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16. Abstract NASA established a program with the Environmental Research Institute of Michigan (ERIM) on 20 December 1979 with the objective of investigating methods of making Landsat technology readily available to a broader set of private sector firms through local community colleges. This report summarizes the second year accomplishments of this very successful technology transfer effort. To achieve the desired objective - the transfer of Landsat technology - the program applies a network where the major participants are NASA, universities or research institutes, community colleges, and local-private and public organizations. The methodology employed by the program gives local users an opportunity to obtain "hands-on" training in Landsat data analysis and Geographic Information System (GIS) techniques using a desk-top, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone line, and provides for generation of land use and land suitability maps and other data products via remote command. During the period from 22 September 1980 - 6 March 1982, 15 workshops and other training activities were successfully conducted throughput Michigan providing hands-on training on the RAS terminals for 250 or more people and user awareness activities such as exhibits and demonstrations for 2,000 or more participants.

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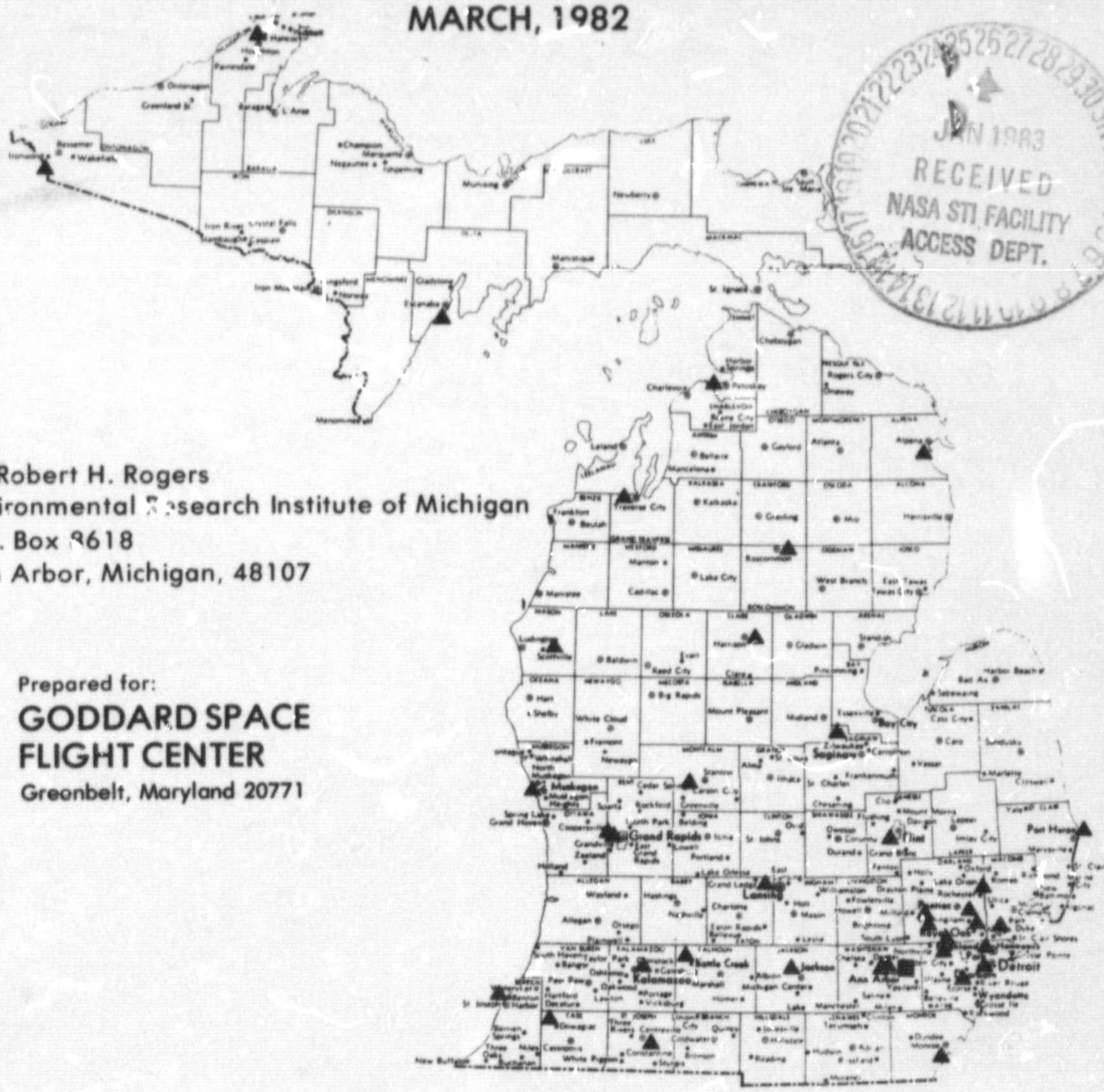
Final Report

LANDSAT TECHNOLOGY TRANSFER TO THE PRIVATE AND PUBLIC SECTORS THROUGH COMMUNITY COLLEGES AND OTHER LOCALLY AVAILABLE INSTITUTIONS, PHASE II PROGRAM

MARCH, 1982



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▲ LOCATIONS OF COMMUNITY, JUNIOR, AND TECHNICAL COLLEGES WITHIN THE STATE OF MICHIGAN

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5. Dr. Rainer R. Erhart, Western Michigan University
6. Dr. Eugene Jaworski and Dr. Rockey Ward, Eastern Michigan University
7. Dr. Roy Klopcic and Dr. John Grossa, Central Michigan University
8. Professor Morris Thomas, Lansing Community College
9. Mr. Robert Rowley and Mr. Jim Weber, NASA Headquarters
10. Dr. Elaine Wallace and Ms. Mary Ellen Oliver, Wayne County Community College

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1.0 INTRODUCTION

1.1 BACKGROUND

Since the initiation of the Landsat program, most government technology transfer efforts dealing with Landsat use have been focused primarily on the public sector - Federal agencies and State governments - and have not involved the private sector to any significant extent. The application of Landsat data in the private sector has been limited primarily to the private suppliers of Landsat data processing and analysis equipment and services - aerospace companies and a limited number of users in sectors such as the mineral and petroleum industry and timber companies. However, there are many other potential private users who have not yet incorporated Landsat technology in their array of services; some examples are architectural and engineering firms, computer data processing firms, energy and environmental companies, and other consultants providing services in land use planning and development. Lack of greater involvement by these potential users has retarded the growth of Landsat technology, since engineering firms do much of the land use mapping for both government and private industry.

Recent surveys show that a large number of potential users in the private sector and at local agencies are interested in becoming consumers or suppliers of Landsat-derived products and services. However, they have been prevented from entering this market by the high cost of analysis facilities and the difficulty of obtaining training in the new technology. To evaluate methods for bridging this gap NASA established a 12-month program (Phase I) with the Environmental Research Institute of Michigan on 20 December 1979 with the objective of investigating methods of making Landsat technology readily available to a broader set of private sector firms through local community colleges. Because of the success of this first effort and the need for continuing cooperative technology transfer programs to involve more colleges and local users, a second 12-month program was established on 6 March 1981. This report summarizes the work accomplished and the results achieved during this second 12-month period (Phase II) of this very successful technology transfer program.

To achieve the desired objective - the successful transfer of Landsat technology - the program applied a network (Figure 1) where the basic partners are NASA, a university or research institute, community colleges, and local-private and public organizations. The methodology employed by the program gives local users an opportunity to obtain "hands-on" training in Landsat data analysis and Geographic Information System (GIS) techniques, using a desk-top, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone line, and provides for generation of land use and land suitability maps and other data products via remote command.

The role of the university or research institute in this model network is to provide host computer services for demonstration and training with the RAS terminals, develop training packages and programs, and support seminars and workshops staged by the local colleges. For their part, the colleges classify and organize business and industry in their neighborhoods in accordance with technical or information needs, organize and host the seminars and workshops for potential users and suppliers of Landsat data products, and serve as local contact points for technical assistance. The wholesaler-retailer analogy associated with this network is illustrated in Figures 1 and 2.

The Phase I program assembled two (2) RAS terminals, a RAS User's Handbook, and a set of five exercises. These materials were used to conduct three cooperative technology transfer programs which resulted in the training of 100 or so people. The Phase I participants included: NASA, the sponsor; ERIM, who assembled and supplied the RAS and other materials; C.S. Mott Community College; Wayne County Community College;

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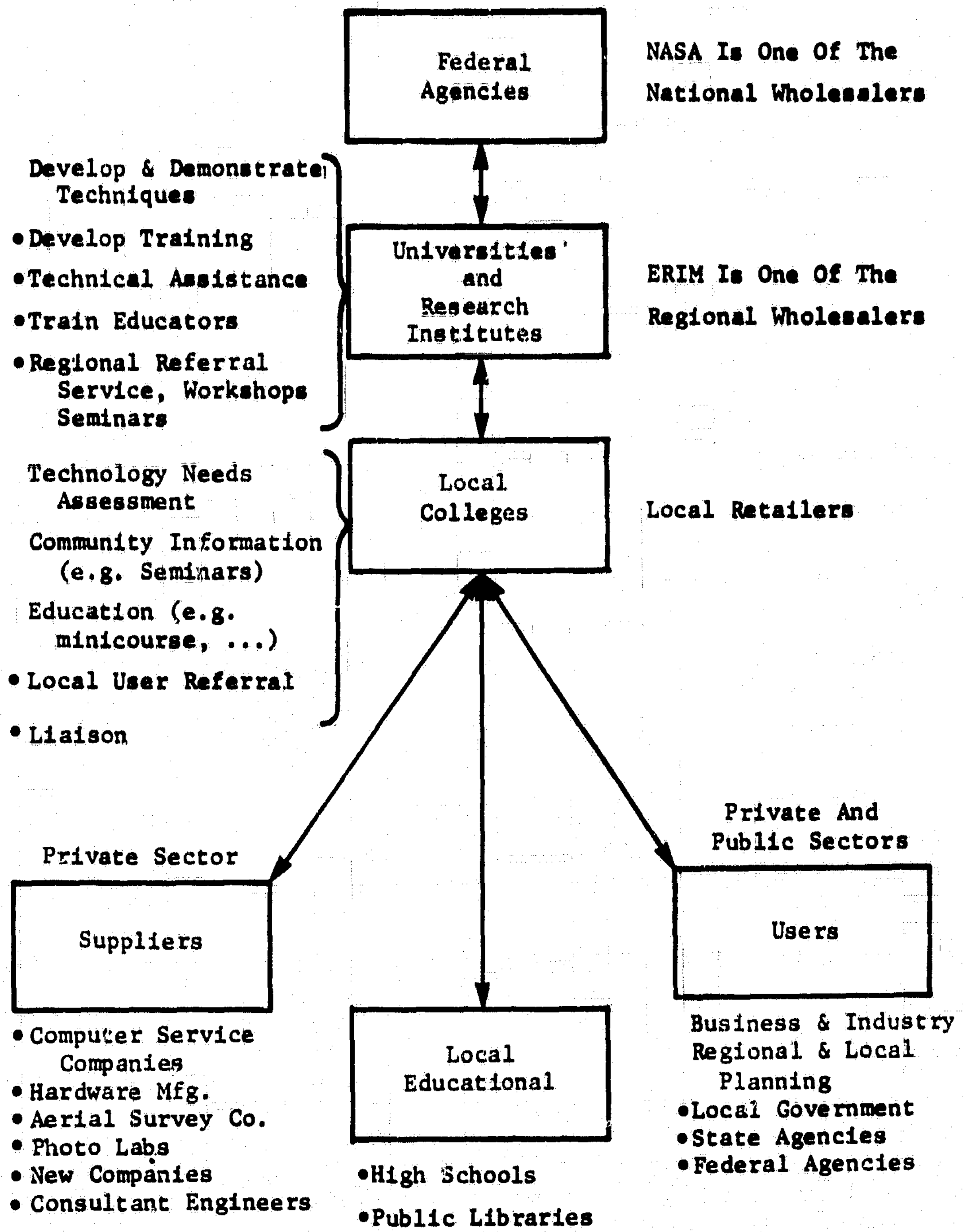
Figure 1. FUTURE NETWORK TO EXTEND LANDSAT TECHNOLOGY TO THE PRIVATE SECTOR



A MODEL OR ANALOGY

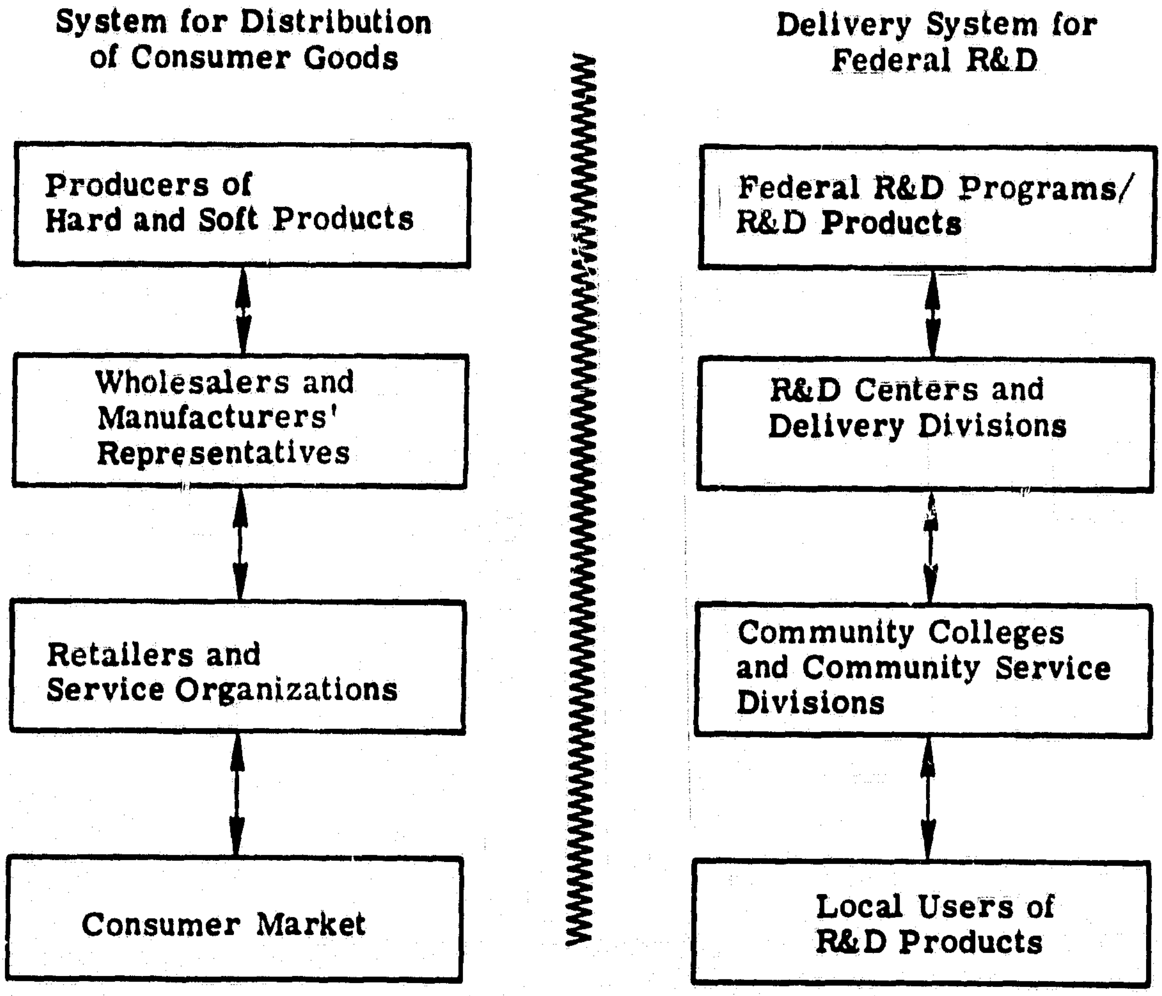


Figure 2

and Eastern Michigan University, who organized and sponsored seminars to attract practicing professionals to a program of training in Landsat technology and the off-campus host for the terminals where trainees obtained additional hands-on training. The off-campus host included: Daedalus Enterprises; Detroit Edison Company; and, Michigan CLS Region V Planning and Development Commission.

The RAS terminals were assembled and deployed to provide the staff of academic institutions and other public and private organizations an opportunity to obtain "hands-on" training in Landsat data analysis within their own community. To improve the probability that local users would adopt the Landsat technology once a successful training and demonstration effort was completed, the terminals were configured to provide high-quality Landsat image and data products at a relatively low initial investment of about $20K.

The RAS terminal shown in Figure 3 consists of a color CRT imagery display, with alphanumeric overwrite and keyboard, as well as a cursor controller and modem. This portable station can communicate via modem and dial-up telephone with a host computer at 1200 baud or hardwired to a host computer at 9600 baud. The station contains a Z80 microcomputer which controls the display refresh memory and remote station processing. Landsat data can be displayed as three-band false-color imagery, one-band color sliced imagery, or color-coded processed imagery. Although the display memory operates at 256 x 256 picture elements, a display resolution of 128 x 128 can be selected to fill the display faster. The interactive operating techniques developed by ERIM permit most of the interaction to be performed at the lower resolutions and faster display fill rates, with high-resolution capability being used for viewing the final processed data.

Figure 3 Remote Analysis Station

The RAS features the following capabilities:

- Low cost - the station can be assembled from readily available hardware for less than $20,000.
- System portability - the user supplies only electrical outlets and a telephone.
- Interactive control - via a simple, menu-driven language.
- Dial-up access - to host computer with selectable trade-off between image viewing speed and quality (resolution).
- Color coded image display - in colors selected from a list with over 40 options.

The RAS is presently used to access the ERIM Earth Resources Data Center for Landsat data processing, including the generation of film images and thematic maps. The specifications for the host computer and peripherals are given in the following section.

1.2 SPECIFICATIONS FOR THE HOST COMPUTER AND PERIPHERALS

1.2.1 GENERAL HARDWARE REQUIREMENTS

Following is a summary of equipment requirements and recommendations for supporting the RAS subsystem.

<u>Mainframe</u>

- Floating point multiply/divide hardware*
- At least 16-bit addressing
- Program memory
  - Required 64K bytes

*Recommended because of the high volume throughput required by imagery data processing.

Peripherals

- Random access disk memory: recommended minimum 5-megabyte (county size area) available for image data storage.
- Magnetic tape dirve: 9 track, 800 or 1600 bit per inch (BPI).
- RAS connected via RS-232 terminal port. The RAS appears as a 9600 baud asynchronous terminal.

1.2.2 GENERAL SOFTWARE REQUIREMENTS

Certain machine software requirements are necessary to support the RAS subsystem without extensive modifications. A list of these requirements follows:

- The host machine must have a 16-bit or a 32-bit word size.
- The host machine must support FORTRAN IV or a higher FORTRAN language.
- The host machine must have machine language for disk and tape data handlers for image data.

1.3 DESCRIPTION

Essentially, RAS is a FORTRAN program used to support the processing and analysis of digital imagery data, such as remotely sensed data and ancillary data. The complete RAS software consists of the RAS program and numerous application modules. The RAS program is coded in FORTRAN except for a few machine-dependent FORTRAN-callable subroutines that are used to accomplish I/O, bit and byte manipulations, and certain control functions. Each of the application modules is also written in FORTRAN but relies on the operating sybsystem for machine-dependent functions.*

---

*"RAS User's Manual", April 1982.

2
SUMMARY OF PHASE II PROGRAM

The following was accomplished during the performance of the overall program objective — successful transfer of Landsat technology.

1. Continued support of cooperative technology transfer programs to involve more colleges and local users. The colleges are providing support for training courses with minimum assistance from NASA program.

2. Upgraded the operational capability of the RAS terminals and host software. The objective was to simplify operations as well as to add capability to manipulate other data sources and to perform user-oriented analyses.

3. Upgraded training materials to facilitate their use by trainees and incorporated additional exercises needed to introduce new terminal capabilities.

4. Encouraged suppliers of terminals, software, host computer services, etc. to meet user needs on an investment basis. Users were to procure their own terminals and software once a successful demonstration project was completed.

5. Developed a means for continuing the technology transfer programs on a self-sustaining, pay-as-you-go basis.

These accomplishments are discussed in more detail in Sections 2.1 through 2.5.

2.1 CONTINUED SUPPORT OF COOPERATIVE TECHNOLOGY TRANSFER PROGRAMS

The role of local colleges in partnership with the private sector to deliver Landsat technology at the local level was further developed through additional training and demonstration projects. Program constraints (e.g., funding and facilities) limited the participants to

ERIM and five academic institutions. ERIM trained and supplied teachers with the RAS terminals and other training materials; the academic institutions organized and sponsored workshops for potential users and suppliers of Landsat and GIS data products, and also served as local contact points for technical assistance. The academic institutions included two Phase I participants, Wayne County Community College and Eastern Michigan University, and three new participants, Lansing Community College, Central Michigan University, and Western Michigan University. The technology transfer activities accomplished by these organizations and listed in Table 1 resulted in:

- Five user awareness activities such as exhibits and RAS terminal demonstrations at trade fairs etc., which were viewed by 2,000 or more attendees.
- Seven free workshops attended by 300 to 400 people, which were designed to attract potential trainees to follow-up classroom courses providing hands-on training.
- Ten or more courses or seminars attended by 150 or so participants who acquired intensive training including 5 or more hours hands-on use of the RAS terminal.

Selection of Phase II participants was accomplished in consultation with NASA. The Phase II effort includes three additional colleges to organize cooperative technology transfer efforts in other regions of the state, (e.g., Southwest Michigan, the Lansing-State Capitol area, and Central Michigan). The criteria used to select the additional academic institutions included:

1. Their expressed interest in remote sensing and Landsat technology.

TABLE 1
PHASE II TECHNOLOGY TRANSFER ACTIVITIES

Date/Location	Activity	Attendance
1981		
April 3 Ann Arbor, ERIM	Teacher workshop to orgagnize and plan Technology Transfer Activities	12
April 10-12 Ann Arbor	'Technology Fair', Exhibits and RAS Terminal Demonstrations	500
May 1 Ann Arbor, ERIM	Workshop to Train Teachers, and Plan for Technology Transfer	12
May 6 Big Rapids, Ferris State College	User Awareness Presentation "Landsat Technology"	30
May 18-22 Lafayette, Indiana; Purdue/LARS:	'Conference on Remote Sensing Education' (CORSE-81), Presentations and Exhibits on Technology Transfer Program	120
May 28-30 Ann Arbor, ERIM	Lectures and Hands-On Training for Staff and Grad. Students of Western Michigan University	10
June 14-19 Glen Arbor	University of Michigan: 'Vegetation Remote Sensing Workshop', RAS Terminal Demonstrations	20
June 23 Lansing, Lansing Community College	Meeting with Landsat Advisory Committee to Organize and Plan Technology Transfer in Lansing area.	10
August 3-7 Ann Arbor, ERIM	Lectures and Hands-On Training for University of Rhode Island, School of Oceanography, Staff and Graduate Students	10
August 10-15 Ann Arbor, ERIM	Workshop to Train Teachers in Use of Terminals and New Exercises	9

TABLE 1 (Cont'd.)

Sept. 6 - Oct. 2 Ypsilanti, Eastern Michigan University (EMU)	Integrate New Training Material Into Remote Sensing Course, GEO 478, 2 Credits	20
Sept. 26 Ypsilanti, EMU	'Business and Industry Day', Exhibits and RAS Terminal Demonstrations	100
Sept. 24 - Oct. 21 Northeast Detroit, Wayne County Community College (WCCC)	Establish New Remote Sensing Course, GEO 240, 4 Credits, Lectures and Hands-On Training in Landsat and GIS Technology	12
Oct. 3 & 4 North Detroit, Cranbrook Inst. of Science	Staff by Wayne County Community College: Exhibits and RAS Terminal Demonstrations	300
Oct. 16 Lansing, Lansing Community College (LCC)	Workshops, 'Remote Sensing and Geographic Information Technology', Presentations, Exhibits and RAS Terminal Demonstrations	36
Oct. 19-21 Detroit	ERIM and Wayne County Community College: 'National Technology Transfer Conference', Presentations and Exhibits	125
Nov. 5 & 6 Mt. Pleasant, Central Michigan University (CMU)	'Conference on Utilizing Space Technology' Combined with Workshop on 'Satellite Remote Sensing and Resource Management Systems'. Presentations, Exhibits, and RAS Terminal Demonstrations	300
Nov 11-20 Lansing, LCC	Seminar on 'Remote Sensing Applications of Landsat', GEO 118, 2 Credits, Lectures and Hands-On Training	7
Nov 17 - Dec 14 Northwest Detroit WCCC	Course Remote Sensing, GEO 240, 4 Credits, Lectures and Hands-On Training	20

TABLE 1 (Cont'd.)

Nov 19 Kalamazoo, Western Michigan University (WMU)	Remote Sensing Technology Transfer Workshop, Presentations, Exhibits and RAS Terminal Demonstrations	30
Nov 23 - Dec 3 Kalamazoo, WMU	Seminar on Remote Sensing Technology, 16 CEUs, Lecture and Hands-On Training on RAS Terminals	10
Dec 7 - 10 Ann Arbor, Washtenaw County Planning Commission	Training and demonstrations for County and Township Planning Staff	6
1982 Jan 18 - Feb. 5 Mt. Pleasant CMU	New Course, Processing and Interpretation of Landsat Data, 3 Credits, Provides Lectures and Hands-On Training	10
Feb 16 - April 16 Detroit, WCCC	Remote Sensing GEO 240, 4 Credits, Lectures and Hands-On Training	20
March 8-10 Ann Arbor, ERIM	Special Workshop for Staff of Envirosphere Company, Lectures and Hands-On Training	7
March 11-13 Ann Arbor, U of M	Hands-On Training in GIS Technology with Terminal for students and staff of Landscape Architecture/Regional Planning Department.	15
March 15-31 Ypsilant, EMU	Remote Sensing Course GEO 478, 2 Credits, Lectures and Hands-On Training	20
April 16 North Detroit Detroit Edison Co.	Training and Demonstrations Using Software Established in Edison Company's PDP-11/70 Computer	10

2. The likelihood that the institution would continue to use or provide training in the use of Landsat technology. A significant factor here was the availability of a computer at the institution which would be able to provide host computer services.

3. Their location to a large number of potential trainees.

The relatively high cost of long distance telephone calls and the possibility of having to make a service call to repair the terminal limited our consideration of participants to those within about a 150 mile radius of Ann Arbor.

The locations and approximate user market areas for the Phase II participants is illustrated in Figure 4. Their roles in the transfer activity, demonstrates one method by which NASA can join in cooperative ventures with local public and private organizations to transfer Landsat and GIS technology to a large number of participants at the grass roots level. A representative set of materials used by the colleges and institutions to publicize training courses is contained in Appendix A.

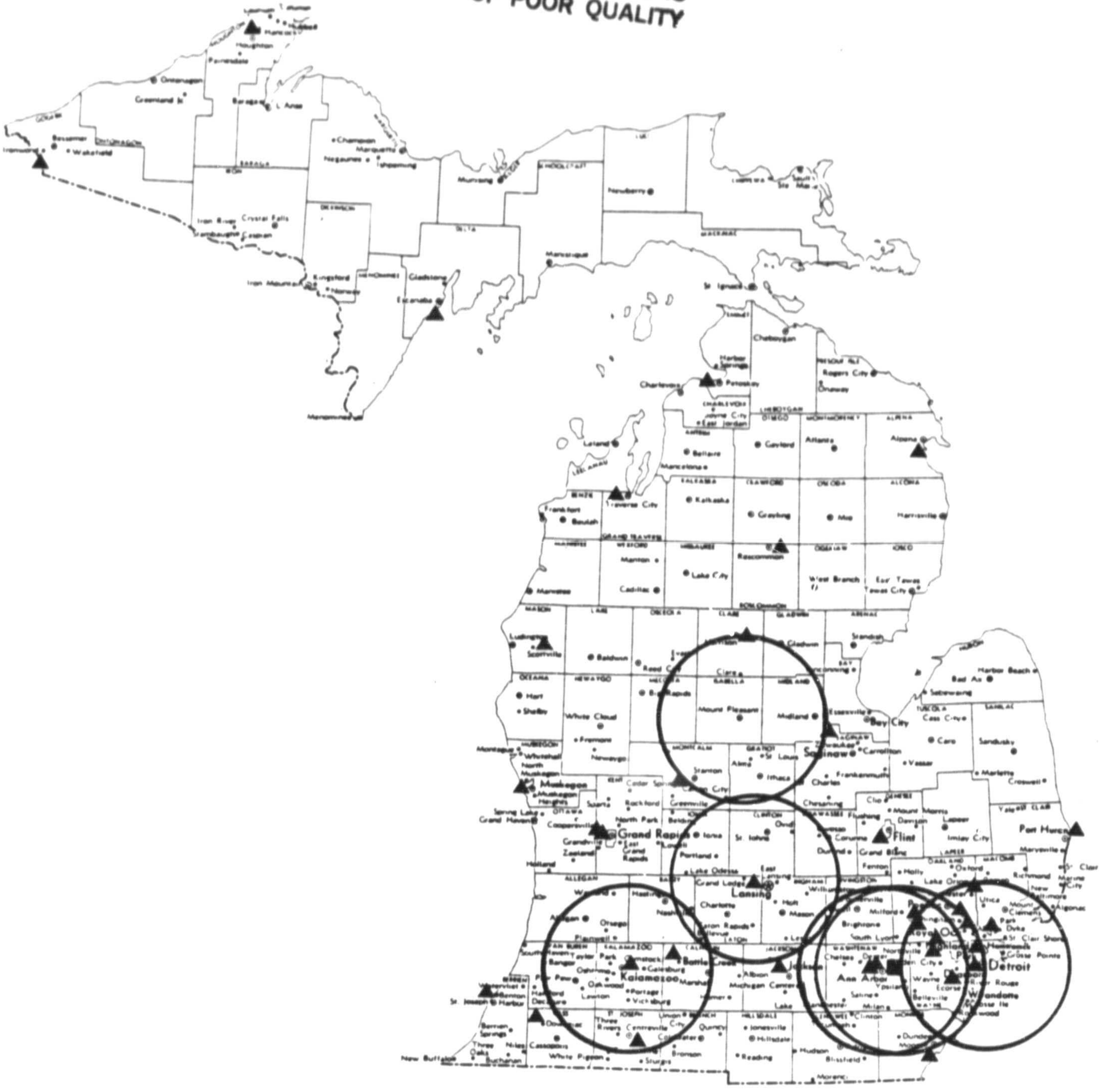
2.1.1 ERIM

ERIM's role in the cooperative technology transfer program included:

1. Hosting organizational meetings needed to establish program participants (e.g., colleges, engineering firms, etc.) for five cooperative transfer efforts.

2. Upgrading the RAS terminals and other training materials (Section 2.2 and 2.3).

3. Assisting participating academic institutions with 'free' workshops and other user awareness activities needed to publicize



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Source: American Association of Community and Junior Colleges, 1976 Directory

Figure 4 Location of Phase II Technology Transfer Centers and recruit trainees to follow-up seminars and courses for which the trainee pays the institution.

4. Training staff from the academic institutions and engineering firms who would be conducting training at their respective organizations, about 20 people.

5. Supplying the RAS terminals, telephone link, host computer services, and copies of other training materials (e.g., User's Manual, exercises) needed to conduct eight courses at the five academic institutions, which resulted in hands-on training of another 130 or more people.

The first organizational training workshop was held at ERIM on 3 April 1981 with NASA, the Phase I participants, and potential Phase II participants. This workshop gave Phase I and Phase II participants an opportunity to review Phase I program mistakes, successes, and recommendations for Phase II. In addition, potential Phase II participants had an opportunity to state their ideas on how to best conduct a cooperative technology transfer effort in their regions. In conjunction with NASA, academic institutions were selected to organize and move forward with the Phase II transfer efforts.

The second and third teacher training workshops were held May 1 and August 10, 1981. The purpose was to train those listed in Table 2 who, in turn, would be training more than 130 others during Phase II of this program.

In addition to the teacher training activity, the program also had the opportunity to train six members of the University of Rhode Island Graduate School of Oceanography and one from the Northeast Fisheries Center who attended a workshop at ERIM from August 3 through 7.

Table II
Staff Trained During Phase II
To Deliver Training in Landsat and GIS Technology

1. Raj A. Aggarawala, U of M
2. Reginald Beasley, Detroit Edison
3. Carol Bronick, EMU
4. Dr. Terry J. Brown, U of M
5. Phil Chase, Johnson and Anderson
6. Russell L. Dodson, MSU and LCC
7. Dr. Rainer R. Erhart, WMU
8. Donald C. Gavin, Detroit Edison Company
9. Dr. John Grossa, CMU
10. Lu Anne Horvath, EMU and Detroit Edison
11. Dr. Eugene Jaworski, EMU
12. Dr. Roy R. Klopcic, CMU
13. Mary Ellen Oliver, WCCC
14. Steve M. Queriolo, Envirosphere Company
15. James Sleep, WMU
16. Jerome Gill Sullivan, U of M
17. Morris Thomas, LCC
18. Dr. Elaine Wallace, WCCC
19. Dr. Rockey Ward, EMU

A recent decision by the Envirosphere Company to adopt Landsat and GIS technology is another good example of how Landsat technology is being transferred to the private sector. During August 1981, Steve Queriolo of the Enviropshere Company, had the opportunity to attend the teacher training session at ERIM. This training provided him and the Envirosphere organization an opportunity to obtain hands-on evaluation of the RAS terminals and the Landsat technology. As a result of this evaluation, the company purchased a terminal for its New York office and will be processing data from this center by April 1982. Staff from their offices in New York; Atlanta, Georgia; Bellvue, Washington; and Newport Beach, California attended a special three-day workshop at ERIM during March 1982. It is anticipated that all of these offices will adopt Landsat and GIS technology as Envirosphere obtains additional experience with Landsat data and better understands its cost and benefits as applied their programs.

2.1.2 EASTERN MICHIGAN UNIVERSITY (EMU)

Dr. Eugene Jaworski, of the Geography-Geology Department of EMU, prepared the User's Manual and most of the exercises and successfully integrated these materials into a seminar — GEO 478 "Special Topics: Remote Area Sensing" during the Phase I program. As a result of the success achieved with these materials and seminars and a need for experienced staff to continue the technology transfer efforts in Southeast Michigan, Dr. Jaworski and EMU were also selected to participate in the Phase II program.

EMU's role in Phase II included:

1. Rewriting the Phase I training materials (i.e., User's Manual and five exercises) and developing a GIS User's Manual and three new exercises (see Appendix B).
2. Assisting ERIM in training staff from other participating academic institutions and organizations.

3. Supporting user awareness workshops at other participating institutions.

4. Integrating and using RAS and training materials into two Remote Sensing Courses which provided training for 40 or more persons in the Ann Arbor-Ypsilanti region.

Evidence of EMU's interest in continuing technology transfer efforts is expressed by its willingness to continue training and demonstrations with the RAS terminals at no additional expense to NASA, and the publication of a new brochure describing remote sensing and GIS training at EMU.

2.1.3 WAYNE COUNTY COMMUNITY COLLEGE (WCCC)

During Phase I Dr. Elaine Wallace, Director of the Coastal Environmental Studies Project at Wayne County Community College, and Mary Ellen Oliver were trained in the operation of the RAS terminal. They applied this training to conduct a very successful seminar for practicing professionals in the Detroit-Metropolitian area and trained students and staff of the Coastal Environmental Studies (CES) project in the use of Landsat technology. The CES project is a two-year program that trains personnel for careers in 1) coastal research, 2) environmental studies, 3) chemical engineering, and 4) coastal planning. Landsat technology was readily integrated into the CES project during Phase I through its geography, geology, and computer data processing courses.

Because of the colleges' success in making Landsat training readily available to professionals and CES students in Detroit and this programs need for experienced staff to continue technology transfer efforts in this metropolitian area, WCCC and Dr. Wallace were selected to participate in the Phase II program.

WCCC's accomplishments during Phase II include:

1. Establishing radio/TV media events, other user awareness activities associated with RAS terminal demonstrations, and exhibiting at the Cranbrook Institute of Science.
2. Co-sponsoring the Second National Technology Transfer Conference with ERIM which was attended by over 125 administrators and staff from academic institutions throughout the country.
3. Assisting ERIM with the organization and planning of technology transfer activities involving other academic institutions.
4. Developing new exercises involving the selection, interpretation, and analysis of aerial photographs, Landsat images, and map and field data collected during several time periods on the Pointe Mouille Michigan State Game Area.
5. Establishing and conducting a new course, Geology 240, Remote Sensing, 4 Credits, which was repeated three times to provide class work and hands-on training on the RAS terminals for about 60 trainees.
6. Providing a lead role in establishing a technology transfer steering committee through which the community colleges and universities are collaborating to continue the transfer of Landsat technology and other technologies on a self-sustaining, pay-as-you-go basis.

Evidence of WCCC's interest in continuing technology transfer is expressed by their work to establish a second course involving training in the geologic interpretations and applications of Landsat data, and their lead role in organizing the academic institutions into a cooperative effort to establish the funding needed to continue technology transfer efforts.

The NASA technology transfer activity in southeast Michigan during the 1980's inspired other organizations to become interested and inquire about the possibility of participating in technology transfer activities. Lansing Community College (LCC), Central Michigan University (CMU), and Western Michigan University (WMU), who were selected as the new Phase II participants are examples of such institutions.

2.1.4 LANSING COMMUNITY COLLEGE (LCC)

Lansing Community College was selected because of: 1) Its location in the Lansing State Capitol area which contains a large number of potential state government users; 2) The strong interest by LCC's Social Sciences Department (ie., Chair person, William H. Heater and Professor Morris O. Thomas) in remote sensing and Landsat technology; and 3) Their close proximity to Michigan State University's Remote Sensing Program and, in particular, Russell Dodson, a Graduate Student. LCC's role in the cooperative technology transfer program included:

LCC's role in the cooperative technology transfer program included:

1. Hosting a Landsat Advisory Committee meeting to assist with planning of technology transfer.
2. Publicizing the technology transfer workshops and seminars.
3. Establishing staff trained in the use of RAS and other training materials.
4. Hosting a free one-day workshop 'Remote Sensing and Geographic Information Technology', October 16, 1981, which was attended by 36 or more persons from public and private organizations in the Lansing area.
5. Establishing and conducting a Seminar on Remote Sensing, GEO 181, 2 Credits, during the week of November 11, 1981 which provided lectures and hands-on training for seven or more participants.

LCC, as well as CMU and WMU, elected to first conduct a user awareness workshop free-of-charge to attendees before the hands-on training course (seminar) when the trainees would pay the institutions through the usual registration-fee method. RAS terminals provided to these institutions for the workshops gave the staff an opportunity to obtain additional hands-on experience before the seminars.

Organizations who participated in the technology transfer activity in the Lansing area either as a speaker at the October 1981 workshop or through their membership in the steering committee included:

1. Abrams Aerial Survey;
2. Consumers Power Company;
3. Dart Oil & Gas Corporation;
4. Eastern Michigan University;
5. Environmental Research Institute of Michigan;
6. Michigan Department of Natural Resources;
7. Michigan Department of Transportation;
8. Resource Information Associates, Inc.

MSU's efforts in assisting LCC is another good example of how a major University or research institute with a strong remote sensing program, can help other colleges develop technology transfer activities. MSU's support included assisting in the selection and recruiting of speakers for the workshop; the use of its newsletters to publicize the workshop and seminar; and a readily available source of trained staff who could be called upon for assistance.

2.1.5 CENTRAL MICHIGAN UNIVERSITY (CMU)

CMU was selected as one of the academic participants in order to establish a technology transfer center readily accessible to the staff of the mineral, petroleum, and timber companies concentrated in north-central Michigan. Another factor was the enthusiam shown by Professors

John Grossa and Roy Klopcic of CMU's Geography Department. At their own expense, they attended workshops and training sessions in Southeast Michigan which allowed them to become qualified RAS users.

CMU's role in the cooperative technology transfer effort included:

1. Establishing a staff trained in the use of the training material.
2. Developing and distributing user awareness publications announcing workshops and seminars.
3. Organizing and hosting two free one-day workshops on Satellite Remote Sensing and Resource Management Systems attended by 100 or more persons from public and private organizations in north-central Michigan.
4. Developing and using a new exercise providing trainees with additional experience in the manual interpretation of Landsat imagery.
5. Establishing and carrying out a seminar, GEO 575, 'Processing and Interpretation of Landsat data' consisting of lectures and hands-on training for 10 or more participants.

Organizations providing speakers and other assistance for the two free one-day workshops in November 1981 included:

1. Abrams Aerial Survey Corporation;
2. Central Michigan University;
3. Daedalus Enterprises, Inc.
4. Eastern Michigan University;
5. Environmental Research Institute of Michigan;
6. Geospectra Corporation;
7. METSAT Corporation;
8. Michigan State University.

Organizations attending the remote sensing workshop and/or the follow-up seminar included staff from many of the high schools and colleges in north-central Michigan as well as staff from the following private organizations:

1. BCA Engineering;
2. Dow Chemical;
3. Electronic Automation;
4. EMCO Petroleum;
5. Hosking Geophysical Corp.
6. McClure Oil Co.;
7. Mears Engineering;
8. Williams International.

Evidence of CMU interest in continuing technology transfer efforts in north-central Michigan is expressed by its plans to continue training and demonstrations with the RAS terminals in January-February 1983 at no additional expense to NASA.

2.1.6 WESTERN MICHIGAN UNIVERSITY (WMU)

WMU was selected as a participant in order to establish a technology transfer center in southwest Michigan which would be readily accessible to the staff of Williams and Works (a major engineering firm in Grand Rapids), the five community colleges in the region, Southwest Michigan Regional Planning Commission, and Consumers Power Company (a major utility company). WMU also had a strong interest in upgrading its remote sensing program to include training in the digital analysis of Landsat data. WMU's interest is in using RAS as both a teaching and research tool.

Another factor in the selection of WMU was the enthusiasm shown by Professor Rainer R. Erhart of the Geography Department and James N. Sleep, a graduate student, in the Computer Sciences Department. They attended workshops in southeast Michigan at their own expense to become qualified in the use of the terminals and other training materials.

WMU's role in the technology transfer program included:

1. Establishing a staff qualified in the use of the training materials.
2. Developing and distributing user awareness publications, such as the workshop and seminar announcements.
3. Organizing and hosting a half-day remote sensing workshop attended by 30 or more people.
4. Conducting a seminar on Landsat technology which consisted of lectures and hands-on training for 10 or more people.

Organizations providing speakers for the half-day (free) workshop in Kalamazoo included:

1. Eastern Michigan University;
2. Environmental Research Institute of Michigan;
3. Michigan State University;
4. West Michigan Regional Planning Commission.

Organizations attending the half-day seminar included staff and graduate students from CMU's Geology, Geography, Biology, and Computer Science Departments, Consumers Power Company, Wilkins and Wheaton Engineering, Williams and Works Consultants, Southwestern Michigan Regional Planning Office, and the Kalamazoo City and County Planning Department. The new GIS capability and the RAS terminals were of particular interest to the Consultants and Planning officials.

Evidence of WMU's dedication to continuing technology transfer efforts in southwest Michigan is demonstrated by its plans to provide training and demonstrations with the aid of the RAS terminal during the March - April 1983 time period at no additional cost to NASA.

2.2 UPGRADING THE RAS TERMINALS AND HOST SOFTWARE

The Phase I efforts revealed that many potential users of Landsat technology had applications that could best be solved with the aid of Geographic Information Systems (GIS). These systems, shown in Figure 5, could integrate and manipulate digital land cover files (derived from Landsat) with files derived from other data sources (e.g., soils and topographic maps, etc). In response to this need and the desire to attract a larger number of potential users to Landsat technology, the Phase II program was upgraded to include training and demonstration in both Landsat and GIS technology. To accomplish this and obtain more reliable terminal operations, the Phase II work included:

1. Modifying the RAS firmware so that the terminal could be used to manipulate GIS software and data bases via telephone line.
2. Establishing a digital data base and image products of Scio Township and Washtenaw County, Michigan, for use in GIS training and demonstrations.
3. Converting the RAS prototype serial interface board into a printed circuit board and relocating the RAS electronics module to improve ventilation and cooling.

2.2.1 SUITABILITY MAPPING AND DATA BASE CONSIDERATIONS

Decisions on what data base to use and how to use it in technology transfer efforts evolved from discussions with NASA and local engineering and academic organizations. Participants in many of these meetings were: Dr. Terry J. Brown, of the Landscape Architecture/Regional Planning Department at the University of Michigan; and Drs. Rockey Ward and Eugene Jaworski of the Geography and Geology Department of Eastern Michigan University. Most of the participants in these meetings agreed that 'suitability mapping' would be the simplest to integrate into the training and demonstration projects and would provide the most dramatic

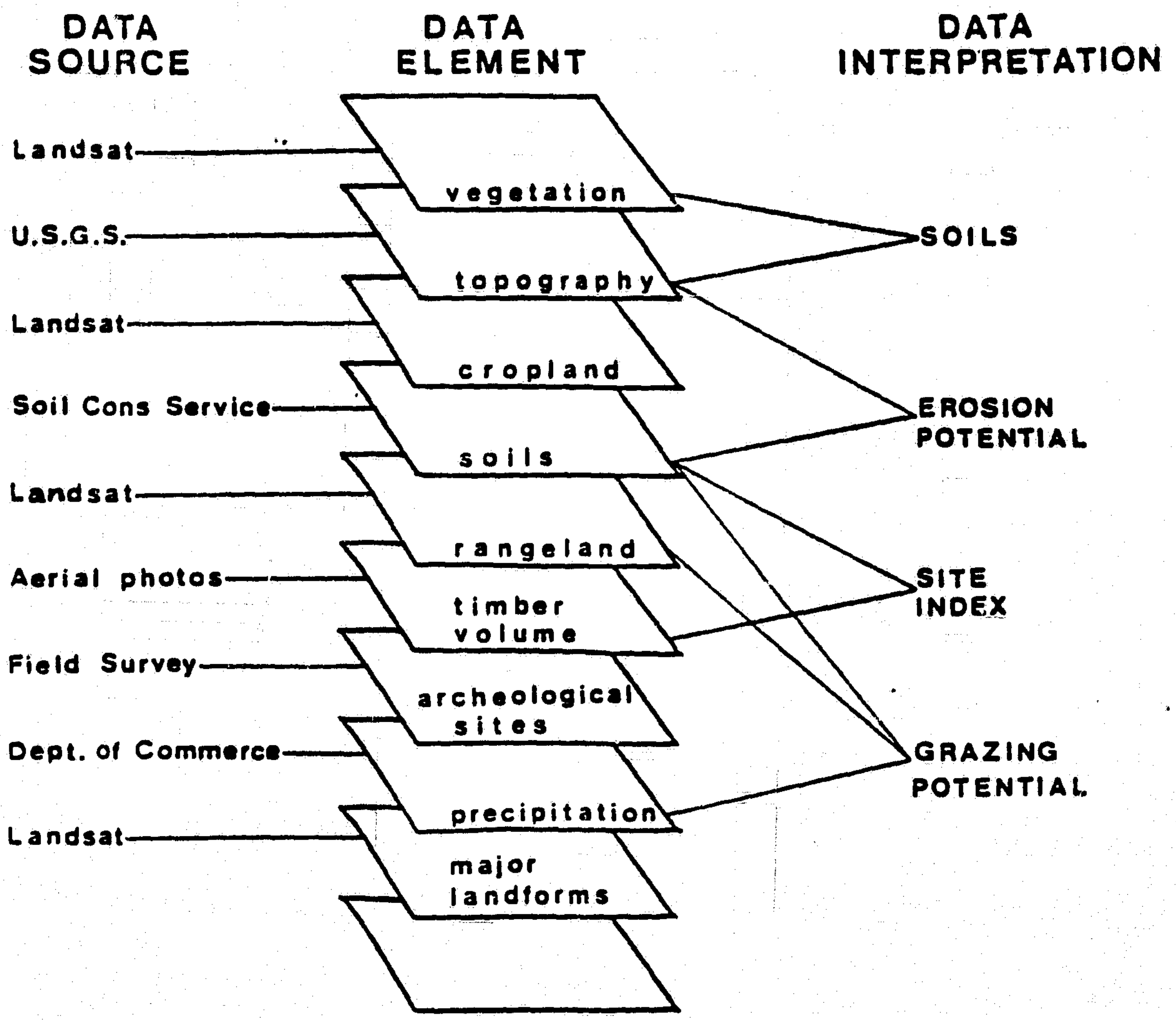

Figure 5 Example of a Geographic Information System

application of a digital data base. Therefore, an early program decision was to provide the trainee with the capability to generate suitability maps and other data products by remote command. After this basic decision was made, the program's activity turned to establishing the data base.

Dr. Terry Brown who has incorporated the use of the Harvard MGRID software into planning and resource management courses at the U of M offered the technology transfer program a digital data base which his students had recently compiled for Scio Township, Michigan. This data base composed of 25 resource parameters coded on a one hectare grid, was gladly accepted and integrated into the program.

To obtain a county size data base for training and demonstrations, the program digitized eight resource parameters for Washtenaw County, Michigan, from maps provided by Dr. Rockey Ward and the Washtenaw County Planning Commission. Many of these maps had been previously used by Dr. Ward and students in his planning courses at EMU to develop land capability and suitability maps using manual analysis techniques. The Washtenaw County data base was of much interest to participants in the technology transfer program since many either lived or worked within this county. The Washtenaw County data was sampled into a one hectare grid to be comparable with the township file.

2.2.2 RAS/GIS OPERATIONS

Firmware in the RAS terminal was modified so that the terminal could be used to access, by telephone line, the GIS Software residing in ERIM's Earth Resources Data Center (ERDC) computer. With this modification it was possible to provide the staff of many public and private organizations the opportunity to participate in demonstration and training with the terminal operating from their own facility or from a nearby college.

The trainees participating in the technology transfer program developed an understanding of and appreciation for GIS technology and its role in the overall land use planning process (see Figure 6) through the generation and analysis of suitability images. Program participants used the RAS terminal to select and view resource parameters (eg., topography, soils, land use) within the Scio Township data base and to input and apply models and coefficients which combined and manipulated two or more parameter files into color coded images showing suitability of land for alternative uses. The number of land use applications that can be analyzed with this relatively large data base is almost unlimited and based on user interest. Some trainees worked on siting new sanitary landfills; others worked on locating the best area for a new industrial park, recreational area, or electrical power generating plant. Most participants selected planning applications of interest to their respective organizations.

Some major features of the RAS GIS operations are reviewed in the following paragraphs and figures.

Menu-Driven: The RAS features interactive control via a simple, user oriented, menu-driven language. After dialing up the host computer and logging in, operation is accomplished on the terminal by simply responding to menu questions displayed on the monitor. For the case illustrated by Figure 7 the user has selected the Scio township data base, recorded on disk drive #0, to generate a color coded image showing suitability for sanitary landfills as denoted by Application Code #11. Divided highways (code 53,3) have been selected to overwrite this image as an orientation aid. (Code numbers are defined in Appendix B). Next the RAS user has the option of displaying a suitability image (which can be done if suitability coefficients have been previously established for the desired application), one of the multiple land resource parameter files, or the color table. The color table (bar) shown at the bottom of

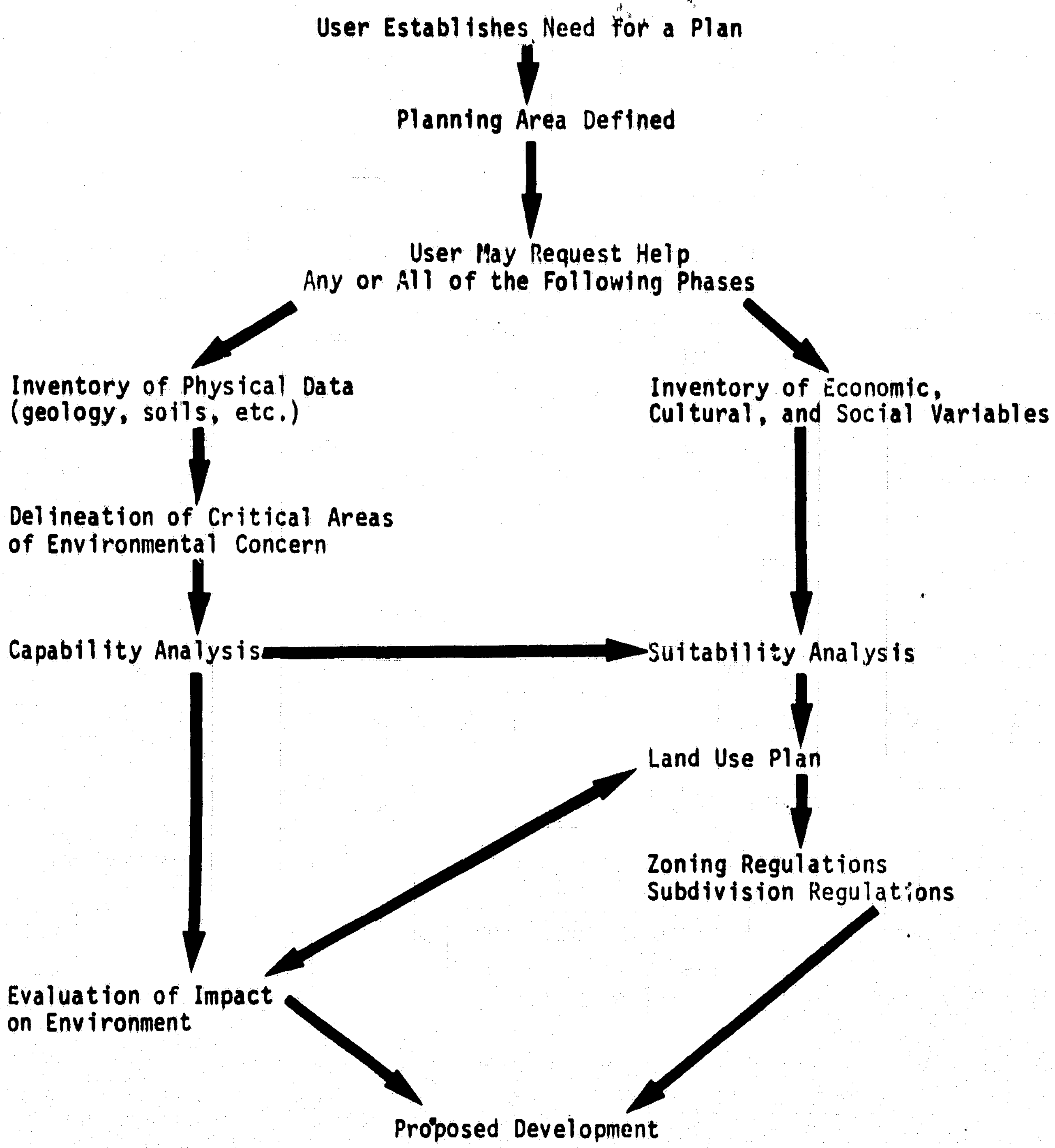

Figure 6 Suitability Analysis In the Land Use Planning Process

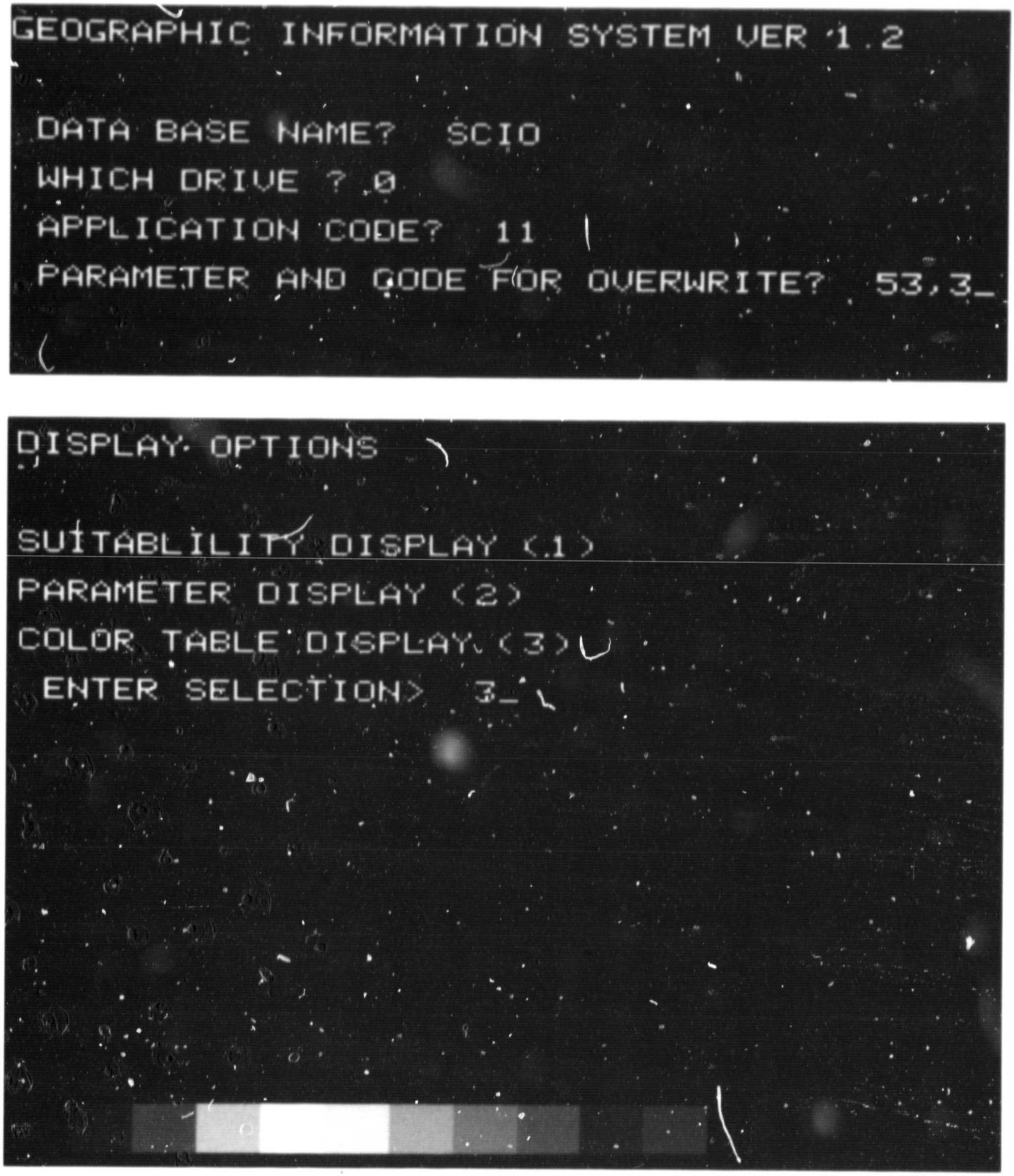

Figure 7. Photograph of Monitor Showing Menu Questions and Color Bar

Figure 7 was selected in this illustration. Parameter files and suitability images are displayed in these 11 color codes.

Interactive Display: The RAS features an interactive display capability which allows the user to view individual data base parameters or the resultant suitability map; to modify suitability transformations on-line; and even to modify the individual parameter codes to correct digitizing errors. The display functions as a window into the data base and thus even large data bases can be very efficiently viewed and manipulated.

The host software permits the RAS user to select and display any one of 30 input parameters. If the Scio Township data base had for example been selected, the user may have wanted to review one or all of the 25 parameter files individually before suitability analysis. This particular data base, used by most trainees in the technology transfer program, is recorded on a one hectare UTM grid, and characterizes soils, topography, geology, vegetation, water, existing land use, and zoning within the township. A complete zoning file with this grid size is shown in Figure 8 with the available 256 x 256 monitor resolution. The color here is used as a code to support interpretation of zoning categories recorded in the zoning file, e.g., red color denotes file category code 9 which represents township areas incorporated into nearby cities, and black denotes a digital code 0 representing areas zoned recreation-conservation. (Appendix B file number 71 lists the other codes).

Input Models and Coefficients: RAS features an interactive capability which allows the user to input matrices relating the coded data base parameters (categories) to suitability numbers (coefficients) for the application of interest (e.g. Sanitary landfill). These matrices with assigned application codes are stored at the host computer as disk files and become inputs to the subsequent manipulations.

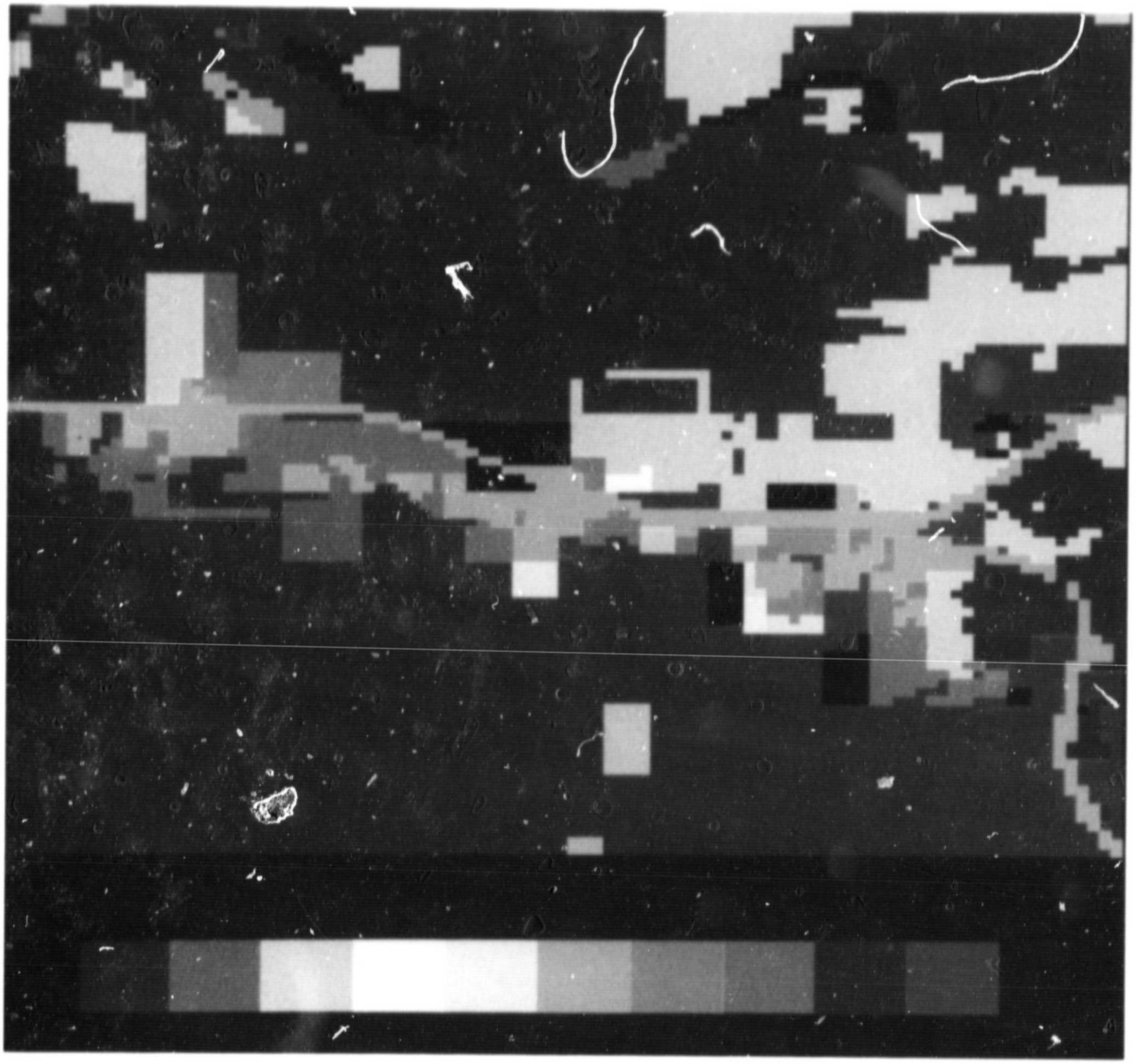

Figure 8. Photograph of Monitor Showing Scio Township Zoning File.

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For each application, the host software provides a 32-coefficient matrix (look-up table) for up to 30 data base parameters. The coefficients position or matrix location is the same as the parameter value or category code, and the number assigned by the user to that matrix location is the suitability of that parameter value or category on a scale from 0 (least suitable) to 10 (most suitable). If the user, for example, is working with the zoning file of Scio township and areas incorporated into the city (category code 9) are to be excluded, i.e. assigned a zero suitability coefficient, the user simply enters a zero coefficient in matrix location nine. Suitability coefficients could thus be assigned to 32 different zoning categories or 32 different soil types etc.

Generate Suitability Image: The GIS operation features file processing software which applies suitability transformations (matrices) to the geo-coded data base and produces a suitability map on the RAS color monitor and coded disk files at the host computer for subsequent output to a hard copy device.

The processed suitability image is displayed almost immediately to the terminal user since the computer manipulations are brief and consist only of replacing the original parameter category codes with suitability coefficients, and computing and scaling the nth root of the product of the coefficients of corresponding cells in the parameter files. The product of this process is scaled from 0 to 10 and displayed to the user on the monitor in 11 color codes, as for example the landfill suitability image in Figure 9.

In this multiplicative process any parameter category associated with a zero suitability coefficient will result in a zero suitability product and be displayed black. In this suitability image the areas most suitable for the landfill are displayed as dark orange (suitability of 8), or red (suitability of 9), or magenta (representing 10).

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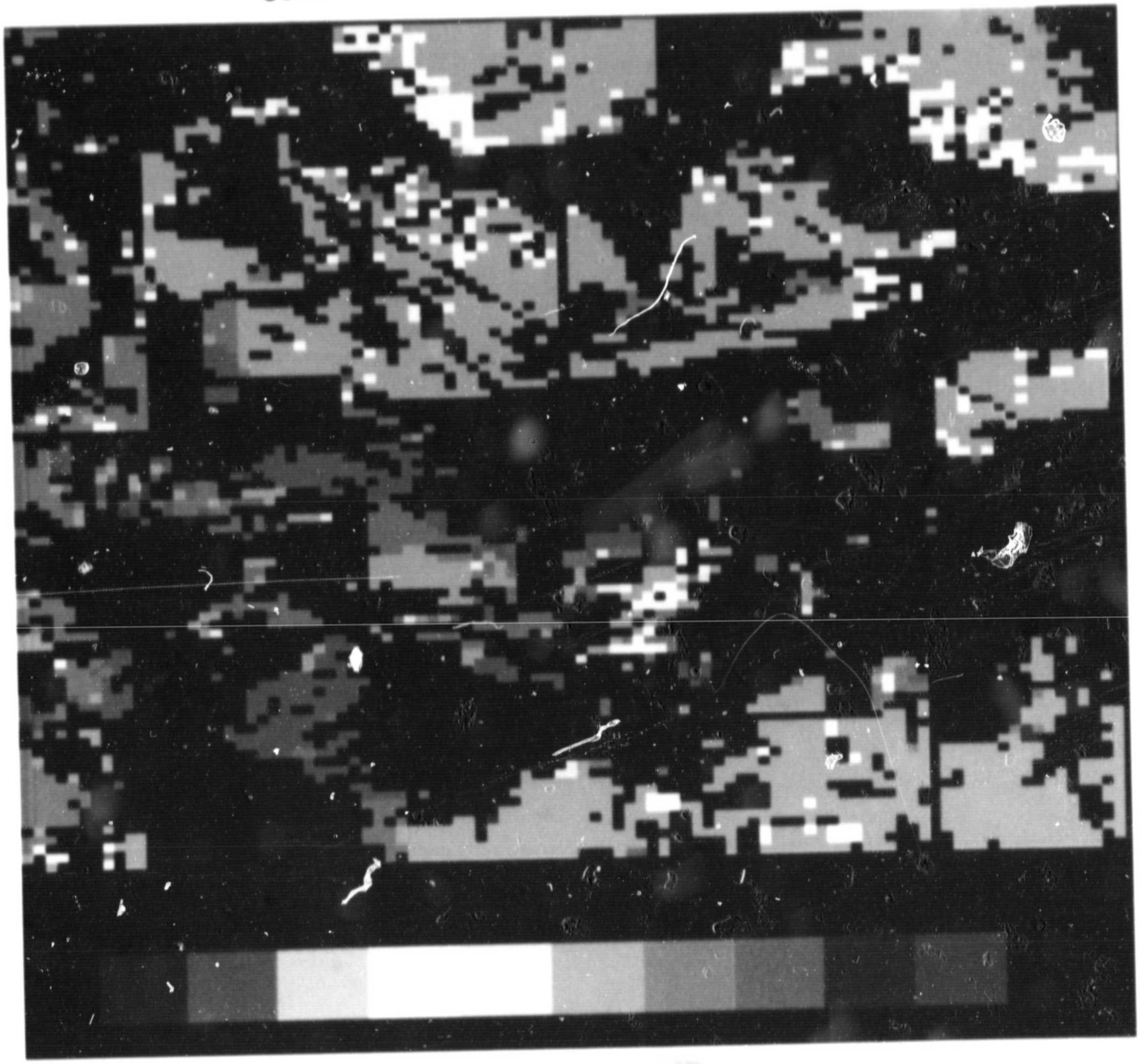

Figure 9. Photograph of Monitor Showing Landfill Suitability.

2.3 UPDATE TRAINING MATERIAL

At the end of Phase I (December 1980) over 100 trainees had worked through the five basic RAS exercises and the User's Manual. Almost all of the trainees had made suggestions for corrections or additions which would improve the training material. In response to these requests and the need for additional material required to incorporate the new GIS capabilities, the Phase II program achieved the following goals:

1. Updated the RAS User's Manual.
2. Reconstructed the five Phase I exercises:
   Ex. 2: Landsat Data: Imagery and Digital Files;
   Ex. 4: Operation of the RAS;
   Ex. 6: Geometric Correction of a Subscene;
   Ex. 7: Training Sets and Their Statistical Analysis;
   Ex. 8: Categorization of an Agricultural Subscene.
3. Developed five new exercises:
   Ex. 1: Geographic Search for Landsat Products;
   Ex. 3: (Optional) Manual Interpretation: Pointe Mouillee State Game Area;
   Ex. 5: Peripheral Interchange Program (PIP) and Other Useful Commands;
   Ex. 9: (Optional) Manual Interpretation of Available Images;
   Ex. 10: Introduction to GIS.
4. Prepared a User's Manual, exercise, and other material needed for training in GIS applications.
5. Acquired additional color slides and other audio-visual material needed to make the training package as self contained as reasonable within the program constraints.

Since Dr. Eugene Jaworski, of EMU, had successfully prepared the original Phase I training program manuscripts, he was also requested to upgrade the Phase II materials. His Phase II contributions included

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updating the Phase I User's Manual and five exercises, developing the GIS User's Manual and three of the five new exercises (i.e., Ex 1, Ex 5, and Ex 10). Draft copies of these new materials were first made available at the teacher training workshop in August 1981 in which Dr. Jaworski participated.

Dr. Elaine Wallace and Ms. Mary Oliver, of Wayne County Community College, developed the Pointe Mouilee exercise (Ex. 3) and the extra credit project (Ex. 9) to provide trainees interested in Coastal Zone applications with additional experience in the manual interpretation and use of Landsat images.

Copies of the upgraded training materials were made available to 150 or more trainees (participants) between mid-August 1981 and 1 April 1982. The first page of these exercises is contained in Appendix B.

2.4 EXPANDING THE SUPPLIER — CONSUMER MARKET

Suppliers of terminals, software, host computer services, etc. were encouraged to meet user needs on an investment basis and users to procure their own terminals and software once a successful demonstration or training activity was completed.

Contacts were made with Tektronix, Science Applications Inc., Applied Dynamics, LogEtronics Inc., Innovative Digital Equipment (IDE), and other potential suppliers in hopes of establishing alternative terminal configurations that offered cost or performance advantages. IDE and Ramtek have provided cost for updated RAS configurations. Trainees were encouraged to purchase their own terminals from one of these sources upon the successful completion of demonstration or training.

As the distance between the terminal and the host increases, long distance telephone rates discourage terminal use. When the terminal can be hardwired to the host computer and operated at 9600 baud, it displays an image eight times faster than it does when operating through the dial telephone line at 1200 baud. Trainees were encouraged to add software to their computers, where possible, to take advantage of faster display rates when the terminals are hardwired to the computer or lower telephone rates if dial-line operations are needed.

The results of the efforts to increase the number of public and private organizations purchasing terminals and associated software for their own use provides one measure of the effectiveness of NASA's technology transfer effort. A RAS terminal and associated software have been acquired by the Institute for Applied Geosciences, Frankfurt, West Germany, and Texas Christian University (TCU), Ft. Worth, Texas. A terminal has been purchased by the New York office of the Envirosphere Company who is using the ERIM computer for host services while it develops the market for its new products and services. Other organizations likely to acquire terminals within the year include Envirosphere's Atlanta, Georgia; Bellvue, Washington; and Newport Beach, California office; DMA's IAGS Cartographic School, Fort Clayton, Panama; Wayne County Community College, Detroit, Michigan; and the Detroit Edison Company, Detroit, Michigan. The cartographic school's terminal in Panama would extend training and demonstrations to potential users throughout Latin America. The Detroit Edison Company has established the software on its PDP-11/70 computer for evaluation and use in training other Edison employees.

The organizations cited in this section have demonstrated that recent developments in computer technology now make it possible for the private sector to provide high-quality Landsat products and services, using a desk-top computer terminal, at a low initial investment of about $20K. In addition, this approach permits the users to gradually expand the initial low-cost facility as their confidence in the technology and their available market (capital) increases.

2.5 CONTINUING TECHNOLOGY TRANSFER ON A PAY-AS-YOU-GO BASIS

ERIM and Michigan's universities and colleges have established a technology transfer steering committee and program to continue training and demonstrations in Landsat technology on a self-sustaining, pay-as-you-go-basis. The sequence of steps leading to the formulation of this collaborative effort are summarized below in hopes that this example may help others interested in developing similar cooperative efforts.

2.5.1 STEP 1: NASA TECHNOLOGY TRANSFER PROGRAMS, DECEMBER 1979 - MARCH 1982

NASA's programs established the training materials and staff needed to demonstrate how public and private organizations which are readily available to the local user community can join in cooperative efforts to deliver training and demonstration in Landsat and GIS technology.

2.5.2 STEP 2: RAS TERMINAL LOAN POLICY ESTABLISHED - 9 DECEMBER 1981

Near the end of Phase II (December 1981), ERIM established a policy for loaning the RAS terminals to organizations who would continue technology transfer efforts. This policy stated that ERIM would loan a terminal under the following guidelines:

1. The participating organizations would pay for all telephone, maintenance (e.g., service calls), insurance, and transportation charges. In addition, they would pay the cost of computer usage, etc.
2. One organization should be point of contact with ERIM and have responsibility for maintaining and scheduling the equipment and continuing the development of a user network.
3. It is not essential that the host for the terminal be a college or university, but it is necessary that one or more persons at the host facility be certified by ERIM in terminal operation.

4. ERIM should continue to review planned use of terminals to insure their maximum use by all public and private organizations.

5. The Terminal users should provide verbal or written reports to justify terminal use and continued technology transfer efforts.

2.5.3 STEP 3. TECHNOLOGY TRANSFER STEERING COMMITTEE IS ESTABLISHED - DECEMBER 1981 - MARCH 1982

Michigan universities and colleges established a coordinated effort to transfer Landsat (remote sensing) and other technologies (e.g., robotics, computer graphics, fluid power, petroleum) on a self-sustaining basis.

During July 1981, Dr. Elaine Wallace, of Wayne County Community College, initiated efforts to formulate an organization which would develop and coordinate technology transfer efforts by Michigan's community colleges and universities. As a result of this effort, a steering committee composed of representatives from Eastern Michigan University, ERIM, Jackson Community College, Macomb Community College, Oakland Community College, Schoolcraft Community College, University of Michigan, Wayne County Community College, and Washtenaw County Community College was formed to develop plans and programs for collaborative technology transfer efforts.

In the fall and winter of 1981 the steering committee formulated their position statement which was distributed at the 28 January 1982 meeting of the committee. The document (Appendix C) states that Michigan's universities and community colleges agree to work together under the guidance of a steering committee that coordinates the development and dissemination of technology transfer programs.

This type of collaboration is intended to decrease the duplication of programs and equipments and to coordinate (foster) the sharing of instructors and equipment resources. It is hoped that this cooperative effort will also result in increased student enrollment at institutions of higher education and contribute to Michigan's economic development through training and retraining programs designed to meet the needs of industry and business.

2.5.4 STEP 4. TRANSFER STEERING COMMITTEE AND ERIM ESTABLISH AGREEMENT FOR SUSTAINING TECHNOLOGY TRANSFER, FEBURARY - MARCH 1982

ERIM and Steering Committee agree on cost and conditions for use of terminal by universities and colleges involved in continuing technology transfer activities. The chairperson of the technology transfer steering committee, Dr. Elaine Wallace, made a formal request on 23 February 1982 to ERIM for use of the RAS terminal and host computer service to continue technology transfer efforts by the following institutions:

1. September-October 1982 — Eastern Michigan University
2. November-December 1982 — Wayne State University
3. January-February 1983 — Central Michigan University
4. March-April 1983 — Western Michigan University
5. June-July 1983 — Wayne County Community College

The institutions/committee agreed to pay for telephone lines, transportation for terminal, terminal maintenance, and computer usage. (Appendix C). ERIM agreed to these terms and conditions, 3 March 1982, and has made plans to support these institutions and others when requested by the steering committee as part of its continuing effort to transfer Landsat and GIS technology to local organizations.

3 CONCLUSIONS

3.1 NETWORK AND PARTICIPANTS

To reach as many practicing professionals as possible within Michigan, the Phase II participants were organized into five cooperative efforts for the purpose of delivering the training and demonstrations. The participants included: NASA, the sponsor; ERIM, who trained the teachers and supplied RAS and other training materials; and, the colleges, who organized and sponsored seminars to attract practicing professionals to a program of training in Landsat and GIS technology and provided local facilities for the terminals where trainees obtained hands-on training. The academic institutions included Central Michigan University, Eastern Michigan University, Lansing Community College, Wayne County Community College and Western Michigan University. An objective was to select institutions that would be convenient to the largest number of trainees and who would most likely continue technology transfer efforts at their own expense at the completion of this program.

Approximately 150 people were provided hands-on training on the RAS terminals, 360 attended one-half to three day workshops, and 2,000 or more attended exhibits and demonstrations. Of those trained, approximately 54% were from academic institutions, 32% from private consulting and engineering companies and 14% from government organizations.

Since the colleges sponsored the training programs through the usual registration-fee method (which pays the instructor), the training and demonstration activities were almost self-supporting. NASA's support included the use of the terminals with host computer support and copies of the training material. A program goal of having approximately 100 local participants trained in Landsat technology by 6 March 1982 was exceeded by 50 trainees. This concept for training and education utilizes existing organizations; one of its greatest strengths is that the various people and organizations occupy roles for which the required positioning and motivation have already been established.

3.2 TRAINING MATERIALS

The five exercises and RAS User's Manual used during Phase I were updated, the GIS software was made available, and four new exercises and a GIS User's Manual were developed and used to train the teachers and other participants.

The number of public and private organizations purchasing these materials for their own use provides another measure of gaugeing the effectiveness of NASA's technology transfer effort. A RAS terminal has been acquired by: The Institute for Applied Geosciences, Frankfort, West Germany, Texas Christian University (TCU) in Ft. Worth, Texas, and the New York office of the Envirosphere Company. Table 3, contains addresses for these and other RAS users who have participated in the technology transfer programs. Other organizations likely to acquire terminals within the year include: Envirosphere Company office's in Atlanta, Georgia; Bellvue, Washington; Newport Beach, California; the DMA IAGS Cartographic School at Fort, Clayton, Panama; Wayne County Community College, Detroit, Michigan; and the Detroit Edison Company, Detroit, Michigan.

The investigation has demonstrated that recent developments in computer technology now make it possible for the private sector to provide high-quality Landsat products and services, using a desk-top computer terminal, at low initial investment of about $20K. It also shows that small colleges as well as private and public organizations, which are readily available to the local user community, can join in cooperative efforts to deliver the needed training in the use of the terminals and the application of Landsat and GIS technology. In addition, this approach permits the users to gradually expand the initial low-cost facility as their confidence and available market increases.

TABLE 3
REPRESENTATIVE RAS TERMINAL USERS

CENTRAL MICHIGAN UNIVERSITY
Geography Department
Mt. Pleasant, MI 48859

Contacts: Dr. Roy R. Klopcic
Dr. John Grossa
(517) 774-3220

DETROIT EDISON COMPANY
2000 2nd Ave.
Detroit, MI 48226

Contacts: Mr. Bill Cumming
Mr. Reginald Beasley
(313) 649-7349 and 649-7358

EASTERN MICHIGAN UNIVERSITY
Geography-Geology Department
Ypsilanti, MI 48197

Contact: Dr. Eugene Jaworski
(313) 487-1480

ENVIROSPHERE COMPANY
Two World Trade Center
90th Floor
New York, NY 10048

Contacts: Mr. Steven M. Queriolo
Mr. Kevin Twine
(212) 839-1106 and 839-1067

LANSING COMMUNITY COLLEGE
Social Sciences Department
Arts and Sciences Bldg.
419 N. Capital Ave.
Lansing, MI 48901

Contacts: Prof. Russell Dodson
Prof. Morris Thomas
(517) 355-4649 and (517) 373-7295

Table 3 (cont'd.)

TEXAS CHRISTIAN UNIVERSITY
Geology Department
Ft. Forth, TX 76129

Contact: Dr. Ken M. Morgan
(817) 921-7270

UNIVERSITY OF MICHIGAN
Landscape Architecture/
Regional Planning
School of Natural Resources
Ann Arbor, MI 48109

Contact: Dr. Terry J. Brown
(313) 764-9315

WAYNE COUNTY COMMUNITY COLLEGE
Coastal Environmental Studies Program
18300 E. Warren
Detroit, MI 48224

Contact: Dr. Elaine Wallace
(313) 882-2997

WESTERN MICHIGAN UNIVERSITY
Geography Department
Woods Hall
Kalamazoo, MI 49008

Contact: Dr. Rainer R. Erhart
(616) 383-1833 and 383-1834

INSTITUTE FOR APPLIED GEOSCIENCES
Klaus Voelger & Partners
Mariannenstrabe 2
D-600 Frankfurt/M.70
West Germany

Contact: Dr. Klaus Voelger
613634

3.3 RECOMMENDATIONS

It is believed that this model extension network has been successfully demonstrated and will continue to expand in Michigan. Additional work is required to establish similar cooperative programs in other states.

3.3.1 UNIVERSITIES AND RESEARCH INSTITUTES

Although there is a considerable number of universities and research institutes (about 100) involved in the use of Landsat data, this is still a small number and the quality of instruction and data application in most institutions is low. In few cases are the equipment and techniques adequate to demonstrate the full potential of Landsat data so that such demonstrations do not support the full range of feasible applications. A program should be considered that would both upgrade the quality of instruction as well as increase the number of universities and colleges involved in the education and the use of the operational era system. Such a program could have the following elements: (1) improved instructional materials, (2) expanded roles in cooperative technology transfer networks, and (3) better student and faculty awareness of existing instructional facilities and options.

It is suggested that NASA encourage organizations in other states to develop cooperative technology transfer programs similar to Michigan's program. This could be accomplished more economically now since the specifications for the terminals and training materials have been developed and successfully used. Three to five institutions could easily share one RAS terminal and a central host computer service. The instructors for the new cooperative efforts could be trained by any one of the five Michigan Colleges who are continuing training and demonstrations in Landsat and GIS technology.

3.3.2 COMMUNITY COLLEGES

There are 1,240 community colleges and technical institutions in the United States, located in 426 of the 435 congressional districts (1977 data); each of these institutions has close connections with various public and private local organizations that could benefit from the use of remote sensing and GIS technology or more directly, from the information it provides. The close relationship between the community colleges and the local communities makes the college ideal for transferring remote sensing and GIS technologies.

Community colleges, then, have the commitment, expertise, and geographic distribution that is essential for effective transfer of remote sensing and other technologies. A national technology extension network, patterned loosely after the USDA Cooperative Extension Service, can be envisioned. Such a network could stimulate the market and mobilize local private sector's initiatives to offer remote sensing products and services. A technology extension network, with support to community colleges paralleling present-day vocational education funding, might be a legislative goal.

3.3.3 COMPUTER TIME-SHARE COMPANIES

Many of the large computer time-sharing firms are now supporting many clients, e.g., consulting engineering companies who are also potential users of Landsat and GIS technology. A well designed transfer of the RAS software to one or more of these hosts could have an immediate impact on the use of Landsat and GIS technology. The development of one or two national or international host computer services would be an important goal for NASA to continue to work towards.

Appendix A
Representative Materials

This Appendix contains examples of announcements and questionnaires used by the colleges to further Landsat technology transfer program efforts. Similar training, workshop and course announcements were used by all Phase I and Phase II participants.

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OF POOR QUALITY

ANNOUNCEMENT OF TRAINING OPPORTUNITIES IN LANDSAT (SATELLITE) TECHNOLOGY

Recent surveys have shown that a large number of potential users in the private sector (such as consulting engineering firms) and at local agencies are interested in becoming consumers or suppliers of Landsat-derived products and services. However, they have been prevented from entering this market by the high cost of analysis facilities, the difficulty of obtaining training in the new technology, and concerns for the continuity of satellite data. The presidential decision, announced in November 1979, to establish operational land remote sensing satellites and recent developments in computer technology which make it possible to generate high quality Landsat products from low-cost (under $20K) desk-top computer terminals, signal the need to take a "new look" at this technology.

To evaluate methods for bridging the gap between local organizations and the technology, NASA is investigating methods of making Landsat technology readily available to a broader set of potential users through local community colleges and universities. As part of this investigation, training in Landsat technology is being planned for June through November in Southeast and Southwest Michigan, the Lansing State Capitol area, and Central Michigan. The methodology employed by the program gives local users an opportunity to obtain "hands-on" training in Landsat data analysis techniques, using a desk-top, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone line, and provides for generation of land cover maps and data products via remote command. The terminals will also make is possible for a few attendees to undertake training on a specific application of their choice. Enclosed is a brief description of the proposed training.

If you have interest in a training opportunity in your community "cast your ballot" by returning the enclosed questionnaire. For additional information on this program, contact me at (313) 994-1200 ext. 319, anytime.

Sincerely,

Robert H Rogers

Robert H. Rogers
Principle Investigator
Technology Transfer Project

REMOTE SENSING TRAINING: Landsat Technology

Course Description

The objective of the course is to train practicing professionals in the cocmputer assisted interpretation of Landsat (satellite) data, generation of digital data bases from Landsat, aerial photography and map sources; and to use these data bases for monitoring and management of the environment, natural resources, and land use.

The course will consist of classroom training; instruction in the use of computuer terminals for processing Landsat data and interacting with other digital data bases; and "hands-on" experience using a color, interactive remote analysis station (RAS) connected by telephone line to a host computer facility.

Sessions will include information on the basic concepts of remote sensing, Landsat characteristics, computer assisted interpretation of Landsat data, and construction of digital files from Landsat, aerial photography, and map sources (e.g., topography, soils, etc.). Selection of data sources considering factors such as cost and detail, development of program plans and specifications for obtaining and processing data will be examined for a number of applications. These applications will be tailored to attendees interest and needs (see Table A-1). Approximately 16 hours of lecture and 20 hours of work book exercises are anticipated. After this basic RAS training, specialized training in applications of Landsat technology can be obtained. These will include approximately 6 hours lecture and 16 hours of exercises per application.

INTENDED AUDIENCE/PREREQUISITES

Practicing professionals will be recruited from the private sector, (e.g., consultant engineering organizations, educational institutions), local governmental organizations (e.g., state, regional and local planning agencies) and computer service companies and hardware manufacturer.

TABLE A-1* SUMMARY OF APPLICATIONS OF LANDSAT DATA IN THE VARIOUS EARTH RESOURCES DISCIPLINES

Agriculture, forestry, and range resources	Land use and mapping	Geology	Water resources	Oceanography and marine resources	Environment
(1) Discrimination of vegetative types: Crop types Timber types Range vegetation	(1) Classification of land uses	(1) Recognition of rock types	(1) Determination of water boundaries and surface water area and volume	(1) Detection of living marine organisms	(1) Monitoring surface mining and reclamation
(2) Measurement of crop acreage by species	(2) Cartographic mapping and map updating	(2) Mapping of major geologic units	(2) Mapping of floods and flood plains	(2) Determination of turbidity patterns and circulation	(2) Mapping and monitoring of water pollution
(3) Measurement of timber acreage and volume by species	(3) Categorization of land capability	(3) Revising geologic maps	(3) Determination of areal extent of snow and snow boundaries	(3) Mapping shoreline changes	(3) Detection of air pollution and its effects
(4) Determination of range readiness and biomass	(4) Separation of urban and rural categories	(4) Delineation of unconsolidated rock and soils	(4) Measurement of glacial features	(4) Mapping of shoals and shallow areas	(4) Determination of effects of natural disasters
(5) Determination of vegetation vigor	(5) Regional planning	(5) Mapping igneous intrusions	(5) Measurement of sediment and turbidity patterns	(5) Mapping of ice for shipping	(5) Monitoring environmental effects of man's activities (lake eutrophication, defoliation, etc.)
(6) Determination of vegetation stress	(6) Mapping of transportation networks	(6) Mapping recent volcanic surface deposits	(6) Determination of water depth	(6) Study of eddies and waves	
(7) Determination of soil conditions	(7) Mapping of land-water boundaries	(7) Mapping landforms	(7) Delineation of irrigated fields		
(8) Determination of soil associations	(8) Mapping of wetlands	(8) Search for surface guides to mineralization	(8) Inventory of lakes		
(9) Assessment of grass and forest fire damage		(9) Determination of regional structures			
		(10) Mapping linears (fractures)			

*Short, N.S., Lowman, P.D., Freden, S.D., and Finch, W.A., Mission to Earth: Landsat Views the World, Report NASA SP-360, NASA, Washington, DC, 1976.

Their background will be varied but will include; geographers, physical scientists, photo interpreters, programmers, educators, and managers who desire a comprehensive understanding at a basic level of the pertinent concepts, ppotentials, problems, and trade-offs associated with the practical and operational aspects of collecting, interpreting, and merging Landsat data with other data sources and applications for these data. No formal prerequisites are required.

LOCATION OF TRAINING

Training will be delivered at Community Colleges, Universities, High Schools and at other institutions, and facilities convenient to the majority of attendees. Some training and demonstrations may be provided to the participant in his own facility.

TEXT

The training package will be completely self contained and not require additional text.

QUESTIONNAIRE

LANDSAT TECHNOLOGY TRANSFER PROJECT

Name ______________________________

Organization ______________________________

Business Name and Address ______________________________

______________________________ Zip Code: ______________

Business Phone ______________________________

Present occupation position (Brief description of duties) ______________

____

Do you have any previous experience in remote sensing? ______________

____

What community college or other location would be most convenient to you?

____

Do You have a preference in time? (Month April-November and day/night)

____

Would you like to receive college credit for participation? ______________

If yes, from what institution? ______________________________

What applications of Landsat data would you like to investigate? (See Table 1)

____

What uses of this technology are most applicable to your organization, clients, or region? ______________________________

____

____

What topics would you like emphasized? ______________________________

____

Can you suggest appropriate media (Publications, newsletters, professional societies, etc.) from which to announce this technology transfer activity?

____

____

____

Name and address of another person who may be interested in this technology transfer program. ______________________

____

Comments ______________________________________

____

____

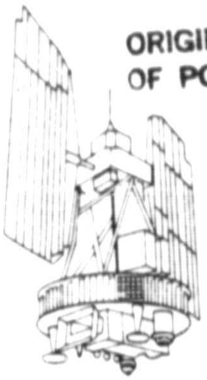
____

____

____

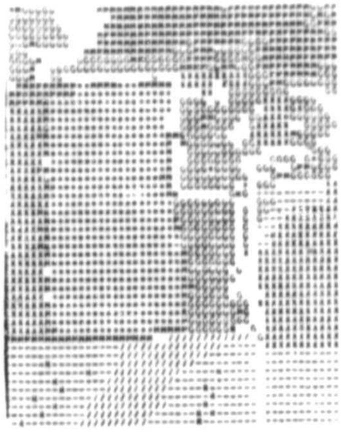
Please Return Questionnaire To:

Robert H. Rogers
The Environmental Research Institute of Michigan
P.O. Box 8618
Ann Arbor, Michigan 48107
Phone (313) 994-1200, ext. 319



ANNOUNCING

REMOTE SENSING:
TECHOLOGY TRANSFER WORKSHOP
AND SEMINAR SERIES



LOCATION

Department of Geography, Wood Hall, Western Michigan University

A campus map and parking permit will be enclosed in your letter of confirmation.

DATE

Workshop, November 19, 1981, 1:00 to 5:00 p.m.

Seminar Series, November 23,24,30, 1981, 7:00 to 9:30 p.m.
December 1,2,3, 1981, Afternoons and Evenings

FEES

Workshop is Free-of-Charge

Seminar Series (includes all laboratory materials and computer time) is $85.00

WHO SHOULD ATTEND

The workshop and seminar series is open to all who are interested in the application of remote sensing technology. The background of participants may include geography, geology, physical sciences, computer programming and education management or planning. The workshop is limited to 40 participants and the seminar series is limited to 16 participants.

REGISTRATION

To register, detach the registration form (on the reverse side) and mail to : Division of Continuing Education, Western Michigan University, Kalamazoo, Michigan 49008 by November 16, 1981. To register for the Seminar Series, include a check or money order (payable to Western Michigan University) with your registration form.. Registration for the Workshop and Seminar Series will be on a first-come, first-served basis. Participants in the Seminar Series will earn 16 Continuing Education Units (CEUs). For further information, contact the Division of Continuing Education at (616) 383-0795.

FOR ADDITIONAL CONTENT INFORMATION

Contact Dr. Rainer Erhart, Department of Geography, Western Michigan University, Kalamazoo, Michigan 49008, Phone (616) 383-1833

-Details Are Listed On The Back-

THE WORKSHOP

The objective of the workshop is to provide information on the application of remotely sensed data and the interpretation and processing of such data by manual as well as automated techniques. The one-day workshop is made possible by a grant from NASA.

The workshop promises to benefit anyone interested in accurate geographic information systems, particularly professionals from consulting and engineering firms, governmental agencies and educational institutions. No formal training in remote sensing is required.

Presentations will be by individuals from the, Environmental Research Institute of Michigan, (ERIM), private consulting firms and universities. A brief hands-on computer session will be conducted at the end of the workshop.

The workshop will be held on November 19, 1981, from 1:00 to 5:00 p.m. in the Department of Geography, Wood Hall, Western Michigan University, Kalamazoo, Michigan 49008

THE SEMINAR SERIES

The Seminar series is designed to elaborate on the concepts introduced in the workshop. The sessions will give each individual the opportunity to complete a series of exercises and to operate the Remote Analysis Station (RAS). The RAS is a desk-top, interactive computer terminal used to generate land cover maps and other products from a variety of data bases stored in the Geographic information System.

- SCHEDULE OF EVENTS -

ORIGINAL PAGE IS OF POOR QUALITY

November 23 7:00-9:30 p.m.	- Lecture - Manual Interpretation Techniques
November 24 7:00-9:30 p.m.	- Lecture - Automated Interpretation Techniques
November 30 7:00-9:30 p.m.	- Lecture and Laboratory - Landsat Imagery and the RAS System
December 1-3	- Laboratory Sessions - Automated Interpretation of Landsat Imagery

(The Lab will be open for participants between 1:00 and 9:00 p.m. on each of these days. You arrange your own schedule.)

REGISTRATION FORM
Remote Sensing
Workshop and Seminar Series

Office Use Only		
M.O.	Check	Cash
Amount Received		Date
Issed by		R.N.

Please Print

Name ______________________ S.S. ______________________

Home Phone ______________________ Business Phone ______________________

Home Address ____
Street City State Zip

Business Address ____
Street City State Zip

Please check: ☐ Workshop, Free-of-charge, November 19, 1981

☐ Seminar Series, $85.00 per person, November 23,24,30, December 1,2,3,1981

Enclosed is $___ for ___ registration (s) for the Seminar Series. Mail for delivery by November 16, 1981 to: Division of Continuing Education, Western Michigan University, Kalamazoo, Michigan 49008. Refunds for the Seminar Series will be honored if notified in writing by November 18, 1981.

ANNOUNCEMENT
Special Course
Eastern Michigan University

NASA

COOPERATIVE TECHNOLOGICAL TRANSFER

- Daedalus Enterprises
- Environmental Research Institute of Michigan
- Michigan Community College Association
- Washtenaw Community College
- National Aeronautics and Space Administration
- Southeastern Michigan Technical Assistance Program

GEO478 "SPECIAL TOPICS: REMOTE AREA SENSING"

Description

This special topics course has been designed as a training-demonstration and educational tool for potential users of LANDSAT (Satellite Imagery) technology. The course gives participants an opportunity to obtain training in the computer assisted interpretation of Landsat data, generation of digital data bases for planning and management of the environment, natural resources, and land use.

Participants will work through five exercises which will involve 18 to 22 hours of training using a color, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone lines, and provides for generation of land cover maps and data products via remote command.

It is anticipated that some trainees may be selected to use the RAS terminal to undertake further work on a demonstration project of their choice.

Intended Audience/Prerequisites

The course is designed for practicing professionals and students who desire a comprehensive understanding at a basic level of the pertinent concepts, potentials, problems, and trade-offs associated with the practical and operational aspects of collecting, interpreting, and merging Landsat data with other data sources and applications for these data. No formal prerequisites are required. The course is open to undergraduate, graduate, and non-credit trainees. Additional work will be expected from the graduate students that enroll for this seminar.

Training Sites

A RAS terminal will be available at Daedalus Enterprises in Ann Arbor and at Eastern Michigan University (Room 222, Strong Hall) in Ypsilanti, Michigan. Dr. Eugene Jaworski of Eastern Michigan University will assign trainees to the site of their choice where possible.

Instructors

Principal Instructor: Dr. Eugene Jaworski, Assistant Professor, Eastern Michigan University, Geography & Geology Department, (313) 487-1480.

Associate Instructor: Steve Goodman, Daedalus Enterprises, (313) 769-5649.

Associate Instructors: Larry Reed, Bill Tyler, and Roger Reinhold, Environmental Research Institute of Michigan, (313) 994-1200.

Training Materials

This course uses the RAS terminal, workbooks, and other material developed by the National Aeronautics and Space Administration, which is evaluating methods of making Landsat satellite technology more readily available to the private and public sectors through local community colleges and universities. The course does not require additional texts or other materials.

Credit

Two hours of undergraduate or graduate credit may be earned by completing this seminar. Enrollment on a non-credit basis is permitted. If you desire further information on non-credit, please contact Paul Borawski at (313) 487-0314.

Cost

Undergraduate		Graduate		Non-Credit
Tuition	$60.	Tuition	$84.	$60.
Registration Fee	$20.	Registration Fee	$20.	
Total	$80.	Total	$104.	

Seminar Schedule

The following schedule will be adhered to. The course will run for two weeks commencing on September 22, 1980 and concluding on October 4, 1980. It will run five days a week from 8:00 a.m. until 10:00 p.m. Students will not be expected to attend the entire time; however, they will be expected to attend at least 30 hours of instructional time during this period. The course instructors will schedule students for computer time during the two week course.

Class Size

The course is designed to accommodate up to twelve trainees with priority given to practicing professionals.

Registration

A registration form has been attached; when completed, it should be mailed to the Registration Office, Briggs Hall, Eastern Michigan University, Ypsilanti, Michigan 48197.

Similar Training Programs

Similar training programs will be offered in the October-November time period by Wayne and Charles Stewart Mott Community Colleges. These programs will deploy RAS terminals at sites in Wayne, Oakland, Genessee, and Ingham counties. For further information on these training opportunities contact: Dr. Douglas E. Lane, C.S. Mott Community College, 1401 East Court, Flint, Michigan 48503, (313) 762-0278, or Wayne Community College, Elaine Wallace, Coastal Environmental Studies, 8551 Greenfield, Detroit, Michigan 38228, (313) 584-9381.

Appendix B
Exercises and GIS User's Manual

B.1 RAS Training Exercises

The following pages are examples of only the first page of each of the exercises used in the RAS training program.

EXERCISE 1: GEOGRAPHIC SEARCH FOR LANDSAT PRODUCTS

Purpose

The purpose of this exercise is to introduce the Landsat user to the types of products available and to provide guidance in ordering these products. Specifically, a sample Landsat Standard Products Order Form and a Geographic Computer Search Inquiry Form will be completed. In addition, a sample computer printout of an actual geographic search will be analyzed.

Materials Needed

As listed below, there are 6 lab materials required. Items 1 through 2 should be included in this exercise, whereas Items 3, 4, and 5 should be available separately but within the RAS working area. Item 6 refers to the availability of a copy machine.

1. Landsat Standard Products Order Form (from EROS).
2. Geographic Computer Search Inquiry Form (from EROS).
3. Indices to Landsat Coverage (Worldwide path-row maps), WPS-1 through WPS-7.
4. Taranik, James V. 1978. "Characteristics of the Landsat Multispectral Data System." USGS Open File Report 78-187.
5. Goode's World Atlas, 14th ed., or similar atlas.
6. Access to a copying machine.

EXERCISE 2 - LANDSAT DATA: IMAGERY AND DIGITAL FILES

Purpose

The purpose of this exercise is to introduce the beginner to the basic principles of Landsat remote sensing so that the RAS computer terminal can be operated and utilized with some utility. Emphasis will be placed on the digital nature of the Landsat, data as well as on spectral signatures, manual interpretation of Landsat and some digital processing concepts. These concepts include the scan line format of the data, and use of locator grids and histograms.

Lab Materials

1. USGS Open File Report 78-187 by James V. Taranik, 1978.
2. Four images of the Toledo Scene, ID # 11111-15220, dated August 8, 1975, 8 1/2 x 11 inches, scale 1:1,000,000. Black & white of Bands 1, 2, and 4, and a False Color Composite of Bands 1, 2, and 4.
3. RAS-1 Histogram, by band or overlay.
4. One page handout entitled "The Landsat System"; see Appendix A.
5. One page handout entitled "Identification of Land Cover Categories".
6. Plastic Landsat Locator Grid, for 8 1/2 x 11 inch imagery.
7. Various maps of the Detroit - Toledo region, for general reference.

EXERCISE 3: LANDSAT TECHNOLOGY TRANSFER RAS TRAINING PROGRAM
Coastal Zone Applications Exercise

Purpose

The purpose of this exercise is to demonstrate the decision-making process in selection of data sources for environmental study. The accuracy, benefits, and costs of manual and computer-assisted interpreted Landsat data will be examined and compared to aerial photography interpretation and field data collection. Additional data sources will be discussed as appropriate.

Coastal zones are environments with two interactive components: The coastal waters and the adjacent wetlands. Thus, studies of coastal zones require extensive data collection and interpretation. This can be very time consuming and expensive.

Remote Sensing can provide many advantages in coastal zone studies. It is more economically feasible in terms of collection of data and its interpretation; it is more timely; it provides a favorable viewing perspective; it allows synoptic observation; it creates permanent graphic records of the study area; it provides consistent data collections; and it reduces the required amount of field work.

This method will be employed in a change detection study on the Pointe Mouille State Game Area designed to quantify the results of management practices conducted by the Michigan Department of Natural Resources. The study will include a classification of land uses/cover and vegetation, sediment flow map, and water quality analysis. Three specific time frames will be observed: 1) the natural state protected by a natural sandbar; 2) the transient state after the loss of the natural sandbar by storm; and 3) the reconstructive state after the construction of the artificial barrier.

The approach for inventory of the study area is to apply the National Wetlands Classification System to Landsat imagery and aerial photography. This provides a consistent set of criteria for inventory work and uniformity in concepts and terminology. This also allows future updates or expansion work on the area to be compared with our findings.

It is expected that the study will show the changes in wetland area and environment and achieve some measure of the amount and types of change. It is also hoped that the effects of toxic dredging materials used in the construction of the artificial barrier will be apparent.

Materials Needed

1. Photographs and imagery of the area for all dates.
2. National Wetland Classification.
3. Overlay map of game area for maps and imagery.
4. Field data.
5. Topographic maps of area for all dates.
6. RAS and line printer.

EXERCISE 4 - OPERATION OF THE RAS

Purpose

This exercise is designed to familiarize the Landsat user to the operation of the Remote Analysis Station (RAS) terminal and the main 7-Option RAS menu. Instructions contained in Chapter II through VI of the RAS User's Manual will be covered. In addition to reading some descriptive material on the RAS system, participants will log in, allocate a file, perform a Contrast Stretch, practice manipulating the cursor, and log out. It requires 4 to 5 hours of hands on training to become sufficiently familiar and confident in operating the RAS so that you do not have to look up how to perform the next step.

Materials Needed

1. RAS system, complete with color display terminal, joystick/cursor controller, keyboard, 1200-baud modem (unless hard-wired in), and quality phone receptacle and line.
2. Remote Analysis Station (RAS) User's Manual.
3. RAS-1 Histograms.
4. One page handout, entitled the "Remote Analysis Station (RAS)".
5. User area assignments, i.e., UIC Number and Password.
6. RAS-1 subscene, carved from full Landsat scene, placed by host facility on disk.
7. Disk Drive Number, i.e., DB Number.
8. Standard color list; to be available near the RAS terminal.
9. Maps of the RAS-1 area.

EXERCISE 5 - PIP AND OTHER USEFUL COMMANDS

Purpose

This exercise provides the RAS user with a working knowledge of the common Peripheral Interchange Program (PIP) commands and other useful commands. Knowledge of these commands is particularly important for those individuals who wish to provide RAS instruction. Chapters X, XI, and XII of the RAS User's Manual should be helpful in this regard.

Lab Materials

1. RAS User's Manual
2. Any RAS subscene on disk.

EXERCISE 6 - GEOMETRIC CORRECTION OF A SUBSCENE

Purpose

The goal of this exercise is to introduce the Landsat user to the need for geometric correction and to train the RAS user to perform the Ground Control portion of the correction process. Specifically, the participant will be identifying the necessary topographic maps, locating control points, entering image control points, hand digitizing map control points, entering map control points, and interpreting the Ground Control Error File output. For background on geometric correction, review paper by Charles L. Wilson (1980).

Materials Needed

1. RAS User's Manual.
2. The Toledo Landsat Image with the RASGEO subscene indicated thereon; scale approximately 1:250,000, false color.
3. Plastic Landsat Data Locator Grid.
4. Michigan topographic map index, Feb. 1978; 1:1,000,000 scale.
5. Four topographic maps, 7 1/2 minute, including Ann Arbor East, Ypsilanti West, Denton, and Ypsilanti East.
6. Access to a light table, drafting table, T-square, and grease pencil.
7. Toledo Landsat Image, Band 5, scale 1:1,000,000, black and white.
8. Access to a Decwriter or other hard copy device.
9. RASGEO file on disk.
10. Plastic TOPO-AID (device for reading latitude-longitude), including instructions.
11. Paper by Charles L. Wilson, 1980, "Landsat Derived Maps of Poorly Mapped Areas", ERIM, 24 pp. It explains geometric correction.

EXERCISE 7 - TRAINING SETS AND THEIR STATISTICAL ANALYSIS

Purpose

In this exercise the Landsat user will identify representative training areas for subsequent land cover/land use mapping using the RAS and the host facility's classification software. The training set data will be characterized statistically and the user must learn to interpret this output in order to upgrade the training sets as well as improve the accuracy of the supervised classification. In the next exercise the emphasis will be on producing a categorical output.

As lab preparation, the RAS user is asked to review the USGS Professional Paper 964 by Anderson et al. (1976), as well as Chapters VI, Section D, and Chapter VIII, Sections A-C, of the RAS User's Manual.

Materials Needed

1. USGS Prof. Paper 964, by Anderson et al. (1976).
2. RAS User's Manual.
3. RAS1 Subscene, carved out of Toledo Scene, Aug. 1975, false color composite, scale approx. 1:73,600.
4. Black & White Aerial photography, flown 5-9-75, by SEMCOG, Photo No. 1138, 1140, 1157, and 1159. Scale is 1:24,000.
5. Access to a Decwriter or similar output device.
6. Topographical maps, 7 1/2 minute, including Ann Arbor East, Denton, Ypsilanti West, and Ypsilanti East.
7. RAS1 Subscene on disk.

EXERCISE 8 - CATEGORIZATION OF AN AGRICULTURAL SUBSCENE

Purpose

This exercise continues where the Training Set Exercise left off. A complete subscene will be categorized following identification of the cover types, designation of training sets, analysis of the training sets, and testing of the categorization results. Thus, in the course of categorical processing of the RASAGR subscene using the host facility's software, the user will experience the four phases of activity, i.e., training, analysis, testing, and production processing. After the scene has been categorized, the user will edit it and obtain area tables of selected areas. Hard copy of this categorized file is obtainable by photographing the display screen.

Materials Needed

1. Enlarged false color composite image of RASAGR Subscene.
2. USGS Topographic Map, 7 1/2 Minute, "Blissfield, MI".
3. Aerial photographs; August 8, 1975 Flight; Scale 1:250,000; from SEMCOG. Photo No. 1460, 1461, 1462, and 1463.
4. Stereoscope, pocket type.
5. RASAGR Subscene and Categorized RASAGR File on disk.
6. ERDC Color list.
7. Access to Polaroid or 35mm camera.
8. Hard Copy terminal or Decwriter.
9. Sample $RCA Output based on this exercise.
10. RASAGR Histogram for Contrast Stretch.
11. Contact print of Categorical RASAGR Subscene.

EXERCISE 9: EXTRA CREDIT

Purpose

This exercise is an extra credit exercise, students may work on the identification of any geologic formation, land cover, or natural resources found on the furnished images.

EXERCISE 10: INTRODUCTION TO THE GEOGRAPHIC INFORMATION SYSTEM (GIS)

Purpose

This exercise is designed to introduce the user to the GIS software as well as to the WASH and SCIO data bases. WASH refers to the Washtenaw County data base whereas SCIO refers to the Scio Township (of Washtenaw County) data base. Both data bases employ a cell-based structure which represents a ground area of 2.5 acres or approximately 1 hectare. The current GIS software can accomodate up to 24 parameters, and uses an overlay procedure to produce suitability maps.

Laboratory Materials:

1. GIS User's Manual
2. WASH and SCIO Data Bases on disk.
3. Handout materials entitled: Washtenaw County Data Base Codes, and SCIO Township Data Base Codes.
4. Report by Wm. J. Campbell, 1981, Geographical Information Systems, A Training Module. NASA.
5. Map of Washtenaw County, by Board of County Road Commissions.
6. Topographical Map, Ann Arbor West, Scale 1:24,000, 1975 PR.

B.2 DATA BASES

The remainder of this Appendix describes the Washtenaw County and Scio Township data bases used to demonstrate the GIS operation.

WASHTENAW DATA BASE

Location: Washtenaw County, Michigan
Source: Washtenaw County Metropolitan Planning Commission
Grid size: 512 cells x 429 cells, representing an area = 2145 sq. km. = 720 sq. mi.
Cell size: 1 hectare = 2.5 acres
Parameters: total of 8, each with codes between 0 and 20

4: Topography, Slope
8: Political Subdivisions, Townships
9: Watersheds
50: Sewer Service Areas
51: Surface Water
52: County Policy
*53: Transportation
54: Soil Types

Note: * Indicates parameter generally used for overwrite.

WASHTENAW DATA BASE (Cont'd.)

4: Topography, Slope
1. 0 - 3%
3. 3 - 6%
5. 6 - 10%
7. 10 - 15%
9. 15% +

8: Political Subdivisions, Townships
1. Lyndon
2. Dexter
3. Webster
4. Northfield
5. Salem
6. Sylvan
7. Lima
8. Scio
9. Ann Arbor
10. Superior
11. Sharon
12. Freedom
13. Lodi
14. Pittsfield
15. Ypsilanti
16. Manchester
17. Bridgewater
18. Saline
19. York
20. Augusta

9: Watersheds
1. Allen Creek
2. Pittsfield Valley
3. Saline River
4. Macon Drain
5. Mill Creek
6. Raisin River
7. Honey Creek
8. Bouden Creek
9. Huron River
10. Arms Creek
11. Traver Creek
12. Fleming Creek
13. River Rouge
14. Swift River
15. Stoney Creek
16. O'Connor Drain
17. Walker Drain

50: Sewer Service Areas
7. Existing 1980
8. Proposed 2000

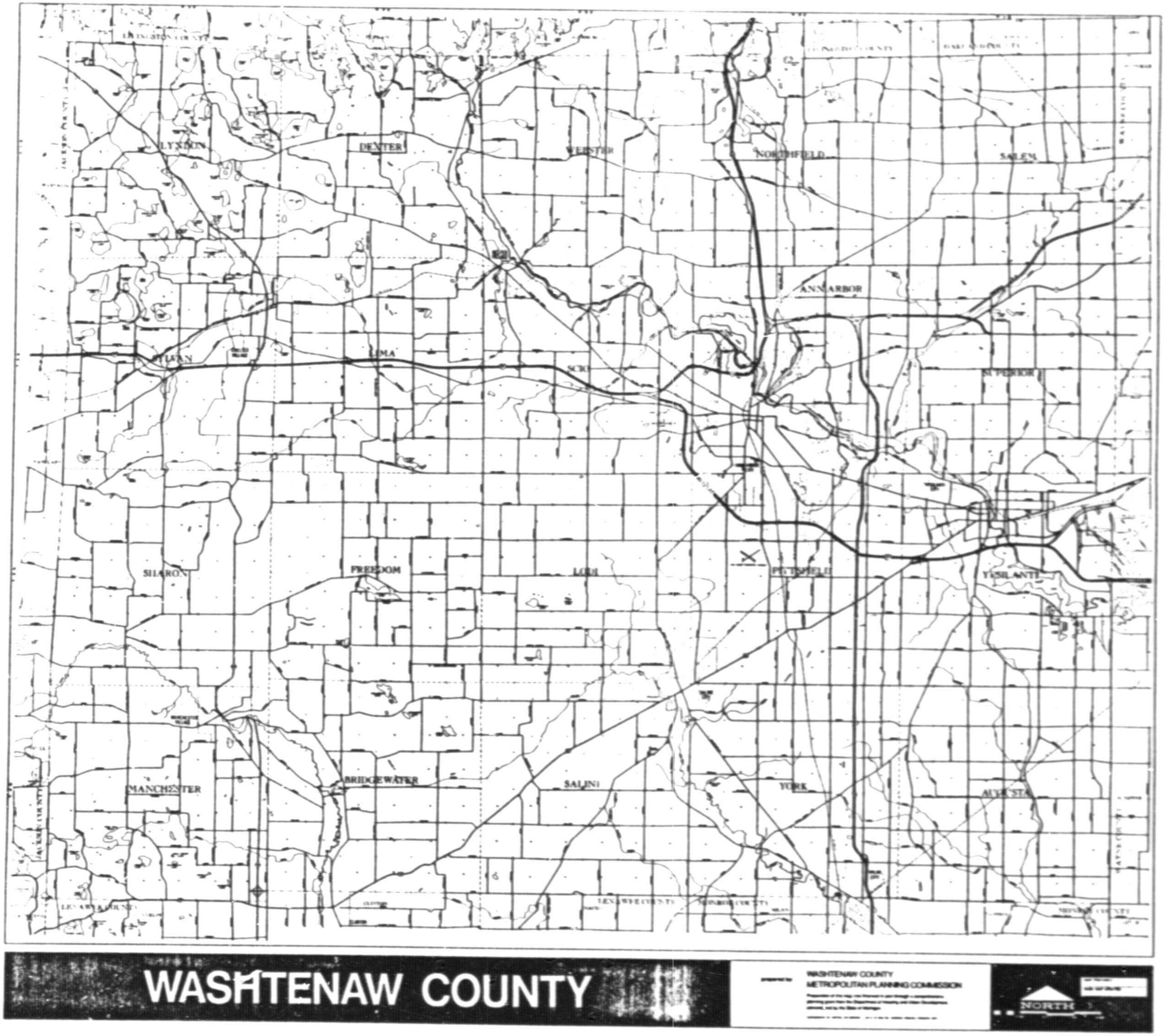
51: Surface Water
5. Streams
7. Lakes
9. Rivers

WASHTENAW DATA BASE (Cont'd.)

52: County Policy
1. Commercial
2. Industry
3. Low Density Residential
4. Medium-High Density Residential
5. Major Public Open Space
6. Rural Residential
7. Agriculture 1 (Essential)
8. Agriculture 2 (Secondary)
9. Fragile Land
10. Agriculture 3 (Reserve)

*53: Transportation
1. Unimproved Dirt
2. Paved Light Duty
3. Paved Medium Duty
4. Heavy Duty
5. Divided with Access
7. Interchange
8. Railroads
9. Airports

54: Soil Types
3. Well to moderately well-drained, moderately fine & medium soils.
4. Well-drained soils with moderately to medium-textured subsurface soils.
7. Well-drained, coarse and moderately coarse-textured soils, underlain by sand & gravel.
9. Moderately well-drained and moderately fine-textured soils, with fine-textured subsoils.
10. Well and moderately well-drained, moderately coarse and medium-textured soils. Slopes 7-18%.
12. Well-drained, coarse and moderately coarse-textured soils, underlain by sand & gravel. Slopes 7-18%.
15. Fresh water marsh and swampy peat land.
17. Somewhat poorly and poorly-drained, moderately fine and medium-textured soils.
18. Somewhat poorly and poorly-drained, moderately fine to fine-textured surface soils & fine-textured subsoils.
19. Somewhat poorly and very poorly-drained, moderately coarse and coarse-textured soils.
20. Moderately fine to moderately coarse-textured alluvial soils, frequently flooded.
21. Very poorly-drained muck and peat soils.


LYNDON
DEXTER
WEBSTER
NORTHFIELD
SALEM
ANN ARBOR
SYLVAN
LIMA
SUPERIOR
SHARON
FREEDOM
LODI
PITTSFIELD
YPSILANTI
MANCHESTER
BRIDGEWATER
YORK
AUGUSTA
WASHTENAW COUNTY
WASHTENAW COUNTY
METROPOLITAN PLANNING COMMISSION
NORTH

SCIO DATA BASE

Location: Scio Township, Washtenaw County, Michigan
Source: Prof. Terry Brown, University of Michigan
Grid size: 98 cells x 97 cells, representing an area = 95 sq. km. = 36 sq. mi.
Cell size: 1 hectare = 2.5 acres
Parameters: total of 25, each with codes between 0 and 9

3: Topography, Centroid Elevation
4: Topography, Slope
5: Topography, Orientation
9: Watersheds
*50: Utilities, Sewer & Water
51: Water, Predominate Type
*53: Existing Land Use, Transportation
54: Soil, Unified Classification, A Horizon
55: Soil, Unified Classification, Lowest Horizon
56: Water Table, Depth to Seasonal High
57: Soil Permeability, A Horizon
58: Soil Permeability, Lowest Horizon
59: Water, Wetland Type
60: Forest, Physiognomic Type
61: Existing Land Use, Agriculture
62: Water Production, Underground Wells
63: Existing Land Use, Residence Type
64: Existing Land Use, Dwellings per Cell
65: Existing Land Use, Community Facilities
66: Existing Land Use, Commerce & Industry
67: Soil, SCS Classification
68: Utilities, Gas & Power
69: Existing Land Use, Recreation Land Use Type
70: Existing Land Use, Recreation Activity Facility
71: Zoning

Notes: * Indicates parameter generally used for overwrite.
- Indicates parameter code not present in data base.

SCIO DATA BASE

3: Topography, Centroid Elevation
3 digit code to nearest 5 feet, ranging from xxx to xxx.

4: Topography, Slope
- 0. 100% Water
- 1. 0 - 3%
- 3. 3 - 6%
- 5. 6 - 10%
- 7. 10 - 15%
- 9. 15% +

5: Topography, Orientation
- 0. 100% Water
- 1. Flat (less than 3% slope)
- 3. Northwest to Northeast - N
- 5. Northeast to Southeast - E
- 7. Southwest to Northwest - W
- 9. Southeast to Southwest - S

9: Watersheds
- -0. None
- 1. Allen Creek
- 3. Saline River
- 5. Mill Creek
- 7. Honey Creek
- 8. Bouden Creek
- 9. Huron River

*50: Utilities, Sewer & Water
- 0. None
- 1. Existing Water Mains
- 3. Proposed Water Mains
- -5. Water Treatment Plants
- 6. Pump Station & Water Tanks
- 7. Existing Sewer Lines
- 8. Proposed Sewer Lines
- 9. Sewage Treatment Plants

51: Water, Predominate Type
- 0. None
- 1. Intermittent Stream
- 3. First Order Stream
- 5. Other Stream
- 7. Lake, Pond
- 9. River

*53: Existing Land Use, Transportation
- 0. None
- 1. Unimproved Dirt
- 2. Paved Light Duty
- 3. Paved Medium Duty
- 4. Heavy Duty
- 5. Divided with Access
- 7. Interchange
- 8. Railroads
- 9. Airport

54: Soil, Unified Classification, A Horizon
- 0. None
- -1. GW-GP Gravel Coarse
- -3. GM-GC Gravel Fines
- 4. SW-SP Sand Coarse
- 5. SM-SC Sand Fines
- 6. ML-CL Fines Liq. Lt. 50
- -7. CH-MH Fines Liq. Lt. 50
- -8. OL-OH Organic Fines
- 9. PT Peat

55: Soil, Unified Classification, Lowest Horizon
- 0. None
- -1. GW-GP Gravel Coarse
- -3. GM-GC Gravel Fines
- 4. SW-SP Sand Coarse
- 5. SM-SC Sand Fines
- 6. ML-CL Fines Liq. Lt. 50
- 7. CH-MH Fines Liq. Lt. 50
- 8. OL-OH Organic Fines
- 9. PT Peat

56: Water Table, Depth to Seasonal High
- 0. 100% Water
- 1. 0 - 5' Ho
- 2. 0 - 1' Br, Hn, So, Sb, Ws, Pc, Pa, Ad, Gf
- 3. 0 - 1.5' Pe
- 4. 1 - 2' Co, Na, Th, Wa
- 5. 1.5 - 2' Yp, Md, Bb, Kn, Mf
- 6. 3.5' + Oa
- 7. 4' + Mn, Dw, Sf
- 8. 5' + Kr, Fo, Bn, Os, Sr, Fp, Sp
- 9. No Reliable Estimates

SCIO DATA BASE (Cont'd.)

57. Soil Permeability, A Horizon
 0. None
 -1. Very Slow, under .06"/hour
 3. Slow, 0.06-0.2
 -4. Slow-Moderate, 0.2-0.6
 5. Moderate, 0.6-2.0
 7. Moderate-Rapid, 2.0-6.0
 8. Rapid, 6.0-20.0
 9. Very Rapid, 20.0+

58. Soil Permeability, Lowest Horizon
 0. None
 2. Slight [limitations for
 5. Moderate septic tank use]
 7. Severe
 9. Very Severe

59. Water, Wetland Type
 0. None
 3. Marsh (grass cover)
 5. Brush (dense shrub & grass)
 9. Swamp (tree cover)

60. Forest, Physiognomic Type
 0. Developed Land, Water, Grass
 -1. Aspen-Cottonwood-Sycamore
 2. Ash-Elm-Red Maple
 3. Evergreens
 4. Other Bottomland
 5. Mixed Upland & Bottomland
 6. Other Upland
 -7. Beech-Maple
 8. Oak-Hickory
 9. Walnut

61. Existing Land Use, Agriculture
 0. None
 -1. Wooded Pasture (oldfield-brush, inactive land)
 -3. Grass (rangeland)
 -5. Feedlots
 7. Orchards, Vineyards, Nurseries
 9. Active Agriculture (cropland & pasture)

62. Water Production, Underground Wells
 0. None
 1. Very Low, 0-15 gpm
 3. Low, 15-50 gpm
 5. Medium, 50-300 gpm
 9. High, 300+ gpm

63. Existing Land Use, Residence Type
 0. None
 1. Farmstead
 2. City Incorporated Area
 3. Mobile Home
 5. Single Family Residential
 7. Single Family Attached
 9. Multi-Family

64. Existing Land Use, Dwellings per Cell
 0. None
 1. 1 dwelling
 2. 2 dwellings
 3. 3 dwellings
 4. 4 dwellings
 5. 5 dwellings
 6. 6 dwellings
 7. 7 dwellings
 8. City Incorporated Area

65. Existing Land Use, Community Facilities
 0. None
 1. Public Recreation
 2. Public & Quasi-Public
 3. Fire Department
 4. Hospital
 5. Church & Religious Institutions
 6. Cemetery
 7. Nursery & Elementary School
 8. Junior & Senior High School
 9. Special Education

66. Existing Land Use, Commerce & Industry
 0. None
 1. City Incorporated Area
 3. Shopping Center
 4. Strip & Roadside
 5. Wholesale Storage & Distribution
 7. Light Industry (research park)
 8. Heavy Industry (foundry, auto)
 9. Extractive (sand, rock, oil)

SCIO DATA BASE (Cont'd.)

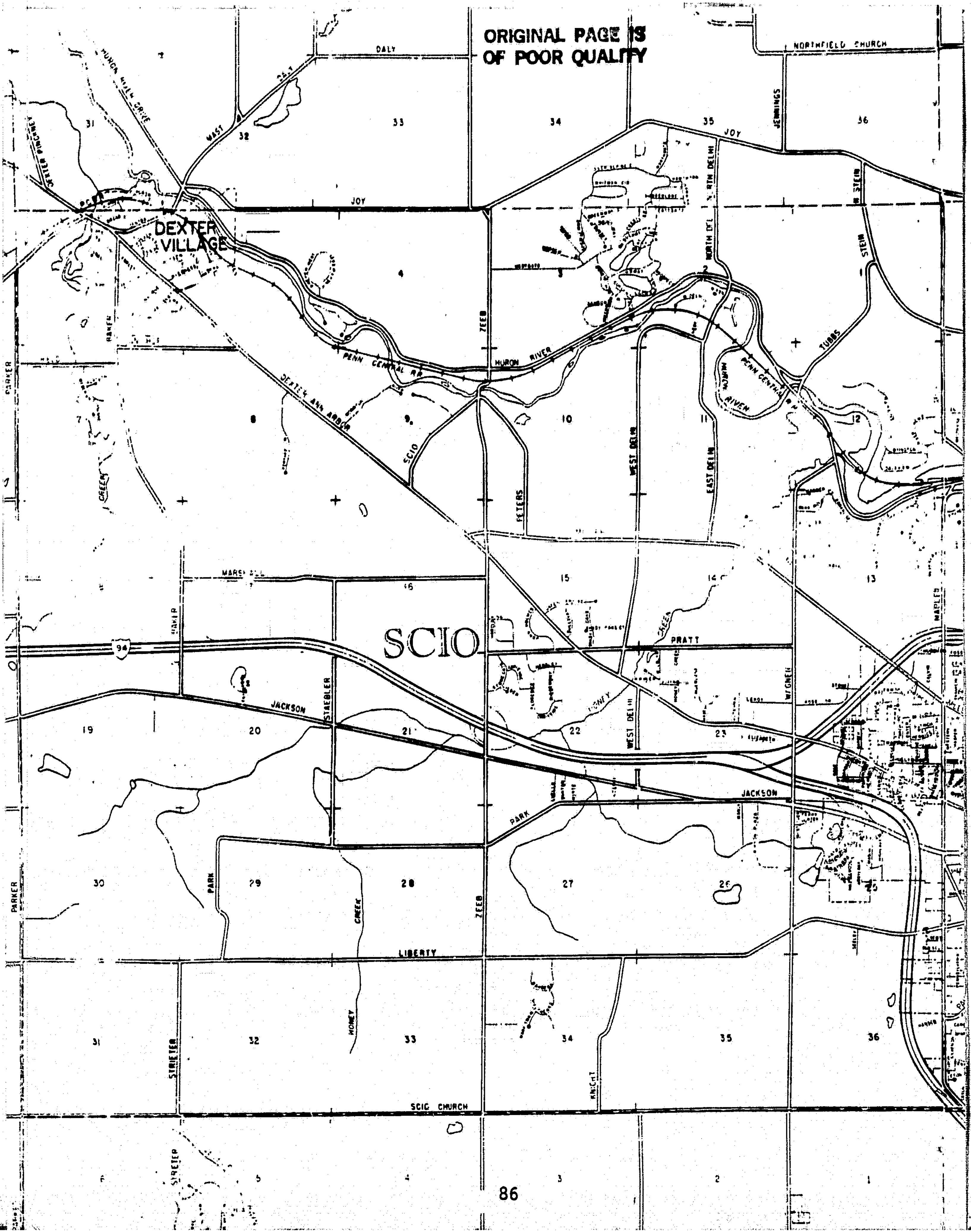
67. Soil, SCS Classification
(Refer to Wash. Co. Soil Survey)
   0. Water
   1. Fd, Kn, Md
   2. Oa, Ws
   3. Fo, Fp, Gf, Kr, Wp
   4. Md, Mf, Sf, Wa
   5. Os, Ow, Th
   6. Bn, Sp, Sr
   7. Bb, Br, Co, Cp, Mm, Pc, SB, So
   8. Ho, Na, Pe
   9. Ad, Hn, Pa

*68. Utilities, Gas & Power
   0. None
   1. Michigan Consolidated Gas Co.
   3. Consumers Power Co. Natural Gas
   4.
   5. Panhandle Eastern Pipeline Gas Co.
   6. Detroit Edison Co. Trans. Line
   7. Detroit Edison Co. Sub-Trans. Line
   8. Electric Step Down Station
   9. Electric Substation

69. Existing Land Use, Recreation Land Use Type
   0. None
   -1. Conservation
   -2. State Park
   -3. County Park
   4. Community Park
   5. Highway Rest Area
   6. University of Michigan Lands
   7. Playing Fields
   8. Activity Facility
   9. Commercial Facility

70. Existing Land Use, Recreation Activity Facility
   0. None
   1. Trails (riding, hiking, biking)
   2. Picnic Areas
   -3. Camping Areas
   4. Swimming, Beaches, Pools
   5. Boat Launch & Dock Facilities
   -6. Skating
   -7. Skiing
   -8. Golfing & Driving Ranges
   9. Tennis

71. Zoning
   0. RC Recreation-Conservation
   1. A1, A2 General & Reserve Agriculture
   2. MHP Mobile Home Park
   3. R1A, R1B, R1C Rural Non-Farm, Suburban, & Urban Residential
   4. R2A, R2B Two Family, Low-Density Multi-Family Residential
   5. R3 Moderate-Density Multi-Family Residential
   6. C1, C2, C3 Local, General, & Highway Commercial
   7. O1, RO Office, Research & Development
   8. W1, I1, I2 Warehouse, Limited & General Industrial
   9. City Incorporated Area


DEXTER VILLAGE
SCIO
DALY
NORTHFIELD CHURCH
JOY
JENNINGS
NORTH DELHI
STEIN
DEXTER PINCKNEY
HURON RIVER DRIVE
MAST
ZEEB
HURON RIVER
PENN CENTRAL RR
TUBBS
PARKER
BAKER
DEXTER ANN ARBOR
SCIO
PETERS
WEST DELHI
EAST DELHI
MARSHALL
MAPLES
PRATT
94
JACKSON
STAEBLER
HONEY
WAGNER
PARK
LIBERTY
CREEK
HONEY
STRIETER
KNIGHT
SCIO CHURCH
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Appendix C
POSITION STATEMENTS

C.1 ERIM RAS LOAN POLICY

ERIM is prepared to loan a RAS terminal to continue Technology Transfer in Michigan Under the following guidelines.

1. No cost to ERIM. This means that the participating organizations should work out means of paying for telephone lines, maintenance (eg., service calls), insurance, transporting terminal, copies of training materials, computer usage, etc.

2. One organization should be point of contact with ERIM and have responsibility for maintaining and scheduling the equipment and continuing the development of a user network.

3. It is not essential that the host for the terminal be a college or university, but it is necessary that one or more people at the host facaility be certified by ERIM in terminal operation.

4. ERIM should maintain, review and veto capability of planned use of terminal to insure maximum use of facilities by all public and private organizations.

5. Terminal user or RAS host should provide verbal or written reports to justify terminal use and continued technology transfer efforts.

C.2 TECHNOLOGY TRANSFER STEERING COMMITTEE POSITION STATEMENT

The institutions of higher education in Michigan have agreed that there is a need for community colleges and universities to work together in developing technology transfer programs. (Training and retraining programs designed to meet the needs of industry and businesses within the State of Michigan). The institutions have formed a steering committee whose main objective is to promote technological training through courses, lectures, seminars and workshops. The committee coordinates the development and dissemination of the technology transfer programs. Each participating institution houses certain programs according to their expertise and capabilities. All institutions of higher education in the State of Michigan are welcome to participate.

This type of collaboration will decrease the duplication of programs and the wastefulness of supplies and equipment. At the same time it will increase student enrollment at institutions of higher education. the collaboration will contribute to Michigan's future economic development by retraining the unemployed for existing jobs.

On January 28, 1982, the following technology transfer programs were recommended by the steering committee.

Program	Institution
Alternate Energies Technology	Oakland Community College
Computer Color Graphics Technology	Wayne County Community College
Computer Graphics Technology	Oakland Community College
Computer Record Keeping for Marine Operators	University of Michigan and Michigan State University - Sea Grant
Computer Science/System Analysis	Oakland Community College
Cardio Vascular Technology	Oakland Community College
Diagnostic Medical Sonography	Oakland Community College
Electronics Microprocessor Technology	Oakland Community College
Electrical Trades Technology	Oakland Community College
Fluid Power Technology	Oakland Community College
Geological Technology	Wayne County Community College

Hydrological Technology	Wayne County Community College
Marine Industry	University of Michigan and Michigan State University Sea Grant
Petroleum Industry	Schoolcraft College and Eastern Michigan University Sea Grant
Photointerpretation for Assessing Wetlands Resources	University of Michigan and Michigan State University - Sea Grant
Polymers and Coating Technology	Eastern Michigan University
Quality Assurance Technology	Oakland Community College
Remote Sensing Technology (Environmental Institute of Michigan)	Central Michigan University Eastern Michigan University Lansing Community College University of Michigan Wayne County Community College Western Michigan University
Robotics Technology	Central Michigan University Macomb Community College Oakland Community College University of Michigan Western Michigan University
Rubber Technology	Eastern Michigan University
Small Boat Construction Program	University of Michigan and Michigan State University Sea Grant
Soil Technology	Wayne County Community College