short-term advisory services required at this time is for aerial triangulation. The request for this assitance had been made, as noted earlier, prior to the arrival of the ET. ET supports this request since the inoperable aerial triangulation function is a serious production problem currently interrupting AMBP plans. It is unlikely that outside training for SD personnel would correct this problem. The ET agrees that the training in India has been an effective use of the training funds. However, it does recommend that SD immediately utilize about $ 50,000 for specific training to improve current deficiencies. While the SD list included in Appendix Q is clearly beyond the budget capability of the SD and beyond the availability of AID loan funds, ET recommends the following list which is keyed to the SD list in Appendix Q:

a)	Exposure of ABMP managers (i.e. Suptd or D.S.G - ABMP) to USGS production mapping centers to observe variant techniques, production management, interchange of ideas. (i.e. one per year for one month trip	- $ 4,000)
b)	Data Processing with emphasis in photogrammetry (SD item 4	- $ 6,000)
c)	Printing and Ink Technology (SD item 14, red. to 1 month	- $ 4,000)
d)	Halftone Photography (SD item 15	- $ 2,000)
e)	Airplane Mechanics (SD item 17, 4 pilots	- $ 7,000)
f)	Routine training for surveyors, photogrammetric technicians, and draftsmen (SD items 2, 5, 10, 11, 12 people/year	- $15,000)
g)	Operation and maintenance of Printing Presses (i.e. one or two initially to Switzerland	- $ 6,000)
h)	Routine maintenance of precision equipment (SD items 7,12, one per year	- $ 3,000)
i)	Misc.	- $ 3,000)
	Total	$50,000

8. ORGANIZATION AND MANAGEMENT

8.1 PP:

The PP recommended that the ABMP operations be organized along lines similar to the organizational structure already in place in SD. Some proposed minor changes were:

a) Consolidate wet lab operations into a centralized photo lab

b) Add a remote sensing and survey research center to address the proposed user assistance function

c) add a staff function for administration, centralizing management of personnel, budget, purchasing, and logistics

d) add a staff function for plans, requirements & technology

e) add a staff fuchtion for programs, production and operations

The proposed organization chart is shown in Appendix R.

8.2 SD:

The current SD organizational structure is shown in Appendix S. The Deputy Surveyor General for ABMP is responsible for all ABMP activites. Some of the units also perform non-ABMP functions. In this case, they report to another line of authority, generally the Deputy Surveyor General II. This complicates management in that many units have multiple chiefs, increasing the possibility of conflicting priorities and resources. In general, however, this organization has been working adequately. Some of the PP recommendations have not been incorporated.

The two photolabs differ in requirements and supplies used. Personnel are shifted between the labs when needed so there does not appear to be a need to centralize the labs. Staff functions have been established for the remote sensing and research activity and for administration. No formal staff functions have been established for plans and programs. Branch superintendents have been doing the proposed functions. However, a quality control officer reviews maps on a sampling basis.

The SD has indicated that one of the primary management concerns is the difficulty in motivating the technician labor force. Typical to most government service jobs, pay is lower than comparable jobs in the private sector. Employees who are trained in complex functions can easily get better offers outside of government service. Instituting double shifts, as proposed by the PP to meet the schedule, has not been feasible. Employees currently have no incentive to work on a swing shift. Most live many miles from the facility and adequate transportation is not available at night. The SD desires to institute "incentive pay", providing extra salary for employees based on productivity. Labor Unions in Sri Lanka are supportive of this "piece-pay" concept. Recruitment of educated

employees has been difficult. Most entry level technicians have the equivalent of high school education with little or no experience in drafting or mapping. In-house operational training is required for new employees and is a constant activity due to fairly high staff turnover. This, of course, interferes with productivity, especially when proficient technicians are used as instructors.

8.3 ET:

Basically, the Survey Department has an effective organization with a high caliber of management expertise. In spite of procurement problems, budget cutbacks, and labor problems, the capability to effectively manage a complicated program has been proven. The ET concurs with the SD that combination of the photo labs is not necessary. The two labs service respectively segregated operations and are functioning adequately.

There continues to be a need for a staff position such as a Plans and Production Officer to perform parallel to the Quality Control Officer. Currently, status and goals are addressed in monthly staff meetings of the D.S.G. - ABMP and the Branch Superintendents. As a result, production planning, monitoring, and cost accounting tend to be de-centralized and insufficient in scope. Some suggested job functions of a new staff function include:

a) maintaining ABMP records of maps produced, maps in backlog, and projected short-term goals by unit of activity;

b) maintaining up-to-date average production rate by employee and an ongoing unit average;

c) detecting workflow problems requiring equipment, materials, or staffing changes <u>before</u> a problem develops;

d) maintain an updated long term plan.

Individual branches would use the statistics to do further internal planning and to monitor efficiency of employee performance. If incentive pay is introduced, individual employee performance monitoring will become critical.

The ET sympathizes with some of the labor management constraints which the SD has experienced. For the most part, the ET findings have verified that motivation is indeed a problem and does have an effect on productivity and flexibility not addressed adequately by the PP. These problems are not uncommon in government service worldwide, but seem particularly serious in the context of this project.

The ET recommends that double shifting should not be forced. The latest approved operational plan does not assume double shifting in the proposed schedule. However, the ET does recommend incentive pay as a scheme to improve job satisfaction and productivity.

9.0 USER ASSISTANCE CENTER

9.1 PP:

The concept of a User Assistance Center was proposed in the PP with two primary objectives:

a) perform research and development of new techniques of resource data collection, analysis, and surveys. Remote Sensing imagery would be the primary medium, including conventional aerial photos, orthophotos, infra-red photos, and satellite imagery. Interpretation of land-use categories for applications useful to other GSL resource agencies was the intended purpose.

b) (as a major focal point of such technology) make equipment and facilities available to other GSL resource agencies to avoid duplication of effort.

The proposal recommended procurement of equipment totalling $68,200, air conditioned facilities, and three months of technical assistance.

9.2 SD:

A User Assistance Center has not been established by loan funds as proposed by the PP. However, an impressive Center for Remote Sensing (CRS) has been established within the SD with about six permanent SD personnel. Some of the proposed equipment as well as some additional equipment has been installed, financed with Swiss grant funds and through USAID (other than ABMP loan)*. The Swiss government has provided technical assistance with two to four people over a two year period. The Swiss grant has, in fact, met most of the research, development, and training objectives for a User Assistance Center as proposed by the PP. Equipment on hand includes about 8 mirror stereoscopes, a mono-photo zoom magnifier, a digital planimeter for measuring areas, a density slicing system, a Cromemco Z-2H computer processor with video screen, 3 light tables, and ground truth camera. The Swiss advisors do not feel that the multispectral camera and additive color viewer are appropriate at this time.

The projects underway include: (a) land-use classification and mapping at 1:100,000-scale, by districts; (b) forest cover analysis using landsat imagery; (c) rice paddy analysis for yield estimating with aerial photographs. Other Sri Lanka resource agencies have been working closely with the Center. Some of these are the Forest Department, Tea Research Institute, Urban Development Authority, and the Department of Census and Statistics. They have provided requirements for the projects and have received user training.

Other forms of user assistance currently provided by the SD includes:

---

* Foot Note: Financed by an AID/W grant to ERIM. Equipment is microprocessor.

a) Satellite imagery selection and purchase provided by the Center for Remote Sensing.

b) Aerial photograph sales by the Air Surveys Branch.

c) Map sales by the Map Sales Office and scattered district offices. The Map Sales Office in the Survey Department in Colombo is staffed with three employees who in 1980 distributed 54,980 maps. (The ET observed on its visit to the Map Sales Office that during the one hour spent there there were fairly brisk sales of maps, including several expatriates who were purchasing maps for projects on which they were working.) The map price is determined by a committee and based on an edition of 10,000 to cover all production costs. Many of the maps are out of print due to paper shortage and press capacity. Space will be available, however, to accommodate the new 1:10,000-scale and the 1:50,000-scale maps when they are produced. No increase in staff is anticipated. See Appendix T for map sale items and price lists.

d) Special purpose tasks for priority development projects usually involving flying of aerial photos, surveys, and photo lab operations with map reproducibles. Some photogrammetric mapping is done for special, non-ABMP projects, although limited due to lack of stereo-plotting instructments.

9.3 ET:

In order to assess the type of demand for SD services mentioned in subpoint (d) immediately above and how these services relate to the overall project purpose of meeting the mapping requirements of rural development in Sri Lanka, the ET secured a list of projects and/or agencies requesting these services and selected a number for interviews. Following is partial list of projects or reports which have received or are still receiving special SD services, and relevant dates when service was provided:

a) CIDA - Lower Uva Regional Development Project 1981;

b) "Monaragala Land Use Study", Hunting Technical Services, Ltd., UK, in conjunction with Resources Development Consultants, Sri Lanka, under aegis of Ministry of Agricultural Research and Development; 1980;

c) Asian Development Bank, Anuradhapura Dry Zone Agricultural Project, under aegis of Ministry of Agricultural Research and Development. SD services to be completed in 1982.

d) National Water Supply and Drainage Project (with Norwegian contribution), under aegis of Ministry of Local Government Housing and Construction SD services to be completed in 1982;

e) Muthikandiya Reservoir Scheme, Lower Uva Project (Australian High Commission funding), under aegis of Ministry of Land and Land Development; SD service to be completed in 1982;

f) Udawalawe Project, under Ministry of Agricultural Development and Research, ET not informed of final status of services requested from SD;

g) Gal-Oya Rehabilitation Project, under Ministry of Lands and Land Development (AID's Water Management Project); ET not informed of final status of services requested from SD.

Services requested ranged from requests for aerial survey work to contact prints and diapositives and available base map details for specific areas. Most of the projects or studies required fairly specific detailed data. In at least two instances, the ET was informed that if it had not been for the services available through SD and the new equipment it had in service the costs of the project would have been considerably higher and the total life of the project would have been extended for at least an additional year. Most of these special services are provided at cost. All of the projects impact, directly or indirectly, on rural development.

While the above is only a partial list, it does indicate that the SD is beginning to provide some of the spin-off outputs suggested in the PP in advance of the final production of the two nationwide maps. While the Department has been able to respond to these requests with varying degrees of time involved before final delivery of the requested services (one project manager indicated he was pleased and surprised at the speed with which he received the materials requested), the special requests, particularly those which are assigned high priority status, could pose a problem to the SD if they interfere with the smooth production schedule suggested elsewhere for the two nationwide maps. The SD assured the ET that this has not presented a serious problem to date, for most of the services requested required only the production outputs of some of the units which were not operating at full capacity. However, it should be noted that the setting of priorities for development projects does not reside in the SD. It must rely on other GSL agencies, particularly the Ministry of Finance and Planning and the Ministry of Lands and Land Development for policy guidance. It must be responsive to priority demands for its services if these have the official approval of the policy - setting ministries. SD, in conjunction with these ministries, must balance the various demands for specialized services against the achievement of the AMBP purpose and objectives.

.4 The current Center for Remote Sensing (CRS) appears to be meeting the concept proposed by the PP. It is the opinion of the ET that this activity can continue to be a viable User Assistance Center by maintaining contact with User Agencies and performing projects funded by grants or the user agencies. There does not appear to be any immediate need for additional equipment or technical assistance. Two alternatives should be considered:

a) Increased sharing of effort between 1:50,000-scale ABMP land-use categories and 1:100,000-scale CRS land-use maps.

b) Organizationally combining sate-lite imagery sales, air photo sales, and map sales into one "Cartographic Information Center" responsive to the needs of other agencies and the public.

No recommendation is made regarding the potential problem that SD could face if special project requests interfere with the production schedule for the 1:10,000 and the 1:50,000-scale maps, other than to note that it is a potential problem of which SD management is fully aware, as well as key officials in both the Ministry of Lands and Land Development and the Ministry of Finance and Planning.

EVALUATION REPORT

AGRICULTURAL BASE MAPPING PROJECT

SRI LANKA

MAY 1982

PART III

Section VI: APPENDICES

PRODUCTION CAPACITY

	1:10,000 Only	1:50,000 Only	1:50,000 From 1:10,000
Aerial Photography & Lab (variable staff, now 10)	not applicable	not applicable	not applicabl
Field Control (variable staff)	10 days/map 25 maps/man year	none (salvage old control)	none
Aerial Triangulation (2 instruments)	½ day/map 500 maps/man year 1000 maps/year limit	12.5 days/map* 20 maps/man year 50 maps/year limit	none
Photogrammetric Compilation (8 instruments, teams of 2)	8 days/map 30 maps/team year 240 maps/year limit	100 days/map 2.5 maps/team year 18 maps/year limit	none
Preparation (variable staff, now 12)	20 days/map 12 maps/man year	60 days/map 4 maps/man year	95 days/map 2.5 maps/man y
Field Revision (35 teams currently)	15 days/map 16 maps/man year	150 days/map 2/3 map/man year	none
Scribing)variable staff)28 currently	65 days/map 4 maps/man year	100 days/map 2.4 maps/man year	100 days/map 2.4 maps/man y
Lettering	80 days/map 3 maps/man year	120 days/map 2 maps/man year	120 days/map 2 maps/man ye
Typesetting (variable staff, now 13)	8 days/map 30 maps/man year	16 days/map 15 maps/man year	16 days/map 15 maps/man ye
Photo Lab (variable staff, now 12)	32 days/map 8 maps/man year	64 days/map 4 maps/man year	64 days/map 4 maps/man yea
Platemaking (variable staff, now 17)	1½ days/map 160 maps/man year	1½ days/map 160 maps/man year	1½ days/map 160 maps/man y
Printing (4 presses, currently 34 people)	4 days/map 60 maps/press/year	4 days/map 60 maps/press/year	4 days/map 60 maps/press/

* may not be required if use salvaged control

APPENDIX B

SURVEY DEPARTMENT PLAN - APRIL 1982

S.G.

Thro' D.S.G.I
D.S.G.II

REPORT REGARDING ABMP SHEET COMPILATION

We have considered the available resources for the compilation of 1:10,000 and 1:50,000 sheets. In the light of the present thinking, we have looked into the possibility of completing the 1:50,000 series prior to 1:10,000 series using all available methods. In certain areas of interest 1:10,000 mapping would also continue simultaneously.

1. Sheet No.1-2 Planimetry - Compile 1:50,000 sheets using 1:10,000 sheets to be compiled, photogrammetrically using 1982 photography (to be taken)

   Contours - Contouring is not necessary as contour plans are already available.

2. Sheet No.3-5 Planimetry - Enlarge 1 inch to 1:50,000 and revise this using 1982 photography.

   Contours - As in 1 above

3. Sheet Nos.6-10 Planimetry - Using rectified enlargements

   Contours - Contour plans are available for most of the area. Balance area to be compiled photogrametrically using 1956 photography.

4. Sheet Nos.11-23, 26-33 and 39

   Planimetry - Using rectified enlargements

   Contours - Area available at 20 foot intervals on existing ½ mile board. The metric equivalent to be given.

5. Sheet Nos.24-25,34-36, 45-47, 51, 57-58, 64-65, 71-72 98, 84, 86, 89 and 92

   Planimetry - Using rectified enlargements

   Contours - To be photogrammetrically compiled using 1956 photography

6. Sheet No.37 (in progress)

   Planimetry - Using rectified enlargements

   Contours - Metric equivalent of 20 feet contours existing on ½ mile boards to be given.

7. Sheet No.38 Planimetry - Using D.S., compile 1:10,000 sheet field revised.

   Contours - As for Planimetry

8. Sheet No.40-44, 48-50, 54-56, 60, 61, 63, 67-70
74-77, 79-83, 85-87, 90-91 (HILLY)

Planimetry - Enlarge 1 inch sheet to 1:50,000
and revise using 1981 photography

Contours - To be compiled photogrammetrically using 1956 photography

9. Sheet Nos.52,53, 59, 62, 66-73

These 1:50,000 sheets will be first compiled on
1:10,000 scale using 1981 photography.

1:50,000 sheets will be compiled by reduction of
this 1:10,000 sheet

The above is a programme for completion of 1:50,000 series. In working out this programme we have considered the present constraints of not having an operational aerial triangulation programme. In this situation whenever stereo compilation is necessary, orientation will be done using available details and Barometric Heights.

If these suggestions are accepted in principle, a time estimate will be worked out. Further this would also mean that ABMP photography on the 1:50,000 for the balance area would have to continue.

J.B.Seneviratne
Supdt.of Air Surveys

S.Shanmuganathan
Ch.Photogrammetrist

N.Abeysiri
S.S.,ABMP (Prep.)

12th February,1982

S.G./D.S.G.(I) /DSG

SUMMARY OF REPORT REGARDING COMPILATION
OF ABMP SHEETS FOR 1:50,000 PLANTING

Further to the report to you dated 12th February 1982 copy annexed for easy reference, the summary of the report is given below :-

2.0 PHOTOGRAMMETRIC SECTIONS: Estimate worked out on the basis that 8 plotting machines would be used for this work.

2.1 PLANIMETRY :

2.1.1 Enlarging of 1" to 1:50,000 metric sheets and revising with 81 and 82 photography.

No. of metric sheets - 35
No. of models (35x25) 875
No. of machine days (norm 3 days/model) = 2625

2.1.2 Stereoplotting of 1:10,000 and compilation of 1:50,000 series

No. of metric sheets - 8
No. of models (8x25 (1:10,000) = 200
No. of models already completed = 35

Balance no. of models to be completed = 165

No. of machine days (Norm 8 days for both planimetry and contours = 1320

2.2 CONTOURING

2.2.1 Using 1956 photography and plotting on the scale of 1:50,000.

No. of metric sheets - 57
No. of models (1:40,000 photography -57x40) - 2280
No. of machine days (Norm 1½ day/model) 3420

2.2.2 Stereoplotting of 1:10,000 scale and compilation of 1:50,000 series

No. of metric sheets - 6
No. of models (6x25) - 150
No. of models already completed 35
No. to be completed - 115

Estimate already included under Para.2.1.2

2.3 Hence the total no. of machine days for planimetry and contouring (1320 + 2625 + 3420) is - 7365

2.3.1 With normal working hours (7 Hours/day)

Setting apart 8 machines for ABMP work the number of days involved (7365/8) is 921

Estimated time for completion is - 3¼ years

2.3.2 With overtime (2 hours of O.T. per day)

By working 2 hours of O.T. per day the total estimated time for completion will be reduced to 3 years.

2.4 BAROMETRIC HEIGHTING

Only Para.2.1.1 needs barometric heighting. No. of points required (3 points/model). A surveyor is expected to about 10 points/month. Estimated time with 10 Surveyors is = 2 years.

2.5 The time estimate for Barometric Heighting is not critical as the entire period required for Barometric Heighting can be absorbed within the time required for stereo compilation, so long as a few barometric heights or other suitable control is available at the commencement. Thereafter this data could be fed in at regular interval. On this basis it is estimated that the stereo-compilation could be completed within 4 years.

3.0 ABMP PREPARATION SECTION

With effective staff of 12 officers the time estimate and summary of the work involved is as follows : -

3.1 Compilation of 1:50,000 sheets using E.S.compiled 1:10,000 sheets and field revised-

No. of sheets - 01
Estimated time - 05 man days

3.2 Compilation of 1:50,000 sheets, using E.S. compile 1:10,000 and revision with B2 Photography.

No. of sheets - 2
Estimated time - 190 man days

3.3 Inserting available contours on 1:50,000 metric sheets enlarged from 1" sheets and then revised photogrammetrically.

No. of sheets - 3
Estimated time - 195 man days

3.4 Planimetry from rectified photos and inserting contours from reduced 1:10,000 E.S. compiled sheets.

No. of sheets - 5
Estimated time 925 man days

3.5 Planimetry from rectified photos and inserting metric equivalents of contours from existing ½ mile boards

No. of sheets - 22
Estimated time 4070 man days

3.6 Planimetry by rectified photos and inserting contour drawn photogrammetrically using 1956 photographs.

No. of sheets - 21
Estimated time - 3790 man days

3.7 Pre and Post full edit only of 1:50,000 sheets fully compiled photogrammetrically.

No. of sheets - 32
Estimated time - 1760 man days

1:10,000 photogrammetric plotting.

No. of sheets 8
Estimated time - 680 man days

3.9 Total estimate time for preparation work in ABMP - 11,560 man days

3.9.1 With normal working hours (7 hours/day)
With a staff of 12 officers the estimate time is $\frac{11,560}{12 \times 240}$ = 4 years

3.9.2 With overtime (2 hours of O.T./day)
Estimated time - $3\frac{1}{4}$ years

3.9.3 With an incentive of 65% the estimate time reduces to $2\frac{1}{2}$ years

4.0 Field revision of all the sheets involved in paras.3.1 to 3.7 will take 23,000 man days.

With a survey staff of 25 the time estimate for field revision is 4 years. With 65% incentive this could be further reduced to $2\frac{1}{2}$ years

5.0 Rectification

No. of sheets - 47
No. of rectified photographs (47x25) 1175
Norm for rectification : 4 models/man days
Estimated machine days $\frac{1175}{4}$ = 294
= $1\frac{1}{4}$ years

6.0 Interpretation

No. of rectified photos involved: 1175
Estimated time - 2 years

7.0 CONCLUSION

7.1 Photogrammetric plotting requires 4 years
Barometric heighting with 10 Surveyors requires 2 years

Preparation section with a staff of 12 requires 4 years

Rectification with one rectifier requires $1\frac{1}{4}$ years

Interpretation work requires 2 years

Taking the above mentioned phases into consideration it is estimated that these phases of the project could be completed within a total period of 4 years, provided there are no unforeseen circumstances which would hamper the progress of each phase.

22/04/85

J.B.Seneviratne
Supdt.of Air Surveys

N.Abeysiri
Supdt.of Surveys (ABMP)

S.Shanmuganathan
Ch.Photogrammetrist

1:50,000 Series

Report on time estimates for Drawing Office, Studio Operations and Printing.

Drafting & Studio Operations:-

1. 165 man days/sheet

   Total time for 92 sheets = 15180 man days.
   With normal working hours (7 hrs./day) and a staff of 30 D'men the estimated time is

$$\frac{15180}{30 \times 240} = 2\tfrac{1}{4} \text{ years}$$

2. With Overtime of 2 hours/day/d'man estimated time is reduced to 2 years.

3. With incentive of 65% the estimated time is reduced to 1½ years.

4. Total time estimate for Drawing Office/Studio Operation is 2¼ years for the present staff of 30 d'men.

5. Activities in the Branch will continue for approximately 3 more months after production activities in Drawing Office/Studio are completed.

APPENDIX C

SCHEDULE FOR 1:10,000-SCALE MAPPING

PHASE	PACE	TIME-FRAME	STAFFING	COMMENTS
Aerial Photography	As reqd.	1000 photos by 1984	10	
Field Control	As reqd.	now to 1987	10	
Aerial Triangulation	400 mdls/ yr.	July 1982 to 1987	2	Begin after Tech Asst., incentive-pay, 2 per machine
Photo.Compilation	240 maps/yr.	now to 1990	16	
Preparation	240 maps/yr.	Sept. 1982 to 1990	20	Recruit 8
Field Revision	240 maps/yr	Dec.1982 to 1990	15	Also 30-60 laborer
Scribing	200 maps/yr	June 1982 to 1992	50)	Recruitment of 10 people required for Drafting Unit
Lettering	200 maps/yr.	June 1983 to 1992	83)	
Typesetting	200 maps/yr.	Sept. 1983 to 1993	7	
Photolab	200 maps/yr.	Sept. 1983 to 1993	25	Recruit 13
Platemaking	200 maps/yr.	Sept. 1983 to 1993	2	
Printing	200 maps/yr.	Sept. 1983 to 1993	10	
			250	

APPENDIX D

SCHEDULE FOR 1:50,000-SCALE MAPPING

PHASE	PACE	TIME-FRAME	STAFFING	COMMENTS
Aerial Photography	As reqd.	100 photos by 1983	10	
Field Control	As reqd.	Now to 1984	4	
Aerial Triangulation	50 maps/year	July 1982 to 1984	4	
Phot. Compilation	18 maps/year	Now to June 1987	18	Incentive Pay 2/plotter
Preparation	18 maps/year	1983 to 1988	5	
Field Revision	18 maps/year	1983 to 1988	25	Also 50-100 laborers
Scribing	18 maps/year	1984 to 1988	7	
Lettering	18 maps/year	1984 to 1988	9	
Typesetting	18 maps/year	1984 to 1989	1	
Photo Lab	18 maps/year	1984 to 1989	4	
Platemaking	18 maps/year	1985 to 1989	1	
Printing	18 maps/year	1985 to 1989	2	
			90	

APPENDIX E

SCHEDULE FOR PRODUCING 1:50,000-SCALE FROM 1:10,000-SCALE

PHASE	PACE	TIME-FRAME	STAFFING	COMMENTS
Aerial Photography	-	-	0	Done for 10,000-scal
Field Control	-	-	0	"
Aerial Triangulation	-	-	0	"
Photo.Compilation	-	-	0	"
Field Revision	-	-	0	"
Preparation	12 maps/year	1983 to 1990	5	
Scribing	12 maps/year	1983 to 1991	5	
Lettering	12 maps/year	1983 to 1991	6	
Typesetting	12 maps/year	1984 to 1991	1	
Photo Lab	12 maps/year	1984 to 1991	1	
Platemaking	12 maps/year	1984 to 1991	-	Negligible effort
Printing	12 maps/year	1984 to 1991	1	
			19	

Wing Commander W. D. H. S. W. Goonetilleke, psc. adc. SLAF.

Telephone { 32171
33184 Ext. 3200

OFFICE OF THE COMMANDER,
SRI LANKA AIR FORCE,
P. O. BOX 594,
COLOMBO.
SRI LANKA (Ceylon.)

Ref:- SLAF/ 72/AIR

දුරකථනය { 32171
33184 දිඩි 3200

ශ්‍රී ලංකා වායු හමුදාව,
ශ්‍රී ලංකා වායු හමුදාව,
තැ. පෙ. 594,
කොළඹ. ශ්‍රී ලංකාව.

106

6th April 1978

Survey General,
Survey General Office (Air Survey Branch),
P.O.Box 506,
Colombo 5

Best Available Copy

MAINTENANCE OF THE SURVEY DEPARTMENT AIRCRAFT

Reference is made to your letter air/A/7 dated 9th February 1978. The Maintenance Agreement as proposed by you has been studied and I am hereby confirming acceptance. However provision needs to be made for the training of SLAF Pilots on air photo work and this item has been included in the revision of para. '2g'. Two copies of the revised Maintenance Agreement are forwarded herewith.

(W.D.H.S.W. GOONETILLEKE)

256(1). In para 7 the following two new added provisions will be invaluable 'entitlement training etc' which is one of the terms of the ~~added~~ new conditions of AID.

Is this from of the agreement OK.

remittance to AID vide sec 5.2 (a) of the project agreement. Might not be possible?

(B) 105

MAINTENANCE AGREEMENT

a) The new Aircraft to be acquired for the Survey Department under the U.S. AID project will be handed over to the S.L.A.F. who will operate and maintain it for the Survey Department.

b) The S.L.A.F. will provide the necessary hangerage and will also be responsible for the safety of the aircraft.

c) The S.L.A.F. will maintain the aircraft providing the necessary personnel for its operation, maintenance and inspection.

d) The S.L.A.F. will provide a Pilot for each photographic flight while the Photographic Crew and the Navigator will be provided by the Survey Department.

e) The S.L.A.F. will provide a minimum of 250 flying hours each year to the Survey Department for photographic flights which will be scheduled when the weather is suitable for aerial photography.

f) The Aircraft provided under the project shall be reserved for projects until all the photography for the base maps under this project is completed. Thereafter additional eligible uses for the Aircraft will be subject to a plan acceptable to A.I.D; provision will be available for the training of SLAF Pilots for Air Survey work. At no time will the Aircraft be used for military purposes.

g) The Survey Department will pay the cost of all fuel, oil and other supplies used for the operation and maintenance of the Aircraft for flights made for the Survey Department.

h) The Survey Department will insure the Aircraft.

i) The S.L.A.F. will import and stock an adequate supply of spare parts required for the maintenance of the Aircraft. The engine overhauls will be done by arranged by the S.L.A.F. The Survey Department will provide the necessary funds for this purpose.

j) The S.L.A.F. will maintain a log book to record particulars of all flights done. A copy of each flight record will also be sent to the Surveyor General soon after each flight.

k) This Agreement will be operative on trial for a period of three years and will be revised thereafter.

Best Available Copy

APPENDIX G

Alternative Procedure: Scribing by photogrammetry

Sequence of Activities:

1. Prepare punch-registered coated-mylar manuscripts (4)

2. Instrument operator compiles entire model in pencil for each manuscript category:

   Sheet I: Orientation control, collar, planimetry (roads, buildings, etc).

   Sheet 2: Hydrography

   Sheet 3: Land-use categories

   Sheet 4: Contours

3. Second technician scribes over pencil copy using appropriate symbology and classification labels. The scribing does not have to meet final engraving quality and the symbols can be free-hand drawn. Photogrammetric symbols used by USGS have been provided to Air Surveys Branch Chief.

4. Hydrography is done before contours and vacuum-frame transferred to contour plate. When contours are scribed, re-entrants should fit hydrography.

5. Scribe guides or cronaflexes for field revision are produced by vacuum frame transfer of scribed copy to film or another scribe guide.

6. Alternative: Avoid pencil compilation altogether and scribe directly in pantograph unit. The copy would not be as good, although the second technician would not be required. That capacity could then be used by subsequent phases to "clean-up" the copy.

APPENDIX H

Alternative Procedure: Field Edit before Photogrammetry

Sequence of Activities:

1. Fly interpretation photography (i.e. 1:10,000-scale to 1:20,000-scale)

2. Preparation Unit prepare boundary and names overlay on enlarged base map (i.e. existing 1":1 mile map enlarged to 1:10,000)

3. Air Surveys Branch identify required control as normal.

4. Surveyor in the field acquires control and classifies map-worthy features on aerial photgraphs. Classification includes a sampling of land-use examples (complete in office by trained land-use interpreters), annotation of buildings, roads, etc. using black rapid-o-graph pens, deletion of non-mapworthy imagery with small "x".

5. Photogrammetry Unit compiles normally from the high-altitude photos, although the field prints are used as a guide for content and classification.

Advantages:

1. Time-consuming field work can get started without waiting for photogrammetry (current bottleneck).

2. No time is spent compiling features ultimately changed or deleted.

3. Photogrammetrist does not need to guess at photo-interpretation, difficult from 1:50,000-scale photography.

4. Overall reduced cycle time and improved production cost.

Disadvantages:

1. Short term training impact to teach surveyors photo-interpretation

2. Cost of low-altitude interpretation photography.

3. Short-term impact of changing an established procedure which is fairly effective as-is.

APPENDIX I

ABMP FLOW CHART 1:10,000-SCALE GOALS

SCRIBING

NO.	DAYS	ACTIVITY
1	1/2	Collate and check manuscript, positive, negative guides etc.
2	1/2 Studio	Order Scribcoat.
3	2 1/2	Match, edit, correct, re-edit, scribe drain lines
4	1/2	Opaque drain line on MS negative
5	1/2 Studio	Order 4 scribe combine scribe, correct drain
6	2 1/2	Scribe cased road and urban fill. Match, edit, correct
7	1 1/2	Scribe fill limits, match, edit, correct
8	1/2 Studio	English composite pos. border, drains, road, fill
9	1	Order openwindow peels (5 -- water, road, paddy, other)
10	3 1/2	Scribe plan detail, match, edit, correct
11	4	Scribe relief, match, edit, correct
12	2 1/2	Scribe admin boundaries, misc.
13	1/2 Studio	Composite drain, plan, relief, bound, border
14	1/2	Check peels, guides, starting symbols, etc.
15	1 1/2	Peel water, opaque, edit, correct
16	1 1/2	Peel roads, urban fill, etc
17	1 1/2	Peel paddy, etc.
18	2 1/2	Peel vegetation and border data, etc.
19	1 1/2	Peel other
20	1 1/2	Stick-up other fills, etc.
21	1/2 Studio	Contact negative of positive overlays fill
22	1 Studio	Compositive positive English border, windows
23	1/2	Edit composite each separation, edit, correct
	33 days	

TYPE

NO.	DAYS	ACTIVITY
24	1/2	Collate and check, etc.
25	2 1/2	Write English, edit, correct
26	1 1/2	Write Sinhala, etc
27	1 1/2	Write Tamil etc.
28	1/2	Print type, proof, correct, review, approve, wax
29	4 1/2	Stick-up English, match, edit
30	2	English correct and reset
31	1	Block out lines for type, edit, correct
32	1/2 Studio	Negatives for color separation of type
33	1/2 Studio	Diazo type composites guides for other language
34	4 1/2	Opaque for type separates, edit, correct
35	3 1/2	Stickup Sinhala
36	3 1/2	Stickup Tamil
37	1 Type	Set type, edit, correct
38	1/2 Studio	Content negative Sinhala (Black, Blue, Red)
39	4 1/2	Opaque Sinhala for separation
40	1/2 Type	wax, correct, re-edit
41	1/2 Studio	Contact negative (3) Tamil
42	4	Opaque, edit, etc.
	37 1/2 days	

QUALITY CONTROL AND PROOFING

NO.	DAY	ACTIVITY
43	1 1/2 Studio	Prepare report, order composite positives
44	2	Proof, prepare report
45	1	Edit separates, correct
46	1 1/2 Studio	English proof
	1	Edit proof
47	1 1/2 Studio	Sinhala proof
	1	Edit proof
48	1 1/2 Studio	Tamil proof
	1	Edit proof
49	1	Correct separates and reedit
50	1 1/2 Studio	Final composite English negatives (6)
51	1/2	Opaque negatives and order plates (6)
52	1 Studio	Composite Sinhala type negative, opaque
53	1 Studio	Composite Tamil type negative, opaque
54	1/2 Studio	Composite positive all plates except yellow
	17 1/2	

PRESS PLATES

NO.	DAY	ACTIVITY
55	1	Prepare plates from negatives English (6)
56	1/2	Prepare plates Sinhala (3)
57	1/2	Prepare plate Tamil (3)
	2	

PRINTING

NO.	HOURS	ACTIVITY
58	3/4	Make ready language only
59	1	Make ready between color
60	1/4	Machine roller wash (before lunch)
61	1/4	Check and approve color
62	1/2	Run 2000 copies
63	1 1/4	Run 6000 copies
	4 hrs	

- 4 days 6450 copies 1 machine

PRINT SEQUENCE

Black line and type English
line and type Sinhala
line and type Tamil
Blue line,type and fill English etc.
Red line , type and fill English etc.
Brown line, type and fill Universal
Green symbol and tints Universal
Yellow tint Universal

Total copies include progressives = 6480

APPENDIX J

ALTERNATIVE PROCEDURE: SINGLE COLOR LETTERING

* Print all map lettering in black

This will reduce printing plates for three languages edition from 12 plates to 8 plates and thereby reduce cost of labor and material in platemaking and press by 33%. An additional saving results in scribing in that opaquing of names from six negatives will not be required nor will the negatives be required. Labor in Scribing and Studio for these activities is 14 days per map. In summary:

	Dollar Material	Hour Labor
1800 1:10,000 maps x 6 films @ $8	86,400	
92 1:50,000 maps x 6 films @ $8	4,016	
1800 1:10,000 maps x 4 plates @ $9	64,800	
92 1:50,000 maps x 4 plates @ $9	3,312	
1800 1:10,000 maps x 2 hr. lab press & plate		3,600
92 1:50,000 maps x 2 hrs. lab press & plate		188
	$158,528	3,788

APPENDIX L

EQUIPMENT NEEDS

VITAL TO ABMP:

1.	Phototypesetter	$30,000
2.	Roller coater for pressplate	$ 5,000
3.	Varimat lens for Apollo camera	$ 4,000
4.	Vacuum back for Lanston camera	$ 5,000
5.	Phototype Processor	$ 5,000
6.	Platemaker 11 X17	$ 1,000
7.	Diffusion Transfer Processor	$ 500
8.	Spare parts for Press and Processor	$15,000
9.	Aircraft maintenance and parts	$30,000
10.	Misc. equipment	$15,000
		$110,500

OTHER DESIRABLES, BUT NOT VITAL:

1.	Roll film processor	$30,000
2.	Aerial camera	$125,000
3.	Roll paper printer	$20,000
4.	Surveying equipment	$64,000
5.	Digitized coordinatograph	$10,000
6.	Orthophoto attachment	$80,000
		$329,000

APPENDIX M

INVENTORY OF MAP PRODUCTION MATERIALS

(DRAFTING UNIT)

No.	Item	Quantity in hand
1.	Hobbyists Kit	60
2.	Pin Vise	60
3.	Crowquill Pen Holders	48
4.	Film Rule Cutters	6
5.	Lettering Pen Holders	48
6.	Adjustable dual cutters	12
7.	Swivel Knives	12
8.	Linen Testers 5 x	10
9.	Needle Cutters	12
10.	Paste Up Kits	48
11.	De Luxe Knife Sets	6
12.	Super De Luxe Knife Sets	2
13.	Proportionate dividers	6
14.	Swivel scribing gravers	60
15.	Straight Line Scribing gravers	30
16.	Rigid scribing ravers	120
17.	Building ravers	25
18.	Building Graver Blade Attachment	25
19.	Building Graver Lens Attachment	25
20.	Blade Sharpeners	6
21.	Plastic blocks with sharpening stone	6
22.	Needle Sharpeners	6
23.	Dotters	30
24.	Needle files set	1
25.	Mars Irregular Curves	90
26.	Mars Flexible Curves	12
27.	Mars Triangles	126
28.	Mars Templates	30
29.	Mars Triangular Scales	50
30.	Mars Triangular Scales	6
31.	Metric Pen sets	20
32.	Mars Jewel Pens	40
33.	Mars Jewel Replacement Points	76
34.	Mars Lead Holders	50
35.	Mars Lead Pointers	12
36.	Drafting Brushes	100
37.	Erasing Shields	100
38.	Leroy Lettering Sets	1
39.	Mars Duraglide Pens	40
40.	Mars Duraglide Pen Points	40
41.	Moto Tool Set	1
42.	Magnifiers 9 X	5
43.	Reading Glasses 4"	20
44.	Needle Files	1
45.	Graphic Arts Comparators	6
46.	Eye Loupes	100
47.	Linen Testers 9 X	1
48.	Map Measurers	12
49.	Linen Testers 5 X	10
50.	Screw Driver Set	1

No.	Item	Quantity in hand
51.	Micro Drill Set	1
52.	Metric Micrometers	12
53.	Microscopes Direct Measuring	6
54.	Gooseneck magnifiers	5
55.	Swivel blades for swivel knives	120
56.	Styles Burnishers - Packs of 6 each	10
57.	Single edged razor blades - boxes of 100 blades	44
58.	Crovex Drafting film, matt 2 sides 26" x 36" 50 sheet boxes	155
59.	Crovex Drafting film matt 2 sides, 36" x 100 ft rolls	4
60.	Plastic Type Cleaners, dozen	100
61.	Tungsten Carbide Cutters	210
62.	Magic Rub erasers, gross	5
63.	Higgins Colored Ink, 1 oz bottles, dozens	139
64.	Higgins Black 32 fl. oz. bottles	28
65.	Spirit ball pens, assorted colors, dozens	110
66.	Color leads for lead holders, gross	21
67.	Desk sharpening stones	20
68.	Drafting Tapes, 1" rolls	360
69.	Register studs	640
70.	Adheser liquid, cleaner and thinner, bottles	84
71.	Release paper for Adheser Coater, packets	6
72.	Unsensitized scribcoat 26" x 36" sheets	4000
73.	Printing paper, reams	1050 Reams

INVENTORY OF MAP PRODUCTION MATERIALS
(PHOTO-LAB)

			Units	Balance @ present
1	Kodilith Ortho Films 60 Cm x 30m		Rolls	Nil
2	Kodilith Super R.T. Developer	10 Litre	Packs	31
3	Kodak Unifid Powder	10 Litre	Packs	36
4	Kwik Proof Sheets 27"x37 1/2"x0.010"		Sheets	184
5	Kwik Proof Assorted colors		Quarts	27
6	Kwik Proof Blocks		Nos.	02
7	KP/WC Brighter		Gallons	04
8	KP Wipes		Rolls	31
9	Stouffer sensitivity guide		Nos.	01
10	Cronaflex Projection Direct Film PDM-7 26x36x.00&"		50 Sht. boxes	38
11	Bright Light contact film BLC7 26x36x007"		50 Sht. boxes	266
12	Cronalar engineering negative film EN7 .007"x36"	x100'	Rolls	07
13	Graphic Arts Litho Film CEL4 50x60 cm		Sheets	1000
14	Du Pont 21D Litho Developer Powder(10 Lit x 10	per case)	Cases	10
15	Du Pont 21D Developer (10 Lit x 10 per case)		Cases	04
16	Kwik Proof colours assorted		Gallons	09
17	Striprite sheets 26"x36"		Sheets	150
18	Striprite Etch		Quarts	60
19	Striprite Developer		Gallons	76
20	Striprite Etching Blocks		Nos.	05
21	Squeegees		Nos.	06
22	3M Translucent stripping film 10"x12"x0.005"		Sheets	4300
23	Cromalin Proofing film 4/CP 25"x300' Rolls		Rolls	22
24	Kromekote Proofing stoll 26"x40"		Sheets	900
25	Cromalin Toner (Assorted)		Jars	04
26	Cronaflex Processor Developer PDC (5 gallon-Cans)		Cans	77
27	Cronaflex Processor Fixer PFC (5 gallon-Cans)		Cans	75
28	Cronalor Engineering Negative EN7 26x36x.007"		Sheets	350
29	IC & E Stabilene Dry Developing Diazo film 24"x36"		Sheets	87
30	K&E Helios Dry Developing Diazo Paper 24"x36"		Sheets	498
31	Rubber gloves		Pairs	24
32	Cellular Tape-Transperent magic		Rolls	29
33	Scribecont - sensitized		Sheets	Nil
34	Western Pressready developer		Gallon	Nil
35	Red Granite Long Run Developer	(32 Ozs)	Bottles	12
36	Western super A.G.E. Finisher	(32 Ozs)	Bottles	16
37	High Concentrate Neg.Coating solution		Gallons	04
38	Superkote 28 1/2"x38 1/2" x .012 Western Litho	Plates	Nos.	25
39	Sterkote - do -		Nos.	25
40	Pressready "		Nos.	25
41	Diazo Sensitizer A & B	(32 Ozs)	Packs	07
42	Cronalar Eng. Neg.Film EN4 36"x100'		Rolls	20
43	Lithographer Tape - Scotch 3M 1/2" x 72 yds		Rolls	142
44	Drafting Tape - Scotch 3M 1"x60 yds		Rolls	756
45	Starkote $\frac{3523}{64}$ x $\frac{4151}{64}$ x .012" Western Litho Plates		Nos.	25
46	Natural Sponges		Nos.	50
47	Artificial sponges		Nos.	120
48	Gum Arabic - Liquid		Gallon	36
49	Applicator Blocks (Proof Pads - Rubber)		Nos.	12
50	Cotton Wool - 100 Pad Rolls		Rolls	40

			Units	Balance @ Payment
51	Lithkemko deep etch developer		Gallons	24
52	Reagent Alcohol - Methyl		Gallons	12
53	Alcohol - Methyl 4 gal.tin	4 gal.tin	Tin	01
54	Wipe on Pads		Nos.	10

APPENDIX N

MATERIALS - 2 YEAR NEEDS

	Item	Quantity	Unit	Cost
1.	Bright Light contact film 26 x 36 x .007 sheet	8000	7.50	60,000
2.	Project matte film 26 x 36 x .007 sheets	400	9.00	3,600
3.	Stripfilm 10 x 12 x .005 sheets	3000	2	6,000
4.	Peelcoat, sensitized 26 x 36 x .007 sheets	3000	12	3,600
5.	Diazo, sensitized mylar blackline 26 x 36 x .005	300	4	1,200
6.	Diazo, sensitized paper blackline 26 x 26 mm	4200	1.50	6,300
7.	Drafting film matte one side, 26 x 36 x .005 sheet	1000	3.00	3,000
8.	Sribecoat, unsensitized 26 x 36 x .007 sheet	1500	6.50	9,750
9.	Kwikproof, white, matte 26 x 36 x .010 sheet	500	3	1,500
10.	Kodatrace/acetate cover 26 x 36 x .002 sheet	6000	0.25	1,500
11.	Pressplates pre-sensitized aluminium 898 x 1064 mm	3600	9	32,400
12.	Printing paper 30 x 40 inch, reams	1044	112.	116,900*
	3500 copies/sheets x 92 maps (2000 English, 1000 Sinhala, and 500 Tamil)			
	1000 copies/sheets x200 maps (500 English, 250 Sinhala, 250 Tamil)			
13.	Set screen tints 133-line (10,20,30,50,70) 30x40 in 3 angles (30°,45°,60°)	15	100	1,500
14.	Contact screen, magenta, 133-line, 45°, 75°,105°	3	200	600
15.	Contact screen, grey, 133-line 45°, 75°, 105°	3	200	600
16.	Plus x 2402, or equal aerial film, 250 ft rolls	20	200	4,000
17.	Contact prints, double weight, semi-matte 3 prints each, 50 sheets	20	75	1,500
18.	Diapositives, Aerographic Positive, 6 rolls	5	150	750
19.	Aviation fuel, Est. 100 hrs @ 40 gallons/hr	4000	5	20,000
20.	Misc.			25,200
				300,000

* Inventory of paper on-hand is 1050 reams which is adequate for next two years for ABMP project. Lag time in procurement will make it necessary to place next order within one year.

Schedule of Training Provided.

Name of Officer	Nature of Trip	Cost U.S.$
A.A. Wilson Perera Artificer	Training in Servicing and Maintenance of Surveying Equipment at Kern, Switzerland. 8 weeks. Aug - Oct. 1979.	3,300.00
A. Kettiarachchi	Training in and Maintenance of Photogrammetric Equipment at Kern, Switzerland. 8 weeks. Aug.- Oct. 1979.	3,300.00
S.D.F.C. Nanayakkara	Seminar on Remote Sensing in Costa Rica. 23 - 30 April 1980.	3,310.72
N.G.R. Fernando S. Berugoda.	Seminar on Remote Sensing 5 - 7 November 1980 in Bankok.	1,587.53
Cpl. Fernando P.N. Cpl. Premaratne M.M. Cpl. Jayasinghe D. Cpl. Kamunasena A.	Air Force Technicians training at Heli Orient Singapore. January 1980.	7,266.51
G.N. Perera H.A.S. Chandrasekera A. Weeratunga E. Maldeniya P. Sivalingam.	Training at S.T.I., Hyderabad in scribing. 9 weeks from 5 November 1980.	6,117.02
D.T. Gunaratnam M.P. de Silva V. Dainis H. Godellawatta T. Thiagaraja	Training at S.T.I., Hyderabad in Cartography (Supervisor) 3 months from 24, April 1981.	9,740.27
T. Sarvanandam	Training at S.T.I.,Hyderabad in Map Reproduction. (Supervisor) 3 months from 24, April 1981.	
N.L.C. Haturusinghe M. Mahalingam A.D.S.K. Chandrasekere G.N. Perera H.A.S. Chandrasekere A. Weeratunga E. Maldeniya P. Sivalingam	Training at S.T.I., Hyderabad in Cartography 2 months from 16th October 1981.	8,500.00 (approx.)
		43,122.05

Total Technical Training Budget	$254,000.00
Balance available	43,122.05
	210,877.95

APPENDIX P

TECHNICAL ASSISTANCE PROVIDED

~~Technical Assistance~~

R.D.A. - Senior Technical Advisor
Mr. Bruno E. Sciambi
November 1978 - May 1980

- Photo Pilot Instructor
Mr. Frank T. Lodge
February - April 1980

Total Payments to R.D.A.	$177,076.16
Advance	36,000.00
Pre Contract Cost	2,000.00
Termination claim (in dispute)	33,084.24
	248,160.40

Total Technical Assistance Budget	$503,000.00
	248,160.40
Balance available	254,839.60

Appendix Item K

EQUIPMENT (AID Procured)

Description	PP Est. Cost	Actual Cost	Difference	Comments
A. PHOTO ACQUISITION, AIRCRAFT, & ACCESSORIES				
1. Aircraft, Cessna 421C	385,000	405,675	+ 20,675	
2. Equipment spares, tools	110,000	147,912	+ 37,912	
3. Aircraft modification	40,000	55,350	+ 15,350	
4. B3 Driftsight	1,000	0	- 1,000	deleted
5. Statoscope	500	0	- 500	deleted
6. Renovation of camera	16,000	0	- 16,000	deleted
7. Aircraft Ferrying/landing	0	13,500	+ 13,500	added
Subtotal	552,500	622,437	+ 69,937	
B. FIELD CONTROL, EDIT				
1. 4WD Jeeps (40)	360,000	325,358	- 34,642	35 procured
Subtotal	360,000	325,358	- 34,642	
C. TRIANGULATION				
1. Kern PG2-AT Plotters (2)	110,000	0	-110,000	purch. by swiss
2. IBM 545 Card Punch (2)	12,400	0	- 12,400	deleted
3. Kern MK-2 Comparator	45,000	56,897	+ 11,897	chg. to CPM-1
Subtotal	167,400	56,897	-110,503	

Description	PP Est Cost	Actual Cost	Difference	Comments
D. COMPILATION				
1. Wild A8/PP08 Ortho	150,000	0	- 150,000	deleted?
2. Aviotab TA Coord'graph	100,000	120,746	+ 20,746	3 procured
3. Wild St-10 strip Stereoscope	600	0	- 600	deleted
4. Wild Glass Scales	4,100	0	- 4,100	deleted
5. Minicomputer	3,700	0	- 3,700	deleted
Subtotal	258,400	120,746	- 137,654	
E. PHOTOGRAPHIC LAB				
1. Kodak Versamat Roll Proc	25,000	0	- 25,000	deleted
2. MAFI Processor	2,000	0	- 2,000	deleted
3. Lithosheet Processor	22,500	22,925	+ 425	
4. Log-E Printer	25,000	21,208	- 3,792	
5. Vacuum For Copy Camera	4,000	0	- 4,000	pending
6. Pulsed Xenon lamps(6pr)	10,200	11,450	+ 1,250	chg to 2 pr
7. Whirler Coating Machine	4,300	0	- 4,300	deleted
8. Graining Machine (3)	25,800	0	- 25,000	deleted
9. Map Repro Machine	43,300	0	- 43,300	deleted
10. Printing Down Frame	3,700	3,660	- 40	2 procured
11. Color Sensitometer	2,000	866	- 1,134	2 procured
12. Densitometer	2,000	4,580	+ 2,580	2 procured
13. Point Light Source	450	6,819	+ 6,369	4 procured
14. Photographic Equipment	2,500	2,321	- 179	
15. Darkroom Equipment	4,000	64,801	+ 60,801	Added Camera
16. Shipping Costs	17,650	0	- 17,650	incl. above
Subtotal	194,400	138,630	- 55,770	

Best Available Copy

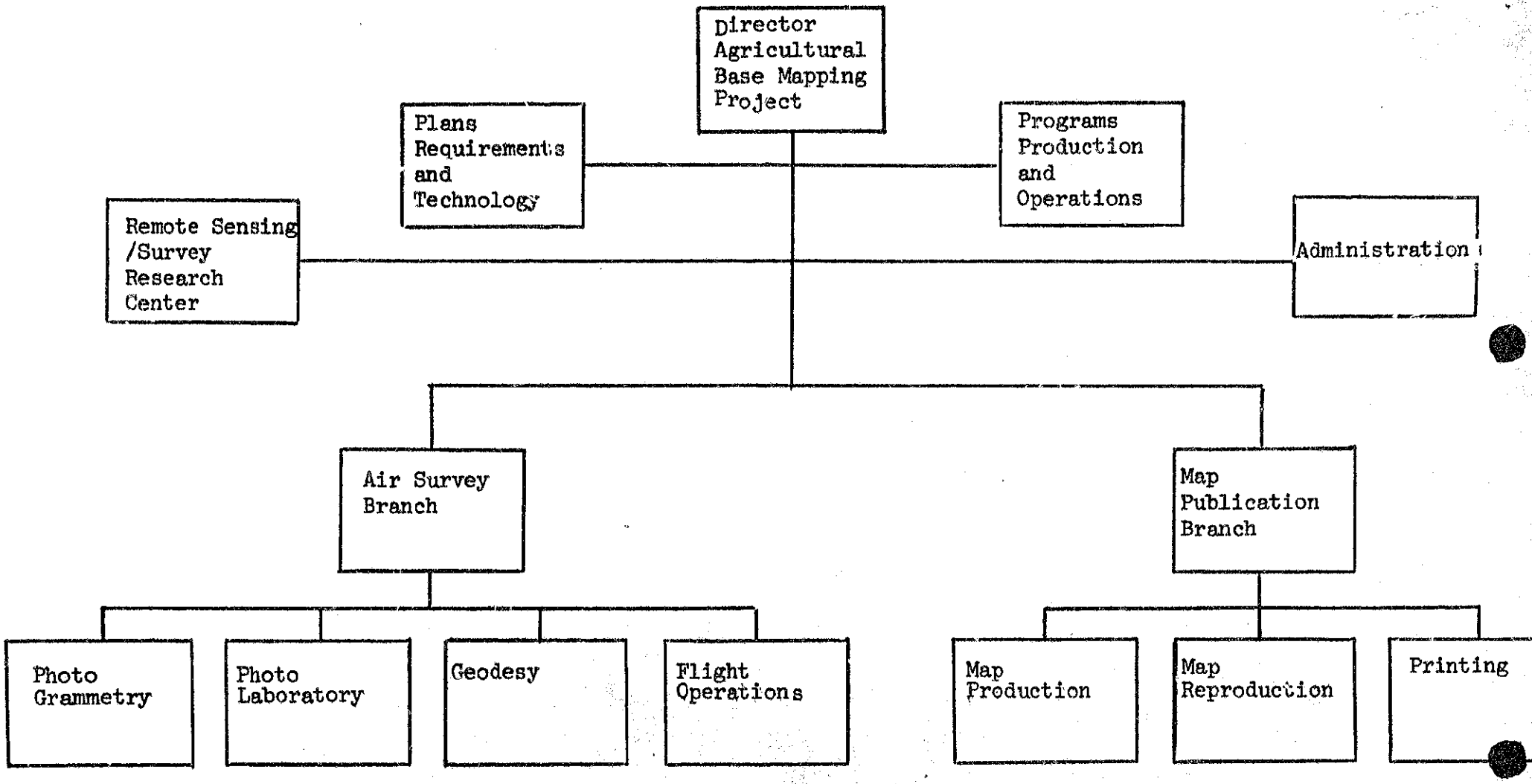
Description	PP Est.Cost	Actual Cost	Difference	Comments
F. Map Production-Drawing				
1. Scribing tool holders (10)	150	1,235	+1,085	9 procured
2. Scribing cutters (100)	500	6,031	+5,581	50 procured
3. Registration Punch	2,000	4,500	+2,500	
4. Reflecting Projector	4,200	6,040	+1,840	
5. Line Contact Screens (16)	2,000	2,000	0	44 procured
6. Photo Composing Machine	25,000	0	-25,000	Pending
7. Misc. Equipment	4,000	9,702	+5,702	
8. Shipping costs	3,750	0	-3,750	Incl.above
Sub-total	41,600	29,508	-12,092	
G. Map Production-Litho				
1. Offset Printing Machine	87,000	542,501	+455,501	3 procured
2. Guillotine Paper Cutter	7,900	44,248	+ 36,348	
3. Misc. Equipment	4,000	0	- 4,000	Pending
4. Shipping costs	9,900	0	- 9,000	Incl.above
Sub-total	108,800	586,749	+477,949	

Description	PP Est.Cost	Actual Cost	Difference	Comments
H. User Assistance Center				
1. Richards 940 Light Table (3)	6,000	0	-6,000	Procured by Swiss
2. B&L Stereomicroscope	10,000	0	-10,000	Pending
3. B&L Zoom Transfer Scope	7,000	0	-7,000	Procured by separate USAID funds
4. I^2S Multispectral Camera	10,000	0	-10,000	Delete ?
5. I^2S Add. Color viewer	19,000	0	-19,000	Delete ?
6. Portable Spectrometer	5,000	0	- 5,000	Delete ?
7. Camera, Projector, & acces.	1,500	0	- 1,500	Procured by Swiss
8. Misc. Equipment	1,000	0	- 1,000	Pending
9. Material & Training Aids	2,500	0	-2,500	Pending
10. Shipping Costs	6,200	0	-6,200	Delete
Sub-total	68,200		-68,200	
I. Doppler Geodesy				
1. Equipment Lease	10,000	0	-10,000	Delete
Sub-total	10,000		-10,000	
TOTAL EQUIPMENT	1,761,300	1,880,325	+119,025	

APPENDIX Q

TRAINING DESIRED BY SURVEY DEPARTMENT

Subject	Institute	Length	Grade	Frequency
1. Advanced Geodesy leading to M Sc.	Ohio State Univ. or equiv.	2 yrs.	Supdt.or above	1 per 2 yrs.
2. General Surveying	Survey Training Inst., India	3 mo.	Surveyor	2 per year
3. Advanced Photogrammtry leading to M Sc.	ITC, Holland or Ohio State Univ.	2 yrs.	Supdt. or	1 per 2 yrs.
4. Data Processing w/ emphasis on photogrammetric aspects	ITC, Holland or U.S.A Univ.	6 mo.	Asst.Supdt. or above	1 per 2 yrs.
5. Photogrammetic Technician Training	ITC, Holland or or STI,India	8-12 mo.	Photogrammetric Tech.	2 per year
6. Aerial Photography & Navigation	ITC, Holland	1 yr.	Air Photographer	1 per year
7. Photogrammetric Equipment Maintenance	Swiss Factory	3 mo.	Inst.Mech.	1 per 2 yrs
8. Advanced Cartography	ITC, Holland	1 yr.	Asst.Supdt. or above	1 per 2 yrs
9. Carto.Technician	ITC, Holland or STI, India	1 yr.	Draftsman	1 per year
10. Scribing Training	STI, India	3 mo.	Draftsman	5 per year
11. Map Production	STI, India	3 mo.	Draftsman	2 per year
12. Map Production Equipment Maintenance	Unidentified	3 mo.	Inst.Mech.	1 per 2 yrs.
13. Printing & Ink Technology	Lond.School of Printing or equiv.	1 yr.	Asst.Supdt.	1 per year
14. Litho Printing & Ink Techology	Unidentified	3 mo.	Printer	1 per year
15. Halftone Photography	Unidentified	1 mo.	Draftsman	2 per year
16. Survey Flights	ITC,Holland or equivalent	3 mo.	SLAF Pilot	Once
17. Training on airplane electronics, air frames, and engines	Cessna factory or representative	3 mo.	SLAF Pilot	as required
18. Management,Production Planning & Evaluation	USGS (Informal)	1 mo.	Supdt.or above	one per year



igure 6: PROPOSED AGRICULTURAL BASE MAPPING ORGANIZATION

EVALUATION SCOPE, TEAM COMPOSITION, METHODOLOGY, CONTACTS

Scope of Work

I. Purpose:

1. Determine if the project is still necessary to meet the project's purpose;

2. determine if the project can be completed in approximately two years; and

3. if this is not possible, determine means for completing the project in alternative time spans and resources necessary for the Survey Department to sustain and complete the project taking into account modifications in the project that may be necessary.

II. Approach:

USGS staff with the participation of Survey Department and AID staff, will be responsible for the technical aspects of the evaluation including review and evaluation of project methodology, equipment and supplies, staffing, operating procedures and quality of work. The USGS team with assistance from the Survey Department, will also review the Survey Department's plans for completing the project, explore and identify any alternatives for completing the project more quickly, identify the nature and cost of equipment, supplies, or contracts necessary to complete the project as planned by the Survey Department or under alternatives posed by the team. AID and Survey Department officials will utilize the team's findings in determining future actions on the project.

III. Specific Team Actions:

A. Review the maintenance and operation of the Cessna 421C Aircraft used to fly photo missions including the project related skill of the pilots and crew and the adequacy and use of related equipment;

B. Evaluate the flow of work and output at each step of the mapping process, identify problem areas, and propose necessary improvements;

C. Review following process steps and corresponding output and evaluate and make recommendations to improve:

Process Step	Product/Output
Aircraft	Operation/Maintenance
Photo Acquisition	Aerial Photos
Film Processing	Original negative, paper prints and diapositives
Field Control	Additional ground control points
Triangulation	Oriented Models (Stereo pairs)
Compilation	Draft manuscript
Field Edit	Completed manuscript
Scribing	Color separations
Plate making	Litho plates
Printing	Map sheets
Organization/Management	Work accomplished

D. Review plans for the operation of a user assistance center and comment on the viability of such plans.

IV. Reports:

Prior to departure from Sri Lanka the team will prepare a draft report for review with USAID and the GSL, and a final report each in 10 copies.

V. Background Information:

The team will review the feasibility reports of the project prepared by RDA, AID's project paper, and other material which may be provided by the Survey Department in order to understand the background, development, and current status of the project.

Program/Policy Evaluator will:

A. Ensure the evaluation covers all aspects of the project and conforms to AID's requirements for a full evaluation;
B. Relate the analsysis and findings of the technical team to the requirements and realities of Sri Lanka's development interests and capabilities;
C. Serve as bridge between AID and USGS team in their work, focusing on primary purpose of the Evaluation.

Team Composition

The Evaluation Team had two components: a three-man technical team with expertise in the fields of aerial photography, field surveys, photogrammetry, cartography and printing, contracted by AID under a PASA arrangement with USGS; and a program/policy evaluator contracted by AID under an IQC arrangement with Development Associates, Inc. The head of the technical team and the program/policy evaluator were designated as co-team leaders.

The technical team commenced work in Sri Lanka on 20 April and were joined by the program/policy evaluator on 24 April. Two members of the technical team completed their assignment on 22 May. The third member and the program/policy evaluator completed their assignment on 14 May.

Procedure and Methodology

Procedural problems might have arisen due to the different start-up dates for the two components of the team. These were minimized, however, by the explicit scope of work prepared for each and by holding daily joint review sessions. If the entire team did not meet then, at least, the two co-team leaders met.

In order to familiarize the various Survey Department heads of office, production units and branches with the purpose of the evaluation and the procedures the team would be employing, a short orientation session was held in the Survey Department. If the whole team had arrived simultaneously this would have been held on the first day. However, even holding it a week or so later, it did provide a focus for SD staff and gave them a better understanding of what was being attempted in the evaluation. Both the role of evaluations in general and the specific role of this evaluation in particular comprised the subject of this orientation session.

The methodology specifically involved the utilization ot the tools generally associated with the empirical process: file and document research; data collection, corrobation and comparison (i.e. 1982 data cf of 1977 data); observation of operations and field trips; interviews, meetings and discussions. The findings were screened from both a technical as well as programmatic standpoint in arriving at the final list of recommendations.

The Team interviewed at every level of management (beginning with the Surveyor General and his deputies) as well as the technical and unit branch levels. All operational areas and functions within the Survey Department directly or indirectly involved in the Agricultural Base Mapping Project were examined on-site as well as within the context of overall policies and established procedures. User organizations (both GSL departments and agencies as well as donor agencies) were interviewed. GSL officials responsible for providing policy guidance to the Survey Department (i.e. the Secretary of the Ministry of Lands and Land Development and the Director of National Planning) were also interviewed. USAID officials were interviewed.

File research was facilitated in that the project files in both USAID and the Survey Department were made available to the team. All major project documents (feasibility studies, preliminary project papers, the final project paper, the loan agreement, the technical assistance contract) were provided and read by the team. Implementation documents (eg. progress reports, quarterly reports, letters of implementation, procurement papers, revised operatioal plans) were also providedd and read by the Team.

Two general review sessions were held with Survey Department officials, two were held with USAID officials, and one joint review session was held with participation of USAID and SD officials and the full team.

A first draft of the technical analysis section (Section V) and most appendices was prepared and circulated for comment on Monday, May 10, 1982. A draft of the remaining sections was prepared and circulated for comment on Tuesday, May 18, 1982. The final version of the Evaluation Report was prepared and left with USAID on Saturday, May 22, 1982.

Contacts:

The following is apartial listing of individuals interviewed by the Evaluation Team and their agency or office designation:

Survey Department

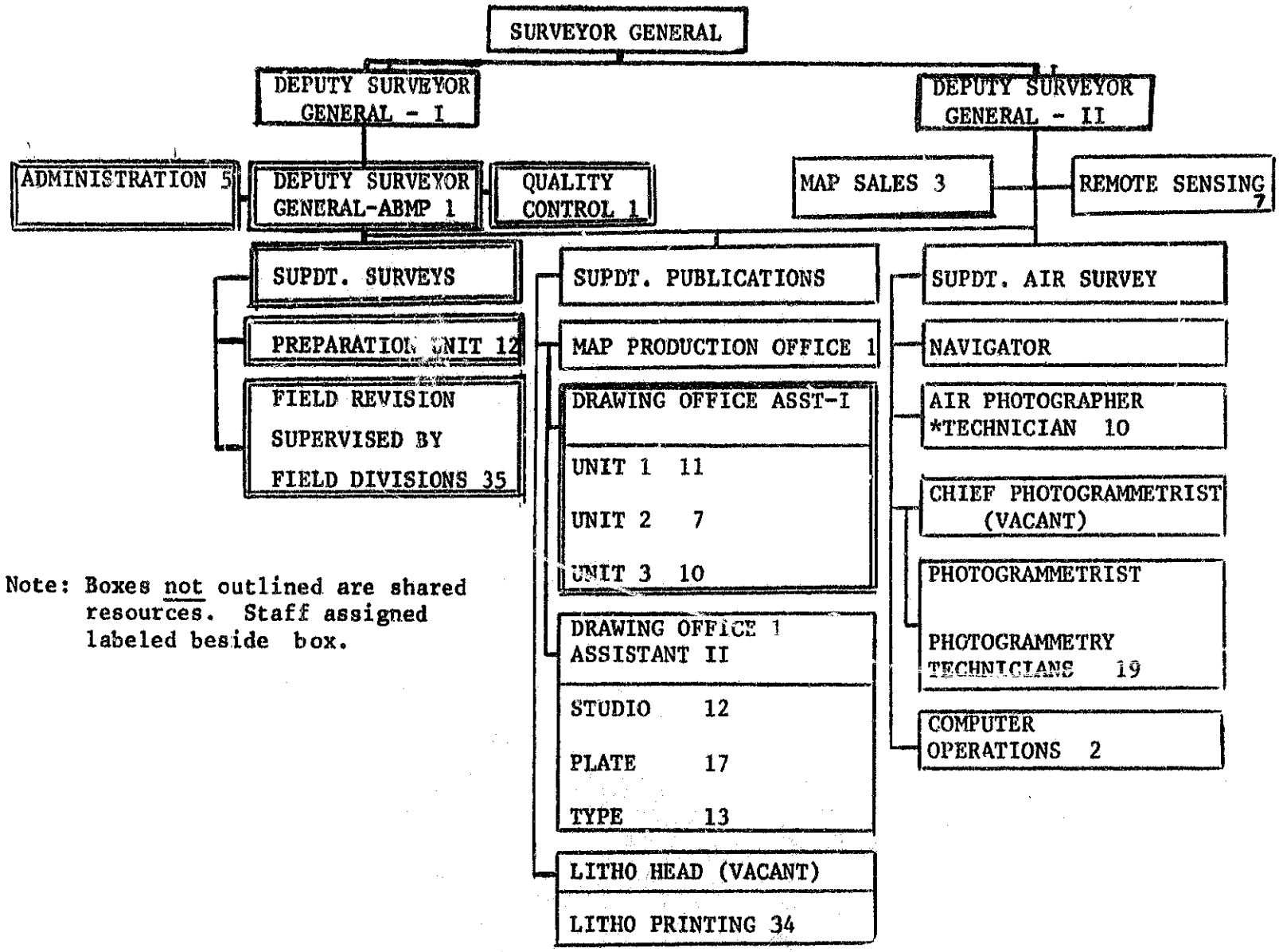
Mr. S.D.C. Nanayakkara, Surveyor General
Mr. N.G.R. Fernando, Deputy Surveyor General-I
Mr. S. Berygoda, Deputy Surveyor General-II
Mr. J.B. Seneviratne, Deputy Surveyor General-ABMP
Mr. N. Abayasiri, Supdt. of Surveys-ABMP
Mr. A. Shanmuganathan, Suptd. of Air Surveys Branch
Mr. L.A.G. Perera, Supdt. of Map Publication
Mr. W. Guneratne, Map Production Officer
Mr. S.I. Francis, Head of ABMP Administration
Mr. V. Poobalan, Navigator (Air Surveys Branch)
Mr. P. Heenkenda, Lab Technician (Air Surveys Branch)
Mr. A. Hettiarachchi, Chief photogrammetic technician (Air Surveys)
Mr. S. Gunawardena, Head of Map Preparation Unit, (Surveys Branch)
Mr. S.D. Chandrathilaka, ABMP Surveyor
Mr. G.R. Jacob, Head of Map Sales Office
Mr. Urs Geiser (Swiss Technical Advisor), Project Manager, Swiss Grant, Center for Remote Sensing
Mr. Martin Sommer (Swiss Technical Advisor), Swiss Grant, Center for Remote Sensing.

Sri Lanka Air Force

Air Commodore A.W. Fernando, Chief of Staff
Group Captain, J.P. Eliyathamby, Director of Electronics
Wing Commander, B.E.S. Fernando, Director of Aeronautical Engineering

Mr. Francis H. Drane, Australian High Commission, Lower Uva Project
Mr. Brede Gundersen, Norplan/Engineering Consultants to National Water Supply and Drainage Project
Mr. Jayasinghe, Deputy Director, Ministry of Agricultural Research & Development
Mr. N. Abeywickreme, Secretary, Ministry of Lands and Land Development

ORGANIZATION CHART ABMP



Note: Boxes not outlined are shared resources. Staff assigned labeled beside box.

Scale 1 Inch.	Descriptions	Size in Inches.	Price. Rs. Cts.	Medium.
	Town Maps - Coloured.			
12 Chains	Anuradhapura (Old Town)	33 x 31	4 . 25	
8 Chains	Avissawella	24 x 21	4 . 25	
6 Chains	Diyatalawa	29 x 37	4 . 25	
8 Chains	Hambantota	32 x 26	4 . 25	
8 Chains	Horana	24 x 34	4 . 25	
8 Chains	Matale	19 x 30	4 . 25	
2 Chains	Nuwara Eliya	31 x 30	4 . 25	
8 Chains	Wattala-Mabole-Poliyagoda	25 x 42	4 . 25	
	Town Maps Uncoloured.			
12 Chains	Anuradhapura (Old Town)	33 x 31	1 . 00	
5 Chains	Bandarawela	25 x 24	1 . 00	
10 Chains	Batticaloa	29 x 40	1 . 00	
8 Chains	Chilaw	20 x 42	1 . 00	
16 Chains	Colombo & Surroundings	26 x 43	7 . 25	
16 Chains	Colombo & Surrounding - showing Municipal Wards	26 x 43	7 . 25	
16 Chains	Colombo & Surroundings - showing Electoral Districts	26 x 43	7 . 25	
	Colombo & Environs Bus Routes	-	0 . 75	
2 Mile	Tourist Map of Colombo		5 . 00	
1:12,500	Colombo & Suburbs (Coloured)		17 . 50	
1:12,500	Trincomalee (Coloured)		8 . 00	
10 Chains	Jaffna		1 . 00	
8 Chains	Moratuwa		1 . 00	
12 Chains	Dehiwala - Mt. Lavinia	21 x 38	1 . 00	
6 Chains	Diyatalawa	29 x 37	1 . 00	
12 Chains	Galle	38 x 27	1 . 00	
8 Chains	Kalutara	21 x 40	1 . 00	
12 Chains	Kandy	33 x 38	1 . 00	

(Contd. 4)

Scale 1 Inch.	Descriptions	Size in Inches.	Price. Rs. Cts.	Medium.
1 Mile. (1:63,360)	Sri Lanka in 72 Sections.			
	Topographical Maps	31 x 23	11 . 00 (each)	
	Grey Coloured Maps	-do-	4 . 50 (each)	
1 Mile (1:63,360)	Land Use and Forest Cover Maps	31 x 23	1 . 00 (each)	
	Land Forms and Soil Maps	-do-	1 . 00 (each)	
	Electoral Districts and Administrative Boundaries	-do-	5 . 75 (each)	
	Tectonic Map of Rangala	-do-	2 . 00	
	Tectonic Map of Polonnaruwa	-do-	2 . 00	
	Geological Map of Rangala	-do-	2 . 00	
2 Mile	Sheets of Sri Lanka	-do-	2 . 25	
1/5 Miles (1:12,672)	Sheet No. Kataragama/9	20 x 26	15 . 00	
	" " Nuwara Eliya/18-23	-do-	15 . 00 (each)	
	" " Nuwara Eliya/29-31	-do-	15 . 00 (each)	
	" " Timbolketiya/18	-do-	15 . 00	
	" " Buttala/1	-do-	15 . 00	
	" " Hatton/15 & 22	-do-	15 . 00 (each)	
	" " Baputale/4,5,8 & 16	-do-	15 . 00 (each)	
	Sri Lanka Historical Maps.			
24 Miles (1:1,520,640)	Medieval Ceylon	10 x 15	0 . 50	
	Dambadeni, Kurunegala & Kotte Periods	-do-	0 . 50	
	Pre-Historic Sites	-do-	2 . 00	
	Colombo - Portugese Period No.1	25 x 21	1 . 00	
4 Chains	Fort of Galle	22 x 28	10 . 00	

(Contd. 3)

LIST OF MAP PUBLICATIONS FOR SALE IN GS[illegible]ALES OFFICE

PRICE LIST.

Conversion 5/82 Rs 20 - $1

Scale 1 Inch	Descriptions	Size in Inches.	Price Rs. Cts.	Medium
4 Miles (1:253,440)	Sri Lanka - Coloured and layered (in 4 Sections 1 - 4 : Each Section Rs.14.00).	49 x 74	56 . 00	
	Map of Sri Lanka - General (in 4 Sections 1 - 4 : Each Section Rs.3.75).	-do-	15 . 00	
	Parliamentary Electoral Districts (in 4 Sections 1 - 4 : Each Section Rs.10.25).	-do-	41 . 00	
	Land Utilisation Map (in 4 Sections 1 - 4 : Each Section Rs.20.00).	-do-	80 . 00	
	Post Offices and Sub-Post Offices (in 4 Sections 1 - 4 : Each Section Rs.1.65).	-do-	6 . 50	
	Proposed Development of River Basins (in 4 Sections 1 - 4 : Each Section Rs.4.15).	-do-	16 . 50	
8 Miles (1:506,880)	Climate Map of Sri Lanka	26 x 39	5 . 50	
	General (Grey) Map of Sri Lanka	-do-	5 . 25	
	General Soil Map of Sri Lanka	-do-	8 . 00	
	Great Soil Groups of Sri Lanka	-do-	15 . 75	
	Road Map of Sri Lanka	-do-	5 . 00	
	Parliamentary Electoral Districts	-do-	2 . 50	
24 Miles (1:1,520,640)	Contour Map of Sri Lanka	10 x 15	0 . 25	
	Itinerary Map of Sri Lanka	-do-	0 . 15	
	National Reserves and Sanctuaries	-do-	0 . 50	
23.67 Miles (1:1,500,000)	Population 1953	-do-	0 . 10	
	Agriculture	-do-	0 . 25	
	Crop Distribution Index	-do-	0 . 25	
31.56 Miles (1:2,000,000)	Divisional Revenue Officers' Division	6 x 9	0 . 50	
	Epigraphical	-do-	0 . 50	
	Land Utilisation	-do-	0 . 50	

(Contd. 2)

[illegible]T OF MAP PUBLICATIONS FOR SALE IN G[illegible]ALES OFFICE

PRICE LIST.

Conversion 5/82 Rs 20 = $1

Scale 1 Inch	Descriptions	Size in Inches.	Price Rs. Cts.	Medium
4 Miles (1:253,440)	Sri Lanka - Coloured and layered (in 4 Sections 1 - 4 : Each Section Rs.14.00).	49 x 74	56 . 00	
	Map of Sri Lanka - General (in 4 Sections 1 - 4 : Each Section Rs.3.75).	-do-	15 . 00	
	Parliamentary Electoral Districts (in 4 Sections 1 - 4 : Each Section Rs.10.25).	-do-	41 . 00	
	Land Utilisation Map (in 4 Sections 1 - 4 : Each Section Rs.20.00).	-do-	80 . 00	
	Post Offices and Sub-Post Offices (in 4 Sections 1 - 4 : Each Section Rs.1.65).	-do-	6 . 50	
	Proposed Development of River Basins (in 4 Sections 1 - 4 : Each Section Rs.4.15).	-do-	16 . 50	
8 Miles (1:506,880)	Climate Map of Sri Lanka	26 x 39	5 . 50	
	General (Grey) Map of Sri Lanka	-do-	5 . 25	
	General Soil Map of Sri Lanka	-do-	8 . 00	
	Great Soil Groups of Sri Lanka	-do-	15 . 75	
	Road Map of Sri Lanka	-do-	5 . 00	
	Parliamentary Electoral Districts	-do-	2 . 50	
24 Miles (1:1,520,640)	Contour Map of Sri Lanka	10 x 15	0 . 25	
	Itinerary Map of Sri Lanka	-do-	0 . 15	
	National Reserves and Sanctuaries	-do-	0 . 50	
23.67 Miles (1:1,500,000)	Population 1953	-do-	0 . 10	
	Agriculture	-do-	0 . 25	
	Crop Distribution Index	-do-	0 . 25	
31.56 Miles (1:2,000,000)	Divisional Revenue Officers' Division	6 x 9	0 . 50	
	Epigraphical	-do-	0 . 50	
	Land Utilisation	-do-	0 . 50	

(Contd. 2.)

AGRICULTURAL BASE MAPPING PROJECT

SRI LANKA

1977-1982

Report of a Project Evaluation

Conducted By:

A. Norman Brew, Co-Team Leader
Chief, Branch of Contract Management
U.S. Geological Survey, National Mapping Division
Reston, Virginia

Richard D. Kidwell
Cartographer, Office of Research
U.S. Geological Survey, National Mapping Division
Reston, Virginia

Randle W. Olsen
Chief, Branch of Geometronics
U.S. Geological Survey, National Mapping Division
Menlo Park, California

Paul Prentice, Co-Team Leader
Consultant in Planning, Design & Evaluation
Development Associates, Inc.
Arlington, Virginia

April 20 - May 22, 1982

U.S. Agency for International Development

Washington, D.C. and Colombo, Sri Lanka

May 1982

This Evaluation Report represents the considered, professional opinion of the Evaluation Team based essentially on emprirical judgement. The findings, conclusions and recommendations do not necessarily represent the opinions of either the Survey Department or the USAID. Some issues may have been overlooked by the Evaluation Team, given the short period of time available for research, data collection, interviews, meetings and observation trips. Similarly, some of the data or information, particularly that contained in the appendices, may be found to be incomplete or even inaccurate. Readers are invited to submit any divergence of opinion or suggest corrections in data by corresponding directly with USAID/Colombo.

The Evaluation Team expresses its appreciation for the very cordial welcome and cooperation afforded by the Survey Department, at all levels. Without the full cooperation of management and the heads of production units and staff, the Evaluation Team would not have been able to complete its assignment. Discussions were candid and friendly. The Team was able to proceed with its scope of work with a minimum of organizational detail and orientation.

Needless to say, the support of USAID was indispensible for the Team to perform the tasks assigned to it. This was given, fully and cheerfully, The Team expresses its gratitude to all members of

ABMP EVALUATION REPORT

TABLE OF CONTENTS

PART I

Section I: EXECUTIVE SUMMARY 1

Basic Project Identification Data 4

Section II: CONCLUSIONS AND RECOMMENDATIONS 5

Major Conclusions and Recommendations 6
Other Conclusions and Recommendations 8

PART II

Section III: THE SRI LANKA CONTEXT 13

Section IV: DEVELOPMENT OF THE AGRICULTURAL BASE MAPPING PROJECT 16

Section V: DISCUSSION OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS 19

1.0 INTRODUCTION 19

2.0 OPERATIONS ANALYSIS 22

2.1: Map Requirements 22

2.2: Production Capacity 23

2.3: Review of Proposed Plans 23

2.4: Analysis of Alternatives 25

2.5: Implementation Plan 28

3.0 MAP PRODUCTION PROCESS 30

3.1: Aircraft 30

3.2: Photo Acquistion 32

3.3: Air Surveys Laboratory 33

3.4: Field Control 35

3.5: Aerial Triangulation 37

3.6: Photogrammetric Compilation 38

3.7: Field Edit 39

3.8: Scribing 41

3.9: Lettering 42

3.10: Map Production Laboratory 44

3.11: Plate making 45

3.12: Printing 47

4. FACILITIES 48

5. EQUIPMENT 51

6. MATERIALS 52

7. TECHNICAL ASSISTANCE AND TRAINING 57

8. ORGANIZATION AND MANAGEMENT 60

9. USER ASSISTANCE CENTER

PART III

Section VI: APPENDICES

A. PRODUCTION CAPACITY
B. SURVEY DEPARTMENT PLAN - APRIL 1982
C. SCHEDULE FOR 1:10,000-SCALE MAPPING
D. SCHEDULE FOR 1:50,000-SCALE MAPPING
E. SCHEDULE FOR PROCESSING 1:50,000-SCALE FROM 1:10,000-SCALE
F. AIRCRAFT MAINTENANCE AGREEMENT - SLAF/SD
G. ALTERNATIVE PROCEDURE - SCRIBING BY PHOTOGRAMMETRY
H. ALTERNATIVE PROCEDURE - FIELD EDIT BEFORE PHOTOGRAMMETRY
I. ABMP FLOW CHART 1:10,000-SCALE GOALS
J. ALTERNATIVE PROCEDURE: SINGLE COLOR LETTERING
K. EQUIPMENT - LOAN FUNDS
L. EQUIPMENT NEEDS
N. MATERIALS - 2 YEAR NEEDS
M. INVENTORY OF MAP PRODUCTION MATERIALS
O. SCHEDULE OF TRAINING PROVIDED
P. TECHNICAL ASSISTANCE PROVIDED
Q. TRAINING DESIRED BY SD
R. PP PROPOSED ORGANIZATION CHART
S. CURRENT SD ORGANIZATION CHART
T. LIST OF MAP PUBLICATIONS FOR SALE IN MAP SALES OFFICE
U. EVALUATION SCOPE, TEAM COMPOSITION, METHODOLOGY, CONTACTS

EVALUATION REPORT

AGRICULTURAL BASE MAPPING PROJECT

SRI LANKA

MAY 1982

PART I

Section I: EXECUTIVE SUMMARY

Basic Project Identification Data

Section II: CONCLUSIONS AND RECOMMENDATIONS

Project Purpose: to meet the mapping requirements of rural development in Sri Lanka.

Purpose of this Evaluation:

1. determine if the project is still necessary to meet the project's purpose;

2. determine if the project can be completed in approximately two years; and

3. if this is not possible, determine means for completing the project in alternative time spans and resources necessary for the Survey Department to sustain and complete the project taking into account modifications in the project that may be necessary.

Summary of Findings:

The project was originally designed to assist the Survey Department (SD) of Sri Lanka in acquiring the necessary equipment and technology to meet the demands on it for the provision of up-to-date maps and related data, on a priority basis, to be utilized in rural development project planning and implementation. Current maps were out-dated or did not contain sufficient back-up, detailed data to meet the needs of anticipated accelerated rural development activities of key Government of Sri Lanka (GSL) departments and ministries as well as international development and donor agencies.

The Evaluation Team (ET) found that the pressure on SD for this type of service is even greater now than when the project was first conceived and planned. The pace of development activities, particularly in rural areas, has quickened in response to current GSL policies and plans. The project remains a priority of the Minsitry of Lands and Land Development receiving the personal attention of the Secretary of the Ministry of Finance and Planning.

While the purpose of the project is officially reiterated, there have been three major revisions of the project plan, particularly the implementation plan and schedule which alter certain key aspects of the project as originally planned and iterated in the Project Paper (PP). The most important change has been the timeframe. It was estimated at the time the PP was prepared that the two major outputs of the project (a 1:10,000 and a 1:50,000 scale map) could be completed by the planned expiration of AID participation in the project (November 1983). Because of late project start-up, delays* in equipment, supplies and materials procurement, and problems in contracting for facilities renovation, SD revised its plans to suggest new completion dates for the two map series. These extended beyond the AID Project Activity Completion Date (PACD).

The other outputs were not significantly affected by the new SD plans: provision of specific, detailed maps and data on a priority development project and area basis; trained pilots and photographers; trained SD and User Assistance Center staff; a functioning User Assistance Center (UAC).

*due, in part, to inaccurate source, origin and cost estimates provided by the AID-financed feasibility and design contractor and, in part, to unforeseen cost escalation for certain items and unforeseen procurement problems which extended the time originally alloted for procurement.

significant assistance from a Swiss-funded remote sensing project. It is the intention of the SD that, in fact, the CRS will perform the role of the UAC and that UAC functions rather than its actual establishment be viewed as a project output.

The ET found the latest (April 1981) SD plan, prepared prior to ET arrival, to be feasible, with few modifications, in terms of dealing with the production of the two map series. Priority has been assigned to the completion of the 1:50,000-scale map series in a three-to-four year time span with no specific date assigned for the completion of the 1:10,000-scale map series, other than to estimate that it will probably take at least ten years. The specific need for greater detail maps and data can be handled by SD on an assigned priority basis for specific development projects and areas, without causing undue violence to the production schedule of the 1:50,000-scale map. It was felt, and the ET concurred, that this map would provide sufficient detail for most user agencies and that specific requests could be entertained for greater detail.

To meet this new plan and production schedule, SD has indicated additional needs which it wishes to meet, utilizing some of the balance in the AID loan. These are for additional equipment, materials, supplies, training and some short-term technical assistance. The Evaluation Team has reviewed these various lists with SD and has segregated out for recommendation those which are urgently needed, should and can be procured during the remaining life-of-project and will significantly contribute to meeting the project purpose. These total approximately $750,000 (including some pipeline items and contingencies) out of a current loan balance of $1,350,000.

The ET believes that the SD has just about reached the point where smooth production of the anticipated major outputs, from photo acquisition through final map production, can be realized. SD is aware of the major bottlenecks and is taking steps to correct them. Specific ET recommendations address this situation. ET believes that, given the reason detailed in the body of the report, the project, while technically three years behind schedule, has actually only recently entered what could be designated as production implementation. Most activities up till mid-1981 were of a preparatory nature, i.e., procurement, facilities renovation, technical assistance and training. If the SD is able to keep to its recent plan, reviewed and commented on by the ET, the ET believes that the project purpose basically will be met within the revised timeframe. The original schedule, even if no procurement and related problems had been encountered, was grossly optimistic under any circumstances.

The fact that the project is managed by a Deputy Surveyor-General, the second rung of authority within the SD, is indicative of the priority the project is accorded within the Department. SD management was found to be capable, active, enthusiastic and hard working. Both SD staff and management are and have been aware of the major problems faced in the project and have shown flexibility both in dealing with and in taking appropriate steps to correct these problems. These were discussed with considerable candor.

The ET found that USAID Mission staff was aware of the status and problems of major facets of the project, sensitive to the SD's requirements, and maintains excellent rapport with departmental personnel.

1. The SD should initiate production of the 1:50,000-scale map series immediately, using their proposed approach, with a completion goal of three to four years. Limited production of greater detail maps should be done simultaneously only for designated high priority projects and areas.

2. SD should avail itself of the planned USGS technical assistance and immediately implement aerial triangulation capability.

3. SD should initiate procurement of critically needed additional equipment, supplies and materials, the latter to provide it with a two-year inventory.

4. SD should review its critical training needs and begin scheduling training for key individuals as well as key operational units as soon as feasibly possible.

BASIC PROJECT IDENTIFICATION DATA

1. Country: Sri Lanka

2. Project Title: Agricultural Base Mapping Project

3. Project Number: 383-T-0045; Loan Number: 383-T-20

4. Project Dates:

   a. First Project Agreement: February 28,1978
   b. Final Obligation: February 28, 1978
   c. Project Activity Completion Date (PACD): November 30, 1983

5. Project Funding:

a.	A.I.D. bilateral funding (loan):	$4,500,000
b.	Host Country Contribution:	$1,918,000 (equiv.)
	Total Project:	$6,418,000

6. Mode of Implementation:

   a. Direct procurement by the Survey Department with A.I.D. assistance: equipment, supplies, materials and technical services, including training.

7. Project Design: A.I.D. and Resource Development Associates

8. Responsible Mission Officials:

   a. Mission Director: Thomas Arndt, A.I.D. Representative, 1976-1978;
      Sarah Jane Littlefield, Mission Director, 1979 - present.

   b. Project Officer: Jeffrey W. Evans, 1977 - present.

9. Previous Evaluation and Reviews:

   None, other than informal USAID/Survey Departtment reviews.

10. Cost of Present Evaluation: (Budget figures only)

a.	USGS Contract:	$40,000
b.	Development Associates, Inc. Contract:	$17,962
	Total	$57,962

SECTION II: CONCLUSIONS AND RECOMMENDATIONS

The major findings and conclusions of this evaluation are summarized here, each followed immediately by one or more recommendations that derive from the respective conclusion or "finding". Where appropriate, references are given to Part II, Section V, indicating sub-sections upon which those conclusions or findings are based.

PP: Project Paper

SD: Survey Department of Sri Lanka

ET: Evaluation Team

ABMP: Agricultural Base Mapping Program

USGS: United States Geological Survey

1. Operation Analysis

The PP described an operational approach, schedule, and resources required for the SD to produce nationwide coverage of two ABMP map series' within a six-year time frame. The ABMP has suffered significant delays due primarily to long procurement cycles for aircraft, equipment, materials and initial technical assistance, and to labor management constraints resulting in poor worker motivation, high turnover, and restriction to single shifts. The schedule proposed in the PP, based on an AID-financed feasibility study, was clearly over-optimistic with respect to staffing requirements, productivity, and procurement scheduling. The SD has continuously reacted to delays by readjusting schedules and implementing operational procedures necessary to begin production. Now that most of the resources required are in place, the SD has proposed a schedule for a 4-year completion of 1:50,000-scale maps and limited production of 1:10,000-scale maps in priority areas. The ET feels that this plan, with minor variations, is the best approach with respect to requirements by user agencies, reasonable workflow estimates, effective use of available capacity, and budget considerations. Part II, Sect.V, ss 2.5).

Recommendations:

The SD should initiate production of the 1:50,000-scale series immediately, using their proposed approach, with a completion goal of 3 to 4 years. Limited production of 1:10,000-scale maps should be done simultaneously for identified high priority areas, as planned,using capacity not critically needed to complete the 1:50,000-scale series. The SD should gear up smooth workflow for consistent long term 1:10,000-scale production of about 200 maps per year, once the 1:50,000-scale series is completed. Efficient procedures and unit costs should take precedence over a target completion date for the 1:10,000-scale series.

2. Map Production Process:

An evaluation of the map production processes, phase-by-phase, has indicated that the SD has implemented an effective technical approach. Generally, procedures are consistent with those recommended by the PP. Deviations from the PP are, in most cases, warranted. The initial problems with aircraft and acquisition of aerial photos have been corrected. The aircraft is operational and the flight and maintenance agreement made with the Sri Lanka Air Force is very adequate to meet future needs. (Ref. Sec.V, ss 3.1.3). Remaining procedural problem areas are in aerial triangulation (ref. 3.4.3 and 3.5.3 d)lettering (3.9.3), and printing (ref. 3.12.3). In most cases, deficiencies had been already identified by the SD with appropriate plans for improvement.

Recommendations:

The current agreement with the Sri Lanka Air Force should be continued to complete high altitude photo coverage in 1983 followed by systematic lower altitude coverage for the 1:10,000-scale series. Aerial triangulation capability should be implemented immediately with the technical assistance which SD has requested from USGS. The lettering operation should be improved by immediate procurement of a photo-typesetter and by a map design change consolidating all lettering into a single black color. The third printing press should be installed and necessary training in printing and ink technology should be initiated to avoid a printing bottleneck. As planned by the SD, the number of printed copies per edition should be considerably reduced from the PP plans.

3. Facilities:

The SD has recently completed (about three years behind schedule) most of the facilities changes recommended by the PP. The electrical system still suffers occasional voltage fluctuations and community-wide "brownouts", not considered serious to the ABMP. The air-conditioning system is functional, although generally turned off during non-working hours to reduce electricity costs. This has caused unstable temperature and humidity over a 24-hour period which adversely affects stability of materials. The PP recommendation to consolidate the two photo labs has not been done and is deemed unnecessary by the SD. (Ref. Sec.V, 4.3).

Recommendations:

The SD should maintain consistent temperature and humidity in the platemaking and printing facility over a 24-hour period. This might be done by relocating platemaking into the printing facility and by keeping the airconditioning continuously on or continuously off. Consolidation of the two photo labs is not necessary. Light leaks in the map finishing lab should be sealed. Photographic materials requiring refrigeration should be stored in cold storeage, requiring more effective use of the cold storage facility.

4. Equipment:

Most of the equipment recommended by the PP has been installed and is operational. Due to underestimation of equipment costs by the PP, based on the feasibility study, and to inflation and procurement delays, many items were considerably more expensive than estimated and caused scheduling delays. Approximately $1,880,000 has been expended for equipment using loan funds: $119,025 over budget. Many recommended items were deleted by the SD which were considered unnecessary or of a lower priority to avoid further cost overruns. Some items planned for AID loan funding were financed instead under a Swiss project. Some additional equipment, totalling about $110,500, is still required for effective implementation of the ABMP. Equipment maintenance continues to be a problem due to the complexity of new systems, especially in electronics, and the inability to bring in American or European factory representatives on an on-call basis. (Ref. Sec.V, ss 5.1.3 and 5.2.3).

Recommendations:

Loan funds totalling about $110,500 should be used immediately to procure equipment vital to ABMP. Major items include a photo-typesetter and related processor; accessories for photo-lab cameras; and spare parts for aircraft, photographic processors and the printing presses. In-house equipment maintenance capability should be improved by additional factory training in photogrammetric, photographic, and printing equipment.

5. Materials:

As with equipment, estimated cost of materials was grossly underestimated in the PP. In addition, the amount of materials required per map were underestimated. There has also been an enormous escalation in price for most materials. The SD has used a combination of loan and SD funds to build up a modest inventory. The ET feels that this inventory is not sufficient to meet the needs of the proposed operational plan for the next several years. Specific material needs for a two-year program have been identified, totalling an estimated $300,000 in expenditures. Maintenance of an adequate supply of materials for a 200-map per year level of production in the future will will require an additional $175,000 per year, plus inflation. Within the SD, inventory and procurement planning methods have a tendency to be short-sighted which could cause significant delays preventing smooth workflow or meeting planned schedules. (Ref.Sec.V, ss.6.3).

Recommendations:

Materials, totalling about $300,000, required for the next two years should be ordered now in order to meet the needs of the recommended short-term operational plan. The SD should plan to procure additional materials costing $175,000 plus inflation for at least eight years beyond 1983. The following actions should be initiated to reduce materials costs: (a) single-color lettering; (b) reduced number of colors (i.e. eliminate yellow); (c) reduced edition size per map; and (d) switch to diazo coated press plates instead of pre-sensitized plates. The SD should improve long term planning and monitoring of materials used or needed, possibly by centralizing the supervision of these functions.

6. Technical Assistance and Training

Technical assitance has not been utilized to the extent envisioned in the PP. The SD contracted with a U.S. firm to provide up to 36 months services of a long-term technical advisor, up to six months of services of a photo-pilot instructor and other miscellaneous short-term advisory services on as needed and optional basis. The photo-pilot services were provided in a three-month period. The long-term technical advisor provided effective services, including on-the-job training, the conducting of some training course and the preparation of a manual on cartographic procedures. His services were terminated after a stay of eighteen months in-country, due to his medical evacuation and subsequent death.

short term consultants and technicians. Additional loan-financed technical assistance has been requested for aerial triangulation work and is scheduled to begin late this month or early June.

Substantial effective technical assistance for the Center for Remote Sensing (which incorporates many of the functions originally planned for the User Assistance Center) has been provided under a Swiss-funded remote sensing project.

Funds were designated in the PP budget for five areas of training: (1) remote sensing training course/seminar in Sri Lanka; (2) USGS training courses in the US; (3) international study fellowships; (4) equipment familiarization, and (5) international conference attendance, (the later designated for management-level personnel).

The remote sensing training course was underway during this evaluation and conforms with original plans, but is not financed by AID.

Equipment familiarization courses have been held, financed from training funds in the ABMP loan budget as well as in conjunction with equipment procurement costs. The latter have not always been totally satisfactory, particularly the training given in conjunction with the acquisiton of the new printing presses.

A major change in the utilization of training funds has been to substitute technical training in India for the broader international exposure envisioned in the PP for senior staff as well as for technical staff. This change enabled SD to train more technical staff at a considerable savings, thus accounting for the large balance of unexpended remaining in the training component of the budget.

Additional training needs have been identified by the SD and the ET has responded to the suggested list in preparing its recommendation (Ref.Sec.V, ss7.4).

Recommendation:

The ET agrees with the SD that long-term technical assistance is not required and that the only short-term technical assistance needed at this time is for assistance in solving some aerial triangulation problems.

The request for this assistance was made by the SD before the ET arrived in-country, and the ET endorses this request feeling that such assistance is critical to the solution of a major bottleneck in photogrammetry operations.

The ET recommends that the SD should make immediate plans to secure specific training to improve current deficiencies which have been identified elsewhere in this report. The cost of this training is estimated at $50,000 (Ref. Sec.V, ss 7.4). Identified training needs include management exposure to other mapping agencies, such as USGS; analytical photogrammetry, printing and ink technology, half-tone photography, airplane mechanics, equipment maintenance and operation, and routine technician training.

performance of relatively complex job duties. There is a tendency for trained or highly [illegible]ivated workers to leave the g[illegible]rnment service, attracted by substantially higher salaries offered elsewhere. This is a systemic problem with government service universally, but seems especially serious in the context of this project in Sri Lanka. It was quite underestimated or overlooked in the PP. To carry out the proposed production plan, the SD proposes increased staffing, especially in the drawing office. Staffing capacity requirements projected by the ET confirm a critical shortage for those map finishing phases performed in the drawing office. The method of production management used by the SD tends to be crisis-oriented, lacking centralized monitoring of workflow, cost accounting, and resource planning. (Ref. Sect.V, ss 8.3).

Recommendation:

The SD should plan on salary support for 250 technical staff exclusive of management and laborers, to meet the proposed operational plan. Two critical positions, Chief Photogrammetrist and head of the printing room, should be immediately filled with technically qualified people. Three or four photogrammetric technicians should also be immediately recruited. By 1983, over 100 draftsmen should be assigned for the Preparation and Drawing Office units. To meet the proposed schedule, the SD should institute incentive pay to reward productivity. It is not recommended that SD initiate a double shift, given the current labor management constraints. The SD should centralize a plans and production management staff function to improve workflow monitoring, maintain production costs, and perform short and long range resource planning.

8. User Assistance Center:

A self-contained User Assistance Center as proposed by the PP has not been implemented. However, most of the original objectives are being met through the SD Center for Remote Sensing (CRS) or other user-oriented services of the SD. A Swiss grant, providing equipment and over six man-years of technical assistance, has provided the means to develop the CRS to be quite responsive to the needs of user agencies concerned with resource planning. The emphasis of the CRS is on use of both satellite imagery and conventional photography for resource applications. Other units within the SD carry out map sales, photo sales, and special surveying or mapping projects which are user-specific. Other Sri Lanka government agencies as well as implementing agencies for various rural development projects are generally satisfied with the level of support and assistance provided by the SD. (Sect.V, ss.9.3, and 9.4).

Recommendation:

The SD should maintain the Center for Remote Sensing as an operational user assistance center sensitive to applications of this technology for resource agencies. The CRS should be self-supporting by grants or pay-for-services. The SD should also continue the current level of map and photo public sales and support surveying or cartographic special projects within available capacity. It is not recommended, at this time, to form a User Assistance Center as originally designed. It is not recommended to procure additional remote sensing equipment with loan funds.

9. Intermediate Scale Land-Use Mapping:

The SD has planned to include the same land-use categories proposed for the 1:10,000-scale series for the 1:50,000-scale series. The land-use mapping is a time-intensive activity for photo interpretation, scribing, and color separation processing. Concurrently, for a number of districts, the Center for Remote Sensing (CRS) is producing land-use maps at 1:100,000-scale using old 1:63,360 maps for the planimetric base. This is an apparent duplication of effort aimed at the same user agencies who need land-use categories for resource planning or monitoring. (Ref.Sect.V, ss.2.5.2).

Recommendation:

The SD should consider elimination of land-use categories on 1:50,000-scale maps, resulting in the potential to shorten the target completion by over a year. Compiled and edited 1:50,000-scale bases should be supplied to the CRS for 1:100,000-scale landuse mapping on an up-to-date base. Ultimately, after initial publication of 1:50,000-scale topographic maps, the 1:100,000-scale copy could be enlarged to 1:50,000-scale for a land-use overlay if user agencies identify such a requirement.

This is a suggestive recommendation, which SD has taken under advisement. SD was not prepared to adopt such a recommendation when the ET made it.

10. Alternative Procedures for 1:10,000-Scale Mapping

Basically, as identified in conclusion No.2 above, current SD procedures are adequate for ABMP operations. There are a number of phases, however, which are using outdated or inefficient methods. While it is recognized that dramatic changes of procedure are disruptive in the short-term, some changes are worthy of consideration for the benefit of long-term efficiency and low unit costs. (Ref. Sec.V, ss 2.5.3).

Recommendation:

The SD should consider the following procedural changes for long-term 1:10,000-scale mapping after completion of the 1:50,000-scale series: (a) use of up-to-date low altitude (i.e., 1:10,000 feet) interpretation photos for up-to-date feature classification; (b) field classification before photogrammetry using photo-interpretation and annotation methods with low altitude photos; (c) scribing instead of pencil copy for photogrammetric manuscripts; (d) increased use of computer software to aid photogrammetry; (e) single color lettering; (f) elimination of yellow color; (g) use of rectified or orthophoto imagery at 1:10,000-scale for a short term, low cost temporary product.

In most cases, training or visitation of operational managers to agencies such as USGS would be recommended before implementation.

11. Additional Equipment:

Equipment needs vital to ABMP have been identified in conclusion No.4 above. However, to improve flexibility or capability, the SD has identified additional equipment deemed desirable. The ET has also

identified some desirable options depending on operational approach and SD budget support. (Ref. Sec.V, ss.5.1.3).

Recommendation:

The SD should procure additional equipment which improves capability to meet user needs other than that defined by the ABMP if alternative funds are available. About $329,000 in equipment has been identified by the ET deemed worthy of consideration, including a new aerial camera, roll film and paper processors, surveying equipment, a digitized coordinatograph, and an orthophoto attachment to an existing photogrammetric plotter.