performance criteria. Initially, these criteria will be established by the user agency.

5.6.4.1.2 Develop Change Monitoring System

1. Technical Approach

Change monitoring encompasses not only change "detection" (generally considered a qualitative or relative assessment of altered land cover), but also the quantitative, location-specific identification of natural and man-induced change to land cover forms. Change monitoring in this quantitative sense then allows, over a period of time, trend and pattern assessment and land utilization prediction.

- Establish and test change monitoring procedures

At present, there are some R&D efforts underway that, at a minimum, seek to detect land cover change. For instance, the radiance shift in going from a vegetation cover to bare soil in a short non-seasonal time frame is being studied as an indication of active clear-cutting. These types of methodologies should be reviewed for applicability to the USDA Secretary's Initiative. Initially, candidate methods should be investigated; at least 2 should be selected for more intense research, beginning in FY 80. Procedure development includes modifying (or designing) the procedure and software and operation on a representative computer system to establish a credible "proof of concept" level. Once each change monitoring method reaches this level, it should be documented and released for a pilot test. Accurate frame-to-frame (scene-to-scene) registration of data (0.5 pixel relative displacement) is essential to change monitoring procedure success, and all procedure research must early-on assess this fact. Ultimately, change will have to be stored and retrieved in terms of a geo-based reference system.

- Develop methodology for land cover data base use in change monitoring

A comprehensive land cover data base, containing both remotely- and non-remotely-sensed variables will contribute greatly to effective change monitoring techniques. The addition of variables, such as soils or census, increases the dimensionality (and inherent accuracy) of the decision-making process, and, in a computer-oriented system, does not necessarily make it more time consuming or costly. This task should investigate only the practical utilization of data bases for change monitoring purposes. It is not the intention to develop an all-encompassing national data base for USDA use, but only to develop and test data bases of limited area and number of variables to support specific change monitoring procedure research.

2. Data Requirements

The requirement for change monitoring information can be related to the inventory update mandates contained in such recent Federal legislation as the Resources Conservation Act of 1977 and the Renewable

Resources Planning Act of 1974. Most programs related to current environmental concerns also have a need to monitor and subsequently reveal the location of undesirable land cover change (e.g., desert encroachment on tillable lands). Specific data gathered under Task 1 is sufficient for Task 2 also.

3. Agency Responsibilities/Interfaces

This task is perceived as one in which NASA will take the lead role in technique development in the early phases of RD&T. Once a change monitoring technique has reached the "proven" concept stage and has been documented, a pilot test will be developed. The pilot test, jointly conceived, will be executed by USDA and NASA on a test site of USDA choice. USDA will participate in data processing at a NASA facility and USDA facilities (for technique familiarization) and will subsequently evaluate the technique against prior, mutually-agreed-to evaluation criteria.

4. Schedules/Milestones

- Establish and test change monitoring procedures (see Figure 5.6-2).
- Develop methodology for land cover data base use in change monitoring (see Figure 5.6-3).

5.6.4.1.3 Pilot Testing

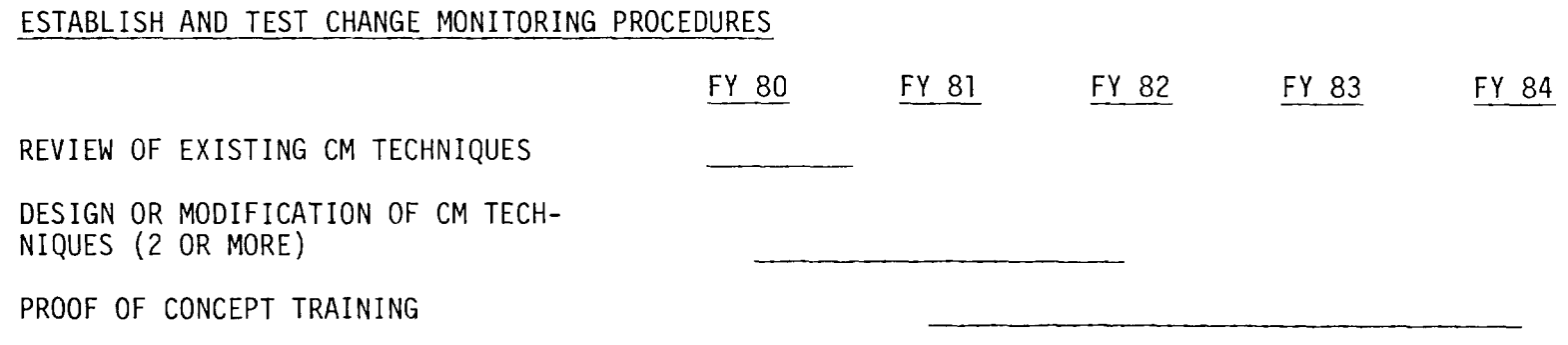
1. Technical Approach

Some of the detailed tasks outlined for our pilot test are:

- Design a pilot test program.
- Select samples for maximum variability.
- Collect ground truth.
- Collect satellite data.
- Determine area estimates.
- Conduct change monitoring.
- Develop performance criteria and sensitivity.
- Evaluate accuracy.
- Validate utility.
- Define LSAT plan.

FIGURE 5.6-2

DOMESTIC CROP AND LAND COVER PROJECT SCHEDULE



*PILOT TEST AS DEFINED HERE WILL BE AN INTEGRAL PART OF THE OVERALL DOMESTIC CROP AND LAND COVER AREA ESTIMATING PILOT TEST.

FIGURE 5.6-3

DOMESTIC CROP AND LAND COVER PROJECT SCHEDULE

DEVELOP METHODOLOGY FOR LAND COVER DATA BASE USE IN CHANGE MONITORING

	FY 80	FY 81	FY 82	FY 83	FY 84
EXAMINE EXISTING DATA BASE SYSTEMS	———				
INTEGRATION OF CANDIDATE DATA BASES WITH PROMISING CHANGES MONITORING PROCEDURES		———————			

*PILOT TEST

*PILOT TEST AS DEFINED HERE WILL BE AN INTEGRAL PART OF THE OVERALL DOMESTIC CROP AND LAND COVER AREA ESTIMATION PILOT TEST.

2. Data Requirement

Major data requirements for the pilot test are:

- Ground Truth - More comprehensive ground truth will have to be collected by USDA enumerators for those states selected for study. Six to 8 states will be involved.

- Landsat Data - A rapid delivery system of CCT's to the USDA is needed to support land use classification. Full-frame Landsat CCT's are needed one to 2 weeks after the satellite data are recorded. This data must be preprocessed and registered. In addition, high contrast black and white images will be required.

- CPU - Computer capability equivalent to ILLIAC-IV must be mainted or provided.

- Aircraft High Altitude Photography - Aircraft high altitude photography will be required for segment verification and to assist in the overall accuracy verifications for the test.

- Data gathered for the crop area estimation pilot test should apply to R&D Tasks 1 and 2.

3. Output Products/Results

The major data products ancitipated as a result of the pilot test are:

- An overall demonstration of basic capability including

  - Multitemporal analysis capability.

  - Expected precision for acreage estimates.

  - Improved application of statistical and data processing methodologies.

  - Capability of new sensors to improve land cover classification.

  - Location and mapping of land cover types with known accuracies.

  - Additional land use parameter investigation.

  - Timely land cover classification.

  - Change monitoring procedures.

  - Methodology for a land cover data base.

- Performance evaluation by the user.

4. Agency Responsibilities/Interfaces

The pilot test will be jointed conceived and conducted with USDA having the overall responsibility for execution. The test site will be chosen by USDA. NASA will participate in data processing at USDA facilities. The analysis will be conducted at USDA facilities since USDA ground data will be used for pilot. The following represents the activities and agency involvement.

- o USDA
  - Design test.[1]
  - Select samples.
  - Collect ground data.
  - Collect remotely sensed data.[1]
  - Data processing.
  - Aggregate area estimates.[1]
  - Change monitoring test.
  - Develop sensitivity.[1]
  - Evaluate accuracy.[1]
  - Validate utility.
  - LSAT preliminary design.[1]
- o NASA
  - Design test.
  - Collect remotely-sensed data.
  - Provide CPU.
  - Aggregate area estimates.
  - Change monitoring test.[1]
  - Develop sensitivity.
  - Evaluate accuracy.
  - LSAT preliminary design.
- o USDI
  - Landsat data storage, retrieval, and dissemination.

5. Schedules

The schedules for the Pilot Test are found in Figure 5.6-4 and Figure 5.6-5.

[1]Lead responsibility

FIGURE 5.6-4

CROP AREA ESTIMATION PILOT TEST SCHEDULE

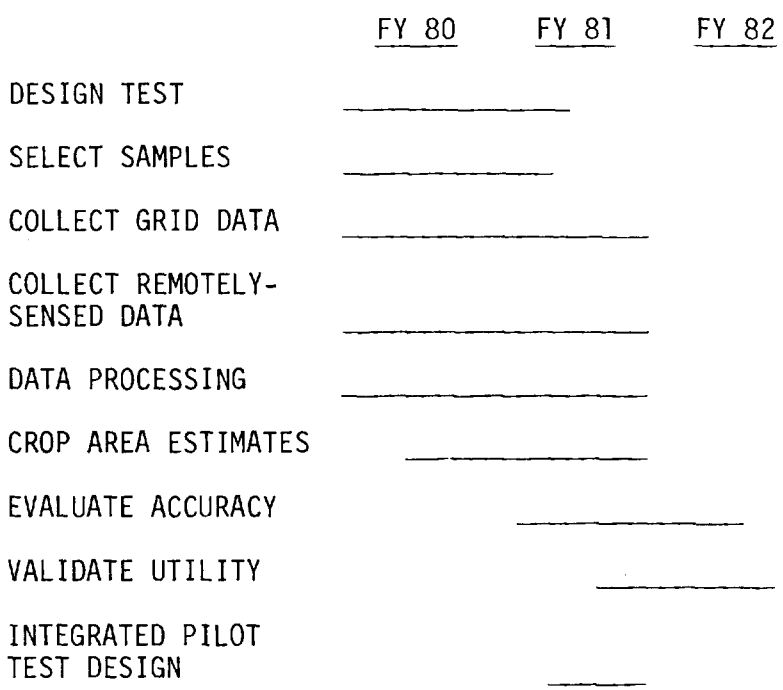
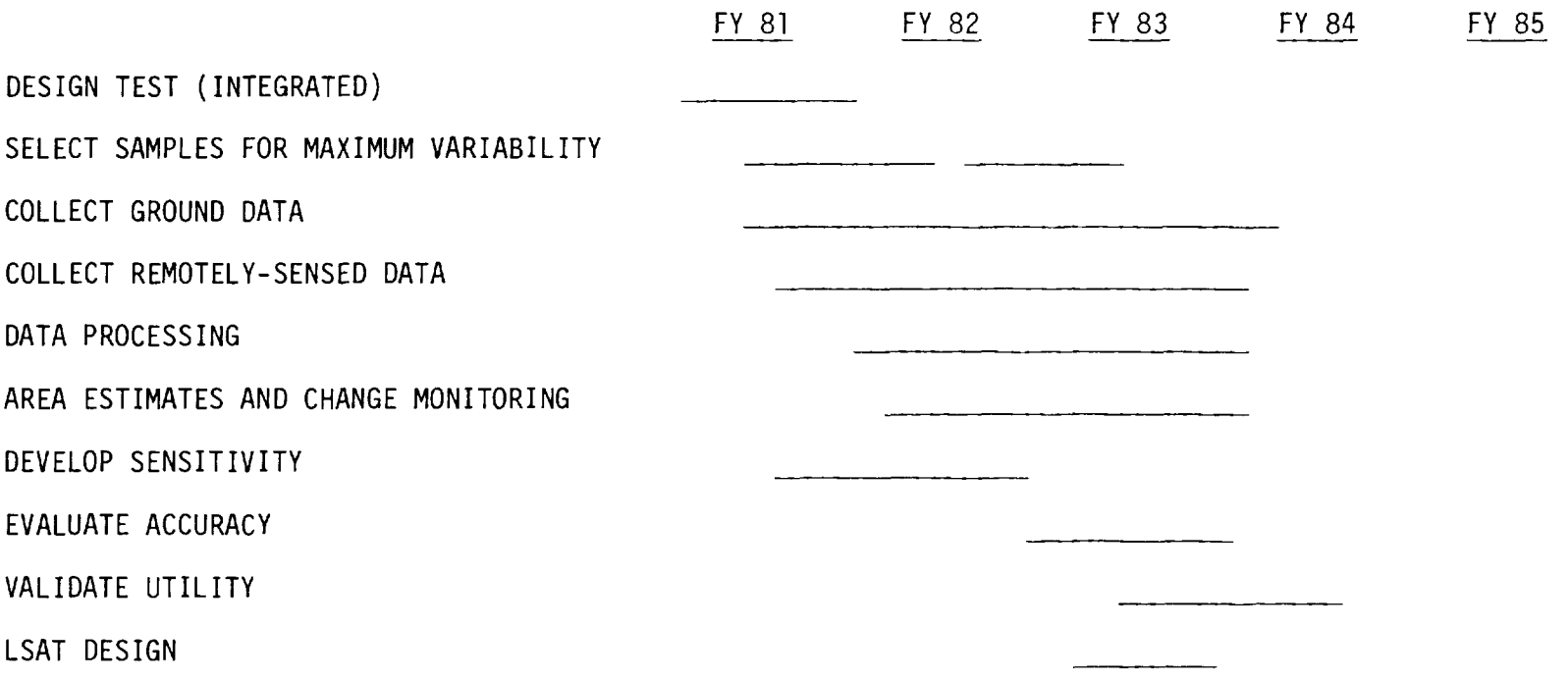


FIGURE 5.6-5

INTEGRATED PILOT TEST (DOMESTIC CROP AND LAND COVER)



5. Performance Evaluation

Developmental research will have periodic evaluations. Systems performance will by necessity vary from project to project. Once a performance criteria is developed, it will be submitted to the cognizant USDA and NASA centers.

5.6.4.2 Large Scale Application Test

1. Technical Approach

The purpose of the LSAT phase is to evaluate newly-tested techniques in conjunction with the basic capability. The LSAT is an adaptation of the methodology and technology from the pilot test in a quasi-operational evaluation. Basic system changes are not made in this element of the program, but if major deficiencies are identified, they will be returned to the RD&T elements for resolution. Operational cost and effectiveness are addressed in this element. USDA will be responsible for designing, operating, and evaluating the LSAT with minimal support from NASA. The LSAT will start in 1984 with 8 to 10 states. These states will be selected to represent the different land uses, agriculture, and climate throughout the U.S. The major tasks of the LSAT are:

- Design the large scale test and select areas.
- Obtain Landsat and ground data.
- Extract information from remotely-sensed data.
- Evaluate accuracy and utility of information.
- Cost/assessment analysis of land use inventory.
- Develop preliminary operational plan.

2. Data Requirements

Major data requirements for the pilot test are:

- Ground Truth - More comprehensive ground truth will have to be collected by USDA enumerators for those 8-10 states selected for study.

- Landsat Data - A rapid delivery system of CCT's to the USDA is needed to support domestic crop and land use classification. Full-frame Landsat CCT's are needed one to 2 weeks after the satellite data are recorded. This data must be preprocessed and registered.

- CPU - Computer capability for data analysis.

- Aircraft Requirements - Aircraft high altitude photography will be required for segment verification and to assist in the overall accuracy verifications for the test.

3. Output Results

The expected output results from the LSAT are:

- Acreage estimates for major crops and land cover types with known and acceptable precision levels at the state, CRD, multi-county, and county.

- Land cover classification maps with known accuracies at the county level.

- Cost-effective and efficient method for storing and retrieving land cover classification information.

- Cost-effective and efficient change monitoring system for crop and land cover location and acreage estimation.

- Cost/assessment analysis.

- Preliminary operational plan and the elements of an operational system.

4. Agency Responsibilities

The LSAT will be designed and operated by USDA. The task/activities outlined in the LSAT technical approach will be carried out primarily by USDA.

5. Schedules/Milestones

The LSAT schedules are found in Figure 5.6-6.

6. Performance Evaluation

USDA will evaluate all elements of LSAT to determine whether or not to go operational. This evaluation will be based on criteria established prior to the execution of LSAT. Any elements not meeting these criteria will return to RD&T for further testing and research. Detailed documentation will be written for all evaluations.

5.6.5 Consolidated Schedule

See Figure 5.6-7.

FIGURE 5.6-6

LARGE SCALE APPLICATION TEST (DOMESTIC CROP AND LAND COVER)

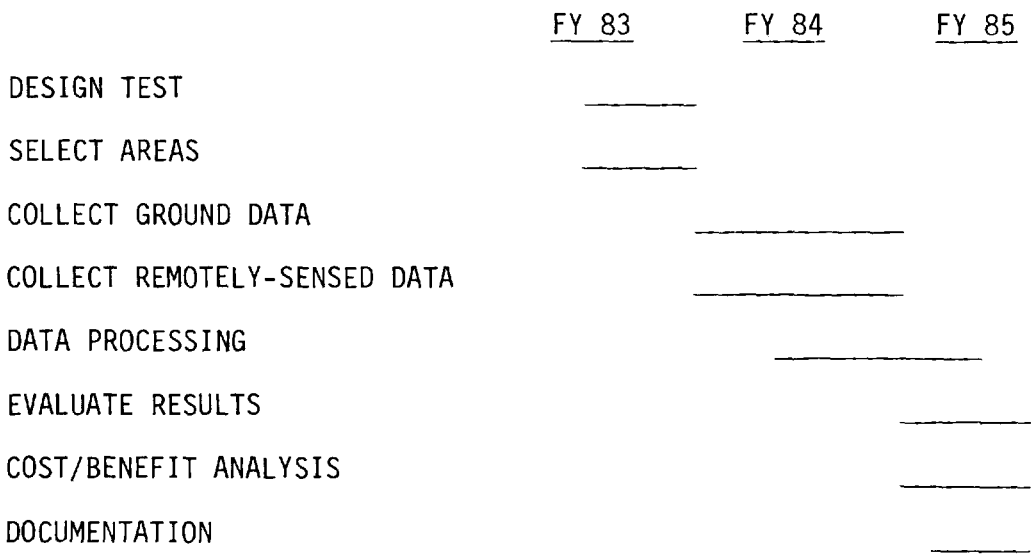
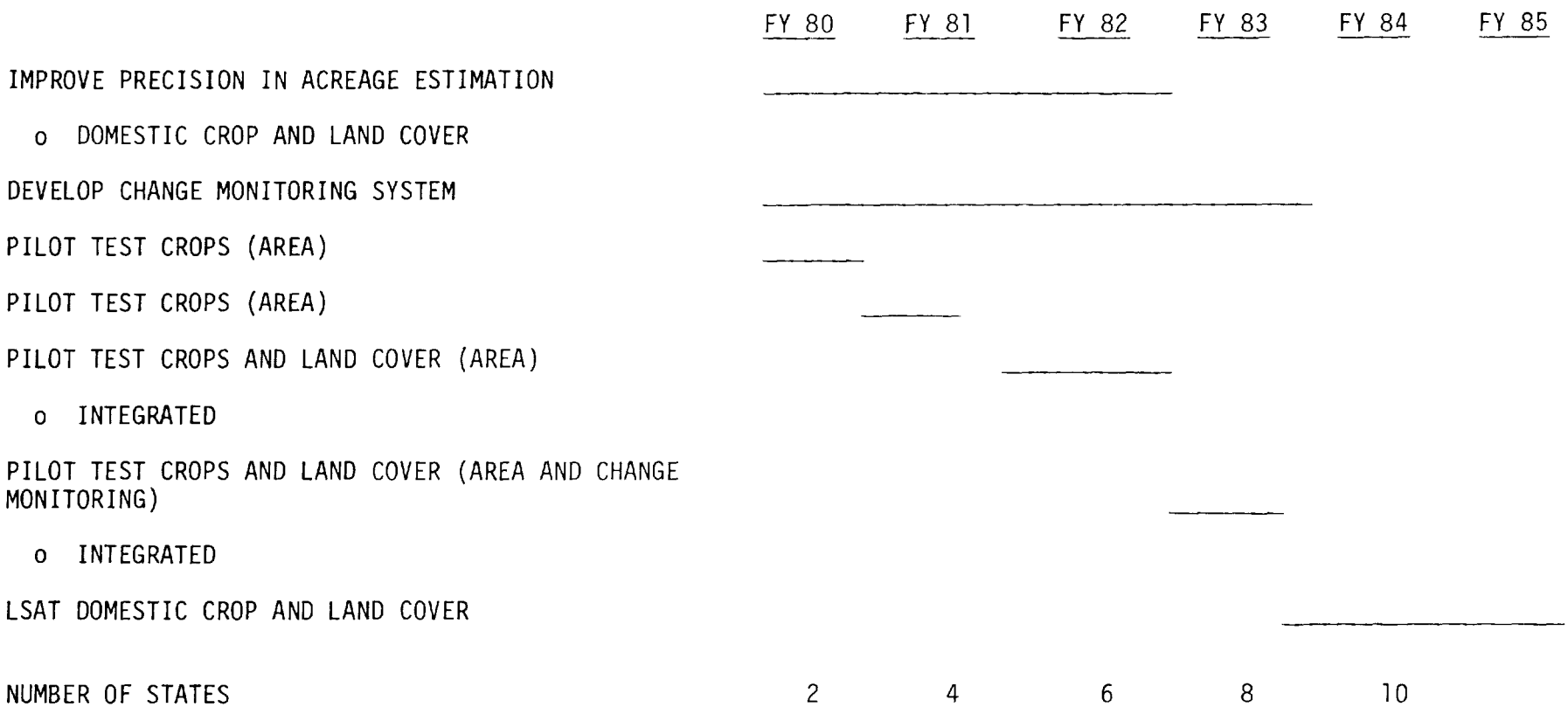


FIGURE 5.6-7

CONSOLIDATED SCHEDULE - MAJOR, RD&T AND LSAT ACTIVITIES

(DOMESTIC CROP AND LAND COVER)



Section 5.7 Renewable Resources Inventory

Project Manager: F. P. Weber, USDA/USFS

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5.7.1 Objectives

The overall goal of the Renewable Resources Inventory Project is a cooperative effort to develop, test, and evaluate methods and techniques for applying new remote sensing technology to the inventory, monitoring, and management of forest and rangeland renewable resources. The project was developed specifically as one element of the USDA Secretary's Initiative and respond to several program elements identified by both the Forest Service and the Soil Conservation Service in the Initiative.

5.7.2 Technical Approach

A balanced program involving research, development activities, and evaluation methodology, including pilot testing, has been developed for this preliminary plan. These efforts address national legislative requirements, such as the National Forest Management Act, the Resource Planning Act, the Soil and Water Resources Conservation Act of 1977 (RCA), and agency missions dealing with state and local responsibilities. The major emphasis has been placed on the improved spatial and spectral capabilities of the new advanced sensor technology; however, Landsat MSS technology is being used for a major pilot test going into the program. This pilot test was developed from previous experimental work carried out with Landsat MSS activities.

5.7.3 Major Problem Areas

5.7.3.1 Regional and Large Area Inventories

Legislation enacted by Congress assigns lead responsibility to USDA for the development of inventory techniques using aerospace and other technology to assist in Regional and Large Area Inventories.

This mission is in response to legislation which includes the Forest and Rangeland Renewable Resources Planning Act (RPA), the National Forest Management Act, the Resource Conservation Act (RCA), and agency responsibilities to state and local governments.

In the near term the majority of RRI Project resources will be focused on research and development support to the Multiresource Inventory Methods Pilot Test, which is an advanced demonstration of Landsat satellite technology to supplement current methods of conducting recurrent inventories of renewable resources over large land areas.

5.7.3.2 Current Technology Assessment

The assessment of current remote sensing technology is a corner stone of the Renewable Resources Inventory Project objectives during the period FY1980-85. The principle reason USDA is involved in AgRISTARS is to provide a means of getting new technology into operational service for meeting Department objectives. Current Technology Assessment provides an important bridge between a research environment and the realities of an operational environment wherein technology which is candidate for implementation can be subject to thorough assessment and evaluation. Within RRI, tasks tend to flow from New Technology Development to Current Technology Assessment and eventually become pilot tested under problem area 1, Regional and Large Area Inventories.

5.7.3.3 New Technology Development

The major direction of research sponsored under this problem area will be directed toward improving the spatial and spectral capability of remote sensing systems. This includes - as a principal activity - the definition of new and advanced technology remote sensing systems to satisfy the unfulfilled data requirements of the Department of Agriculture in pursuit of renewable resource inventory, assessment and management objectives.

Emphasis of sponsored research will also be directed toward improving data utility through the development of new analytical systems, development of new analysis algorithms, development of new methods for enhancing data utility through the additional effect of multiple registered data sources.

High priority is given to microwaves research with new sensor systems as applied to forest and rangeland evaluations. Field experiments will be initiated to provide basic microwave data applied to renewable resource situations. Also, tests will be performed using the appropriate aircraft SAR system to evaluate the utility of SPOTLITE radar techniques.

5.7.3.4 Dectection, Classification and Measurement of Disturbances

Improved methodology for detection, classification and measurement of natural and man-caused disturbances to renewable resources has tremendous implication of vastly improved efficiency in the conduct of field surveys and inventories.

A new remote sensing capability that can periodically monitor the permanent location of Renewable Resource Evaluation plots and determine - as an alarm - the existence of change, can provide the means for interim update of national inventory information between the 10-year cycle of recurrent surveys. This is a very high priority task and will be pursued vigorously by the RRI Project concurrent with the Multiresource Inventory Methods Pilot Test in South Carolina and Idaho.

While the demonstrated capability of civilian spaceborne sensors for detection and characterization of forest insect and disease damage has been disappointing at best, the RRI will aggressively pursue the all source approach to testing and evaluating remote sensing methods for components with detection and evaluation of insect and disease damage to forest communities. In the near term the RRI Project will sponsor R&D efforts which focus on new high altitude reconnaissance camera system and the use of new sampling schemes. In the long term sponsored research will focus on the definition of new space sensors like the High Resolution Pointable Imaging System having 10 meter or better spatial resolution as a means of improving the quality and responsiveness of space-derived data for detection of disturbances.

5.7.3.5 Classification, Modeling and Measurement of Renewable Resources

The driving need in this problem area of the Renewable Resources Inventory Project is for significant improvement in the classification and characterization of forest stands and habitat types. This implies research and development needed on two broad but specific fronts: (1) classification and characterization of existing vegetative cover types, and (2) classification and characterization of sites for potential natural vegetation.

Two areas common to other AgRISTARS projects, but having unique requirements in RRI are snow and water as elements in the forst environment. The RRI will sponsor specific tasks to locate and characterize snow in forest habitats and to determine the feasibility of using remote sensing for analysis of urban soil water potential as affected by forest practices in the surrounding area.

5.7.3.6 Determination of Site Suitability and Land Management Planning

Among the important issues raised by the National Forest Management Act, none are more important than those redefining the Forest Management Planning Process. The importance is reflected in the new Timber Management Regulations as well as the new LMP section of the manual.

The role of remote sensing technology in this problem area is well defined and the challenge is significant -- development, test and evaluation of new methods for accuractely delineating boundaries and conflict zones for conflicting resource values, and to supply data which can be used in the optimum allocation of a resource value to a pertinent site in support of the planning process.

The technical implication of this challenge is to identify the current characteristics of a forest land management compartment - as a component of a National Forest - and to analyze the compartment in relation to the surrounding environment and management objectives, with the end product being an array of alternative management strategies.

This problem is considered complex where remote sensing data is one element contributing to the solution of the problem. The need for concurrent economic analyses as a basis for alternative solution is implied.

5.7.3.7 Analytical and Cartographic Support to the Resources Information Display System

The Resource Information Display System defines the protocol used in the Forest Service for dealing with digitized resource data from multiple sources including remote sensing.

The principle focus for RRI in this problem area is to transfer remote sensing data into the RIDS format while retaining geometric and spectral fidelity. More specifically, initial tasks will develop methods for using RIDS to (1) create a multi-layered data base; (2) to interactively update the data base with new mission remote sensing data; and (3) to define and demonstrate the role of interactive graphics display devices which link the RIDS generated data base for a forest to the real time alternatives arrayed to support the forest planning process.

5.7.4 Schedules

The detailed schedules are found in Figure 5.7-1. (TBD)

Section 5.8 Conservation and Pollution Project

Manager, J. Ritchie, USDA/SEA-AR

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5.8.1 Conservation

5.8.1.1 Objectives

The Conservation Project will develop, test, and evaluate an integrated satellite/aircraft/ground data capability to supply accurate information on conservation practices. The ability to determine sites and effects of conservation practices is needed and represents a major information need required by several USDA agencies.

Although Conservation is predominantly an R&D program, demonstrations and evaluations will take place for more promising techniques, for example, monitoring snow resources for input into hydrological model predictions and conservation inventory.

The key research and development areas within the Conservation program include:

1. Procedures development to determine snowpack characteristics such as snow depth, density, water equivalent, and free water.

2. Procedures development and optimization for conservation inventory and for determining areas where conservation practices are needed.

3. Determine remote sensing input into hydrologic and watershed models.

As a result of developing new and different types of data sources, written procedures and user manuals are to be generated that would enable operational organizations to adapt the new procedures to their operations.

Pilot tests are to evaluate the R&D results and not be an extension of the R&D activities. The general goals are to be directed toward producing more accurate predictions than conventional practices, expending less resources, and consuming less time. The quantitative aspects of these 3 variables are to be defined for each specific task.

5.8.1.2 Technical Approach

Existing hydrologic models will be selected for the input of aerospace data. Outputs from the modified model will be compared with surface information for selected watersheds to determine the validity of the model output.

Landsat MSS, TM, and high resolution photography information will be evaluated for their usefulness to inventory conservation practices and to determine areas where conservation practices should be installed.

Different remote sensors will be evaluated to determine snowpack characteristics such as depth, density, water equivalent, and free water.

5.8.1.3 Task Descriptions

5.8.1.3.1 Task 1 - Conservation Inventory

1. Task Description

The conservation inventory task will develop remote sensing techniques to inventory conservation practices and to identify areas in which conservation practices are needed.

Landsat, TM, and high resolution photography data will be collected over an area when the various conservation practices or the lack of practices are most likely to exhibit unique spectral signatures. Basic soil data and factor data for input into the universal soil loss equation will be supplied by USDA and converted for input to a data base by NASA. Slope data will be obtained from NCIC elevation tapes or supplied by USDA.

The approach will:

- Determine the most cost-effective means for inventorying the various conservation practices by comparing results obtained using Landsat data, TM data, and high resolution photography. Certain conservation practices, such as no-till and stubble-mulch farming, appear to be detectable from Landsat MSS data because of the rather large uniform areas; whereas, the detection of strip cropping would appear to be more successful with the higher resolution TM. Practices such as terracing and contour planting can only be identified by photo-interpretation of high resolution photography.

- Identify areas in which conservation practices are needed. It will be accomplished by incorporating remotely-sensed surface cover data (i.e., slope and soils) into a data base for computing relative soil loss under the current management practice. Those areas that exceed acceptable levels of soil loss will be identified and mapped. Remotely-sensed data will be studied for correlation between spectral response and the need for conservation practices.

2. Products

The conservation inventory task product goals include:

- Maps showing locations and identification of the conservation practices.

- Data on the cost effectiveness associated with the identification of a practice where more than one sensor type was involved.

- Maps showing locations and areas in which conservation practices are needed and should be installed.

- Data showing the effects of different conservation practices on a given area in order to identify the needed practice.

3. Data Requirements

A cumulative total of 200 Landsat and TM scenes and accompanying medium or high altitude color infrared photography will be required, as well as soil survey and climate data.

5.8.1.3.2 Task 2 - Water Resources Management

1. Task description

o Develop procedures and capabilities for improved determination of runoff through the use of hydrologic models that better utilize remotely-sensed data.

o Develop hydrologic prediction models and management simulation models that use remotely-sensed data as input or to infer certain hydrologic and soil type parameters, physical characteristics of the watershed, and various initial state or real-time parameters, such as snowpack characteristics and soil moisture levels.

o Develop snowmelt runoff models making better use of the physical characteristics of the snowpack (e.g., snowmelt, snow depth, snow density, and snow water equivalent).

o Data extraction algorithms will be developed to convert the remotely-sensed data into data accepted for hydrology models. The models selected will be adapted/modified, or new models will be developed and tested on selected watersheds. In predominately snowmelt runoff areas, sites representing a variety of terrains, snow cover, and altitudes will be chosen in cooperation with NOAA and USDA. Non-snowmelt runoff watersheds representing various mixes of urban, agriculture, forest, and water types in different climatic zones will be chosen in cooperation with NOAA and USDA.

o Model performance will be tested with and without remote sensing inputs leading toward operational implementation of promising methods.

2. Products

Models developed or modified to include remotely-sensed data will provide better management of such water resources problems (e.g., flood control, irrigation, power, etc.) Documentation covering the various methods and procedures will be produced for use in subsequent experiments and for implementation by operation agencies.

3. Data Requirements

A cumulative total of 100 Landsat and TM scenes and medium altitude aircraft data will be required, in addition to historical and ground information.

Cumulative HCMM, TIROS-N, GOES, Seasat, NIMBUS-G, and NIMBUS-7(SMMR) data will be used; data requirements are expected to equate to a total of five Landsat scenes.

5.8.1.3.3 Task 3 - Snowpack Assessment

1. Task Description

- Develop techniques to determine physical characteristics of the snowpack; viz., snowmelt, free water, snow depth, snow density, and snow water equivalent.

The various physical characteristics of the snowpack are required inputs to hydrologic models being developed and tested in support of water resource managers.

In FY 80, efforts will be directed toward the following sub-tasks:

- Field studies of snow spectral reflectance and microwave response under diverse conditions using in-situ spectral radiometric measurements.

- Development of techniques to estimate albedo of snow from polar-orbiting satellite sensors (TIROS-N and HCMM).

- Determination of the effects of snow physical properties and substrate on spectral reflectance, microwave emission, and microwave reflectance.

- Determination of the effect of atmospheric attenuation on snow thermal response. This task will involve testing of various satellite temperature models incorporating both upper air (radio-sonde) and satellite soundings.

The above short-term tasks will be extended through FY 81 and will provide input to the following longer-term (FY 82-84) projects.

- Testing of a snow-cloud discrimination sensor in the near-infrared (1.55-2.00 μm) spectral range.

- Determination of snowpack density from ground-based, aircraft, and satellite data (visible and/or microwave spectral regions).

- Determination of snowpack depth, water equivalent, and free water from ground-based, aircraft, and satellite data (visible and/or microwave spectral regions).

- Determination of the effects of ground cover, solar insolation, and slope aspect on snowmelt rate (in-situ/satellite study).

2. Products

It is expected that these longer-term projects will output snow parameters for use in support of operational hydrologic programs.

3. Data Requirements

A cumulative total of 50 Landsat and TM scenes and medium altitude aircraft data will be required, in addition to historical and ground information. NOAA is to supply the meteorological data.

Cumulative data from other space platforms will also be used, equating to a total of five additional Landsat scenes.

5.8.1.4 Relationship of the Conservation Project to Other Projects

Sensors developed under the Soil Moisture Project and soil moisture information from that Project are to be used as required in conduct- the four tasks outlined on the Conservation Project Plan.

No unique test sites are contemplated for this Project.

5.8.1.5 Agency Responsibilities Summary

The organization responsible for specific activities/functions that combine to make up the Conservation Project are indicated below.

1. USDA (Tasks 1 and 2 only)

   - o Select test sites.
   - o Historical data.
   - o Ground data collection.
   - o Interpret aerospace data.
   - o Assist develop change detection techniques.
   - o Provide guidelines/handbooks.
   - o Participate in R&D activities.
   - o Lead pilot test planning/operations.
   - o Plan LSAT, initial operations.

2. NASA (All Tasks)

   - o Develop capabilities to monitor conservation practices.
   - o Data preprocessing.
   - o Machine model evaluations.
   - o Usefulness of microwave.
   - o Extraction/reduction.

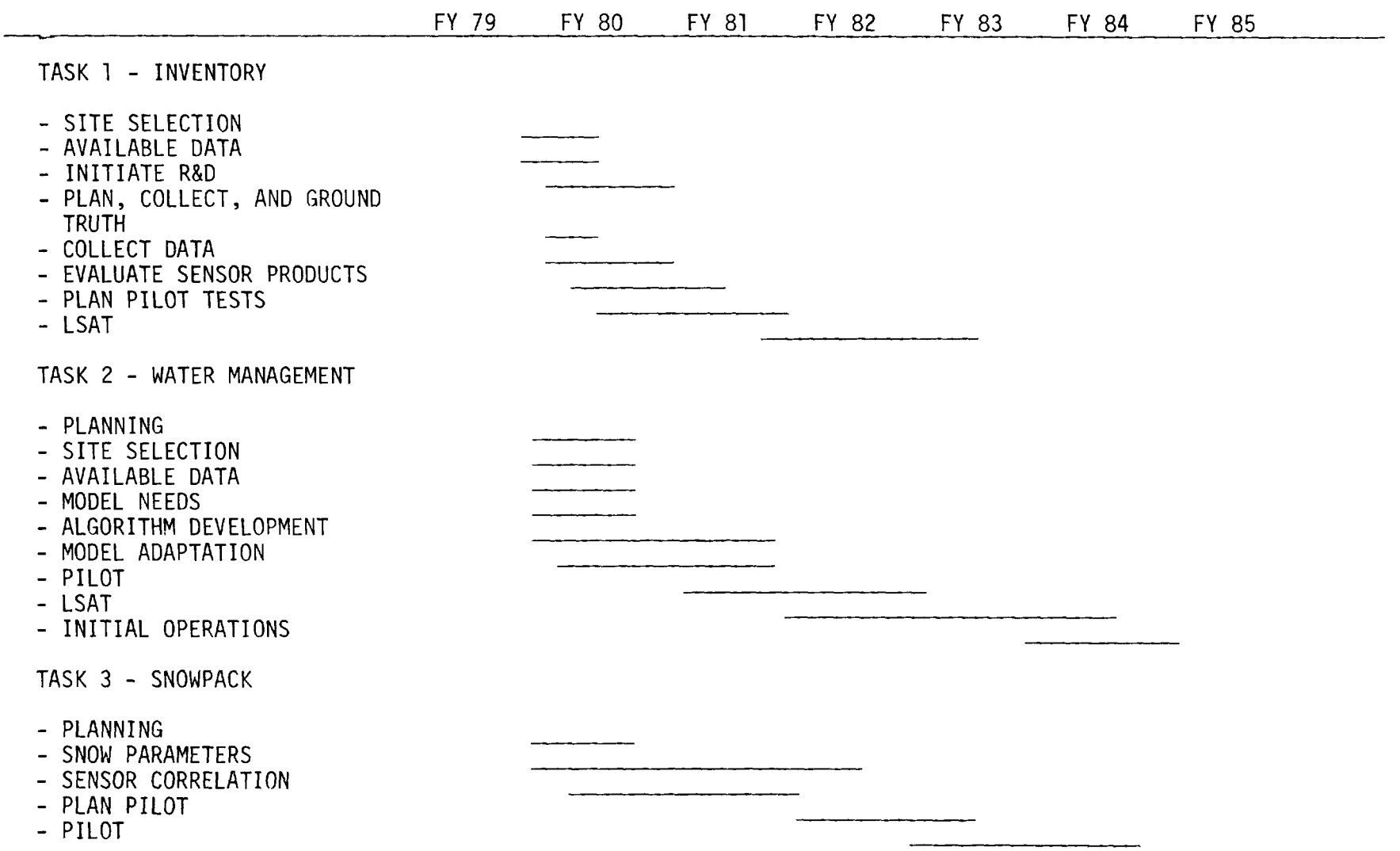
3. NOAA (Task 3)

   - o Determine physical characteristics snowpack remotely.
   - o Evaluate usefulness of remote platforms.
   - o Ground data collection.
   - o Supply space data for pilot/LSAT.

4. USDI

   - o Provide Landsat data storage, retrieval, and dissemination.

FIGURE 5.8-1 CONSERVATION SCHEDULES WITH MILESTONES



5.8.2 Pollution

5.8.2.1 Objectives

The objective of the Pollution Project is to provide an assessment of the effectiveness of agricultural and forestry practices within the U.S. through the application of remote sensing, ground data, and models in an integrated system. This assessment is essential to the determination of the effectiveness of best management practices and the elimination of effects of pollution on production potential and on natural resources. The ability to monitor and to assess conservation practices supports several USDA agencies, as well as legislative responsibilities related to pollution and non-point sources of pollution.

Sediment is the primary water pollutant of initial concern, and both point and non-point sources are of importance. An integral part of this objective is mode validation and the development of remote sensing input for pollution models. The potential of models as management tools is already recognized and many are being developed; however, their acceptability for use with a confidence of their strengths and limitations requires extensive validation efforts.

Remote sensing capabilities have also been developed to monitor gaseous air pollutants, and it is proposed that far-term emphasis of the Pollution Project be addressed to the monitoring of air pollution in areas where its impact on vegetation is suspected. Efforts would also address the problem of remotely sensing the impact vegetation.

5.8.2.2 Technical Approach

The basic approach for project implementation will be to conduct laboratory and field investigations to determine and verify techniques for detecting and inferring the concentrations of water pollutants associated with agricultural and forestry runoff with an initial emphasis on total suspended sediment. These efforts will demonstrate the developed capability with appropriate satellite and aircraft overflights of several test sites where adequate ground truth verification is obtained. Joint USDA/NASA pilot experiments will be conducted for early initial tasks of using remote sensing for measuring and assessing various agricultural practices.

Management practices which influence runoff will be defined, such as row crops on slopes (contoured versus non-contoured), tillage practices (till versus no-till), crop type (for determining application amounts of fertilizers, pesticides, and herbicides), irrigated versus non-irrigated, and clear-cutting. Other concerns will be identified where relevance to pollution is known, such as saline soils, slope and slope length, the presence of feedlots, and animal access to streams. Test sites will be selected to encompass as many of the identified potential sources as possible and will include sites where non-point pollution models are being tested. The methodology will be documented and its use demonstrated in one or more sites where its effectiveness

will be determined independently by ground truth methods. Care will also be taken to include in the analysis any point sources (e.g., municipal sewage treatment plants) which may be influencing the water pollution in the area of interest.

To support the long-term interest in monitoring other specific pollutants, laboratory and field investigations will be conducted to determine if the form of fertilizer, pesticide, herbicide, fungicide, toxic chemicals, and other agricultural/forestry-related pollutants in water have spectral reflectance signatures which can be detected with multispectral scanning and whether algorithms can be developed to infer their concentrations.

Pollution and management simulation models will be modified or developed that use remotely-sensed data as input or infer parameters that are necessary to drive such models.

The air pollution emphasis will define agricultural and forest regions known or suspected to be impacted by air pollution and identify gaseous and particulate pollutants involved. Existing techniques will be modified and new techniques developed, if required, to remotely sense the specific pollutants and to detect the impact on vegetation. Tasks at selected sites will demonstrate the remote sensing capabilities using aircraft and satellite as appropriate.

5.8.2.3 Supporting Elements

5.8.2.3.1 Task 1 - Assessment of Conservation Practices

1. Task Description

- Provide a quantitative assessment of sediment runoff in selected test areas where various agricultural practices are known and controlled and where extensive ground monitoring exists.

- Utilize existing models for predicting sediment runoff and determine their accuracy, limitations, and transferability to other sites. Determine the application of remote sensing data as inputs for parameters needed for pollution models.

- Test sites will be selected from those currently being used by the USDA for their basic ongoing programs. The selected sites will be coordinated with those being used in the remote sensing studies on conservation inventory. Thus, the task includes data from evaluations of spatial resolution effects involving the 30m capability and the high resolution CIR photography for agriculture. These data may be supplemented with additional multispectral aircraft measurements for sediment determination pre- and post-rainfall events. Initially, Landsat data will be evaluated when available, and satellite TM data will be used later in the program. Existing algorithms for determining sediment concentrations will be evaluated in these pilot experiments

by comparison with surface truth measurements. Additional algorithms will be developed, if required, to account for various ranges of turbidity and soil types. The resulting techniques will be documented for potential operational use, including the generation of maps of sediment distributions and concentrations.

- Laboratory and field spectral measurements will be made as an adjunct effort to provide data for analytical efforts directed toward the development of advanced algorithms and selection of more optimum spectral bandwidths. Soil samples will be collected and laboratory spectra determined at various concentration levels in water. These spectra will be compared with field spectra and with analytical techniques for predicting spectra. These tests will provide the basis for extensions of this technique to other pollutants of interest. These results will also provide means for distinguishing sediment types using remote sensing techniques.

- Existing models for predicting sediment runoff will be exercised at the previously identified test sites. Special emphasis will include the contributions of remotely-sensed data in providing inputs for these models and for the accuracy determination for sediment loading predictions. Comparisons will be made of the results from several test sites to identify the conditions of acceptable usage and the definition of model improvements desired or required.

- In cooperation with operational agencies, LSAT will be defined and conducted following the pilot experiments at a new test site, which will demonstrate the techniques and procedures in a quasi-operational mode. The LSAT results will provide go/no go information for decisions for incorporation in operational use.

2. Products

The following products are planned for this task:

- Documented procedures for using remotely-sensed data for measuring sediment.

- Laboratory and field spectra at various sediment and other pollutant concentrations.

- Assessment of effectiveness of models in predicting non-point source sediment pollution.

- Detailed procedures for implementing remote sensing technology into operational monitoring of the effectiveness of agricultural and forestry practices for reducing pollution due to runoff.

3. Data Requirements

Five test sites are to be involved and a total of 100 Landsat scenes are to be required. A selected stream will be identified, and

those pixels (one percent of scene) will be processed with a designated algorithm to estimate suspended sediment concentration and other water pollutant parameters. Some of the scenes will be analyzed for Level I and Level II land use categories over approximately 20 percent of their areas. Aircraft NS-001 scanner data is estimated to be equivalent of 2 Landsat CCT's, which is to be operated on by a suspended sediment algorithm and algorithms for at least 2 other water parameters. The results will be presented as 10 isopleths covering the range of detected suspended sediment and the other 2 parameters and as isotherms, or as color-coded images showing sediment concentration ranges and algal bloom extent. Ground truth is to be supplied by USDA agencies.

5.8.2.3.2 Task 2 - Air Pollution and Vegetation Impact

1. Objectives

Develop the capability to detect gaseous and particulate air pollutants and their impacts on agricultural and forestry resources.

Agricultural and forest areas subjected to known air pollutants will be surveyed. It is anticipated that pollutants, such as ozone and the oxidants in photochemical smog, will be of importance as will the oxides of nitrogen and sulfur dioxide which are related to "acid rain." Particular emphasis will be on areas such as the inter-mountain valleys of Arizona and California and on agricultural areas in the vicinity of industrial centers such as the south shore of Lake Ontario. Gas filter radiometry has been demonstrated to be an effective approach for remotely sensing troposperhic gases. This and other techniques will be studied, and existing equipment will be modified to assess the ability to monitor the identified air pollutant or pollutants of primary interest. Existing MSS techniques will also be evaluated and modified as needed to remotely sense vegetation which has been impacted by air pollutants. Pilot experiments will then be conducted at selected sites where independent ground truth measurements can verify the results. Special emphasis includes wind erosion effects also. Assessments will then be made as to the potential for routine monitoring for agriculture/forestry purposes.

2. Products

The following products will result from this task:

- Techniques for using applicable remote sensors to measure near-surface concentration distributions of oxidants (e.g., ozone, the oxides of nitrogen, and sulfur dioxide in atmospheric regions upwind of selected test sites.

- Techniques for using MSS data to identify vegetation impacted by specific air pollutants.

3. Data Requirements

At least 10 test sites will be identified and approximately 10 percent of each of 50 Landsat scenes will be analyzed with some special methddology to identify vegetated areas impacted by air pollutants. A gridded map of the selected portion of the scene displaying the impacted region and a computation of its area is required. This data product is required within one month of Landsat overpass. The air pollutant sensor data will be the equivalent of 2 Landsat CCT's operated on by an algorithm to produce pollutant concentration. These pollutant concentration data will be presented as 10 isopleths covering the measured range on a gridded map showing the impacted vegetated area. Ground truth is to be supplied by USDA.

5.8.2.4 Relationship of the Pollution Project to other Projects

No test sites are contemplated that would be unique only to the Pollution Project.

5.8.2.5 Agency Responsibilities Summary

The organization responsible for specific activities/functions that combined to make up the Pollution Project are indicated below:

1. USDA

- Select sites.
- Provide ground data.
- Interpret imagery/verification for model inputs.
- Develop non-point and water quality models.
- Expand models.
- Define data sets needed.
- Evaluate test results.
- Guidelines/handbooks for use of models.
- Evaluate wind-erosion damage.
- Implement successful models.

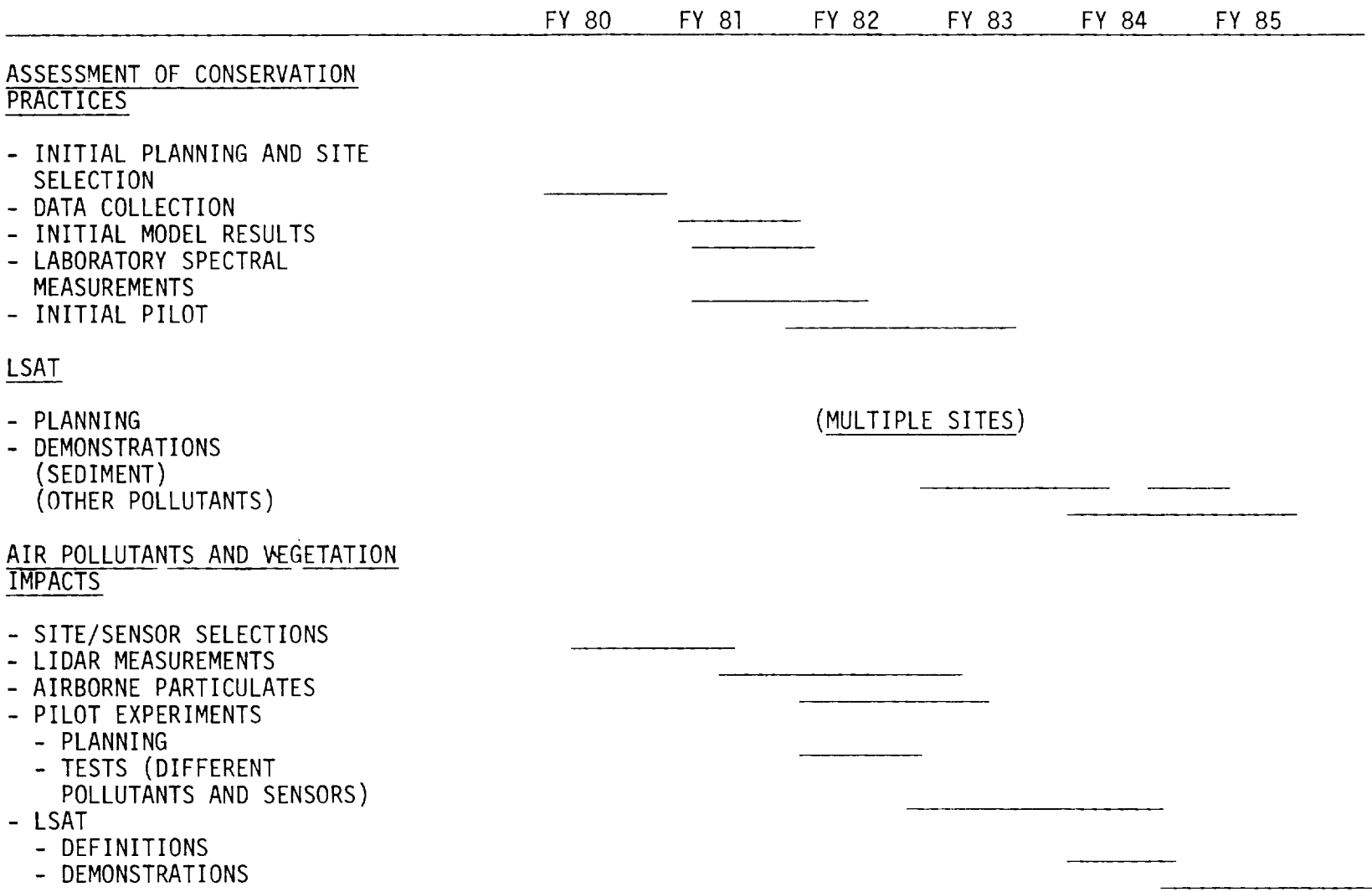
2. NASA

- Obtain aerospace data.
- Evaluate assessment methods.
- R&D to make aerospace data applicable to non-point source modeling.

- Adapt algorithms, test, hydro-water water quality models.
- Lab/field spectra.
- R&D to collect pollutants.

3. USDI
   - Provide Landsat data storage, retrieval and dissemination.

FIGURE 5.8-2 POLLUTION SCHEDULE



LISTING OF SUPPORTING DOCUMENTATION

AgRISTARS PROGRAM

Document	Approval Authority
Technical Program Plan	ICC
(Eight Project Plans)	PMT
Appendix A Supporting Documentation Listing	
Appendix B Data Management Plan	PMT
Appendix C User Evaluation Plan	PMT
Appendix D LSAT Guidelines/Plans	PMT
Management/Organization Plan	ICC
Appendix A PMT Change Control Plan	PMT
Appendix B ICC Change Control Plan	ICC
Resources Program Plan	IPB
Project Implementation Plans	PMT
(Eight Separate Plans)	
Appendix A ICD (See Note)	Project Managers
Appendix B ICD	Project Managers
Appendix C ICD	Project Managers
Appendix D ICD	Project Managers

Note
ICD's required between projects will be attached as appendices to the effected plans and will be jointly approved by the participating project managers.

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Technical Program Plan
Appendix B

Data Management Plan

NASA

This plan will be included as soon as completed and approved by the Interagency Coordinating Committee.

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Technical Program Plan
Appendix C

User Evaluation Plan

NASA

USDA PRELIMINARY EVALUATION GUIDELINES
FOR REMOTE SENSING RESEARCH

1.0 INTRODUCTION:

The purpose of these guidelines is to establish procedures whereby USDA management may obtain objective appraisals of the probable usefulness to USDA of the results of ongoing and future joint investigations into the possible uses of different types of remotely sensed data in the production of improved agricultural information, both domestic and/or foreign.

The joint activity in question is a research program. In the context of this program, "research" is defined as the development of new knowledge and technology which can be applied to provide new or improved information necessary for the USDA to perform its missions. Different lines of inquiry will be pursued, not all of which will produce usable methods or techniques. The fact that some research results are negative does not imply that the research effort has been a "failure". Carrying out the research process is not a question of success or failure, and results will not be defined in these terms.

Before detailed evaluation criteria can be developed, it is necessary to understand the philosophy that will be followed by the Department in evaluating any results from the program. The philosophy is based on the experience gained during the course of the LACIE Project, and in other research activities conducted by the Department.

This philosophy is that the research and experiments conducted must show tangible results which are repeatable, and which provide information of value to the Department in a cost-effective manner when compared with or incorporated into existing methods for obtaining the same information. Finally, it should also be understood that even though the results of the research into a specific area prove useful and provide accurate data, it does not follow that they will be adopted and implemented by the Department immediately.

2.0 EVALUATION GUIDELINES

Performance or evaluation criteria will be developed concurrently with the detailed technical research plan.

2.1 RESEARCH PLANS

Research implementation plans for the major project elements discussed in the Technical Program Plan have been developed. These research plans discuss the objectives of the specific research that will be conducted, define the data requirements of the research, provide a schedule of the first two years' activities and describe the anticipated results at the conclusion of the research.

The research plans have been reviewed by the Program Management Team. If major changes are required, the plan must be rewritten, and the new plan must be evaluated and approved, as provided for in the Program Management Plan.

2.2 EVALUATION PLANS

An evaluation plan will be developed by USDA for each research project. This plan will include statements on at least the following items:

(1) Nature and objectives of the research.

(2) Potential areas of application.

(3) Evaluation procedures, including data requirements, and sources of that data. This procedure should include comparisons with existing data sources as to probable accuracy and timeliness, start-up and operating costs, data requirements, and overall compatability with the present system.

2.3 EVALUATION SCOPE

Evaluation of research activities will be carried on throughout the research, development, and test phases of the program.

User evaluations will be accomplished at the completion of research, development, and test program. Thus, user evaluations will be conducted upon completion of the pilot tests.

2.4 EVALUATION TEAM

The USDA Evaluation Team has a chairman appointed by and responsible to the USDA representative to the Interagency Policy Board with members from the potential user agencies.

Specific duties of the Chairman include:

(1) Coordinate all USDA remote sensing evaluation activities, related to the Secretary's Initiative.

(2) Assign evaluation tasks to specific potential USDA user agencies.

(3) Review and/or design proposed evaluation plans and reports.

(4) Distribute research results and evaluations to all potential USDA user agencies.

Other members of the Evaluation Team would be assigned by the USDA user agencies as required to evaluate remote sensing research activities of potential interest to those agencies. Such members should be technically capable (although not personally involved in the particular research project) and able to develop and execute evaluation plans. Both the evaluation plans and the evaluation reports will be reviewed both by the affected agencies and the Evaluation Team Leader.

User evaluations will be the sole responsibility of USDA. The results of a given research task will be evaluated by the USDA user agencies concerned with that area of research. User agency technicians participating in the evaluation will use the evaluation plan and criteria developed prior to the start of the research as a guide in evaluating the research results. This evaluation will result in a recommendation to continue research or to initiate operational testing.

The final user evaluation will address the following:

- To what extent does the new technology provide new, improved or more timely information as compared to or combined with existing USDA user agency information systems?
- Will new or improved information be of value to the USDA user agency decision makers on a continuing basis?
- Can the new technology be easily adopted, or integrated into existing USDA information systems?
- Can the cost of modifying present systems in integrating and implementing the new procedures in USDA be justified?

3.0 EVALUATION REPORT

The final Evaluation Report should include at least the following items:

(1) The original objective of the research.

(2) A description of the research methodology.

(3) What was accomplished (Include negative results).

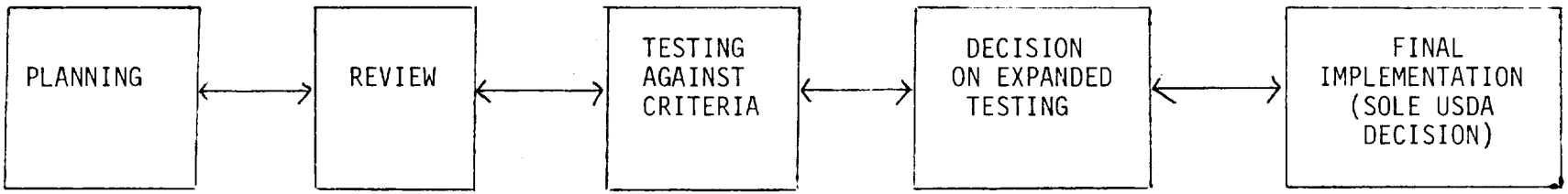
(4) Comparisons with existing data sources (accuracy, timeliness, cost, etc.)

(5) Unsolved researchable problems.

(6) Potential areas of application. If any--include probable costs and data requirements.

(7) Recommendations on future action (1) adopt or adapt methodology for USDA application testing or implementation as appropriate, (2) refer back for further research, or (3) redirect R&D resources to more fruitful lines of inquiry.

RESEARCH EVALUATION MODEL



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Technical Program Plan
Appendix D

Large Scale Application Test (LSAT)

Guidelines/Plans

NASA

This plan will be included as soon as completed and approved by the Interagency Coordinating Committee.