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of the  
NASA-sponsored  
Cornell University Remote Sensing Program  
June 1 - November 30, 1978

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Principal Investigator: Ta Liang

Co-Investigators: Arthur J. McNair  
Warren R. Philipson

Remote Sensing Program  
Cornell University  
Hollister Hall  
Ithaca, New York 14853

December 1978

## INTRODUCTION

The primary objective of the NASA-sponsored, Cornell University Remote Sensing Program is to promote the application of aircraft and satellite remote sensing, particularly, in New York State. In accordance with NASA guidelines, this is accomplished through conferences, seminars, instruction, newsletters, news releases, and most directly, through demonstration projects. Each demonstration project must be, in some way, unique; essentially noncompetitive with commercial firms; and potentially, benefit- or action-producing. Relatively little emphasis is placed on technology transfer, per se.

The activities of the Remote Sensing Program staff, from June 1 to November 30, 1978, are reviewed in this Semi-Annual Status Report, the thirteenth to be submitted to NASA since the Program's inception in June 1972.

## COMMUNICATION AND INSTRUCTION

### Contacts and Cooperators

During the past six months, the Program staff spent many hours discussing remote sensing with representatives of various federal, state, regional, county and local agencies, public and private organizations, the academic community, and foreign countries.

In addition to receiving project cooperators from the U.S. Environmental Protection Agency, the New York State Department of Health, the New York State Department of Environmental Conservation, and the Planning Department of Tompkins County, N.Y., the Program staff also provided remote sensing consultation to visitors from the U.S. Army Cold Regions Research Engineering Laboratory, the New York State Commission on Tug Hill, and the State University of New York at Binghamton. Among the many visitors seeking information on remote sensing or Cornell capabilities in remote sensing were those from the Environmental Management Council of Cayuga County, N.Y., the Eastman Kodak Co., Exxon Corp., the Soviet Union, and the Commission of the European Communities' Joint Research Center, in Italy.

Many new and continuing dialogs were also held via the mail and telephone, particularly in the course of developing new remote sensing demonstration projects (Appendix G). Moreover, Program staff traveled to discuss or conduct projects with representatives of the New York State Board of Hudson River-Black River Regulating District, the New York State Department of Environmental Conservation, the New York State Department of Health, the New York State Office of Parks and Recreation, the U.S. Army Corps of Engineers, and the U.S. Air Force Rome Air Development Center (Appendices A, E, F and G).

## Newsletters and News Releases

The Program's "Cornell Remote Sensing Newsletter," continued to provide a valuable link to and beyond the Cornell community. The Newsletter, which highlights remote sensing activities at Cornell while reporting other items of general interest, is now received monthly by more than 475 individuals and groups in some 30 states and 15 foreign countries (Appendices H and I).

Program investigations continued to receive publicity through local and nationally distributed news items (e.g., "ASCE News," Appendix G). National and Canadian concern for problems associated with the Love Canal in Niagara Falls led to numerous newspaper and radio reports on the Program's involvement (Appendix A).

## Seminars

For six years, the Program's weekly Seminar in Remote Sensing has brought experts from government, industry and other institutions to Cornell to discuss remote sensing topics with students and staff. The Seminar was not held during the fall semester, 1978, in order to devote more time to other activities, but planning for the spring semester is well underway. Speakers from NASA, the U.S. Department of Energy, the U.S. Geological Survey, the Defense Mapping Agency, and Earth Satellite Corporation have been scheduled, and others have been invited.

## Courses, Special Studies and Workshops

Cornell's curriculum in aerial photographic studies, photogrammetry and remote sensing, and the possibilities for research through special topics courses, professional master's design projects, and M.S. or Ph.D. theses, have been reviewed in earlier Semi-Annual Status Reports. During the fall semester, 1978, Program staff offered a special, six-week course, "Remote Sensing of Environment," for 20 freshman engineers. In addition, one "special topics" course is focusing on digital analysis of remotely sensed data, thereby laying the groundwork for a regular course on this subject. Typical of the Program staff's extracurricular instructional activities over the past six months are an invited seminar delivered to some 20 students and staff in geology at Hamilton College in Clinton, N.Y.; a special orientation lecture given to some 60 Cornell students in a course in landscape architecture; and another orientation lecture given to some 15 Cornell students in a course in Army R.O.T.C.

## DATA AND FACILITIES

As described in earlier report, staff research and instruction have been enhanced through continued acquisition of a wide range of remotely sensed, aircraft and satellite data, and through extension of capabilities for their analysis and interpretation. These data, along with Program facilities and equipment, are made available at no cost to cooperators, students and other interested users.

With assistance from the NASA Office of University Affairs, the Program has received Landsat, Skylab, high altitude and low altitude coverage of sites in the Northeast, and two new high altitude aircraft missions were recently flown over New York's Finger Lakes Region. The U.S. Environmental Protection Agency has also overflown Program-selected sites at no cost to the Program; and images have been obtained from the U.S.A.F. Rome Air Development Center, the U.S. Geological Survey, the U.S. Department of Agriculture, the St. Lawrence Seaway Development Corporation, the National Air Photo Library of Canada, the Tri-State Regional Planning Commission, the National Archives, Eastman Kodak Company and several commercial mapping firms.

The Program maintains or has access to a spectroradiometer and selected image analysis equipment (i.e., zoom and non-zoom stereoscopes, density slicer, color-additive viewer, Zoom Transfer Scope, densitometer, stereoplotters, and other photogrammetric and photographic instruments). The Program also maintains a series of computer routines for analyzing multispectral digital data. These routines are receiving increased usage in Program-sponsored and spinoff investigations with Landsat and aircraft scanner data.

#### PROJECTS COMPLETED

During the six-month period, June 1 to November 30, 1978, the Cornell Remote Sensing Program staff completed five demonstration projects:

1. Preliminary Assessment of Leachate Migration from the Love Canal Landfill, Niagara Falls, N.Y.
2. Landsat Analysis for Pheasant Range Management in New York State.
3. Selection of Sites for Dredge Spoil Disposal and Subsequent Recreational Development, Columbia County, N.Y.
4. Examination of Agricultural Districts for Possible Changes in Zoning, Columbia County, N.Y.
5. Inventory of Potential Mosquito Breeding Sites in an Urban Setting, Rome, N.Y.

The projects are summarized here, and pertinent material on each is included in an appendix.

1. *Preliminary Assessment of Leachate Migration from the Love Canal Landfill, Niagara Falls, N.Y.*

Leaching of toxic chemicals from the Love Canal Landfill in Niagara Falls, N.Y., caused the site to be declared a State and Federal disaster area and 237 homes to be evacuated. The Program staff

was requested by officials of the N.Y.S. Department of Health to assist in determining the extent of leachate migration.

Using aerial photographic coverage acquired in 1938, 1951 and 1966, staff members analyzed the soils and geology of the area, compiled time-sequential, map overlays of land use, and identified the most critical sites for field sampling (Appendix A). In addition, the basic parameters for collecting new aerial photographs of the area were outlined for State Health personnel.

All recommended sites have been sampled, new 35mm and 70mm photography has been flown, and consultations--including those with the legal staff of the U.S. Environmental Protection Agency--are continuing. The value of remote sensing has been demonstrated to the extent that the State is funding the Program to conduct a remote sensing evaluation of 38 other industrial landfills in the Niagara Falls area.

## *2. Landsat Analysis for Pheasant Range Management in New York State.*

Working closely with the New York State Department of Environmental Conservation (DEC), Program staff examined the value of Landsat data for separating land cover types being considered for inventory under the DEC's pheasant habitat management program (Appendix B). As discussed in the Program's report to the DEC, Landsat data could not provide adequate separability of all cover types of interest when single dates of Landsat were analyzed digitally or when multiple dates were analyzed manually. Supervised classification of Landsat digital data from two dates would likely prove successful, and some improvement in separability with manual methods would likely accompany improvements in the quality of imagery. These possibilities as well as changes in the land cover types to be inventoried are now being considered by the DEC. It is probable that some level of cooperative effort will follow.

## *3. Selection of Sites for Dredge Spoil Disposal and Subsequent Recreational Development, Columbia County, N.Y.*

At the request of the Planning Director of the Planning Board of Columbia County, N.Y., Program staff identified and assessed the best five zones for disposing of Hudson River dredge spoil and subsequently developing river-oriented recreation (Appendix C). Land stability, land use and cover, aesthetics, proximity to population and existing recreation, and water quality were evaluated at each zone using multi-date, medium and high altitude aerial photography and background reports. The information submitted to the County Planning Board is providing fundamental input to the development of a comprehensive coastal zone management plan and to County proposals for funding for implementing this plan.

4. *Examination of Agricultural Districts for Possible Changes in Zoning, Columbia County, N.Y.*

Another project conducted at the request of the Planning Board of Columbia County, N.Y., involved inventorying land use (as "active agriculture", "inactive agriculture" or "other") and providing a preliminary assessment of soils as "prime agricultural soils" (Appendix D). This countywide study was performed using high altitude aerial photographs and the existing reconnaissance soils report. The submitted information has been used for general planning, and it will be used by the County Planning Board and Agricultural Committee in reviewing the County's eleven agricultural districts. It is expected that the Program's submissions will provide the basis for changing agricultural district boundaries as well as related town zoning classifications. (The review of agricultural districts requires public hearings, and the complete process will not be finalized for about two years.)

5. *Inventory of Potential Mosquito Breeding Sites in an Urban Setting, Rome, N.Y.*

As a follow-up to earlier work on characterizing known mosquito breeding sites with the New York State Department of Health (12th Semi-Annual Status Report, June 1978), Program staff demonstrated the value of aircraft remote sensing for inventorying potential mosquito breeding sites in an urban area (Appendix E). Using large scale panchromatic photographs, acquired by the U.S. Air Force over most of Rome, N.Y., members of the Program staff performed a comprehensive inventory of wet sites (permanent and temporary) occurring at ground level as well as on roof tops. This information guided selected field checks by State and county health personnel, who had spent the summer of 1978 collecting ground data to determine the need for urban-mosquito spray operations in Rome and two other New York State cities.

The efficiency, accuracy and cost for aerial surveys appear attractive to State Health officials, especially as regards the opportunity to identify water accumulations on roof tops--sites which had not been included in the summer field surveys. It is likely that further assistance will be given to the State in testing and designing a survey plan.

PROJECTS IN PROGRESS

Program-Sponsored

As of December 1, 1978, the Program staff was conducting two projects under the NASA grant: (1) Estimating flooding in Black River Basin, N.Y., with Landsat and in-situ data, and (2) Assessment of vineyard-related problems. The objectives, cooperators, users, expected benefits and actions, and status of these projects are described, as follows:

1. *Estimating Flooding in Black River Basin, N.Y., with Landsat and in-Situ Data*

- cooperator/user: N.Y.S. Board of Hudson River-Black River Regulating District
- benefit/action: Reliable estimates of inundation and consequent damage obtained in real time; methodology applicable in other river basins.
- expected completion date: Preliminary Results - February, 1979

Landsat imagery is being used as the primary source of information on flooding in the Black River Basin of northern New York State. Approximately 65 kilometers of the Black River floods annually, inundating farm land and breaching roadways. Ground surveys of the actual areas flooded are incomplete and thus inadequate for estimating agricultural and other losses.

Landsat images (band 7) depicting flood conditions during several flood seasons since 1972 were obtained for analysis. Visual interpretation of flood boundaries is providing the basis for quantitatively relating in-situ measurements of river discharge with the areas and locations of inundation. This, in turn, will provide a model for real-time estimation of flood losses over the entire river basin.

2. *Assessment of Vineyard-Related Problems*

- cooperators: Taylor Wine Company and other vineyards; N.Y.S. Agricultural Experiment Station, Geneva, N.Y.; Cornell Depts. of Plant Pathology and Pomology; Eastman Kodak Co.
- users: Taylor Wine Co. and other vineyards; N.Y.S. Cooperative Extension.
- benefits/action: Appropriate action by vineyards on range of problems assessed with remotely sensed data; development of remote sensing as a vineyard management tool; ultimately, improved production.
- expected completion date: June 1979

The Program staff is examining the extent to which remotely sensed data might provide useful information for assessing vineyard-related problems. The first phase of the investigation, an evaluation of vineyard drainage, was completed and described in the Program's 7th Semi-Annual Status Report (Dec. 1975). For the second phase of the investigation, Program staff used large-scale color infrared aerial photographs to assess plant vigor. This project was discussed in the Program's 9th Semi-Annual Status Report (Dec. 1976). Follow-up

studies of vineyard siting, crop vigor, yield-related factors and practical monitoring techniques are being conducted using low altitude, multispectral aircraft data acquired for the Program by NASA during the summer 1977. Although some delay was experienced in obtaining the computer-compatible tapes of the multispectral scanner data, an analysis of yield-related factors is now underway.

### Spinoff Projects

During the past six months, members of the Program staff have been involved in two non-NASA funded projects which arose directly from Program-sponsored investigations. As a consequence of earlier work on remote sensing strategies for inventory dams (9th Semi-Annual Status Report, Dec. 1976), the U.S. Department of the Interior, Office of Water Research and Technology funded a one-year investigation, "Remote Sensing Assessment of Dam Flooding Hazards: Methodology Development for the New York State Dam Safety Program." Copies of the final report were recently submitted to the NASA grant monitor, and excerpts are included here, in Appendix F.

A second spinoff project involves a remote sensing analysis of nearly 40 landfills in the Niagara Falls, N.Y., area. Funded by the New York State Department of Health, this work follows the Program-sponsored assessment of Love Canal (Appendix A), as well as previous leachate detection work which was funded jointly by NASA and the EPA.

### Inactive Project

With Program staff assistance, Cornell's Physical Plant Operations (PPO) contracted for an airborne thermal survey of campus steamlines (6th Semi-Annual Status Report, June 1975). After studying the thermal data for steamline leaks, personnel of the PPO requested that the Program utilize the data to evaluate roofing insulation of campus buildings. With these data as a focal point, the Program staff began a study to develop an airborne survey/analysis methodology which would characterize roofing materials as well as insulation needs. Toward this end, the Program requested NASA to overfly the campus area during the winter and spring of 1976. Only the spring mission was flown, and the data were not supplied to the Program until five months after the mission. These delays were accompanied by changes in personnel and initiation of projects with more immediate "payoffs." During this period, many similar studies were conducted by other research groups in the United States and Canada. Although it was expected that the thermal investigation would be re-defined and re-initiated, this has not yet occurred.

### FUTURE PROJECTS

The Program staff is continually soliciting and receiving proposals for new remote sensing demonstration projects. As noted, criteria

for project acceptance are that the project must be, in some way, unique; that project acceptance would not be competing unduly with private companies or consultants; and that, if completed successfully, the project would produce tangible benefits or actions by definable users.

Among topics under current consideration are (Appendix G):

1. With the *Planning Board of Albany County, N.Y.*--assess landslide susceptibility within the county.
2. With the *Department of Environmental Control of Suffolk County, N.Y.*--evaluate relationship between salinity and changes in the configuration of the barrier island inlets to Long Island's south shore bays.
3. With the *New York State Office of Parks and Recreation*--study the protection, maintenance and enhancement of recreational resources on barrier island (Jones Beach and Fire Island).

Depending on user interest, personnel and available funds, any of these as well as other projects may be undertaken.

#### PROGRAM STAFF

The Program staff is comprised of Prof. Ta Liang, principal investigator, Prof. Arthur J. McNair and Dr. Warren R. Philipson, co-investigators, Mr. Thomas L. Erb, research specialist, Mr. Jan P. Berger, graduate research assistant, Mr. John G. Hagedorn, data analyst, Ms. Deborah Halpern, photographic laboratory technician, and Ms. Pat Webster, secretary. Prof. Donald J. Belcher and Dr. Ernest E. Hardy are general consultants to the Program and, for specific projects, assistance has been provided by many Cornell and non-Cornell personnel. Students who have contributed to the Program staff effort over the past six months include David W. Adams, William R. Hafker, Jay N. McLeester and William L. Teng.

## LIST OF APPENDICES

- A. Preliminary assessment of leachate migration from the Love Canal landfill, Niagara Falls, N.Y.
- B. Landsat analysis for pheasant range management in New York State
- C. Selection of sites for dredge spoil disposal and subsequent recreational development, Columbia County, N.Y.
- D. Examination of agricultural districts for possible changes in zoning, Columbia County, N.Y.
- E. Inventory of potential mosquito breeding sites in an urban setting, Rome, N.Y.
- F. Remote sensing assessment of dam flooding hazards
- G. Selected correspondence and project-related items
- H. Newsletter recipients
- I. Recent Newsletters

APPENDIX A

PRELIMINARY ASSESSMENT OF LEACHATE MIGRATION FROM  
THE LOVE CANAL LANDFILL, NIAGARA FALLS, N.Y.



# Cornell University

REMOTE SENSING PROGRAM  
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING  
HOLLISTER HALL  
ITHACA, NEW YORK 14853  
(607) 256-4330, 256-5074

27 September 1978

Dr. Steve Kim  
N.Y.S. Department of Health  
Division of Laboratories and Research  
Empire State Plaza Laboratories  
Albany, New York 12201

Dear Steve:

Please forgive my delay in providing you a summary of our Program's "Love Canal" activities, completed or undertaken since my initial letter of 4 August 1978. Chronologically, they include the following:

1. On 5 August, I accompanied you on the aircraft flight to obtain hand-held, color infrared, 35mm slides of the site and vicinity. I provided some assistance in defining photogrammetric parameters, and I obtained a series of 35mm color slides with my own camera. (You have copies of my slides.)
2. On 9 August, Ta Liang and Thomas Erb (Professor In-Charge of our Remote Sensing Program and Research Specialist, respectively) visited the Love Canal area for field observations.
3. On 9 and 10 August, our staff examined the 35mm slides obtained on 5 August and the 70mm color infrared transparencies flown by the N.Y.S. Department of Environmental Conservation on 7 August. (Both sets of slides, with some omitted, were sent to Ithaca via Mall Airway by Fred Muller.) An examination of these slides, together with a re-examination of the 1938, 1951 and 1966 aerial photographs, allowed us to respond to your telephone requests for recommended sampling sites. (The DEC slides were returned to Albany by Ed Horn, who visited campus on 8 Sept.; we still have the Health Dept. slides.)
4. Several interviews were given during the next few days. Cornell's Public Information Office prepared a brief news item on our participation, and a radio interview was taped. Other calls were received from Ithaca, Buffalo and Albany news stations or newspapers, as well as from CBS News in New York.
5. George Shanahan and Steve Zelson, of the U.S. Environmental Protection Agency legal staff, visited with Prof. Liang and me on 15 August. They examined the 1938, 1951 and 1966 photographs and requested our interpretation, primarily, as regards a possible ditch between Love Canal and the Niagara River. They also requested assistance in locating any additional pre-1966 photographs.

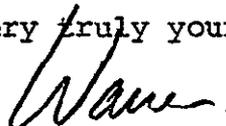
6. We determined that other dates of photography were available from several sources (accompanying table). We ordered this additional coverage of the Love Canal area, and advised Shanahan and Zelson of its existence.

7. On 8 September, we responded to your telephone request for an assessment of possible dumping near the 93rd Street School.

8. You provided us with ground data and background material on the Love Canal. As we receive the additional aerial photographs, we are (slowly) initiating further site analyses.

As you realize, all of our activities to date have been conducted under our NASA grant. I would be happy to expand on any of the above.

Very truly yours,



Warren R. Philipson  
Sr. Research Associate

WRP/pw  
cc: Prof. Ta Liang

AERIAL PHOTOGRAPHIC COVERAGE ORDERED OR  
ON HAND FOR ANALYSIS OF LOVE CANAL AREA

<u>Date</u>	<u>Nominal Scale</u>	<u>Source</u>
25 Sept. 38	1:20,000	National Archives
14 Oct. 51	1:20,000	ASCS, U.S. Dept. Agriculture
26 May 56	1:12,000	Rist-Frost-Warneck & Partners
16 May 58	1:20,000	Rist-Frost-Warneck & Partners
1958	1:20,000	ASCS, U.S. Dept. Agriculture
15 Jan. 60	1:60,000	U.S. Geological Survey
3 Sept. 60	1:28,000	Nat'l. Air Photo Library, Canada
26 Nov. 62	1:38,000	U.S. Geological Survey
7 May 63	1:24,000	U.S. Geological Survey
12 June 66	1:20,000	ASCS, U.S. Dept. Agriculture

- Notes:
- (1) All photographs are black-and-white panchromatic.
  - (2) The 1958 photographs ordered from the ASCS/USDA may be the same as those from Rist-Frost-Warneck & Partners, an engineering/surveying company in Watertown, New York.
  - (3) Other post-1970 aerial photographs of the area are available from several sources. These include small-scale, partial coverage by Canadian agencies in 1970, 1972, 1975 and 1976; as well as larger scale, complete coverage by U.S. firms. Only the Canadian photographs have been ordered.



# Cornell University

REMOTE SENSING PROGRAM  
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING  
HOLLISTER HALL  
ITHACA, NEW YORK 14853  
(607) 256-4330, 256-5074

4 August 1978

Dr. Steve Kim  
N.Y.S. Department of Health  
Division of Laboratories and Research  
Empire State Plaza Laboratories  
Albany, New York 12201

Dear Dr. Kim:

We have completed our preliminary assessment of potential sites of leachate contamination associated with the Love Canal landfill in Niagara Falls, N.Y. The findings are based entirely on stereoscopic analysis of "historic" aerial photographic coverage; new coverage and, of course, field investigations are recommended.

Included in or with this letter are: (I) a list of the aerial photographs used in the study; (II) our copies of the 1938 photographs (please return); (III) a brief description of the geology of the landfill area; (IV) a series of 1:24,000 scale map overlays depicting drainage and related conditions in 1938, 1951 and 1966; (V) a 1:24,000 scale map overlay depicting sites for immediate field investigation; (VI) recommendations for flying new photography; and (VII) general comments.

I. Aerial Photographs Used in Study (all black & white contact prints at scales of 1:20,000 to 1:24,000).

<u>DATE</u>	<u>SOURCE</u>	<u>PHOTO NUMBERS</u>
25 Sept 1938	National Archives	ARE-18-80 and 81
14 Oct 1951	U.S. Dept. Agr.	ARE-5H-214 and 215
12 June 1966	U.S. Dept. Agr.	ARE-2GG-25 and 26
29 April 1968	Lockwood Mapping	NY-10-1577-1672 and 1673

II. 1938 Aerial Photographs (stereoscopic pair enclosed).

III. Geology of Area

The landfill area lies within the floodplain of the Niagara River. It is characterized by relatively flat topography with minor irregularities. In general, the local surface sediment will be predominantly coarse materials (coarse silts to sands), with finer sediments found associated with topographically depressed areas and channel scars produced during periods of flooding. Subsurface sediments are highly variable. Boundaries of sediment types are unpredictable both vertically and horizontally, and randomly situated lenses of sands, silts or clays, as well as buried channel scar material are not uncommon. The ground water table is normally high. Because of the nature of the subsurface materials, it is difficult to determine local directions of ground water flow. The dolomitic limestone bedrock is generally no more than three meters from the surface.

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#### IV. Drainage Map Overlays--1938, 1951 and 1966 (enclosed)

A stereoscopic analysis of the multi-date photographs was performed, tracing drainage and related information onto acetate overlays. This information was subsequently transferred to a U.S. Geological Survey 1:24,000 scale topographic map base. The enclosed map overlays are described as follows:

- 1938: The Love Canal landfill was open and operating in 1938. The map overlay depicts the location of the landfill and drainways in the vicinity.
- 1951: The landfill was partly backfilled by 1951, and substantial residential development had taken place, especially in the poorly drained area west of the landfill. The map overlay depicts the canal, backfilled portions, drainways, and the principal area of residential development.
- 1966: By 1966, the landfill was completely backfilled, and a school and residences had been erected on or adjacent to the site. These developments and the drainways are shown in the map overlay.

#### V. Field Sampling Points--Map Overlay (enclosed)

The 1:24,000 scale map overlay depicts the area presumed to be affected by landfill leachate and selected locations for monitoring surface or ground water quality.

#### VI. Recommendations for New Photography

The leachate contamination may be rather extensive. New aerial photography over the area would be of value to the field program, primarily in providing evidence of where to sample. The basic parameters of an aerial photographic mission are listed below. A thermal survey of the area is not recommended. Further assistance in planning, implementing or contracting for an aircraft mission would be provided upon request.

film: Kodak Aerochrome Infrared, 2443 or 3443; (a true color film such as Kodak 2445 or 2448, would be a useful supplement).

filter: Wratten 12 or Wratten 15 with color infrared film.

scale: 1:5,000; (smaller scale coverage, say 1:10,000, may be a useful supplement).

time of flight: solar noon--sun should be as high as possible; best if cloud-free.

season: wet periods will maximize the number of observed problem sites; avoid heavy tree foliage.

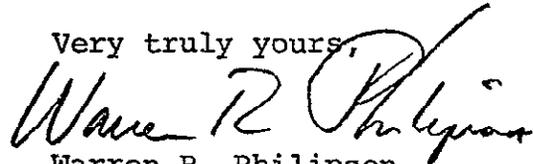
coverage: obtain complete stereoscopic coverage over the area south to the Niagara River, west to Cayuga Creek, north to Black Creek (and Bergholtz Creek), and east about 2 kilometers from the landfill. River shoreline and creeks noted above should be included.

VII. General Comments

As noted, it is difficult to predict the direction of ground water flow in this area because of the variability of the flood-plain soils. Although the general pattern is from east to west, localized surface and subsurface flow from west to east will likely be encountered. Given that the soils are relatively shallow, leachate infiltration of the bedrock through fractures should also be expected.

As a final note, we are anxious to learn if and how the enclosed information is used, and we are prepared to provide further assistance using funds from our NASA grant. Any citation of assistance should refer to the staff of Cornell's NASA-sponsored Remote Sensing Program (several individuals contributed to the results). I have enclosed a sheet which describes our Program.

Very truly yours,



Warren R. Philipson  
Sr. Research Associate

WRP/pw

Encs.

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## Assess Spread of Toxics

# CU Aerial Photo Analysts Work on Love Canal Project

ITHACA (UPI) — Aerial photography experts from Cornell University are helping state and federal officials define the spread of toxic chemicals in the chemically contaminated Love Canal area in Niagara Falls.

A five-man team of analysts from the College of Engineering are using 1930s photographs taken of the area before the canal was filled in, to determine its original drainage pattern.

Warren R. Philipson, who heads the team, said Friday the information pro-

vides a base for testing how widely the chemicals have leached away from the landfill site.

Also being used in the analysis are photographs of the area taken in the 1950s and 1960s and showing the development of homes and how the original drainage pattern has been distorted.

Along with the older photos, Cornell engineers also are analyzing photos taken in the past week.

Using infrared photos, engineers are

able to pick out indications of the possible spread of the chemicals by observing the health of vegetation and moisture conditions.

About 235 families have begun evacuating their homes on the waste dump used by the Hooker Chemical and Plastics Corp during the late 1940s and early 1950s. The canal now poses a health threat because cancer-causing chemicals are leaching into the soil and seeping into home basements.

4A ROCHESTER DEMOCRAT AND CHRONICLE Sunday, Aug 13, 1978

## Caution the key to cleanup

NIAGARA FALLS (UPI) — State health officials said yesterday massive precautions, including detoxification showers, disposable work clothes and gas masks, are being planned for the cleanup of the chemically-contaminated Love Canal.

"Significant precautions will be taken," said Louis Violante, regional engineer for the state Department of Health.

He said the plans, being formulated by environmental, health and disaster aid officials, also call for air packs and mobile toxic analysis units. The plans are aimed at providing maximum safety for workers.

A federal emergency has been declared in the area where oozing chemicals from a chemical landfill closed 25 years ago are seeping into basements and backyards, forcing the evacuation of 234 families from their homes because of threats of their health.

Violante said plans also involve regular washing of all bulldozers, excavators, trucks, road graders and pumps, and for around-the-clock security patrols of the site.

The first phase of the cleanup will include digging two parallel trenches 10 to 12 feet deep running the three-

block length of the landfill. Work won't begin until all the families are moved out.

Two deep wells will be sunk at the end of the trenches to collect materials, Violante said. Water flowing into the wells will be pumped into a 30,000-gallon storage tank at the site.

Violante said liquids from the tank will be fed through the "Blue Magoo," the Environmental Protection Agency's mobile filtration system, and then fed into the city sewer system.

He also said scientists will be monitoring and testing ahead of the construction work for explosive gases, dangerous chemicals known to be in the site, and for highly toxic chemicals, like sulfur dioxide, that have not yet been found.

The safety plans must be approved by state Health Commissioner Robert Whalen and area residents before construction begins, officials said.

Violante said construction was scheduled to start Tuesday, but because of the mass evacuation, the starting date would be delayed at least two more weeks.

More than 40 families have been relocated with relatives, at motels or at apartments at the Niagara Falls Air Force base.

The state and federal governments are paying moving expenses and have offered to pay "fair-market" values for the homes.

Meanwhile, a five-man team of aerial photography experts from Cornell University is comparing 40-year-old photographs with current ones of the area to help determine the canal's original drainage pattern.

State health officials say infrared aerial photographs and old maps indicate that the Love Canal dumping site may have extended from Frontier Avenue south to the Niagara River, more than 200 yards.

Deputy Health Commissioner Glenn Haughie said the chemicals dumped on the site by the Hooker Chemical and Plastic Corp., 25 years ago show up in light green patches on the infrared photographs. This green runs beyond the southern boundary of the residential area "as though the canal extended all the way to the river."

Haughie also said some 1938 aerial photographs "have been interpreted as showing an extension of the canal to the river."

Officials said there are no homes there and the first phase of cleanup operations doesn't call for any remedial efforts.

# Cornell aids in pollution search

By PHILIP LERMAN

Experts in aerial photography at Cornell University are helping state Department of Health officials in assessing the potential spread of chemical contamination throughout the Love Canal and Niagara Falls area

Using photos owned by Cornell of the site as it was in the 1930's, when the canal was still open, a team from the College of Engineering has been able to determine the original drainage pattern of the area

"Luckily, the area had been photo-

graphed several times," said Warren R. Philipson, a senior research associate in the college of Civil and Environmental Engineering "And luckily, we had those photos here at Cornell "

Philipson explained that by looking at the original drainage patterns, and by looking at subsequent photos to see the change in the drainage of the canal over the years, the team has been able to come up with a good guess about where the contaminated drainage might be going

"We don't think it's migrated very

far in general," Philipson said

The project, funded largely under the Remote Sensing Program by NASA, was initiated to help state health officials decide where to test water samples for contamination

In addition, the Cornell team took aerial photos of the Love Canal area last week with color-infrared film, which Philipson said is useful in observing the health of vegetation and the moisture conditions of the area. These can also be helpful in studying the spread of contaminants, he said

Syracuse Herald-American, Sunday, Aug 13, 1978

## Contaminated area may be enlarged

NIAGARA FALLS (AP) — Recent infra-red photographs and 1938 aerial pictures provided by Cornell University appear to indicate a forgotten section of the contaminated Love Canal lying beyond what were thought to be the former dump's borders, health officials here said

The suspected additional area of contamination has great significance because it may link the known danger area to the Niagara River, which is an international

body of water forming the boundary between the United States and Canada, and which flows into Lake Ontario

The federal Environmental Protection Agency was trying to determine to what extent chemicals left in this previously unsuspected area may have leaked into international waters

The discovery of the forgotten stretch came as state officials prepared to announce plans for a cleanup program. (Concluded on Page 10)

## Greater contamination feared

(From Page One)

announce the first phase of remedial cleanup plans for the area that is known to be contaminated.

State Deputy Health Commissioner Glenn Haughie said Friday that chemicals dumped in the region by the Hooker Electrochemical Co., now Hooker Chemicals and Plastics Corp., 25 years ago show up on the infra-red photos as light green streaks

Haughie said this tell-tale green line runs beyond that was thought to be the southern border of the landfill at Frontier Avenue "as though the canal extended all the way to the river."

In addition, Haughie said, 1938 aerial photographs given to the department by Department of Engineering "have been interpreted as showing an extension of the canal to the river "

"We have nothing conclusive to show that (the canal) communicates directly with the river, said David Axelrod, director of the Health Department's Division of Laboratories and Research, "but the evidence points in that direction "

There are no houses near the new section and currently no plans to perform remedial work there.

The plans for the \$840,000 first phase of remedial work for the already-known

canal site were set to be released tomorrow

These plans are thought to depend heavily on a private consulting firm's recommendations to the City of Niagara Falls that an underground tile system be built to drain off dangerous chemicals from the former dumping ground

Runoff from the sewer system would be fed through an EPA-designed carbon-activated filtering system and then sent through Niagara Falls' regular sewage system.

State officials from the other two departments in the Love Canal task force — health and transportation — meanwhile worked on plans to round out medical records by testing former residents and to evacuate the 237 families living on the two streets bordering the canal

The state has promised that the 97 families in the inner ring of houses directly abutting the canal will be moved before remedial work starts

The Love Canal, the ditch left behind by a never-completed 19th-century project by developer William Love to create a shortcut between the Niagara River and Lake Ontario, was used as a dump by Hooker and from 1943 until 1953, company officials said

## No Love for Love Canal

Experts in aerial photography at Cornell University are helping state Health Department officials assess the potential spread of contaminated chemicals throughout the Love Canal area in Niagara Falls

Using photographs of the site taken in the late 1930s before the canal began to be filled in, a team of analysts in the College of Engineering at Cornell has been able to determine the original drainage pattern of the area

According to Warren R. Philipson, a senior research associate, who heads Cornell's five member team, this information provides a base for testing how widely the chemicals have leached away from the landfill site itself

Also being used in the analysis are photographs at Cornell of the area in the 1950s and 1960s showing the historical development of the area and the ways the original drainage pattern has been distorted.

The work being done for the state at Love Canal is provided for under a grant to Cornell from the National Aeronautics and Space Administration

The pictures at Cornell are part of one of the world's largest university collections of photographs covering the entire globe. Some date back to the early 1930s. They are part of the Remote Sensing Program in the College of Civil and Environmental Engineering at Cornell.

APPENDIX B

LANDSAT ANALYSIS FOR PHEASANT RANGE  
MANAGEMENT IN NEW YORK STATE

LANDSAT ANALYSIS FOR PHEASANT RANGE  
MANAGEMENT IN NEW YORK STATE

Remote Sensing Program  
Cornell University  
Hollister Hall  
Ithaca, New York 14853

July 1978

## ACKNOWLEDGMENTS

This study was supported by NASA Grant NGL 33-010-171, and conducted by Brian L. Markham at the request of Peggy R. Sauer, Supervising Wildlife Biologist, New York State Department of Environmental Conservation. Several other staff and students of the Remote Sensing Program contributed to the work. Warren R. Philipson assisted in project direction and development; Josephine Ng implemented the digital analyses of the satellite data; Ann E. Russell and Laurie B. Schuller collected and compiled the cropping data; Jeffrey R. Gregrow provided additional crop information; Deborah Halpern performed the photographic darkroom work; and Pat Webster typed this manuscript.

Ta Liang  
Professor In Charge,  
Remote Sensing Program

## INTRODUCTION

As part of the pheasant habitat management program of the New York State Department of Environmental Conservation (DEC), there is a need to relate pheasant densities to the State's land cover patterns. The DEC has identified twelve land cover types that should be inventoried, with a minimum mapping unit of approximately four hectares. Seven of the twelve cover types had already been mapped by the statewide Land Use and Natural Resources Inventory, LUNR\* (Table 1); however, five cover types of interest had not been separated: (1) hay, (2) corn, (3) other (small) grains, (4) soybeans, and (5) truck crops. This study set out to test remote sensing methods that might be adopted by the DEC for separating these cover types in the Finger Lakes-Lake Plains Region, the area of New York which supports the densest population of pheasants.

### APPROPRIATE REMOTELY SENSED DATA

In general, two types of remotely sensed data would be potentially applicable for inventorying the five land cover types of interest, aerial photographs and Landsat satellite data.

#### Aircraft Photography

The existing aerial photographic coverage of New York State is predominantly medium scale (1:15,000-1:40,000), stereoscopic, black-and-white, panchromatic photography (normally 0.5-0.7 $\mu$ m), flown within the last ten years, during the early spring or fall. Because of age and season, this coverage is not appropriate for crop identification.

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\* The LUNR is a computer-based inventory, derived primarily through interpretation of 1:24,000 scale, panchromatic aerial photographs, flown mainly in 1967-1968. Although ten years out of date, the LUNR data seemed to provide a reasonable representation of the seven categories in test areas. Moreover, the LUNR demonstrates how these categories could be updated using the comparable but more recent aerial photographs that cover most of the State.

Table 1. Land cover types selected by State for pheasant-related inventory and LUNR equivalents.

<u>STATE-SELECTED TYPES</u>	<u>LUNR EQUIVALENT</u> <sup>*</sup>
1. Brushland	1. Forest Brushland (Fc) <sup>**</sup>
2. Woods	2. Forest Lands (Fn) <sup>**</sup>
3. Forest Plantations	3. Forest Plantations (Fp)
4. Orchards & Vineyards	4. Orchards & Vineyards (Ao, Av)
5. Fallow fields (inactive agriculture)	5. Inactive Agriculture (Ai)
6. Pasture	6. Pasture-permanent (Ap)
7. Wetlands	7. Wetlands (Wb, Ww)
8. Hay (alfalfa, timothy, etc.)	8. } included under active cropland (Ac and At)
9. Corn	
10. Other Grains (wheat, oats, barley, etc.)	
11. Soybeans	
12. Truck crops and Plowed land	

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\* LUNR: Land Use and Natural Resources Inventory of New York State.

\*\* The demarcation between Fc and Fn is nominally 30 feet, while State would prefer 15 feet.

Most of the Finger Lakes Region is also covered with high-altitude (1:130,000 scale), color infrared photography (3-layer film; 0.5-0.6 $\mu$ m, 0.6-0.7 $\mu$ m and 0.7-0.9 $\mu$ m), flown by NASA for the Cornell Remote Sensing Program on May 7, 1975. Season and age also caused this coverage to be of little value for crop identification.

If aerial photographs were to be the primary tool, it would have been necessary to fly new photography over the entire Lake Plains-Finger Lakes Region.\* Given the size of the area, this would have been an expensive task, especially since the DEC would be interested in periodically updating the inventory.

#### Landsat Data

At the time of this study, there were two operating Landsat satellites (1 and 2). Each carried a multispectral scanner (MSS) which collected solar-reflected radiation in four parts of the electromagnetic spectrum: 0.5 to 0.6 $\mu$ m (green, designated band 4), 0.6 to 0.7 $\mu$ m (red, band 5), 0.7 to 0.8 $\mu$ m (near infrared, band 6) and 0.8 to 1.1 $\mu$ m (near infrared, band 7). Radiation in these four spectral bands was sensed through optics which subtended a ground area of 79-by-79 meters (0.6 hectares), corresponding to the smallest element of a 185-by-185km Landsat picture (i.e., a "resolution element," "picture element" or "pixel").

The Landsat data are available in image form, there being one image for each spectral band or four "spectral" images for each Landsat scene; or they are available in digital form, there being one high density, computer-compatible tape (CCT) for each Landsat scene. At the time of this study, a positive 70mm transparency of a spectral

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\* High-altitude, color and color infrared photography over most of the Finger Lakes was flown by NASA for other Cornell studies on May 26, 1978. The films were received on June 26, 1978, after the analysis had been terminated.

image cost \$8 (i.e., \$32 for all images of a scene), and a CCT cost \$200. Although digital analysis of the CCTs is nearly always more costly than analysis of the images, the digital data provide the maximum amount of spatial and spectral information.

Each satellite passed overhead about 9:30 a.m., every 18 days. Although the satellites were once separated by a 9-day interval, orbital changes resulted in one satellite preceding the other by 12 days and subsequently following the other by 6 days. Another significant development was that band 4 of the Landsat-1 MSS ceased operating in March 1977.

Unlike most aerial photography, the spatial resolution of Landsat MSS data (0.6 hectares) is insufficient for extracting much if any information on crop texture or crop-associated features, and Landsat data provide no information on crop height. For cover type studies with Landsat, emphasis must be placed on spectral information (e.g., different crops can be separated if they reflect different amounts of solar radiation in the same spectral band). Landsat data provide quantitative information on visible and near-infrared spectral reflectance; they are repetitive (subject to cloud cover and haze), and available at a comparatively low cost.

In general, if a methodology for using Landsat data to separate the cover types of interest could be developed--primarily on the basis of spectral or spectral/temporal differences--then the Landsat satellites would provide an effective tool for the DEC. The minimum size mapping unit of four hectares is compatible with Landsat resolution, and overall, the Landsat system is scheduled for future upgrading.

#### DATA FOR ANALYSIS

##### Landsat Data

The Landsat coverage of New York's Finger Lakes Region, collected at times of less than 80% cloud cover, during the growing season of 1977, is listed in Table 2. For the digital analyses, the CCT

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Table 2. Landsat coverage of the Finger Lakes Region, N.Y., collected at times of less than 80% cloud cover, during April to October, 1977. (Source: EROS Data Center, Sioux Falls, S.D.)

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DATA TYPE MULTISPECTRAL													
IMAGERY TYPE	SCENE ID	PATH,ROW	FILM	SOURCE	QUALITY	CLOUD	EXPO	DATE	SCENE CENTER POINT	SCENE SCALE	MICROFILM	CC1	CCP
LANDSAT-2 (MSS)	8601314441500	017,030	B&W 2.2"	8,8,8,8	10%	10/31/77	N43D07M59S	W076U54M0GS	1:3,369,000	0000		F	P
CORNER POINT COORDINATES=#1:N43D42M39S W075D29M58S ,#2:N44C03M12S W077D41M49S ,#3:N42D12M26S W076D07M41S ,#4:N42D32M22S W078D18M29S													
LANDSAT-2 (MSS)	8299514451500	017,030	B&W 2.2"	8,8,8,8	50%	10/13/77	N43D12M59S	W076D51M59S	1:3,369,000	0000		P	P
CORNER POINT COORDINATES=#1:N43D47M25S W075D28M29S ,#2:N44D07M48S W077D39M34S ,#3:N42D17M50S W076D05M55S ,#4:N42D37M36S W078D13M59S													
LANDSAT-1 (MSS)	8586013591500	017,030	B&W 2.2"	8,8,8,8	20%	08/26/77	N43D13M59S	W077D03M59S	1:3,369,000	0000		F	P
CORNER POINT COORDINATES=#1:N43D49M25S W075D40M35S ,#2:N44D08M39S W077D52M53S ,#3:N42D18M59S W076D16M38S ,#4:N42D37M36S W078D25M50S													
LANDSAT-2 (MSS)	8294114462500	017,030	B&W 2.2"	8,8,8,8	50%	08/20/77	N43D06M0GS	W076D54M59S	1:3,369,000	2100340048		F	P
CORNER POINT COORDINATES=#1:N43D43M53S W075D30M29S ,#2:N44D01M33S W077D43M08S ,#3:N42D10M05S W076D08M23S ,#4:N42D30M07S W078D17M57S													
LANDSAT-1 (MSS)	8584214012500	017,030	B&W 2.2"	8,8,8,8	50%	08/08/77	N42D27M0GS	W077D20M59S	1:3,369,000	1100610657		F	P
CORNER POINT COORDINATES=#1:N43D02M43S W075D58M15S ,#2:N43D21M50S W078D09M34S ,#3:N41D31M48S W076D33M55S ,#4:N41D50M20S W078D42M13S													
LANDSAT-2 (MSS)	8292314492500	017,030	B&W 2.2"	8,8,8,8	10%	08/02/77	N43D04M59S	W076D52M59S	1:3,369,000	2100330678		F	P
CORNER POINT COORDINATES=#1:N43D39M51S W075D27M54S ,#2:N44D01M00S W077D41M07S ,#3:N42D08M39S W076D06M24S ,#4:N42D29M09S W078D16M32S													
LANDSAT-1 (MSS)	8582414030500	017,030	B&W 2.2"	8,8,8,8	40%	07/21/77	N43D06M0GS	W077D07M59S	1:3,369,000	1100600776		F	P
CORNER POINT COORDINATES=#1:N43D41M42S W075D43M59S ,#2:N44D01M00S W077D57M11S ,#3:N42D10M28S W076D20M21S ,#4:N42D29M18S W078D30M25S													
LANDSAT-2 (MSS)	8290514501500	017,030	B&W 2.2"	8,8,8,8	20%	07/15/77	N43D04M59S	W076D54M59S	1:3,369,000	2100321240		Y	P
CORNER POINT COORDINATES=#1:N43D39M56S W075D30M10S ,#2:N44D00M48S W077D43M14S ,#3:N42D08M50S W076D08M17S ,#4:N42D29M03S W078D18M15S													
LANDSAT-2 (MSS)	8288714511500	017,030	B&W 2.2"	8,8,8,8	10%	06/27/77	N43D06M59S	W076D52M59S	1:3,369,000	2100320451		F	P
CORNER POINT COORDINATES=#1:N43D41M35S W075D28M39S ,#2:N44D02M27S W077D40M44S ,#3:N42D11M12S W076D06M40S ,#4:N42D31M26S W078D15M48S													
LANDSAT-1 (MSS)	8578814064500	017,030	B&W 2.2"	8,8,8,8	20%	06/15/77	N43D09M0GS	W077D06M59S	1:3,369,000	1100590506		F	P
CORNER POINT COORDINATES=#1:N43D44M19S W075D43M12S ,#2:N44D03M58S W077D55M41S ,#3:N42D13M39S W076D19M50S ,#4:N42D32M42S W078D25M13S													
LANDSAT-1 (MSS)	8577014083500	017,030	B&W 2.2"	8,8,8,8	10%	05/26/77	N43D15M0GS	W077D10M59S	1:3,369,000	1100590000		F	P
CORNER POINT COORDINATES=#1:N43D50M43S W075D47M59S ,#2:N44D00M20S W078D00M15S ,#3:N42D20M17S W076D23M16S ,#4:N42D38M20S W078D32M26S													
LANDSAT-2 (MSS)	8285114525500	017,030	B&W 2.2"	8,8,8,8	10%	05/22/77	N43D15M0GS	W076D50M59S	1:3,369,000	2100310329		F	P
CORNER POINT COORDINATES=#1:N43D49M17S W075D27M30S ,#2:N44D09M46S W077D32M25S ,#3:N42D19M53S W076D05M04S ,#4:N42D39M45S W078D12M58S													
LANDSAT-1 (MSS)	8575214101500	017,030	B&W 2.2"	8,8,8,8	50%	05/10/77	N43D15M0GS	W077D07M59S	1:3,369,000	1100590100		F	P
CORNER POINT COORDINATES=#1:N43D50M26S W075D45M01S ,#2:N44D09M20S W077D56M54S ,#3:N42D20M17S W076D20M37S ,#4:N42D38M36S W078D29M25S													
LANDSAT-2 (MSS)	8283314535500	017,030	B&W 2.2"	8,8,8,8	30%	05/04/77	N43D12M0GS	W076D52M59S	1:3,369,000	2100300407		F	P
CORNER POINT COORDINATES=#1:N43D46M29S W075D29M15S ,#2:N44L06M49S W077D40M39S ,#3:N42D16M40S W076D06M51S ,#4:N42D36M33S W078D15M12S													
LANDSAT-2 (MSS)	8281514545500	017,030	B&W 2.2"	8,8,8,8	20%	04/10/77	N43D10M59S	W076D54M59S	1:3,369,000	2100291073		F	P
CORNER POINT COORDINATES=#1:N43D45M46S W075D30M33S ,#2:N44D06M25S W077D43M03S ,#3:N42D15M12S W076D08M29S ,#4:N42D35M14S W078D17M53S													

of the July 15, 1977, Landsat-2 scene was acquired, and the CCT of an August 2, 1976, Landsat-2 scene (#8258014582500) was already on file having been obtained earlier for an unrelated study. For the manual (non-computer) analyses, selected spectral images were acquired of the following 1977 scenes: May 4, May 22, June 27, August 2, and August 26. These images were purchased as 70mm, positive transparencies and subsequently enlarged.

#### Ground Data

Ground data for use in verifying the interpretation of the Landsat data were collected in three areas within the Finger Lakes Region (Fig. 1): (1) along Interstate 81, south of Tully, N.Y. ("Tully area," approx. 35 km<sup>2</sup>); (2) along Cayuga Lake, near King Ferry, N.Y. ("King Ferry area," approx. 35 km<sup>2</sup>); and (3) along Owasco Lake, near Owasco, N.Y. ("Owasco area," approx. 15 km<sup>2</sup>).

The ground data were collected during July and August 1977. They consisted of field observations of land cover types and interview-derived data on land cover (crop) types that were present in 1976. The field boundaries and cover types were recorded on enlarged, black-and-white prints of available high-altitude aerial photographs.

#### Auxilliary Cropping Data

To aid the interpretation and selection of imagery, a "calendar" of planting, growth and harvesting dates of the major field and truck crops in the Finger Lakes-Lake Plains Region was prepared from several interview and literature sources (Fig. 2).

### SINGLE DATE ANALYSES

#### Procedure

The initial attempts to discriminate the five cover types of interest involved the use of Landsat data in digital form. Although computer analysis techniques are nearly always more expensive than manual approaches, for problems requiring spectral recognition,

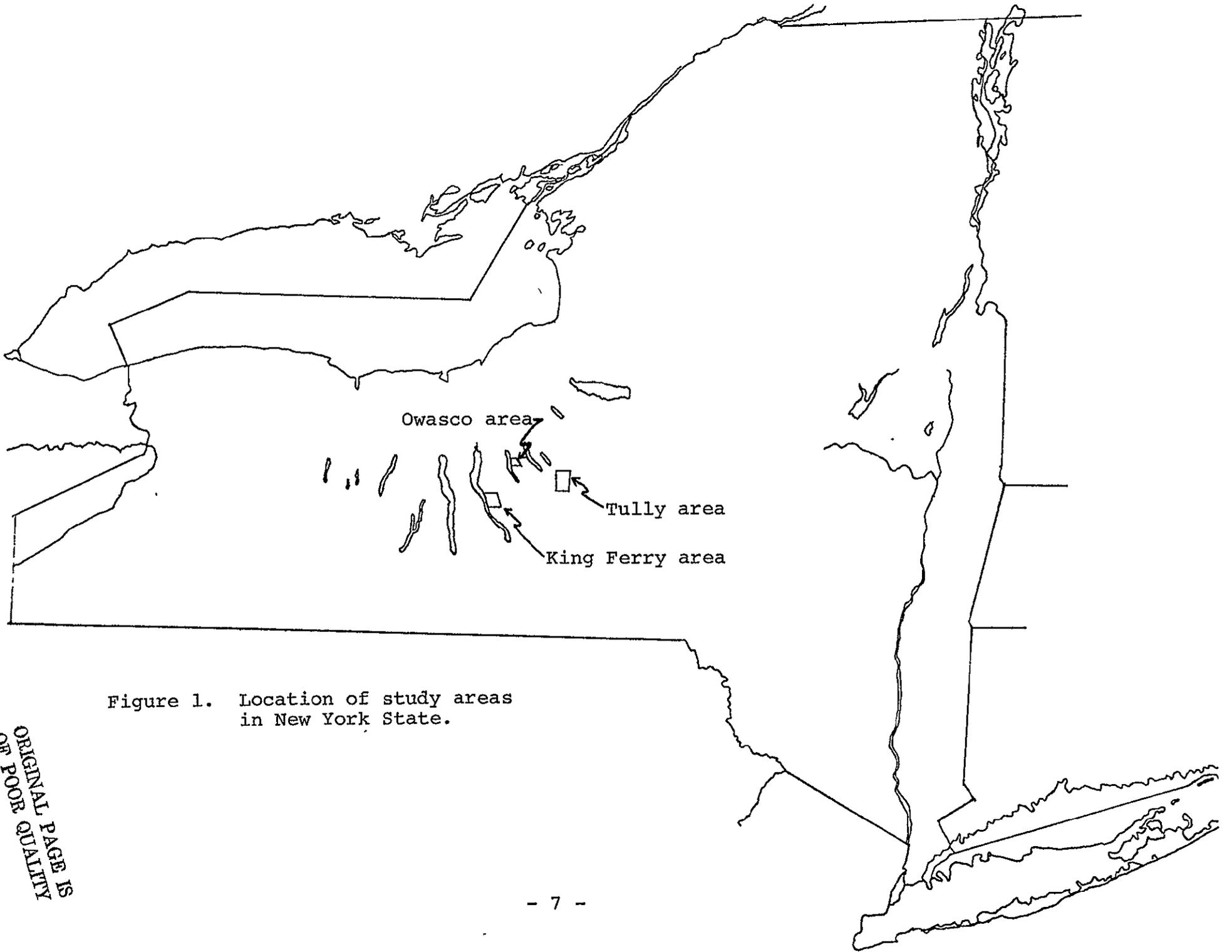
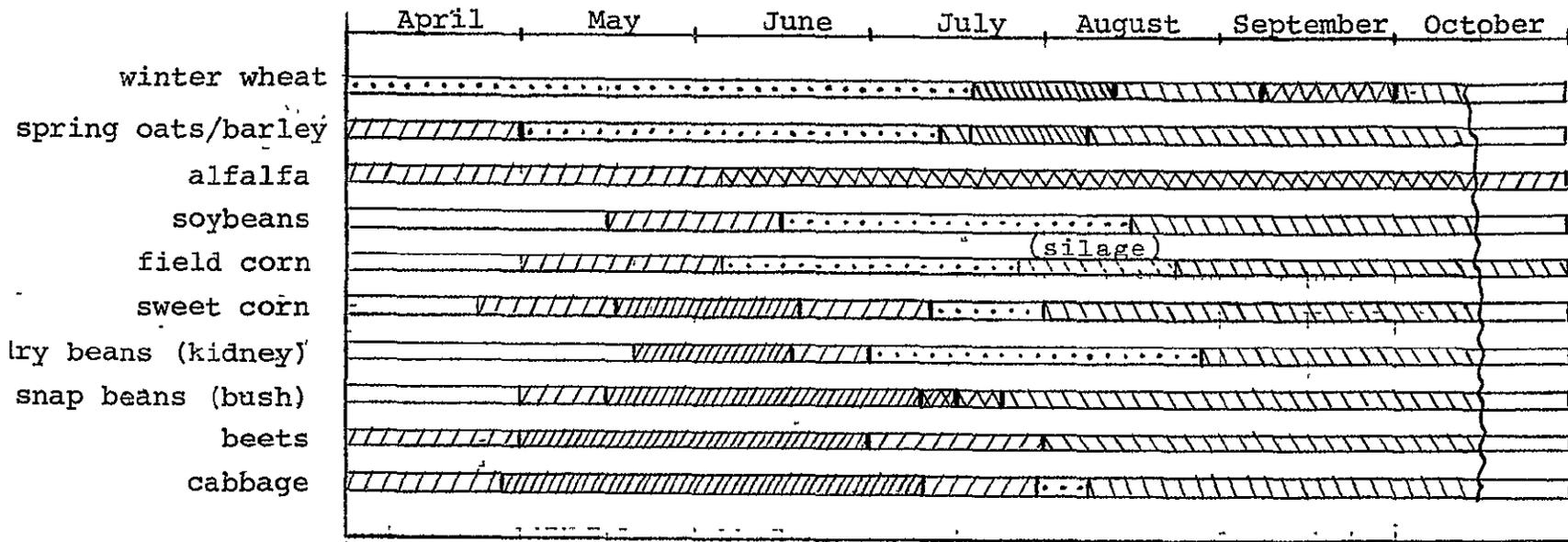


Figure 1. Location of study areas in New York State.

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Figure 2. Crop calendar for Finger Lakes Region and western New York State.



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crop generally absent	crop generally present
general planting period	general harvesting period
primary planting period	primary harvesting period
concurrent planting and harvesting	

Notes:

1. Data compiled primarily from: "Cornell Recommends for Field Crops, 1977" and "Commercial Vegetable Production Recommendations, 1977," from the N.Y.S. College of Agriculture and Life Sciences, Cornell University, Ithaca, N.Y. Average weather and the most common farming practices are assumed.
2. Most fields of alfalfa, a perennial crop, are not planted every year.
3. Field corn is planted 10 days before the average last frost date, and beginning in late-July, it may be cut for silage.

computer techniques will normally indicate whether the desired information is derivable from the data. Failure to separate the cover types with digital data would indicate that manual analyses would also be unsuccessful, however, the reverse is not necessarily true.

A July 15, 1977, Landsat-2 scene was chosen for analysis because the crop calendar indicated that most fields should have crops on this date (Fig. 2). The CCT of an August 24, 1976, Landsat-2 scene, on hand for another investigation, was also analyzed.

The digital analyses were conducted using a supervised classification procedure. This involves "training" the computer to separate the various categories of interest on the basis of their spectral value. The essential steps are: (1) using the ground data, choose test sites in the Landsat scene (e.g., test site 1 includes pixels--picture elements--that depict fields known to have corn; test site 2: pixels depicting alfalfa fields; etc.); (2) have the computer generate selected statistics on the spectral characteristics of the chosen sites (e.g., calculate the average values of the spectral responses of corn and alfalfa in the test sites, for each spectral band); and (3) input these statistics to algorithms that classify all pixels of the scene, or portion of the scene, into the category to which it is most similar spectrally (e.g., pixels displaying spectral values closer to those of the test site corn than to those of the test site alfalfa will be classed as corn).

Several data pre-processing routines were used in an attempt to improve the classification. These include canonical analysis, where the spectral data are transformed to provide maximum separability among test site categories, and ratioing, where the ratio of a pixel's value in one spectral band to its value in another spectral band is computed and used to represent the pixel. No special attempt was made to eliminate atmospheric effects (e.g., haze) from the data.

The Tully area was used as the primary area for analysis, and the King Ferry area was used as a secondary area (Fig. 1). Certain crops present in the King Ferry area were not present in the Tully area. The Owasco area was used to check the applicability of classifications developed in the Tully or King Ferry areas.

### Results

July 15, 1977 data:

The crops in the Tully area were primarily corn and alfalfa, with some oats and truck crops (mainly cabbage); while corn, alfalfa, oats, wheat and beans (snap, red kidney and soybean) were the principal crops in the King Ferry area. The spectral characteristics of these crops are shown in Table 3. Being at various growth stages, alfalfa exhibited a wide range of spectral values. The crop was arbitrarily separated into two spectral categories which were thought to correspond to recently cut and uncut alfalfa fields. Similarly, in the King Ferry area, corn was separated into two categories (apparently, early and late-planted) and beans into three categories (soybeans; unharvested snap beans and red kidney beans; and harvested snap beans and/or late-planted snap or kidney beans--essentially bare fields).

The results of spectrally classifying the canonically transformed test site categories are reported in Tables 4 and 5. A computer printout for part of the classified King Ferry area is presented in Figure 3.

August 24, 1976 data:

The analyses conducted with the 1976 data were not as extensive as those with the 1977 data, principally because the 1976 ground data were obtained by interview during 1977 and were thus judged to be of lower reliability. The spectral characteristics of the crops in the Tully area on August 24, 1976 are reported in Table

Table 3. Means and standard deviations, in parentheses, of spectral radiance counts of test site cover types in Finger Lakes Region, N.Y., as recorded by Landsat-2 on July 15, 1977.

TEST SITE CATEGORIES	NUMBER PIXELS	LANDSAT SPECTRAL BANDS			
		4	5	6	7
<u>Tully Area Test Sites</u>					
Corn	71	16.9 (0.9)	14.2 (1.1)	58.1 (4.6)	31.8 (3.0)
Alfalfa-1*	49	18.2 (1.0)	16.2 (1.7)	66.1 (4.9)	35.4 (2.4)
Alfalfa-2*	26	20.7 (1.9)	22.3 (3.1)	52.5 (2.6)	25.4 (1.7)
Oats	24	16.8 (0.8)	14.7 (1.4)	53.5 (4.9)	28.1 (3.4)
Cabbage	8	22.1 (1.7)	21.4 (1.4)	73.9 (4.2)	36.1 (2.0)
<u>King Ferry Test Sites</u>					
Corn-1**	76	20.2 (2.0)	18.2 (2.7)	60.1 (2.3)	31.9 (1.6)
Corn-2**	57	33.2 <sup>1</sup> (5.1)	42.0 (8.6)	54.6 (6.4)	22.4 (2.9)
Beans-1***	56	28.4 (2.7)	34.8 (5.5)	50.3 (3.6)	21.6 (2.3)
Beans-2***	17	26.2 (1.7)	26.9 (2.3)	63.0 (3.2)	29.9 (1.3)
Soybeans	15	19.8 (1.4)	16.9 (1.1)	77.3 (7.3)	41.1 (3.8)
Alfalfa-1*	38	20.0 (1.2)	16.6 (1.1)	66.0 (5.6)	34.8 (3.2)
Alfalfa-2*	15	22.3 (1.6)	23.9 (1.6)	45.5 (4.1)	21.7 (2.1)
Oats	24	23.6 (2.0)	27.2 (2.7)	40.8 (2.5)	18.4 (1.2)
Wheat	46	21.3 (2.5)	25.6 (2.7)	38.6 (4.9)	17.0 (2.8)

\* 1-cut, 2-uncut. Alfalfa fields were at different stages of growth. The separation into cut and uncut is somewhat arbitrary.

\*\* Compared to corn-1, corn-2 appears to be late-planted.

\*\*\* 1: includes cut and late-planted snap beans and, possibly, red kidney beans.

2: includes red kidney beans and, possible, uncut snap beans.

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Figure 3. Computer printout of a portion of the spectrally classified King Ferry area.

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(Each symbol denotes a pixel of 15 July 1977 Landsat data, classified after canonical transformation.)

CATEGORY	NAME	NUMBER	SYMBOL	14122191222412229122341223912244122491
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				...//C.//C.CC./..CC//CCC.BOW//...CCC//
				C...//C/C/C...C.CCCCCC...CCC//00WWW
	CORN 1	1	C	CCAA...//...ACC...//C...//CCC...C//CWWWWW
	CORN 2	2	<	CCAA...CC...CC...W/C...//.CC//CC/C//C/WO/CA
	BEANS 1	3	B	CAC...PB...CC.../.../BB.C//CCC//C/W/CAA
	BEANS 2	4	-	...PB...CC.../.../BB.C//CCC//C/W/CAA
	BEANS 3	5	.	...//.../.../.../.../.../.../.../.../...
	ALFALFA 1	6	A	C...//.../.../.../.../.../.../.../.../...
	ALFALFA 2	7	/	/C...//.../.../.../.../.../.../.../.../...
	OATS	8	O	/CC...//.../.../.../.../.../.../.../.../...
	WHEAT	9	w	//P.../.../.../.../.../.../.../.../.../...
	OTHER	10		AC.../.../.../.../.../.../.../.../.../...
1662	I.C..P.../.../.../.../.../.../.../.../.../...			.../.../.../.../.../.../.../.../.../...
1663	I...C..C..P.../.../.../.../.../.../.../.../.../...			.../.../.../.../.../.../.../.../.../...
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1697	I			.../.../.../.../.../.../.../.../.../...

6. No detailed statistics were generated for the King Ferry area crops, although their general characteristics were examined.

### Discussion

Compared to the Tully area, a valley, the King Ferry area is more open, somewhat lower in altitude, and generally, more representative of the Finger Lakes Region. In addition, field sizes tend to be smaller in the Tully area, making it more difficult to obtain reliable statistics on the spectral characteristics of the cover types.

As evidenced in Table 3, some differences in the spectral characteristics of cover types were observed between the two areas, especially in the responses of spectral bands 4 (green) and 5 (red). On the other hand, the generally higher band 4 and 5 responses in the King Ferry area are likely to be at least partly attributed to greater amounts of haze over this area. More significantly, some spectral differences, such as those exhibited by oats in the July Landsat scene (Table 3), are thought to be related to a difference in growth stage. Oats in the Tully area were likely to be at an earlier stage of growth, a possibility which could not be confirmed due to the lack of concurrent ground data.

Although the values presented in Tables 4 and 5 provide only an indication of the accuracy obtainable with spectral classification, it is clear that certain problems were and would be encountered. Within the Tully area, in July, the principal confusion was between oats and corn, with some confusion between alfalfa and corn (Table 4). In August, corn and alfalfa appeared to be generally separable, although some confusion would be expected between harvested corn and cut alfalfa fields (Table 6). The spectral differences for oats in Table 6 may be related to differences in cultivation practices after harvest (or, possibly

Table 4. Results of spectrally classifying the July 15, Tully area test site pixels using a Euclidean distance classifier following canonical transformation.

CLASSIFIED CATEGORIES	ACTUAL TEST SITE CATEGORIES			
	Corn	Alfalpa	Oats	Cabbage
Corn	45 (63%)	7 (9%)	11 (46%)	0 (0%)
Alfalpa	6 (8%)	65 (87%)	1 (4%)	0 (0%)
Oats	20 (28%)	3 (4%)	12 (50%)	0 (0%)
Cabbage	0 (0%)	0 (0%)	0 (0%)	8 (100%)
No. Pixels	71	75	24	8

Table 5. Results of spectrally classifying the July 15, King Ferry area test site pixels using a Euclidean distance classifier following canonical transformation.

A. Pixel Assignments Based on Five Categories

CLASSIFIED CATEGORIES	ACTUAL TEST SITE CATEGORIES				
	Corn	Beans	Soy.	Alf.	O. & W.
Corn	96 (72%)	8 (11%)	0 (0%)	12 (23%)	0 (0%)
Beans-1,-2	29 (22%)	60 (83%)	0 (0%)	1 (2%)	1 (1%)
Soybeans	0 (0%)	3 (4%)	11 (73%)	8 (15%)	0 (0%)
Alfalfa	6 (5%)	1 (1%)	4 (27%)	30 (57%)	6 (9%)
Oats and Wheat	2 (2%)	1 (1%)	0 (0%)	2 (4%)	63 (90%)
No. Pixels	133	73	15	53	70

B. Pixel Assignments Based on Three Categories

CLASSIFIED CATEGORIES	ACTUAL TEST SITE CATEGORIES		
	Corn & Beans	Soy. & Alf.	O. & W.
Corn and Beans-1,-2	194 (94%)	13 (19%)	1 (1%)
Soybeans and Alfalfa	9 (4%)	53 (78%)	6 (9%)
Oats and Wheat	3 (1%)	2 (3%)	63 (90%)
No. Pixels	206	68	70

Table 6. Means and standard deviations, in parentheses, of spectral radiance counts of test site cover types in Tully area, N.Y., as recorded by Landsat-2 on August 24, 1976.

TEST SITE CATEGORIES	NUMBER PIXELS	LANDSAT SPECTRAL BANDS			
		4	5	6	7
Corn	39	15.7 (1.0)	14.0 (1.2)	53.2 (4.3)	30.8 (2.2)
Alfalfa	79	16.6 (0.8)	14.2 (1.4)	70.1 (5.5)	39.9 (3.7)
Cut Fields (Alfalfa and Corn?)	31	19.7 (1.1)	26.4 (2.3)	48.4 (3.7)	24.4 (1.9)
Oats-1 (?)	12	18.7 (1.3)	19.3 (0.6)	54.4 (3.4)	27.9 (1.0)
Oats-2 (?)	16	14.4 (1.2)	13.4 (0.9)	44.4 (1.9)	25.4 (1.0)

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to erroneous ground data), since oats are normally harvested by August 24.

In the King Ferry area, in July, little confusion was observed between oats (and wheat) and corn, however, some overlap between alfalfa and corn was still apparent (Table 5). In addition, much spectral overlap was exhibited by corn and snap and red kidney beans (apparently between recently planted corn and bean fields and recently harvested bean fields) and by alfalfa and soybeans. Although not shown, three groups of crops showed evidence of separability with the August 24 data: (1) alfalfa and certain bean fields (soy? and kidney?), (2) uncut corn, and (3) wheat and oats, cut alfalfa, and certain bean fields (cut snap beans?). For both the July and August data, the nature of the ground data did not allow the cause of confusion to be determined completely.

#### MULTI-DATE ANALYSIS

##### Procedure

Given that few of the cover types of interest could be reliably separated on a single date of Landsat data, it was decided to proceed to a multi-date ("time-sequential" or "temporal") approach. Multi-date analyses of Landsat data can take advantage of cropping patterns as well as reflectance differences, and are therefore potentially more accurate than single date analyses in separating crops. The crop calendar indicated that data collected during either mid-May to early June or mid-August would be most useful (Fig. 2).

Minimally, the mid-May data should allow separation of overwintered crops (wheat and alfalfa) from spring-planted crops (corn, oats, soybeans and truck crops); the wheat and alfalfa should exhibit a near-complete vegetative cover, whereas most of the other crops would be in the early stages of growth or

not yet planted. Also, the early spring planted crops (primarily oats and barley) might be separable from the late-spring planted crops, as they would be in a later stage of growth. Spectral differences between wheat and alfalfa might also allow their differentiation.

The mid-August data should allow separation of most of the small grains (wheat, oats and barley) from corn, soybeans and most truck crops; the small grains would be mostly harvested whereas these other crops would not. The small grains might show some similarity with recently cut alfalfa fields and with harvested snap bean fields.

During the growing season (May-September) of 1977, eight Landsat scenes had less than 40% cloud cover (Table 2). Selected images (positive 70mm transparencies) were obtained of the following dates: May 4, May 22, and June 27, August 2 and August 26. Preference was given to Landsat-2 coverage, as band 4 of Landsat-1 was not functional. The May and August scenes were chosen as being closest to the desired times; the June 27 scene was obtained to assess what additional information it might provide. Clouds or haze over the study areas prevented the May 24 and August 26 data from being of value.

For the multi-date analysis, it was decided to use images instead of the computer compatible tapes, given the expense of the tapes and computer processing. Photographic enlargements of the Tully and King Ferry portions of the band 5 (red) and band 7 (near infrared) images were made for the May 22, June 27 and August 2 dates. These enlarged transparencies (both positives and negatives) were analyzed in an additive-color viewer. This device allows as many as four transparencies to be projected simultaneously onto the same screen, with each transparency being projected by a variable intensity, white light source, through either a red, green, blue or clear filter. Thus, posi-

tive and negative images of different dates as well as of different spectrum bands were superimposed, using different color assignments, and evaluated.

### Results and Discussion

Only gross assessment of the spectral nature of the agricultural fields could be performed through visual methods since only three or four levels of gray could generally be distinguished on any one image. As such, it was usually impossible to ascertain much more than whether or not the fields had a vegetative cover.

Within the agricultural field areas, the band 7 (near-infrared) image was almost a negative of the band 5 (red) image. Fields with a full vegetative cover would be low in red reflectance and high in near-infrared reflectance; bare (or recently cut) fields would be high in red reflectance and low in near-infrared reflectance. Although most of the information for any date could be thus obtained from either the band 5 or band 7 image, the band 5 images were preferred because they usually showed sharper field boundaries.

For the additive-color viewer, the combination of spectral band, color and date that seemed to provide the best discrimination, in the most easily interpreted form, used three band 5, positive images: the May 22 image was projected through a red filter, the June 27 image through a blue filter, and the August 2 image through a green filter.\* At least three categories of crops, or groups of crops, of interest were generally separable with this combina-

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\* This combination as well as others could also be obtained with diazo using a subtractive-color process. Results comparable to those obtained in this study would be gotten by overlaying a cyan diazo exposed with the band 5, May 22 image; a yellow diazo exposed with the band 5, June 27 image; and a magenta diazo exposed with the band 5, August 2 image. This diazo combination is being submitted to the DEC with this report.

tion: (1) alfalfa hay, (2) corn, beans and truck crops, and (3) small grains (oats and wheat). The alfalfa appears brown, greenish brown, green or occasionally dark blue; the corn, beans and truck crops appear red, magenta, white or occasionally yellow (snap beans); and the small grains appear yellow, yellowish green or green. Although the separability was not as good as desired (alfalfa could be confused with wheat, and oats could be confused with snap beans), this combination could give generalized information on the distribution of these cover types in the Finger Lakes Region, if non-cropped areas were excluded using LUNR data.

#### GENERAL CONCLUSIONS AND RECOMMENDATIONS

Neither the single dates (July 15, 1977 and August 24, 1976) of Landsat, analyzed digitally, nor the combination of dates (May 22, June 27 and August 2, 1977), analyzed manually, provided adequate separability of all cover types of interest--hay, corn, small grains, soybeans and truck crops. It would seem that, on any one date, the crop reflectance differences in the spectral regions sensed by Landsat are insufficient for crop discrimination. It would also seem that combining standard product Landsat images of different dates will not provide the required separations. The standard product images can generally provide only gross spectral separations (e.g., whether or not the field is cropped), and therefore differences in cropping pattern (calendar) must be relied upon. In some cases, the differences in cropping patterns are not sufficient to allow crop separation.

Two alternative approaches to attempt to obtain the desired information from Landsat data involve combining the digital and multi-date analyses. The first approach would perform a supervised classification of Landsat digital data from two dates. The two recommended dates would fall within the periods of

May 20 to June 5 and either July 10 to 20 or August 10 to 20.\* With well-distributed ground data for training the classifier, four groups of crops should be adequately separated: alfalfa hay, small grains (oats, wheat and barley), soybeans, and corn together with truck crops and dry beans. Some additional separations within the last category should also be possible (e.g., cabbage).

The mid-July period is probably preferable for use in combination with the May data, as the separation of oats from other crops should be clearer. If data from all three periods were cloud-free, however, their combined use should further improve the classification accuracy, though at a substantially higher cost. Such a multi-date, digital analysis would have been possible with the 1977 data. It was not attempted because of the high cost of data acquisition and analyses, and consequent low likelihood of implementation by the DEC--even if the method was demonstrated successfully. Decreased computing costs with wider availability of array processor-type equipment might cause this alternative to merit future consideration.

The second alternative is to: (1) use digital processing to enhance the spectral differences between the crops of interest on different dates, (2) produce new images of the enhanced data, and (3) overlay these enhanced images with an additive-color or subtractive-color process. Combining enhanced images of the May 20 to June 5 and July 10-20 or August 10-20 dates would probably produce separations similar to those made with

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\* Unusual growing conditions might require adjustment of these times. The first period (May 20-June 5) was chosen to be after the overwintered crops (wheat, alfalfa) have "greened," after early spring crops have started to show some vegetative cover, but before most spring crops have grown much. The July 10-20 period was chosen to be just prior to wheat-oats harvest, both of these crops having matured. The August 10-20 period was chosen to be after oats and wheat had been harvested, but before the harvest of most other crops.

computer-classification of the same dates. These analyses may take less computer time than classification, but they would require the special capability of outputting onto film.

The system for producing standard product Landsat images is scheduled to be upgraded in September 1978. The higher quality images will have been subjected to several digital processing techniques, in addition to improved image recording. Higher radiometric and geometric fidelity, increased effective resolution, along with improved tonal contrast of the images should be apparent. The improved images should increase the capacity to separate the crops of interest (being a form of the second alternative listed above), but more selective enhancements may still be necessary.

Other alternatives that might also be considered include supplementing either the single-date or multi-date analyses, reported here, with extensive field surveys; or, as a final note, redefining the cover types that must be separated.

APPENDIX C

SELECTION OF SITES FOR DREDGE SPOIL DISPOSAL AND  
SUBSEQUENT RECREATIONAL DEVELOPMENT, COLUMBIA COUNTY, N.Y.

# COLUMBIA COUNTY PLANNING BOARD

70 NORTH THIRD STREET, HUDSON, NEW YORK 12534

Telephone (518) 828-3375

RAIPH I WILLIAMS Chairman  
Claverack New York 12513

ARTHUR KOWEEK, Vice Chairman  
Hudson New York 12534

GRANVILL HILLS Secretary  
Hudson New York 12534

ALAN P. MUIR  
Planning Director

August 10, 1978

Warren R. Philipson  
Remote Sensing Program  
Hollister Hall  
Cornell University  
Ithaca, New York 14853

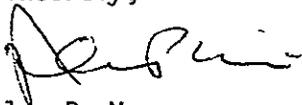
Dear Warren:

I would like to thank you for the work you did using remote sensing and high altitude data in preparing the reports on potential Hudson River recreation areas and the viability of agricultural lands in Columbia County; we are pleased with the scope and quality of both reports.

Presently, both are being circulated to various agencies in the hope that the information produced will create some interest in the use of your findings in local and state programs.

We will let you know how we make out.

Sincerely,



Alan P. Muir  
Planning Director

APM:de

SELECTION OF SITES FOR DREDGE SPOIL DISPOSAL  
AND SUBSEQUENT RECREATIONAL DEVELOPMENT  
IN COLUMBIA COUNTY, N.Y.

Remote Sensing Program  
Cornell University  
Hollister Hall  
Ithaca, New York 14853

July 1978

## PREFACE

This analysis of dredge spoil/recreation sites was performed by William R. Hafker under the direction of Warren R. Philipson and Ta Liang. The work was requested by representatives of the Planning Board of Columbia County, N.Y., and supported by NASA Grant NGL 33-010-171.

## INTRODUCTION

The Hudson River coastline of Columbia County, New York, offers unique and scenic areas for river-oriented recreation, but few recreation facilities are presently available for public use. Periodic dredging of the Hudson River shipping channel, required for navigation, can provide the materials useful for developing suitable sites. The purpose of this study was to identify and assess the best sites for dredge spoil disposal and subsequent recreational development.

## MATERIALS AND METHODS

### Study Area

Columbia County is located on the eastern border of New York State (Fig. 1). The City of Hudson, the County Seat, lies approximately 50 km south of Albany and 190 km north of New York City. The Hudson River, designated as a coastal zone under the Federal Coastal Zone Management Act of 1972, forms the western border of the County. Much of the approximately 50 km coastline slopes rapidly inland, leaving little flat land along the shore. A major railroad line runs along the shore, restricting access to the river.

### Materials

The primary materials used in this study were aerial photographs, topographic maps, and selected maps and reports provided by the Columbia County Planning Board (Table 1).

### Methods

It was decided that sites would be selected from existing land masses rather than from submerged areas. Four criteria were employed in the initial screening process.

Table 1.

Primary Reference Materials

A. Aerial Photographs

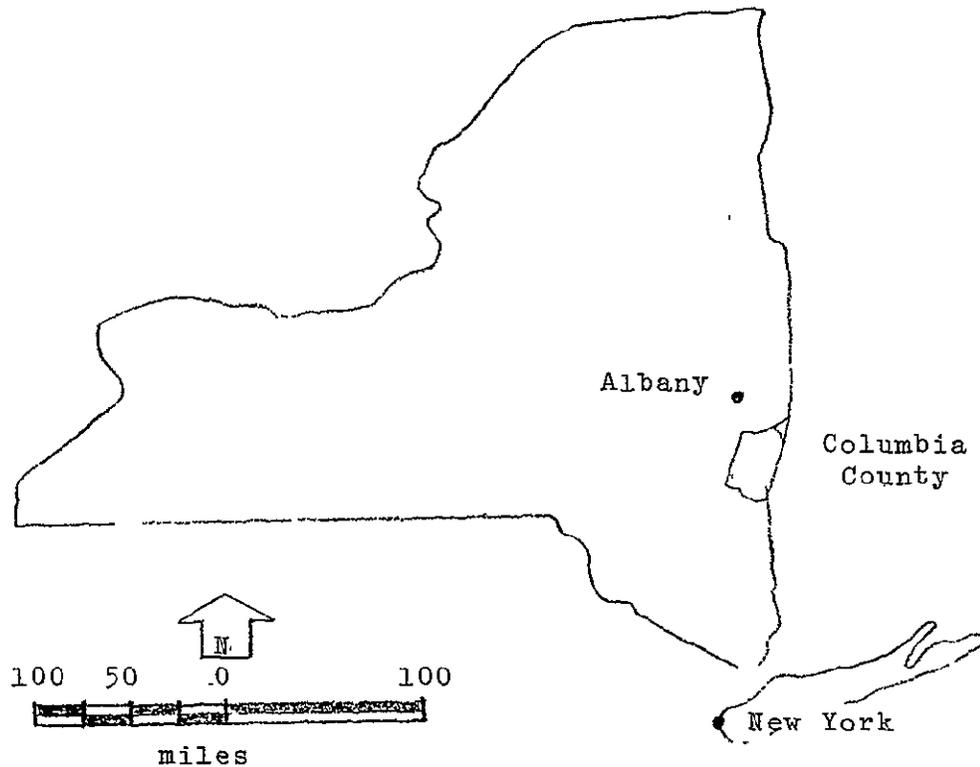
Date	Scale	Film Type	Source
Sept. 1959	1:20,000	panchromatic	U.S. Dept. of Agriculture (ASCS)
March 1968	1:24,000	panchromatic	N.Y.S. Land Use & Natural Resource Inventory (LUNR) [Lockwood Mapping]
April 1973	1:130,000	color infrared	NASA

B. Topographic Maps

U.S. Geological Survey, 7.5 minute, 1:24,000 scale: Ravena 1953, Hudson North 1953, and Hudson South 1963.

Figure 1.

Columbia County in New York State



1) Size: The sites were required to be at least 20 hectares (49 acres). This criterion would insure that significant quantities of spoil could be disposed of and a substantial recreation area could be developed if desired. Size was estimated from the 1973 NASA photographs, the most recent source of information on possible shoreline changes.

2) Location and Access: The sites were required to be located entirely shoreward of the railroad tracks along the coast, with existing or possible access available. The location restriction would facilitate dredge spoil disposal and reduce the hazard of repeated crossings of the railroad tracks by users of any recreation facilities. This factor was determined using the 1973 NASA photographs. Access routes were determined from the 1973 Columbia County Highway Map, the U.S.G.S. topographic maps, and the 1973 NASA photographs. Future access possibilities were determined by considering extension of existing roads, while taking into account such obstacles as slope, marsh, or incompatible land use. Although access by road was given primary consideration, especially good sites for boat access were also noted.

3) Slope: The sites were required to have slopes of less than 5% over most of their area. This restriction would help to insure that spoil disposal would be both possible and safe. Areas that met this criterion were identified by a study of U.S.G.S. topographic maps and the 1973 photographs.

4) Existing Private, River-oriented Recreation: Areas having privately owned, river-oriented recreation facilities were rejected, with the assumption that the County was seeking new areas for development.

Based on these four criteria, five general areas, or "zones," were selected and evaluated with regard to the following:

1) Land stability: Stability refers to the likelihood that the land would be relatively permanent, maintaining its shape and topography, in the face of expected natural processes. This was assessed by a time-sequential analysis of the available photographic coverage, assuming that changes in the configuration of the land would indicate erosiveness or instability.

2) Land Use/Cover: The land use and cover, from 1959 to 1973, was examined to determine if the land was available and suited for the intended uses. Overlays of each zone showing the land use/cover in 1973 were compiled at a scale of 1:24,000 using the 1968 N.Y.S. Land Use and Natural Resource Inventory classification for reference. Appendix A contains descriptions of the terms used in the overlay series.

3) Aesthetics: The existence of any especially pleasant or unpleasant views from each zone was assessed using the 1973 NASA photographs.

4) Proximity to Population Centers and Existing Recreation Areas: The distance that people would be required to travel to reach these zones, as well as the travel required to reach alternative recreation areas is an important factor. Straight-line distances were measured between approximate central points of relevant areas on the 1973 Columbia County Highway Map and the County's 1977 Existing Land Use Map. The population centers considered are the largest areas of residential concentration.

5) Water quality: The quality of water at a given zone determines what type of river-oriented activities could be supported. The Columbia County Stream classification map was used to determine the quality of water in a zone with the knowledge that water quality is variable over time and will depend largely on the actions and care of its various users. The

existence of backwater or stagnant areas was assessed using the 1973 photographs, since water quality problems in such areas could be a problem in the development of a complete recreation facility.

### RESULTS

On the basis of size, location and access, slope and existing recreation facilities, five zones were selected as well-suited for both disposal of dredge spoil and recreational development. These are shown in Figures 2 and 3. Also shown in Figure 2 are the 15 sites that offer existing road access to the river shore. As can be seen, only one zone (Zone B) contains existing public access routes.

These five zones were evaluated for land stability, land use and cover, aesthetics, proximity to population and existing recreation centers, and water quality. The results are presented on the following pages.

Figure 2.

Five Study Zones, A-E, And 15 Points  
Of Access To Hudson River In 1973.

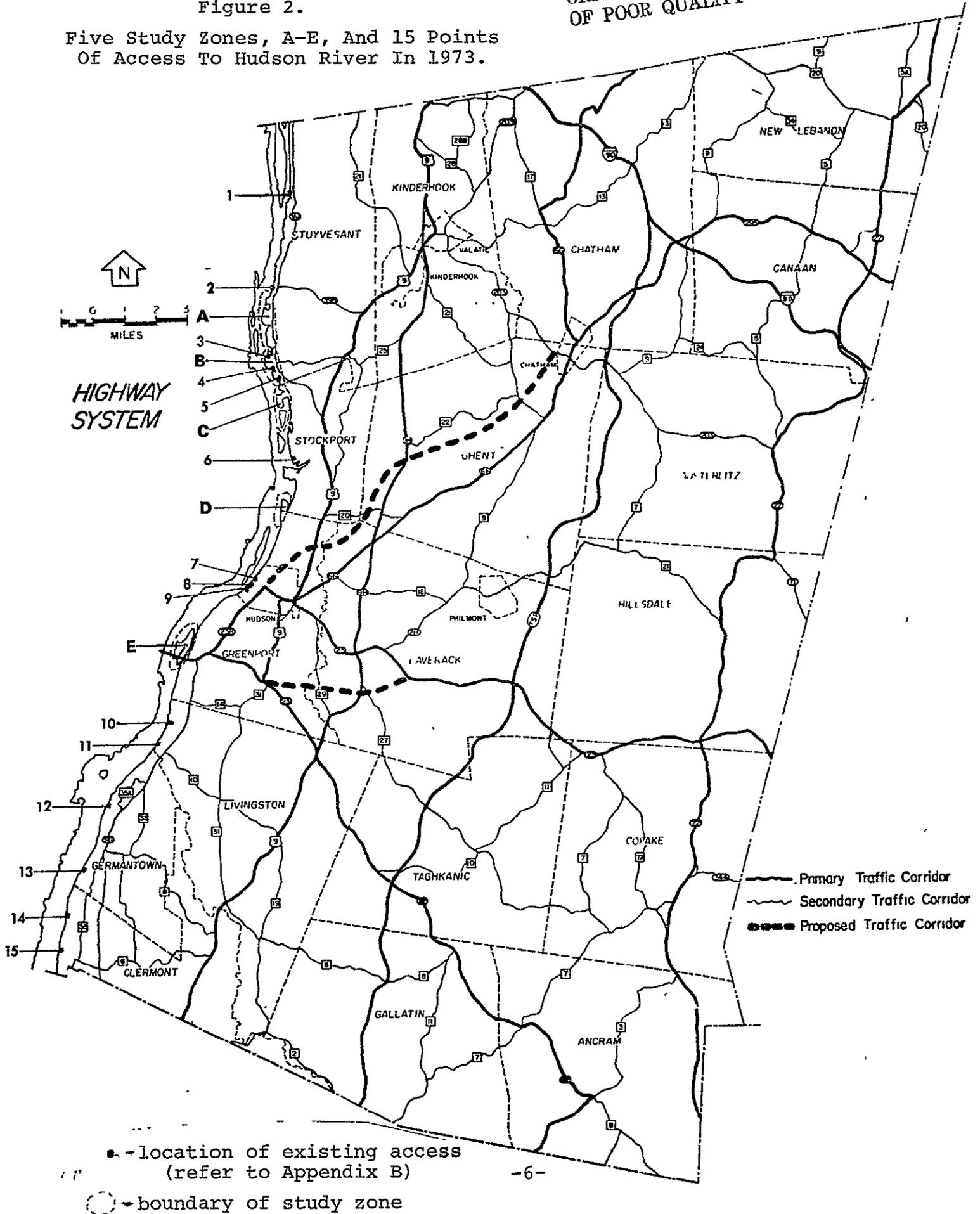


Figure 3.

Wetlands And Recent Dredge Spoil  
Disposal Sites Along Columbia  
County, N.Y., Coastline, 1973\*

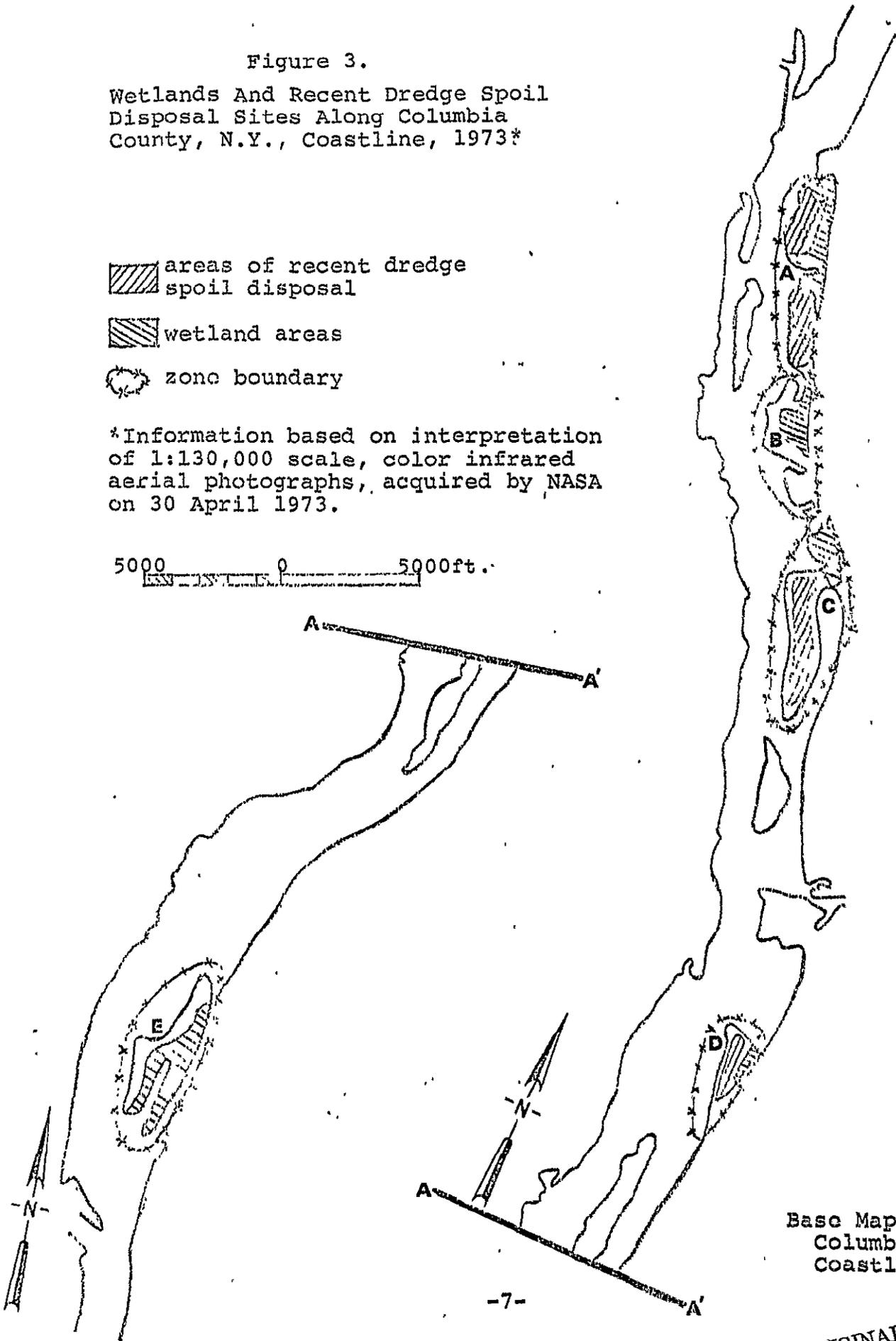
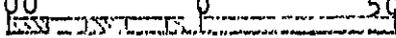
 areas of recent dredge  
spoil disposal

 wetland areas

 zone boundary

\*Information based on interpretation  
of 1:130,000 scale, color infrared  
aerial photographs, acquired by NASA  
on 30 April 1973.

5000 0 5000ft.



Base Map:  
Columbia County  
Coastline Map

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## ZONE A

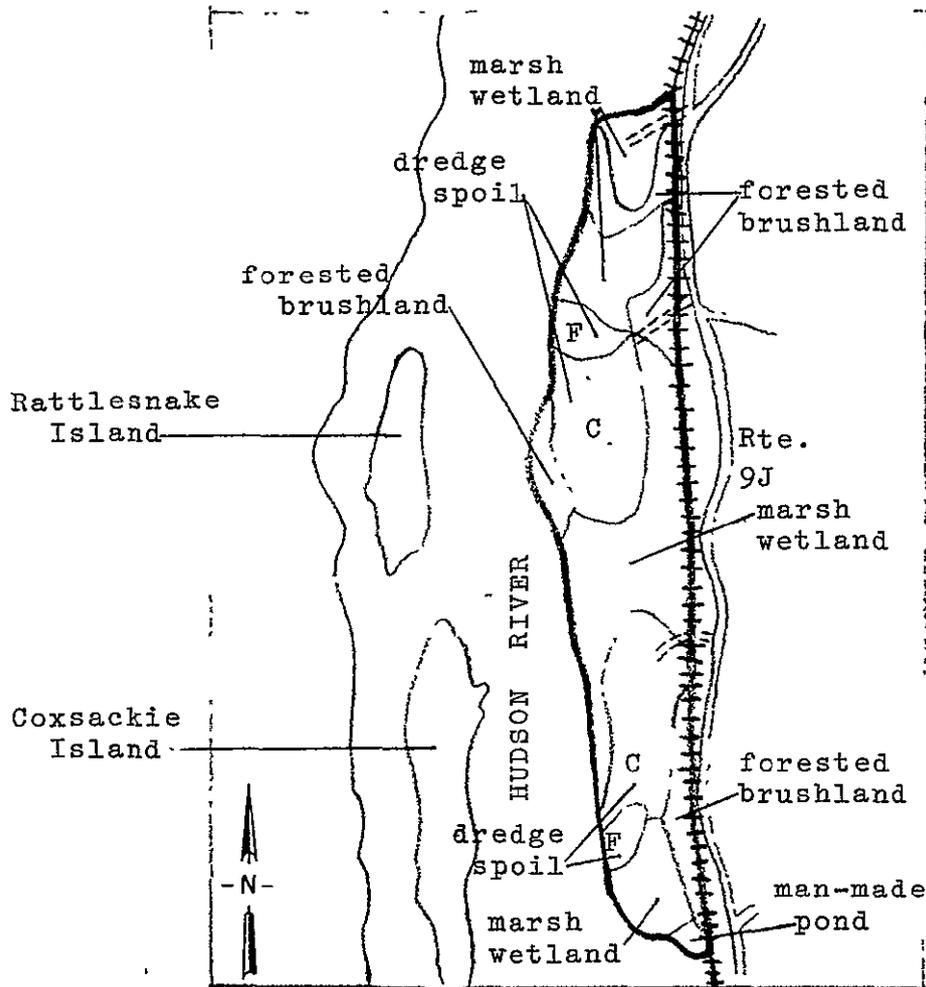
Characteristics as of 1973

(Figs. 3 and 4)

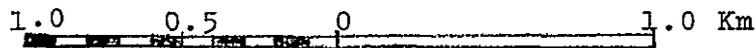
- Area: Approximately 70 hectares (173 acres).
- Land Stability: Stable; no apparent change in size or configuration from 1959 to 1973.
- Land Use/Cover: 1959 - The zone consists of marsh or scrub bogs and forested brushlands.  
1973 - Two large previously forested brushland areas have been used for dredge spoil disposal and now exist as bare or sparsely vegetated sand.  
As of 1973 nothing in the use of this or nearby land indicates that Zone A would be used for any purpose other than dredge spoil disposal.
- Access: None exists but favorable future access routes are available (Fig. 4).
- Aesthetics: Views of Coxsackie, N.Y., Coxsackie Island, marsh on Bronck Island, wooded and farmed areas.
- Distance: See Table 2. Zone A is the zone farthest from the City of Hudson, N.Y.
- Water Quality: Only in contact with free-flowing Hudson River water.
- Relative Advantages: All parts of the zone appear suited for spoil disposal; access to the zone would be easily constructed from New York State Route 9J; marsh in northern half of the zone could be dredged to form a sheltered beach or launching/mooring area with possible use for ice skating.
- Relative Dis-Advantages: This zone is farthest from the City of Hudson; diversion of runoff from the hills may be required; future spoil capacity may be reduced due to relatively recent spoil disposal.

Figure 4.

Zone A



- |   |                         |   |                               |
|---|-------------------------|---|-------------------------------|
|  | zone boundary           |  | railroad                      |
|  | land use/cover boundary |   | dredge spoil:                 |
|  | existing road           | C   | coarse materials (very sandy) |
|  | proposed road           | F   | fine materials                |



Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

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Base Maps: 1953 U.S.G.S. topographic maps, Hudson North, N.Y. and Ravena, N.Y.

ZONE B

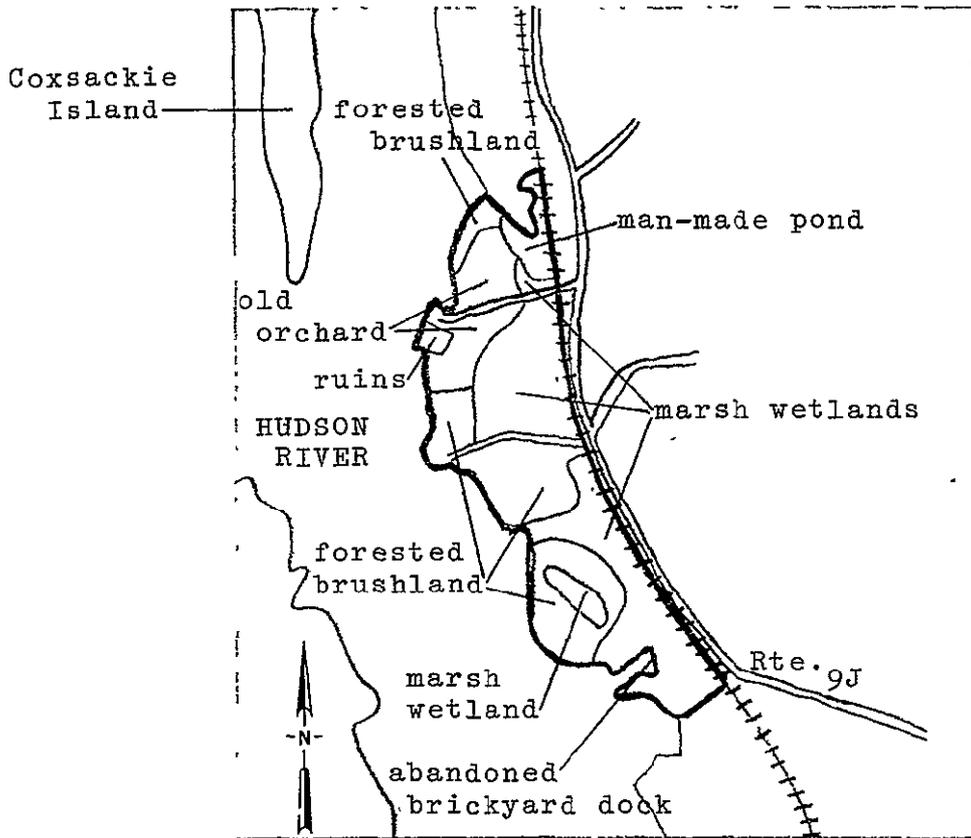
Characteristics as of 1973

(Figs. 3 and 5)

- Area: Approximately 55 hectares (134 acres).
- Land Stability: Stable; no apparent change in size or configuration from 1959 to 1973.
- Land Use/Cover: 1959-1973 - The zone consists of forested brushlands and marsh wetlands over most of its area. The northern coast is occupied by an old orchard, located on an elevated rock landform. A man-made pond is present at the north end, near the railroad track. An abandoned brickyard and its dock are located at the southern end. Some residential development is present along Ferry Road.
- Deterioration of the orchard indicates that it no longer serves a commercial purpose. There has not been an expansion of residential dwelling units from 1959 to 1973, suggesting no trend to alter the land use of this area.
- Access: Access to the zone exists (Fig 5).
- Aesthetics: Views of Coxsackie, N.Y., Coxsackie Island, Stockport Middle Ground, wooded and farmed areas.
- Distance: See Table 2.
- Water Quality: Only in contact with free-flowing Hudson River water.
- Relative Advantages: The varied topography offers good vantage points to view the surroundings; road access exists; suitable spoil disposal sites are present and not recently used; a site for boat access could be established by remodeling the abandoned brickyard dock.
- Relative Dis-Advantages: Parts of the zone are not suitable for spoil disposal; private ownership (orchard and houses) in the area is an obstacle to development of a recreational facility.

Figure 5.

Zone B



-  zone boundary
-  land use/cover boundary
-  existing roads
-  railroad

1.0 0.5 0 1.0 Km

Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

Base Map: 1953 U.S.G.S. topographic map, Hudson North, N.Y.

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## ZONE C

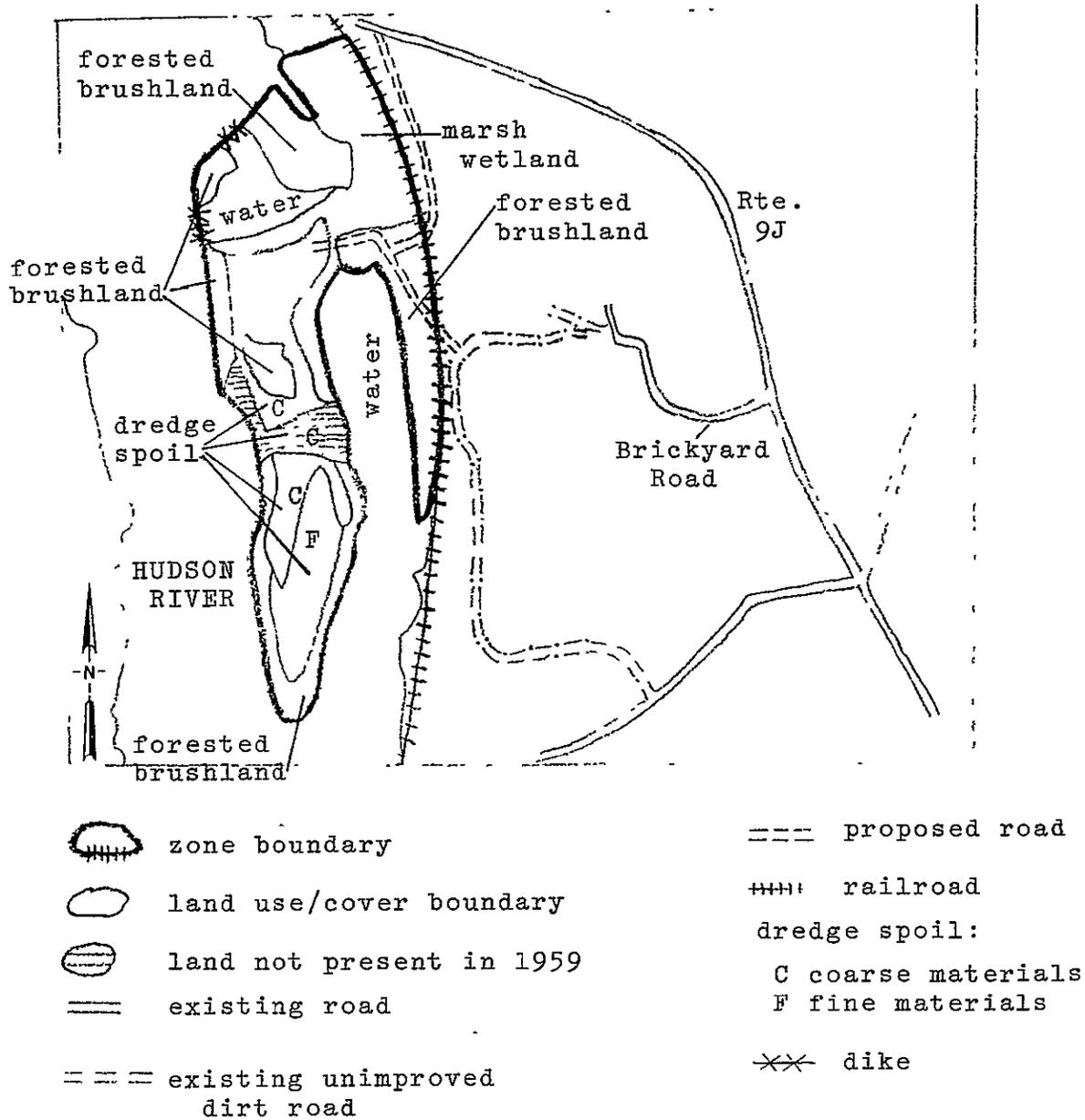
Characteristics as of 1973

(Figs. 3 and 6)

- Area: Approximately 80 hectares (198 acres).
- Land Stability: Stable; land shape and configuration altered by addition of dredge spoil between 1959 and 1968.
- Land Use/Cover: In 1959, this zone consisted of an island and peninsula both of which were covered by forested brushland. In 1973, the zone existed as one large peninsula as a result of dredge spoil disposal. The newly formed land and much of the forested brushland now are bare sand. A large shallow backwater area exists shoreward of the enlarged peninsula. An elevated rock landform exists at the north end of the zone.
- Analysis of the zone and surrounding areas indicates no new trends in land use.
- Access: None exists but favorable future access routes are available (Fig. 6).
- Aesthetics: Views of lower Coxsackie, N.Y., Stockport Middle Ground, and wooded and farmed slopes.
- Distance: See Table 2; Zone C has the shortest average distance to the major population centers considered.
- Water Quality: In contact with free-flowing Hudson River water. Backwater area may be somewhat stagnant.
- Relative Advantages: Most of the zone could be used for spoil disposal; the elevated area provides a good vantage point of the surroundings; access could be easily established; the backwater area could be dredged and used as a marina, rowing and canoeing area, and ice skating, or filled with spoil; the diked area on the north could be secured, stocked and used for fishing.
- Relative Dis-Advantages: Diversion of runoff from hills may be required; future spoil capacity may be reduced due to relatively recent spoil disposal; water quality problems may occur in the backwater.

Figure 6.

Zone C



Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

Base Map: 1953 U.S.G.S. topographic map, Hudson North, N.Y.

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ZONE D

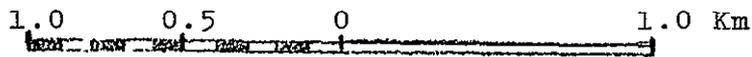
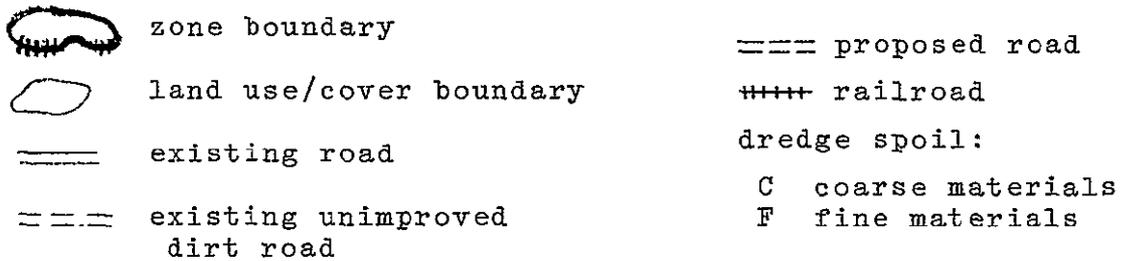
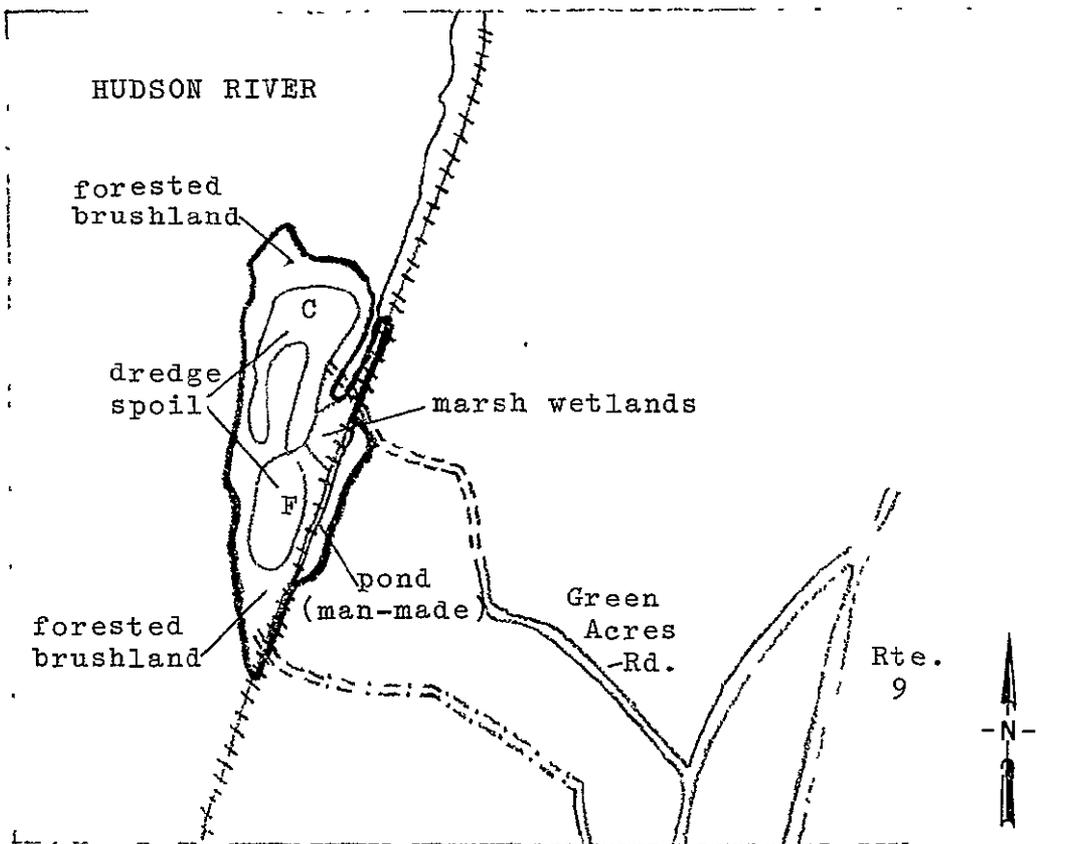
Characteristics as of 1973

(Figs. 3 and 7)

- Area: Approximately 30 hectares (74 acres).
- Land Stability: Stable, no changes noted.
- Land Use/  
Cover: In 1959, this zone was covered with scattered patches of trees, except for the man-made pond and small marshy area near the pond. This zone was subsequently used as a spoil disposal site. In 1973, bare sand covered most of the once forested areas. The remainder of the zone was unchanged.
- Access: Access is not present and may be difficult to achieve.
- Aesthetics: Views of marsh lands, wooded and farmed areas, Middle Ground Flats, and the river front of Hudson, N.Y.
- Distance: See Table 2; Zone D is the zone closest to the City of Hudson.
- Water Quality: This area is in contact with free-flowing Hudson River water and the man-made pond. This pond seems to have no permanent source of water and may stagnate.
- Relative Advantages: The entire area could be used for disposal.
- Relative Dis-  
Advantages: Smallest area; difficult access; water quality problem with pond (if included); danger of excessive railroad crossings to pond (if included); no sheltered area for boat mooring; future spoil capacity may be reduced due to relatively recent spoil disposal.

Figure 7.

Zone D



Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

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Base Map: 1953 U.S.G.S. topographic map, Hudson North, N.Y.

ZONE E

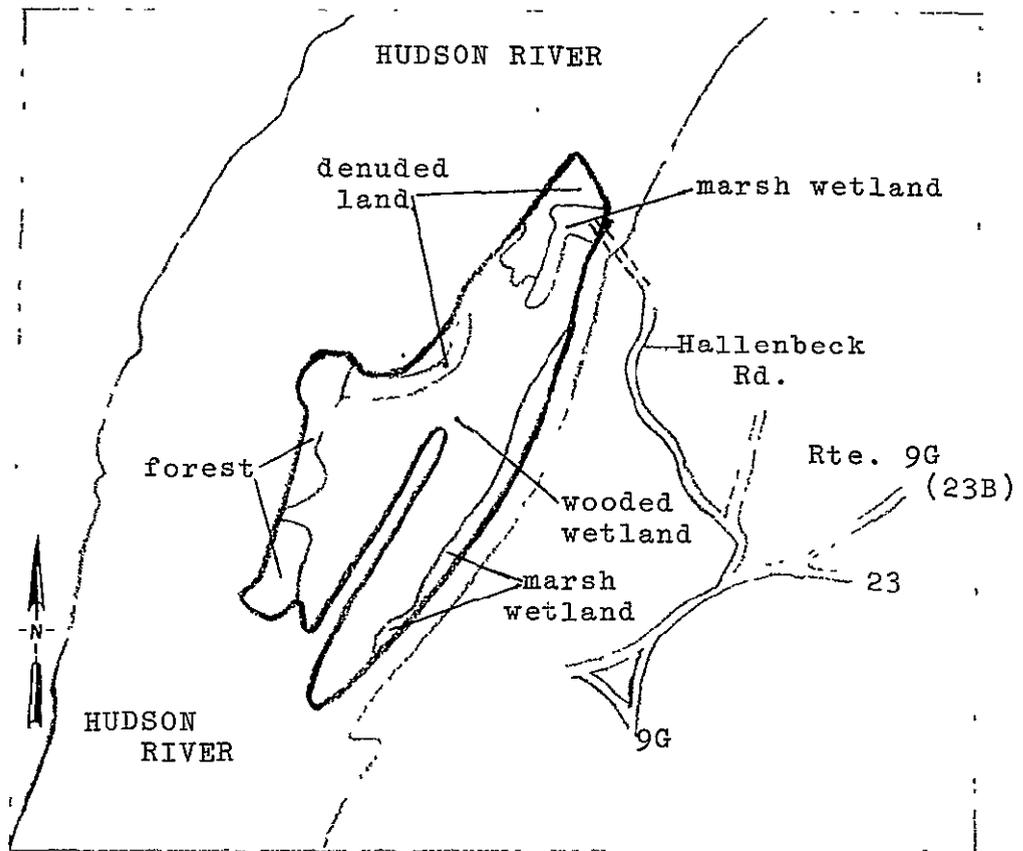
Characteristics as of 1973

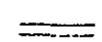
(Figs. 3 and 8)

- Area: Approximately 65 hectares (160 acres).
- Land Stability: Stable; no change apparent.
- Land Use/Cover: Virtually the entire island was a wooded wetland in 1959 with the exception of a forested band on the west coast and a marshy band on the east coast. A stretch of land along the northwest shore of the island was denuded between 1959 and 1973 and is now sparsely vegetated.
- Nearby land use does not appear to influence the use of Zone E. The extensive coverage of the zone by wooded wetlands makes it a fragile and ecologically valuable area.
- Access: No present access exists. Future access appears easy to achieve, but will require the construction of a short bridge to Rogers Island.
- Aesthetics: Views of forested and farmed areas, marsh, lower Catskill, N.Y., and the Rip Van Winkle Bridge (overhead).
- Distance: See Table 2; Zone E has the longest average distance (19 km) to the major population centers.
- Water Quality: Only in contact with free-flowing Hudson River water.
- Relative Advantages: The zone is a discrete piece of land; fairly well sheltered downstream area available for boat mooring.
- Relative Dis-Advantages: Requires short bridge to be built; composed largely of ecologically valuable, fragile wetlands; zone farthest from three of the larger population centers.

Figure 8.

Zone E



-  Zone boundary
-  Land use/cover boundary
-  existing road
-  proposed road

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Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973

Base Map: 1963 U.S.G.S. topographic map, Hudson South, N.Y.

Table 2  
 Straight-Line Distances (Km) From Zones To  
 Population Centers And Existing Recreation  
 Areas In Columbia County, N.Y.

POPULATION CENTER	ZONES					RECREATION AREAS		
	A	B	C	D	E	Nearest Area	Major River- Oriented	Clermont State Park
Hudson	14	11	9	4	6	3	21	1
Chatham	16	16	15	17	25	0	39	20
Kinderhook	7	9	9	14	22	3	37	17
Philmont	18	16	14	12	16	4	27	12
Valatie	10	11	12	16	25	2	39	20
Average	13	13	12	13	19			
RECREATION AREAS								
Nearest Area	2	4	3	3	2			
Major River- Oriented	13	10	8	4	4			
Clermont State Park	31	29	28	23	16			

## DISCUSSION AND CONCLUSIONS

There are at least five zones along the Hudson River coastline of Columbia County, N.Y., that seem well-suited for use as dredge spoil sites and recreation areas. As of 1973, the date of the most recent, available aerial photographic coverage of the coastline, these zones appeared to be physically suitable--size, location, slope, stability, land use/cover--and access to most of the zones either exists or could be constructed without undue difficulty. For land access, some protection, such as an overpass, might be desirable in the area of the railroad tracks; and, for water access, certain parts of the coastline could be transformed into favorably sheltered areas.

Among the significant factors that should be considered in planning or developing the zones are:

- .The zones are all located in flood prone areas.
- .Many of the zones contain substantial amounts of wetlands, a limited resource.
- .Previous use of certain areas within the zones as dredge spoil sites may limit the quantity of spoil that can be added.
- .Maintaining a vegetative cover on those sandy areas that are not to be left in sand may be difficult.
- .Certain sites may require control of runoff from the shoreward hills.
- .On-site water quality monitoring would be desirable and, likely, required for certain types of recreation.

APPENDIX A

Explanation of Terms Used in  
"1973 Land Use/Cover and Access" Overlay Series

- Denuded land - This is relatively bare land known to have been more heavily vegetated in the past 15 years. Identifiable recent dredge spoil sites are not included.
- Dredge spoil - This is bare or sparsely vegetated land resulting from dredge spoil deposition.  
Coarser material - the coarser sandy portion of the spoil.  
Finer material - the finer portion of the spoil found in settling basin areas.
- Forested brushland - This is land containing low standing trees and/or brush with some associated larger trees possibly present.
- Man-made ponds - These are bodies of water of more than .5 hectares, and apparently at least partially the result of man's activities.
- Marsh wetlands - These are lands that are usually wet or waterlogged, and support low growing marsh or bog type shrub vegetation.
- Old orchards - This is land occupied by fruit trees, which are in a poor state of vigor.
- Water - These are areas of water that are part of the Hudson River but have restricted flow due to interference by dikes, or large (greater than 20 hectares) back-water areas formed by the configuration of the surrounding land.
- Wooded wetlands - These are areas that are wet much of the time and support a growth of trees or tall (greater than 1.5 m) shrubs.

APPENDIX B

Potential Recreation Sites  
Based on Available Present Access

<u>FIGURE 2 NUMBER</u>	<u>NAME</u>	<u>CONCLUSION</u>
1	Carmelite Sisters	Insufficient land available
2	Midwood	(idem)
3	Cheviot	(idem)
4	North Germantown Anchorage	(idem)
5	Roe Jan Boat Club	(idem)
6	Oak Hill Landing	(idem)
7	Furgary Boat Club	(idem)
8	Hudson Power Boat Association	(idem)
9	Water Street State Boat Launch Site	(idem)
10	Columbiaville	(idem)
11	Abandoned Brickyard Dock	Acceptable for consideration
12	Newton Hook	(idem)
13	Nutton Hook	(idem)
14	Stuyvesant	Insufficient land available
15	Hook Boat Club	Existing river-oriented recreation

APPENDIX D

EXAMINATION OF AGRICULTURAL DISTRICTS FOR  
POSSIBLE CHANGES IN ZONING, COLUMBIA COUNTY, N.Y.

# COLUMBIA COUNTY PLANNING BOARD

70 NORTH THIRD STREET, HUDSON, NEW YORK 12534

Telephone (518) 828-3375

RALPH I WILLIAMS Chairman  
Claverack, New York 12513

ARTHUR KOWEEK, Vice Chairman  
Hudson New York 12534

GRANVILL HILLS Secretary  
Hudson New York 12534

ALAN P MUIR  
Planning Director

August 10, 1978

Warren R. Philipson  
Remote Sensing Program  
Hollister Hall  
Cornell University  
Ithaca, New York 14853

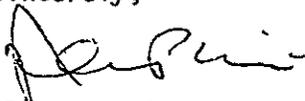
Dear Warren:

I would like to thank you for the work you did using remote sensing and high altitude data in preparing the reports on potential Hudson River recreation areas and the viability of agricultural lands in Columbia County; we are pleased with the scope and quality of both reports.

Presently, both are being circulated to various agencies in the hope that the information produced will create some interest in the use of your findings in local and state programs.

We will let you know how we make out.

Sincerely,



Alan P. Muir  
Planning Director

APM:de

PRELIMINARY ASSESSMENT OF  
AGRICULTURAL DISTRICTS IN  
COLUMBIA COUNTY, N.Y.

Remote Sensing Program  
Cornell University  
Hollister Hall  
Ithaca, New York 14853

July 1978

## ACKNOWLEDGMENTS

This study was requested by representatives of the Planning Board of Columbia County, N.Y., and supported by NASA Grant NGL 33-010-171. The work was conducted by David W. Adams and William R. Hafker under the direction of Warren R. Philipson. Mr. Adams performed the land use inventory, and Mr. Hafker performed the soils and final analyses. This report is accompanied by two maps.

Ta Liang  
Professor-In-Charge

## INTRODUCTION

According to the 1974 U.S. Census of Agriculture, nearly one-third of Columbia County, N.Y., is being actively farmed. Similar to other New York State counties, Columbia County has adopted the use of "agricultural districts" to encourage the continuance of a strong agricultural industry. These districts are geographic zones established through legislation; they are intended to protect farmers from the effects of urbanization and to discourage non-agricultural development in good farming areas.

Agricultural districts in each county are subject to review and modification at eight-year intervals. This study was performed to provide land use and soils information required for evaluating the eleven districts in Columbia County.

## STUDY AREA

Columbia County is located on the eastern border of New York State (Fig. 1). The City of Hudson, the County Seat, lies approximately 50 km south of Albany and 190 km north of New York City. The County contains some 166,800 hectares, approximately 37% of which were in farms, including woodland, in 1974. The land is generally hilly with most of the gently sloping land (less than 5% slopes) located in an 11 km-wide strip, inland from and parallel to the Hudson River, the County's western boundary.

The County's relief is shown on all or part of twenty-three 1:24,000 scale, U.S. Geological Survey topographic maps, compiled from 1944 to 1975. Generalized information on soils of the County is found in the 1929 Columbia County Soil Survey Report and accompanying 1:62,500 scale map (Lewis, H.G. and D.F. Kinsman. 1929. Soil survey of Columbia County, New York. No. 45, Series 1923. U.S. Dept. Agr. Washington, D.C. 43 pp.). Available aerial photographic coverage of the County includes 1:24,000 scale, panchromatic (black-and-white) photography flown in March 1968 by Lockwood Mapping, Inc., for the New

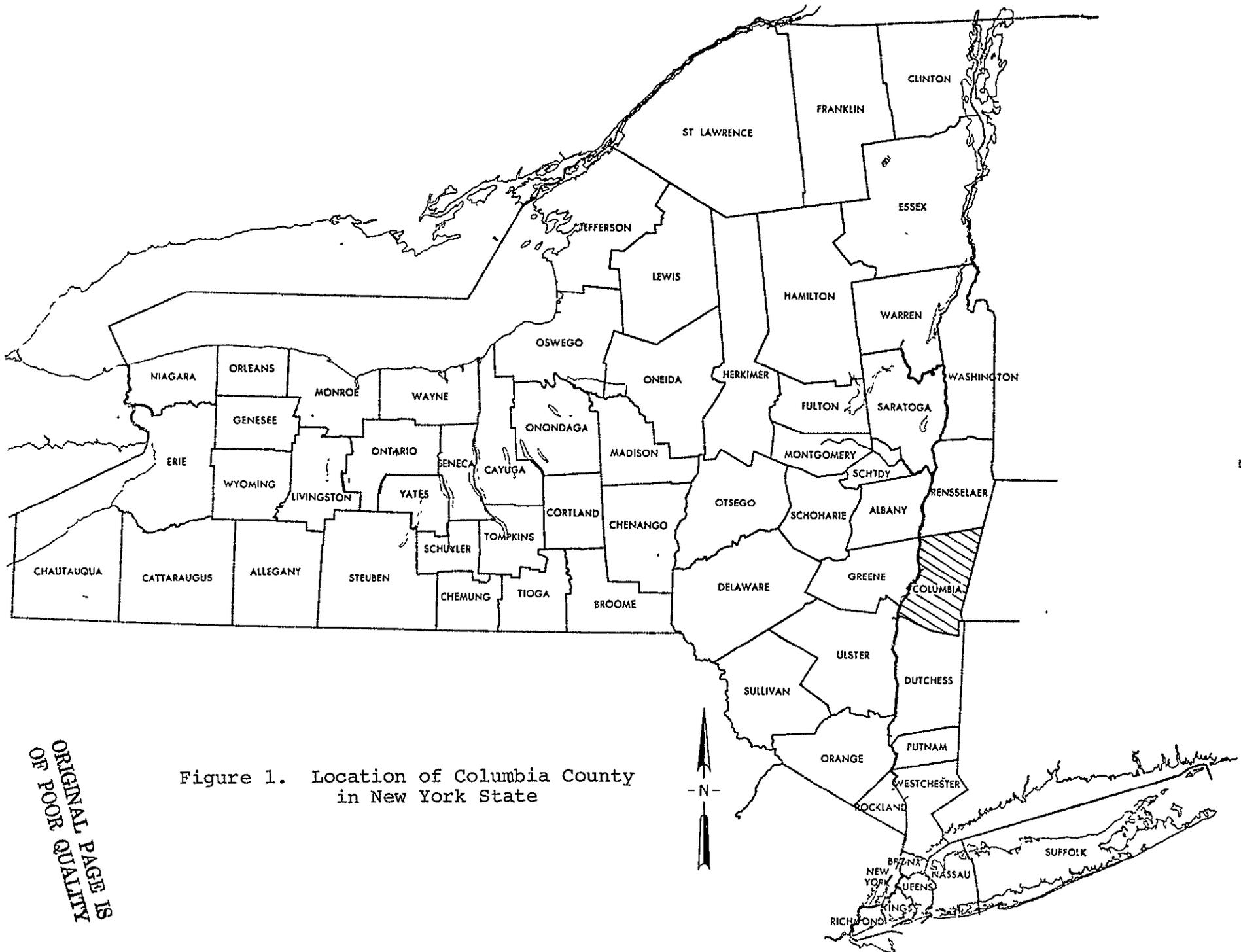


Figure 1. Location of Columbia County  
in New York State

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York State Land Use and Natural Resources Inventory (LUNR); and 1:130,000 scale, color infrared photography flown in April 1973 by the National Aeronautics and Space Administration. The latter coverage does not include the extreme northeastern corner of the County.

## PROCEDURES

### Land Use Inventory

Detailed land use and land cover information for Columbia County is contained in the statewide LUNR, being based on the 1968 aerial photography. The study set out to update the LUNR information for two generalized categories of land use, active and inactive agriculture. Positive transparencies of the 1973, color infrared aerial photographs were analyzed with a zoom stereoscope on a light table, using the LUNR information as a reference. Acetate overlays to the 1:130,000 photographs were prepared showing "active agriculture," "inactive agriculture" and "other." A Zoom Transfer Scope was used to compile the delineations onto a single Mylar base map of approximately 1:95,000 in scale.

Although it was originally planned to derive a second, more recent update of the County's agricultural land use from Landsat satellite data, cloud-free Landsat coverage of the County was not available for appropriate periods (spring-summer) in 1976 or 1977.

### Soils Information

The categorization of soils as "prime" or "prime land" is based on data collected in a detailed soil survey, which has not been performed for Columbia County. Many of the factors considered in rating soils can be evaluated through comprehensive interpretation of aerial photographs, however, such an analysis was judged to be beyond the scope of this study. As an alternative, it was decided to derive the soils information from the 1929 Soil Survey Report and check representative sites with the topographic maps and aerial photographs.

The descriptions of the County's soils were examined, and each soil was placed in one of the following categories: first bottom land (flood-prone), excessively moist, shallow, stony, droughty or other (i.e., no physical limitation other than slope). An acetate overlay of the 1:62,500 scale soil map was developed, excluding soils on slopes greater than 5%, swamps and tidal marshes. Selected areas containing soils of each category were located and analyzed on the 1968 aerial photographs. The presence of features not normally associated with the soils of a particular category was assumed to indicate inaccuracies (inclusions) in the soil mapping unit. Those categories that appeared to be mapped accurately were added to the slope and swamp limitations overlay.

#### General Evaluation

As a final step, the agricultural district boundaries were compared to the soils and 1973 agricultural land use information, with the aid of a Zoom Transfer Scope. Estimates were made of the proportions of each agricultural district in active or inactive agriculture, and the proportions of the districts that might contain prime farmland.

### RESULTS AND DISCUSSION

#### Agricultural Land Use

The status of Columbia County's agricultural land use in 1973 is depicted on the accompanying 1:95,000 scale map. As described, this map of "active agriculture," "inactive agriculture" and "other," was derived through analysis of 1:130,000 scale aerial photographs, with LUNR information as a reference.

A comparison of the 1973 land use with the agricultural districts (Fig. 2) revealed that, on the average, approximately 45 to 60% of the area of a district was devoted to active agriculture. One district (No. 5) contained approximately 80% active farmland, four districts (Nos. 2, 3, 4 and 10) contained approximately 60 to 70% active farmland, and six districts (Nos. 1, 4A, 6, 7, 8 and 9) contained only about 30 to 40% active farmland.

Although often interspersed with active agriculture, inactive agriculture in 1973 usually occupied less than 10% of an agricultural district, with only one district (No. 6) having as much as 15% inactive agriculture. In certain areas, the ratio of inactive to active agriculture appeared to be substantially higher outside of the agricultural districts especially in the eastern part of the County.

#### Soils With Mapped Limitations

Areas of Columbia County with soils of less than 5% slopes, that are not swamp, tidal marsh or subject to flooding, are depicted on the second accompanying map, at a scale of 1:62,500. Soils that have not been excluded are potentially prime soils, but as much as 20 to 30% of the area is likely to be limited by excessive moisture or some other constraint (e.g., shallow or stony).

Based solely on their descriptions in the 1929 Soil Survey Report, the soil mapping units were categorized as: first bottom land, excessively moist, shallow, stony, droughty or other (i.e., no physical limitation other than slope). The results of this categorization, and the photographic assessment of the accuracy of this categorization, are reported in the table.

In general, the first bottom (flood-prone) lands appeared to be accurately mapped; the excessively moist and shallow soils that were not otherwise limited by slope appeared to contain too many inclusions and/or omissions; the droughty soils did not appear to be droughty; and the stoney soils, most of which were excluded by slope, could not be evaluated directly with aerial photographs.

The soils limitation map shows that, as expected, population centers generally occupy the better soils, along with the greater concentrations of active agriculture. Comparison of the soil limitations map to the agricultural districts (Fig. 2) indicates that more than 60% of the areas of the eastern districts (Nos. 1, 4A, 6, 8 and 9) have one or more limitation. In the western districts, this percentage is much lower.

SOIL LIMITATIONS BASED ON 1929 COLUMBIA COUNTY  
SOIL SURVEY REPORT AND 1968 AERIAL PHOTOGRAPHS

<u>Categorization Based on Soil Survey Description</u>	<u>Soil Mapping Units Included in Categories *</u>	<u>Airphoto Evaluation of Reliability of Soil Categories</u>
First Bottom Land	Hotaling, Livingston, Ondawa, Saco	Accuracy acceptable
Excessively Moist	Ghent, Hudson sl and sicl, Livingston, Lyons, Mansfield, Saco sicl, Stockbridge l, Meadow, Muck	Many inclusions and apparent exclusions; accuracy not accept- able
Shallow	All units described as having shallow phases	Many inclusions and apparent exclusions in areas not limited by slope; accuracy not acceptable
Stony	Dutchess sal, stl and stl, shallow phase; Gloucester, Stockbridge stl, Rough Stony Land	Not evaluated and not used
Droughty	Hinckley, Hoosic cosl and fsl, Otisville gsl	No evidence of droughty soils; ac- curacy not acceptable
Swamp and Tidal Marsh	Tidal marsh and var- ious other units des- ignated as swamp on soils map	Accuracy acceptable
Other (no reported physical limita- tions)	All remaining units	Many inclusions and exclusions; accuracy not acceptable

\* Notation:

l	loam	gsl	gravelly sandy loam
sl	sandy loam	stl	stony loam
fsl	fine sandy loam	sal	slate loam
cosl	coarse sandy loam	sicl	silty clay loam

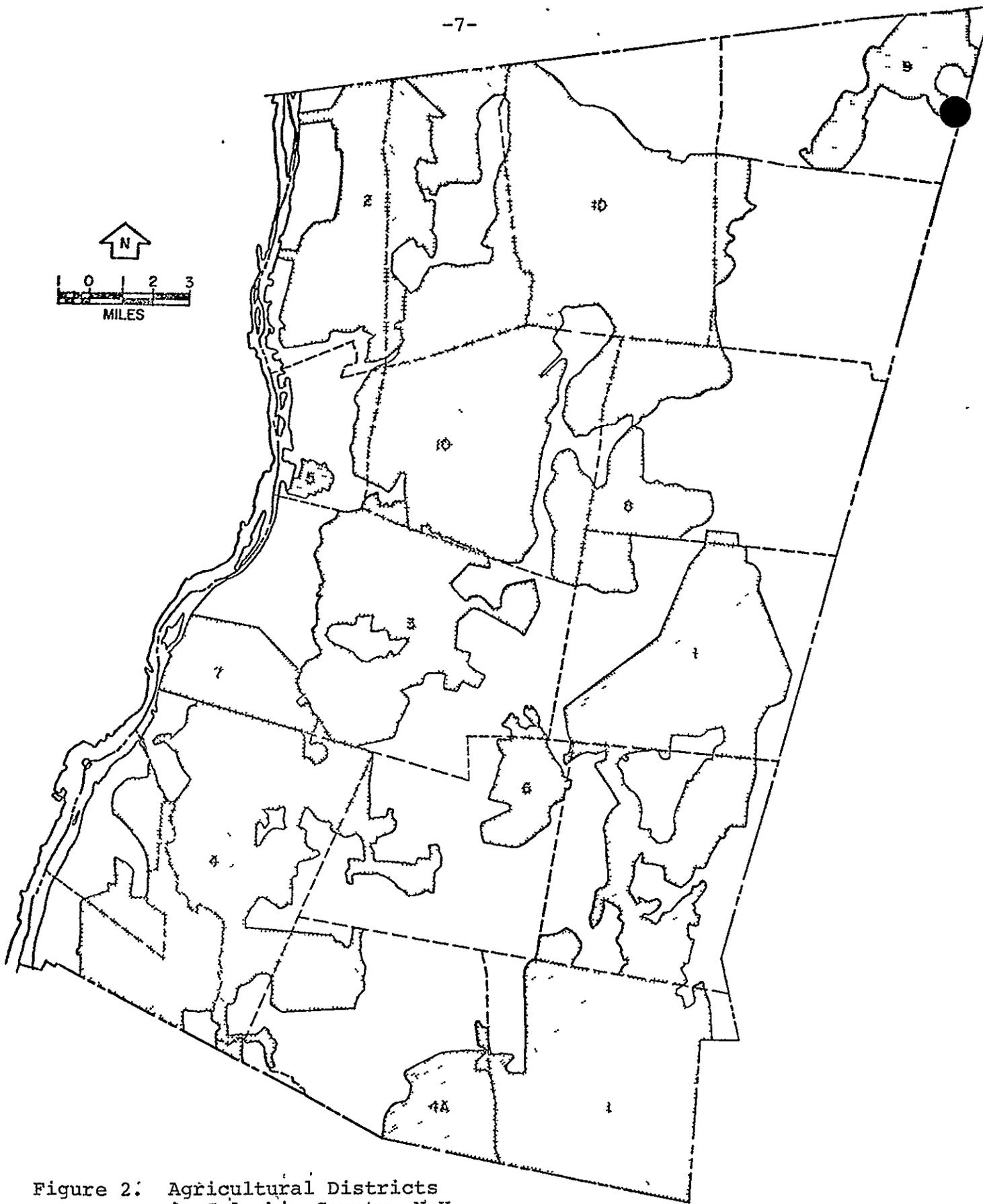
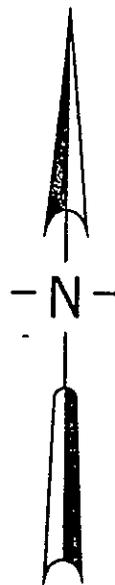


Figure 2: Agricultural Districts  
in Columbia County, N.Y.

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ACTIVE AND INACTIVE AGRICULTURE IN  
COLUMBIA COUNTY, N.Y.

30 APRIL 1973

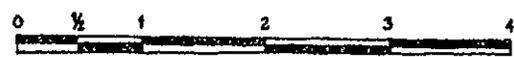
BASED ON INTERPRETATION OF 1:130,000 SCALE,  
COLOR INFRARED AERIAL PHOTOGRAPHS, FLOWN  
BY NASA ON 30 APRIL 1973

KEY.

- A ACTIVE AGRICULTURE
- i INACTIVE AGRICULTURE
- O OTHER

...portion of submitted map...

SCALE IN MILES



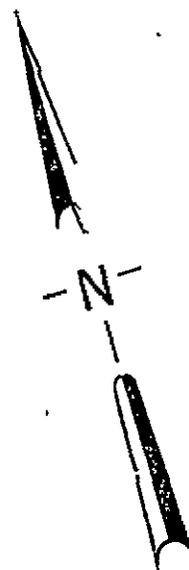
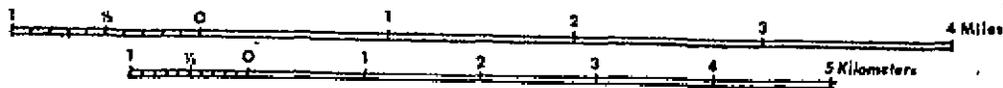
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# SELECTED SOILS LIMITATIONS, COLUMBIA COUNTY, N.Y.

Based on 1929 Columbia County Soil Survey and Interpretation of 1968,  
1:24,000 scale, panchromatic aerial photographs

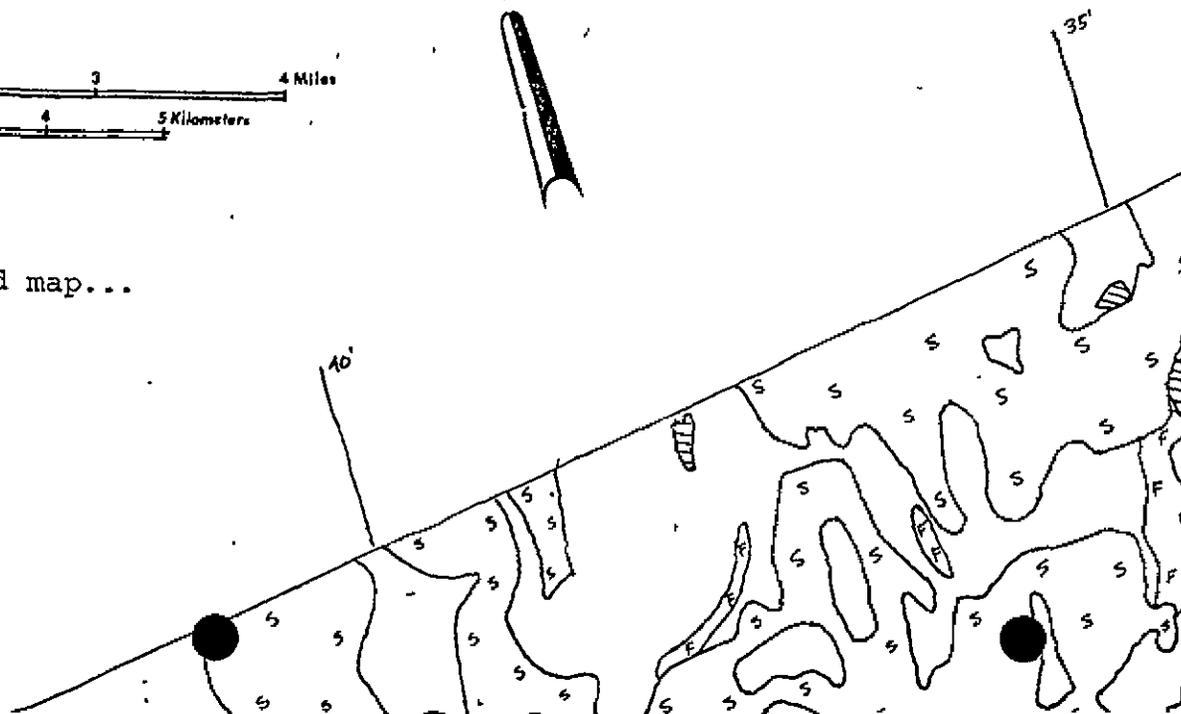
## KEY

- S** slopes greater than 5%
- F** first bottom land (subject to flooding)
- T** tidal marsh
- W** swamp
- No symbol potentially prime soil, but may be limited by moisture, depth, stoniness, or some other factor



...portion of submitted map...

145'



APPENDIX E

INVENTORY OF POTENTIAL MOSQUITO BREEDING  
SITES IN AN URBAN SETTING, ROME, N.Y.

cc: Dr. Philipson - Cornell University Remote Sensing Program

October 31, 1978

Dr. East - Bureau of Disease Control

Dr. Morris - Syracuse Area Office

Remote sensing of potential mosquito breeding areas-Rome, New York

An analysis of the mapping of the potential breeding areas of Rome, New York by Cornell University Remote Sensing Program personnel, as described in the accompanying letter from Dr. Philipson, pointed out one potential drawback of our conventional ground survey. Of the 408 breeding sites detected, 70 (17%) were rooftop water accumulations. Since *Culex* can breed in these types of accumulation, a field check of 16 roof-tops was made by Mr. Kwiat of the Onondaga County Health Department. Although no larvae were found, most sites supported varying degrees of plant and insect life and further suggest that mosquito breeding may occur during the summer.

It is also apparent that the aerial survey was made more rapidly and at less expense than a systematic ground search for water accumulations. Time did not permit extensive field checking of the aerial survey results. However, all of nine ground level sites examined contained mosquito larvae or cast skins.

A comparison of an aerial survey of Onondaga County with the county mosquito control program records would provide an excellent system to update the county survey and concomitantly verify the efficacy of the aerial survey technique for possible use in other counties.

Attachment

cc: Dr. Philipson - Cornell University Remote Sensing Program  
Mr. Barry - Syracuse Area Office  
Mr. Lambert - Onondaga County Health Department  
Mr. Chellemi-Onondaga County Health Department  
Mr. Davendorf - Onondaga County Health Department  
Mr. Marechek - Onondaga County Health Department

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## Cornell University

REMOTE SENSING PROGRAM  
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING  
HOLLISTER HALL  
ITHACA, NEW YORK 14853  
(607) 256-4330, 256-5074

10 August 1978

Dr. Charlie Morris  
N.Y.S. Department of Health  
Illick Hall, Room 133  
College of Environmental Science & Forestry  
Syracuse, New York 13210

Dear Charlie:

I have enclosed a map overlay (Mylar copy and blue print) depicting potential mosquito breeding sites in Rome, N.Y. As you are aware, the 1:9,600 scale base map was obtained from the Oneida County Environmental Management Council.

In accordance with the overlay legend, all findings are based on stereoscopic analysis of 1:5,000 scale, panchromatic aerial photographs, flown on 15 June 1978. These photographs were provided as positive film transparencies by the U.S.A.F. Rome Air Development Center. The portion of Rome surveyed was determined by the extent of the photographic coverage.

The study was performed by William R. Hafker, working under our NASA Grant NGL 33-010-171. Please advise me if you find this information to be of value, and if we can be of any further assistance.

Very truly yours,

Warren R. Philipson  
Sr. Research Associate

WRP/pw

cc (without enclosures):

Ellsworth Hicks, RADC  
Philip Lambert, Oneida County Health Department  
Prof. Ta Liang

Encs.

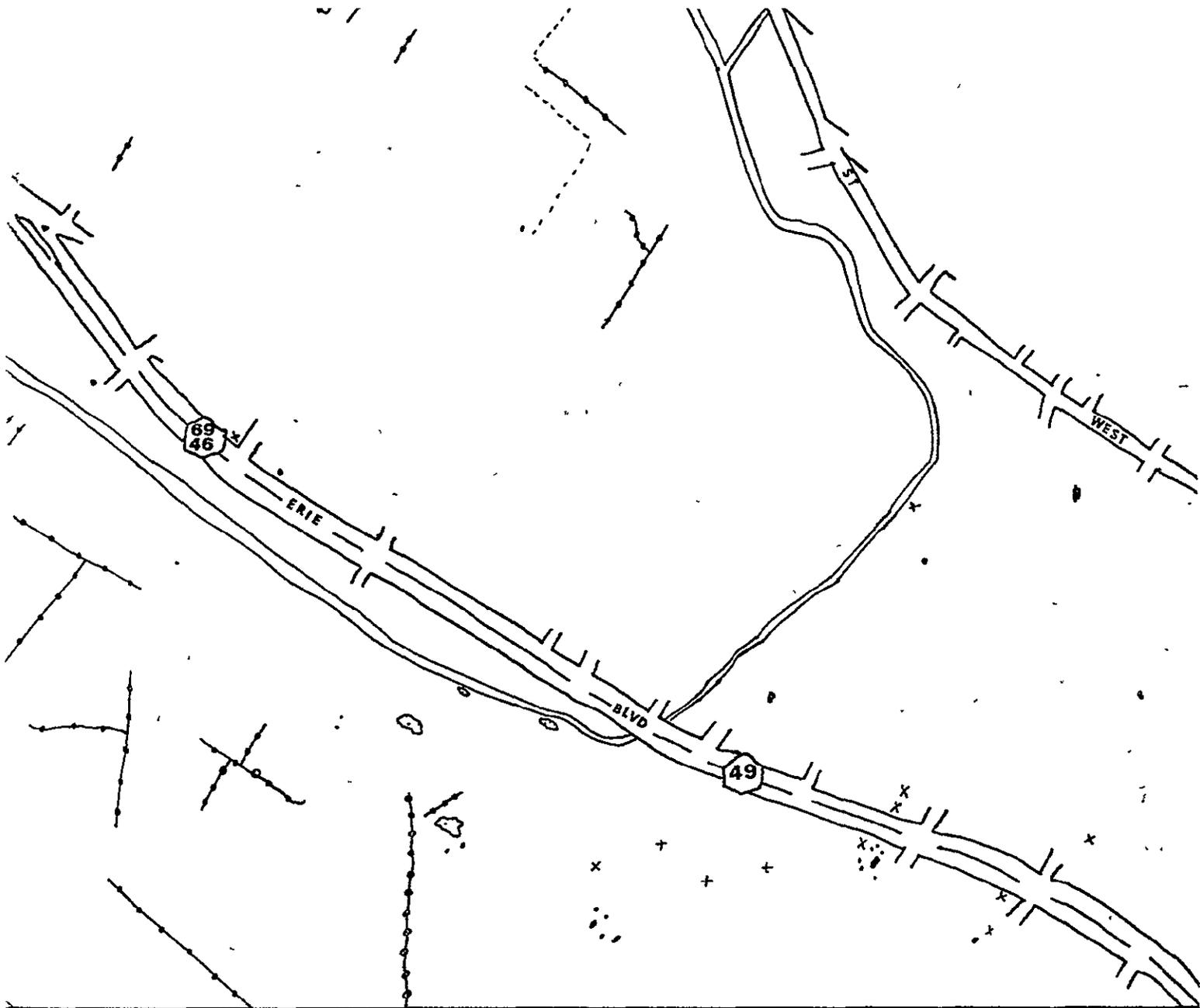
# POTENTIAL MOSQUITO BREEDING SITES, ROME, N.Y.

Based on interpretation of 15 June 1978, 1:5000 scale, panchromatic aerial photographs

Base Map: Rome North, Sheet No. 19; State of New York, Dept. of Public Works, Herkimer -  
Oneida Counties, Transportation and Regional Planning Study Area

## KEY

- ✕ - roof top ponding
- ⊙ - fountain
- ☉ - area of standing water; relatively permanent
- ☼ - area of standing water; probably temporary
- ☽ - potential wet area, dry at time of photography
- ☾ - area presumed to contain standing water (overhead view obscured)
- ~ - river or stream normally wider than 5 meters
- ~ - stream normally less than 5 meters wide
- - dry ditch
- - water-filled ditch
- - ditch with some water
- - area presumed to contain a ditch or stream (overhead view obscured)
- - road



...portion of submitted map overlay...

CORNELL UNIVERSITY  
REMOTE SENSING PROGRAM  
AUGUST 1978

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APPENDIX F

REMOTE SENSING ASSESSMENT OF DAM FLOODING HAZARDS

REMOTE SENSING ASSESSMENT OF DAM FLOODING HAZARDS:  
METHODOLOGY DEVELOPMENT FOR THE NEW YORK STATE  
DAM SAFETY PROGRAM<sup>1</sup>

Research Project Technical Completion Report

by

J.P. Berger, W.R. Philipson and T. Liang<sup>2</sup>

Project No. A-081-NY  
October 1977 to September 1978  
Annual Allotment Agreement No. 14-34-0001-8034

submitted to

The Office of Water Research and Technology  
U.S. Department of the Interior  
Washington, D.C. 20240

November 1978

<sup>1</sup>The work upon which this report is based was supported in part by funds provided by the United States Department of the Interior, Office of Water Research and Technology, as authorized under the Water Resources Research Act of 1964.

<sup>2</sup>Respectively, Graduate Research Assistant, Senior Research Associate, and Professor, Remote Sensing Program, School of Civil and Environmental Engineering, Cornell University, Hollister Hall, Ithaca, N.Y. 14853.

## ABSTRACT

The value and use of remotely sensed aircraft and satellite data for inventorying dams, determining their hazard class, and assessing their condition is described. A methodology is developed to increase the efficiency and accuracy of dam inspection in New York State by incorporating remote sensing techniques into the State Dam Safety Program. This Program, which requires the continuous inventory and characterization of the more than 7,000 dams throughout the State, has been based on permit files and field inspection.

The methodology places emphasis on readily available remotely sensed data--aerial photographs and Landsat data. Aerial photographs are employed in establishing a statewide data base, referenced on county highway and U.S. Geological Survey 1:24,000 scale, topographic maps. Data base updates are conducted by region or county, using Landsat or aerial photographs as a primary source of information. Field investigations are generally limited to high-hazard or special problem dams, or to dams which cannot be assessed adequately with aerial photographs. Although emphasis is placed on available data, parameters for acquiring new aircraft data are outlined and various sensors considered. Large scale (1:10,000) vertical, stereoscopic, color-infrared aircraft photography, flown during the spring or fall, is recommended for assessing dam condition.

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Abstract	ii
Table of Contents	iii
List of Figures	iv
List of Tables	v
Acknowledgments	vi
1. Introduction	1
2: Remote Sensing for Dam-Related Information	2
2.1. Spectral Recognition	3
2.2. Spatial Recognition	5
2.3. Available Remotely Sensed Data	7
2.3.1. Aircraft Photography	7
2.3.2. Landsat Data	8
2.4. Analysis of Remotely Sensed Data	9
2.4.1. Panchromatic Contact Prints	9
2.4.2. Black-and-White Spectral Transparencies	10
2.4.3. Color and Color-Infrared Photographs	11
2.4.4. Densitometric Analyses	12
2.4.5. Magnetic Tape	12
3. Information Needs and Remote Sensing Indicators	12
3.1. Inventory	13
3.1.1. Reservoir Existence, Location and Size	13
3.1.2. Dam Existence and Location	16
3.1.3. Dam Type	19
3.1.4. Dam Height	20
3.1.5. Spillway Existence and Location	25
3.1.6. Spillway Type	25
3.1.7. Reservoir and Dam Use	26
3.2. Hazard Class Determination	27
3.3. Condition Assessment	28
3.3.1. Leaks	28
3.3.2. Erosion, Breaching or Overtopping	28
3.3.3. Spillway Erosion or Deterioration	29
3.3.4. Spillway Obstructions	29
3.3.5. Land Surrounding Impoundments	30
4. Dam Inventory and Inspection with Remotely Sensed Data	34
4.1. Establishing Baseline Data	34
4.2. Updating Baseline Data	37
4.2.1. County Update	39
4.2.2. Statewide/Regional Update	40
5. Collection of New Remotely Sensed Data	41
5.1. Sensor Selection	41
5.2. Photographic Scale	43
5.3. Photographic Monitoring of Dam Condition	45
References	47
Appendix A. Costs and Sources for Remotely Sensed Data of New York State	49
Appendix B. Sensor Selection for Dam Site Monitoring	51

## LIST OF FIGURES

<u>Number</u>	<u>Description</u>	<u>Page</u>
1	Electromagnetic spectrum with types of sensors.	2
2	Spectral reflectance of typical objects and attenuation coefficients of water.	4
3	Spectral irradiance of sun and absorption bands of atmospheric constituents.	6
4	Spectral radiance of a blackbody.	6
5	Landsat Multispectral Scanner image and Landsat-3 Return Beam Vidicon image.	17
6	Small scale, color-infrared aerial photograph of composite dam with internal spillway.	17
7	Earth dam with side channel spillway, photographed with sunglint on reservoir and tree cover over downstream spillway channel.	18
8	Earth dam with possible deterioration of side channel spillway, shoreland erosion and reservoir turbidity.	18
9	Ice cover on reservoir of a concrete gravity dam with a straight drop spillway.	21
10a	Earth dam with concrete upstream face and internal spillway outlet.	21
10b	Straight shorelines created by a road and a dam.	22
11	Composite dam with concrete and earth sections.	22
12	Steep-faced earth dams at different scales.	23
13	Curved earth dam with external side channel spillway.	24
14	Concrete arch dam impounding no water, and bridge shadow of similar appearance.	24
15	Multiple arch concrete dam with internal spillway.	31
16	Concrete gravity dam for hydroelectric power generation.	31
17	Apparent seepage adjacent to reservoir.	32
18	Earth dam with concrete core that has been exposed by overtopping.	32
19	Earth dam with deteriorated concrete spillway.	33
20	Principal steps for dam inventory and inspection.	38
21	Relation between aerial photograph and ground surface.	44
B.1	Distortion pattern of a unit grid by frame camera, panoramic camera and scanner.	53
B.2	Geometry of airborne scanning radiometer.	54

## LIST OF TABLES

<u>Number</u>	<u>Description</u>	<u>Page</u>
1	Ground distances and areas versus image measurements for various scales.	7
2	Exposing radiation viewed when color and color-infrared transparencies are examined over white light through different spectral filters.	11
3	Spectral bands for monitoring dams.	14
4	Photographic and scanner systems of potential values for monitoring dams.	42
5	Mission parameters for aerial photographic sensing of dam condition.	46
A.1	Costs for remotely sensed data.	49
A.2	Primary sources for remotely sensed data.	49
B.1	Ground area imaged by different format photographs of different scales.	51

## ACKNOWLEDGMENTS

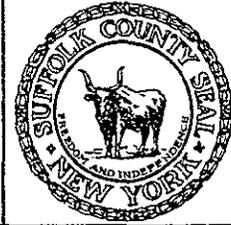
Principal support for this investigation was through funds provided by the United States Department of the Interior, Office of Water Research and Technology, as authorized under the Water Resources Research Act of 1964. Other funds, provided by Grant NGL 33-010-171 from the National Aeronautics and Space Administration, supported the preliminary development of the remote sensing methodology.

The authors would like to acknowledge the cooperation of the staff of the Dam Safety Program, of the New York State Department of Environmental Conservation, and in particular, Kenneth D. Harmer. Appreciation is also extended to Pat Webster, for typing this manuscript, and Deborah Halpern, for assisting in the preparation of the photographic examples.

APPENDIX G

SELECTED CORRESPONDENCE AND PROJECT-RELATED ITEMS

John M. Flynn, P.E.  
Commissioner



SUFFOLK COUNTY  
DEPARTMENT OF ENVIRONMENTAL CONTROL

~~1324 ADISTOX 216KAY~~  
65 Jetson Lane

Hauppauge N. Y. 11787  
(516) 234-2622

September 13, 1978

Mr. Warren R. Philipson . .  
Sr. Research Associate  
Cornell University  
Remote Sensing Program  
School of Civil and Environmental Engineering  
Hollister Hall  
Ithaca, New York 14853

Dear Mr. Philipson:

As I have the prime interest in using remote sensing, Ellis Koch has requested that I respond to your letter of 18 April. My apologies for this long delay in replying.

There are two problems which I feel may lend themselves to study using remote sensing techniques.

1. The change in configuration of the barrier island inlets to Long Island's south shore bays.
2. The seasonal variation of turbidity in Long Island coastal waters.

The first item is one of immediate interest to us as inlet configuration may be an important factor in controlling the salinity of Great South Bay.

The second is of interest as regards plankton populations in our coastal waters. It is these biological populations that would be expected to vary seasonally and, in fact, there are data available (Nuzzi, 1973; Nuzzi and Perzan, 1974), indicating rather large changes in the turbidity of coastal waters that appear to be correlated to plankton populations.

I should think that there already may exist enough remote imagery to initiate both programs with the major problem being the concatenation of the varied disciplines, i. e., I don't know where to get started in researching the proper imagery and I look to you for assistance in this aspect of the study.

To: Mr. Warren R. Philipson

-2-

September 13, 1978

I am most interested in your thoughts on this matter and would appreciate any assistance that you can offer.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "Robert Nuzzi".

Robert Nuzzi, Ph. D., Chief  
Marine Resources Section

RN:ets

Enc.

cc: Ellis Koch

C-2

References:

Nuzzi, R. 1973

A synoptic study of the surface waters of Block Island Sound and surrounding waters, Part I. New York Ocean Science Laboratory Technical Report No. 0019.

Nuzzi, R. and U. Perzan, 1974

Phytoplankton and suspended particles. In An interdisciplinary study of the estuarine and coastal oceanography of Block Island Sound and adjacent New York coastal waters: ground truth. NYOSL Tech. Report No. 0027



891 WATERVLIET-  
SHAKER ROAD  
ALBANY, N. Y. 12205  
(518) 869-0235

October 4, 1978

Mr. Warren R. Philipson  
Cornell University  
Remote Sensing Program  
Hollister Hall  
Ithaca, NY 14853

Dear Mr. Philipson:

Pursuant to our telephone conversation on Tuesday, October 3rd, I am forwarding descriptions of possible work tasks (which were originally requested from you in correspondence dated May 11, 1978).

Of considerable use to the Albany County Planning Board would be assessments of landslide and erosion potential within the County, especially within the Normans Kill drainage basin. Such assessments would be most valuable in the review of subdivision and development proposals referred to our office by municipal governments under the provisions of Section 239 of the New York State General Municipal Law.

At this time I cannot suggest additional projects, other than the ones I originally forwarded to you. If I can be of further service, please do not hesitate to contact me. Also, thanks very much for your willingness to provide our office with such potentially valuable information.

Sincerely,

A handwritten signature in cursive script that reads "Kevin Millington".

KEVIN MILLINGTON  
Planner

KM/bf

Coastal Erosion Reconnaissance Field Trip

Date: Monday, October 16, 1978

Theme: The theme of this field conference deals with the protection, maintenance and enhancement of the physical character of the natural and developed recreational resources that are located on dynamic barrier coastal systems.

We will focus on problems associated with the preservation of New York State's public recreational facilities located on the Jones Beach and Fire Island Barrier Systems.

Participants: A list of participants is included with the several publications and maps supplied to each participant. The following agencies/institutions are represented:

New York State Office of Parks and Recreation (OPR)  
Long Island State Park and Recreation Commission (LISPRC)  
Environmental Management  
Development Bureau  
New York State Department of Environmental Conservation (DEC)  
Water Management Group  
Office of Environmental Analysis  
New York State Division of the Budget (DOB)  
Cornell University  
School of Civil and Environmental Engineering,  
Remote Sensing Program  
U. S. Army, Corps of Engineers

Itinerary: There are eight main stops included in the trip

Morning: On Jones Beach Barrier Island - travel by four wheel drive vehicle from Field 1 along shoreface to Field 9

Lunch

Afternoon: On the Fire Island Barrier - travel by four wheel drive vehicle from Field 5 to Democrat Point and then to the inlet side of Robert Moses State Park.

Trip Leaders:

Frank Hyland, Fred Wolff and Pete Buttner

Participants: Coastal Erosion Reconnaissance Field Trip 10/16/78

Col. Clark H. Benn, District Engineer, N.Y. District, U.S. Army  
Corps of Engineers (COE) (212) 264-9078 (N.Y.C.)

Dr. Peter J. R. Buttner, Director of Environmental Management, NYS  
Office of Parks and Recreation (OPR) (518) 474-0400 (Albany)

Thomas Connors, P.E., Director of Development, OPR, (518) 474-0481  
(Albany)

David DeRidder, Asst. Engineer, Environmental Analysis, NYS Department  
of Environmental Conservation (DEC) Region I, (516) 751-7900  
(Stony Brook)

Dr. Thomas L. Erb, Research Specialist, Remote Sensing Program, Cornell  
University (CU), (607) 256-4330 (Ithaca)

William Hafker, Research Assistant, CU, (607) 256-4330 (Ithaca)

Frank Hyland, P. E., Chief Engineer, Long Island State Park and Recrea-  
tion Commission (LISPRC), (516) 669-1000 (Babylon)

James Kelly, Chief, Water Management Group, DEC (518) 457-3158 (Albany)

Orin Lehman, Commissioner, OPR, (518) 474-0443, (Albany)

Gilbert Nersesian, P. E., Chief, New Jersey Planning Group, COE, (212)  
264-9078 (NYC)

Rudy Runko, Deputy Chief Budget Examiner, NYS Division of the Budget  
(DOB) (518) 474-6037 (Albany)

John Sheridan, General Manager, LISPRC, (516) 669-1000, (Babylon)

William Valentino, Budget Examiner, DOB, (518) 474-2330, (Albany)

Ivan P. Vamos, Deputy Commissioner for Planning and Operations, OPR,  
(518) 474-0449 (Albany)

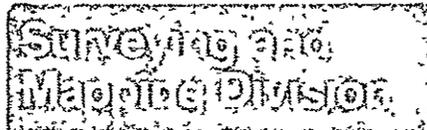
Dr. Fred Wolff, Coastal Sedimentologist, Hofstra University, (516)  
560-3291 (Hempstead)

# ASCE News

OCTOBER 1978/VOL 3, NO 10

News Supplement to CIVIL ENGINEERING-ASCE

American Society of Civil Engineers • 345 East 47th Street • New York, N Y 10017



*Executive Committee - Gunther H. Greulich  
Chairman, Roger F. Dwyer, Vice Chairman, Roscoe B. Snedeker, Donald R. Graff, Doyle M. Clark  
Secretary, University of Texas, Dept. of CE, Box 19701, Arlington, TX 76019, B. Austin Barry  
Management Group, E. Contact Member*

## Cornell Remote Sensing Program

The Remote Sensing Program in the Cornell University School of Civil and Environmental Engineering is endeavoring to establish communication links among persons interested in remote sensing and to solicit and conduct user-oriented demonstration projects. Under the leadership of principal investigator Dr. Ta Liang, the program, in its seventh year, is funded primarily by a grant from NASA. The user-oriented demonstration projects are conducted at no charge to the user, if the project involves a unique benefit- or action-producing application of aircraft or satellite remote sensing in the northeastern United States. Recently completed projects include a study regarding leachate from the Love Canal landfill in Niagara Falls, N.Y., and an assessment of sites for river dredge spoil disposal and subsequent recreational development. A continuing project involves the use of both aircraft and satellite data to develop a remote sensing methodology for assessing dam flooding hazards. Further information can be acquired by writing Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, New York 14853.

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APPENDIX H  
NEWSLETTER RECIPIENTS

CORNELL REMOTE SENSING NEWSLETTER

LIST OF RECIPIENTS

CAMPUS GROUPS AND INDIVIDUALS\*

- |   |                  |   |
|---|------------------|---|
| 1. Academic Funding                       |                  |   |
|   | T.R. Rogers      | (Director)  |
| 2. Administration                         |                  |   |
|   | F.H.T. Rhodes    | (President, Cornell)  |
|   | W.K. Kennedy     | (Provost, Cornell)  |
|   | J.W. Spencer     | (Special Ass't. to President)   |
| 3. Administrative Programming Service     |                  |   |
|   | C. Selvarajah    |   |
| 4. Aerospace Studies (Air Force R.O.T.C.) |                  |   |
|   | J. Levisky       | (Major)   |
| 5. Agricultural Economics                 |                  |   |
|   | O.D. Forker      | (Chairman; Prof.)   |
|   | D.J. Allee       | (Prof.)   |
|   | C.R. Bailey      | (Research Ass't.)   |
|   | H.E. Conklin     | (Prof.)   |
|   | G.R. Fohner      | (Research Specialist)   |
|   | K.V. Gardner     | (Sr. Extension Assoc.)  |
|   | W.C. Hunt        | (Research Specialist)   |
|   | B.F. Stanton     | (Prof.)   |
| 6. Agricultural Engineering               |                  |   |
|   | D.A. Haith       | (Assoc. Prof., Civil & Envir. Eng'g. and Agr. Eng'g.)                         |
|   | L.H. Irwin       | (Assoc. Prof.)  |
|   | W.J. Jewell      | (Assoc. Prof.)  |
|   | G. Levine        | (Prof.; Dir. Center for Envir. Research)                                      |
|   | R.C. Loehr       | (Dir., Environmental Studies; Prof., Civil and Envir. Eng'g and Agr. Eng'g.)  |
|   | D.C. Ludington   | (Assoc. Prof.)  |
|   | O. Zolezzi       | (Research Asst.)  |
| 7. Agronomy                               |                  |   |
|   | R.F. Lucey       | (Chairman, Prof.)   |
|   | R.W. Arnold      | (Prof.)   |
|   | D.R. Bouldian    | (Prof.)   |
|   | W.F. Croney      | (Sr. Ext. Assoc.)   |
|   | M. Drosdoff      | (Prof. Emer.)   |
|   | E.R. Lemon       | (Prof.; Soil Scientist, U.S D.A.)   |
|   | G.W. Olson       | (Assoc. Prof.)  |
| 7. Agronomy (Cont.)                       |                  |   |
|   | J.H. Peverly     | (Asst. Prof.)   |
|   | A.R. Van Wambeke | (Prof.)   |
| 8. Anthropology                           |                  |   |
|   | R. Ascher        | (Prof.)   |
|   | J.S. Henderson   | (Asst. Prof.)   |
| 9. Applied and Engineering Physics        |                  |   |
|   | A.F. Kuckes      | (Prof.)   |
| 10. Astronomy                             |                  |   |
|   | F.D. Drake       | (Dir., Nat'l Astronomy & Ionosphere Center; Prof.)                            |
|   | M.O. Harwit      | (Prof.)   |
|   | C. Sagan         | (Dir. Planetary Studies; Assoc. Dir. Radio-physics and Space Research; Prof.) |
|   | Y. Terzian       | (Prof.)   |
|   | J. Veverka       | (Assoc. Prof.)  |
| 11. Atmospheric Sciences (Agronomy)       |                  |   |
|   | B.E. Dethier     | (Prof.)   |
|   | W.W. Knapp       | (Assoc. Prof.)  |
|   | A.B. Pack        | (Sr. Extension Assoc.)  |
| 12. Boyce Thompson Institute              |                  |   |
|   | E.H. Buckley     | (Plant Biochemist)  |
|   | J.S. Jacobson    | (Plant Physiologist)  |
| 13. Biological Sciences                   |                  |   |
| 14. City and Regional Planning            |                  |   |
|   | S. Saltzman      | (Chairman; Prof.)   |
|   | B.G. Jones       | (Prof.)   |
|   | S.W. Stein       | (Prof.)   |
| 15. Civil and Environmental Engineering   |                  |   |
|   | R.N. White       | (Dir. School of C.E.E.; Prof., Structural Eng'g.)                             |
|   | G.B. Lyon        | (Asst. Dir.; Assoc. Prof., Envir. Eng'g.)                                     |
|   | J.F. Abel        | (Assoc. Prof., Structural Eng'g.)   |
|   | D.J. Belcher     | (Prof. Emer.)   |
|   | J.J. Bisogni     | (Asst. Prof., Envir. Eng'g.)  |
|   | W.H. Brutsaert   | (Prof., Envir. Eng'g.)  |
|   | R.I. Dick        | (Prof., Envir. Eng'g.)  |
|   | L.B. Dworsky     | (Prof., Envir. Eng'g.)  |
|   | T.L. Erb         | (Research Specialist, Remote Sensing Program)                                 |
|   | G.P. Fisher      | (Prof., Envir. Eng'g.)  |
|   | C.D. Gatcs       | (Prof., Envir. Eng'g.)  |
|   | P. Gergely       | (Prof., Structural Eng'g.)  |

\* Newsletters are sent to the main office of each department listed, as well as to various individuals within the department. In addition, Newsletters are provided to graduate and undergraduate students, upon request.

15. Civil and Environmental Eng'g. (Cont.)

J.M. Gossett (Asst. Prof., Envir. Eng'g.)  
 J.G. Hagedorn (Data Analyst, Remote Sensing Program)  
 S.C. Hollister (Prof. Emer.)  
 A.R. Ingraffea (Asst. Prof., Structural Eng'g.)  
 G.H. Jirka (Asst. Prof., Envir. Eng'g.)  
 P.R. Jutro (Sr. Research Assoc., Envir. Eng'g.)  
 F.H. Kulhawy (Assoc. Prof., Structural Eng'g.)  
 T. Liang (Prof., Remote Sensing Program)  
 J.A. Laggett (Prof., Envir. Eng'g.)  
 P. Liu (Asst. Prof., Envir. Eng'g.)  
 D.P. Loucks (Chairman, Envir. Eng'g.; Prof.)  
 W.R. Lynn (Prof., Envir. Eng'g.)  
 W. McGuire (Prof., Structural Eng'g.)  
 A.J. McNair (Prof., Civil and Envir. Eng'g.)  
 A.H. Meyburg (Prof., Envir. Eng'g.)  
 A.H. Nilson (Chairman, Structural Eng'g.; Prof.)  
 N. Orloff (Assoc. Prof., Envir. Eng'g.)  
 T. Pekoz (Assoc. Prof., Structural Research Mgr.)  
 W.R. Philipson (Sr. Research Assoc., Remote Sensing Program)  
 D.A. Sangrey (Assoc. Prof., Structural Eng'g.)  
 R.E. Schuler (Assoc. Prof., Envir. Eng'g. and Economics)  
 C.A. Shoemaker (Asst. Prof., Envir. Eng'g.)  
 F.O. Slate (Prof., Structural Eng'g.)  
 J.R. Stedinger (Asst. Prof., Envir. Eng'g.)  
 G. Winter (Prof. Emer.)

16. College of Agriculture and Life Sciences

D.L. Call (Dean, Prof.)

17. College of Architecture, Art and Planning

K.C. Parsons (Dean; Prof.)  
 H.W. Richardson (Assoc. Dean; Assoc. Prof.)

18. College of Engineering

A. Schultz (Acting Dean; Prof., Operations Research)  
 P.R. McIsaac (Assoc. Dean; Prof., Electrical Eng'g.)  
 F.J. Ahimaz (Dir., Eng'g. Basic Studies; Prof.)

19. Computer Graphics

D.P. Greenberg (Dir.; Prof., Arch.)

20. Computer Science

21. Design and Environmental Analysis

22. Ecology and Systematics

J.P. Barlow (Assoc. Prof., Oceanography)  
 P.F. Brussard (Assoc. Prof., Ecology)  
 G.E. Likens (Prof., Ecology)  
 P.L. Marks (Assoc. Prof., Biology)

23. Education

R.B. Fischer (Prof.)  
 V.N. Rockcastle (Prof.)

24. Electrical Engineering

J.M. Ballantyne (Prof.)  
 T. Berger (Prof.)  
 R. Bolgiano, Jr. (Prof.)  
 N.H. Bryant (Prof.)  
 W.H. Ku (Prof.)  
 S. Linke (Prof.)  
 R.A. McFarlane (Prof.)  
 C. Pottle (Assoc. Prof.)  
 G.J. Wolga (Prof.)

25. Entomology

26. Entomology Extension

27. Floriculture and Ornamental Horticulture

M.I. Adleman (Assoc. Prof., Landscape Architecture)  
 A.S. Lieberman (Prof., Landscape Architecture)  
 P.J. Trowbridge (Asst. Prof., Landscape Architecture)

28. Geological Sciences

J.E. Oliver (Chairman; Prof.)  
 J.M. Bird (Prof.)  
 A.L. Bloom (Prof.)  
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APPENDIX I  
RECENT NEWSLETTERS

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

#### THE SEVENTH YEAR

The Remote Sensing Program is funded primarily by a grant from the National Aeronautics and Space Administration (NASA) to the Cornell University School of Civil and Environmental Engineering. Since the Program's inception in June 1972, its staff has endeavored to strengthen instruction and perform research in remote sensing, building upon Cornell's thirty years of experience in aerial photographic studies; to establish communication links among persons interested or active in remote sensing; and to solicit and conduct user-oriented demonstration projects. These projects are conducted at no charge to the user if the project involves a unique benefit- or action-producing application of aircraft or satellite remote sensing in New York State or in the Northeast.

NASA-sponsored projects completed since May 1978 include (cooperators in parentheses): a comprehensive study and consultations regarding leachate from the Love Canal landfill in Niagara Falls, N.Y. (N.Y.S. Dept. Health); a Landsat analysis of land cover types related to pheasant range management (N.Y.S. Dept. of Environmental Conservation); an assessment of sites for river dredge spoil disposal and subsequent recreational development (Planning Dept., Columbia County, N.Y.); an evaluation of active agriculture and land quality as input to modifying agricultural districts (Planning Dept., Columbia County, N.Y.); and a survey and characterization of mosquito breeding sites in selected areas of central New York (N.Y.S. Dept. Health). (continued, p. 2).

#### ASP DIVISIONAL CHANGES/CALL FOR PAPERS

During the past year, the American Society of Photogrammetry underwent a series of name and structural changes. The Society's three divisions and their respective technical committees are as follows: (1) Primary Data Acquisition (sensor systems; environmental factors; data characteristics, quality and standards; data processing, reproduction and display; and vehicles and navigation); (2) Digital Processing and Photogrammetric Applications (image data processing techniques, development; computational photogrammetry; automated cartography; instrumentation; close-range photogrammetry; cadastral surveys; transportation surveys; and standards); and (3) Remote Sensing Applications (education and interpretive skills; engineering applications; extraterrestrial sciences; geography and land use; geological sciences; hydro-spheric sciences; and plant sciences). For further information contact: William D. French, Executive Director, ASP, 105 N. Virginia Ave., Falls Church, Va. 22046 (tel. 703-534-6617).

The ASP's 45th Annual Meeting will be held in Washington, D.C., from 18 to 24 March 1979. Proposals for papers on recent developments in primary data acquisition, digital processing and photogrammetric applications, and remote sensing applications should be submitted to: Thomas J. Lauterborn, ASP Technical Program Chairman, U.S. Geological Survey, 507 National Center, Reston, Va. 22092. Proposals should include the author's name, address and professional affiliation, a titled abstract of approximately 200 words, the estimated time for presentation (limited to 20 minutes), and the percentage of material presented in a previous talk or publication. Proposals must be received by 15 October.

#### SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing will not be held during the fall semester 1978, but will be offered again during the spring 1979.

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## Cornell's Remote Sensing Program (cont'd)

Continuing projects are using aircraft data to examine vineyard yield factors, satellite data to relate river discharge to flooded area, and both aircraft and satellite data to develop a remote sensing methodology for assessing dam flooding hazards. The latter project is being funded by the Office of Water Research and Technology, U.S.D.I., through Cornell's Center for Environmental Research.

The staff of the Remote Sensing Program includes Ta Liang, principal investigator, Arthur J. McNair and Warren R. Philipson, co-investigators, Thomas L. Erb, research specialist, John G. Hagedorn, data analyst, Deborah Halpern, photographic laboratory technician, and Pat Webster, secretary. Brian L. Markham and Josephine Ng, former staff members, left the Program during the summer. Donald J. Belcher and Ernest E. Hardy are general consultants to the Program, and Carl Diegert is a computer consultant. For specific projects, assistance has been provided by many Cornell and non-Cornell personnel. Students who have contributed to the Program staff effort over the summer include Jan P. Berger, William R. Hafker, Jay N. McLeester and David W. Adams.

### MEETINGS AND SYMPOSIA

- Regional Meeting, Central New York Region, Amer. Soc. Photogrammetry; 15 Sept; in Rochester; Contact: Walter R. Ambrose, Bausch & Lomb, Inc., P.O. Box 543, Rochester, N.Y. 14602 (tel. 716-338-6546).
- Nat'l. Conf. on Capabilities & Limitations of Thermal Infrared Sensing Technology in Energy Conservation Programs; 20-21 Sept; in Chattanooga, Tenn.; (Amer. Soc. Photogrammetry, Dept. of Energy, and Tenn. Valley Authority); Contact: William French, Amer. Soc. Photogram., 105 N. Virginia Ave., Falls Church, Va. 22046 (tel. 703-534-6617).
- 4th William T. Pecora Memorial Symposium (application of remote sensing to wildlife management); 10-12 Oct; in Sioux Falls, S.D.; Contact: Dr. Michael E. Berger, Nat'l Wildlife Federation, 1412 16th St., NW, Washington, D.C. 20036 (tel. 202-797-6881).
- Fall Convention, Amer. Congress Surveying & Mapping - Amer. Soc. Photogrammetry; 15-21 Oct; in Albuquerque, N.M.; Contact: Dr. Stan Morain, Technology Application Center, Univ. of New Mexico, Albuquerque, N.M. 87131 (tel. 505-277-4000).
- LACIE Symposium (review & discussion of Large Area Crop Inventory Experiment conducted by NASA, USDA, NOAA and various university and industrial research personnel); 23-26 Oct; in Houston, Tex.; Contact: Industrial Economics Research Div., Texas A. & M Univ., Box 83, College Station, Tex. 77843 (tel. 713-845-5711).

### SELECTED ARTICLES AND PUBLICATIONS

- Anderson, J.R. (ed.). 1977. Land use and land cover maps and statistics from remotely sensed data. Remote Sensing of Electro-Magnetic Spectrum 4:4:192.
- Barrett, E.C. and L.F. Curtis. 1977. Environmental remote sensing 2: Practices and problems. Edward Arnold (Publishers), Ltd., London. 319 pp. (\$34.50).
- Gordon, H.R. 1978. Removal of atmospheric effects from satellite imagery of the oceans. Applied Optics 17:10:1631-36.
- Kirman, J. 1978. A primer for satellite maps. (A teaching kit for instruction in Landsat remote sensing; contains 63 color Landsat images, etc.: for use at elementary and secondary levels, as well as university level). Puckrin's Production House Ltd., 35 Mill Drive, St. Albert, Alberta, T8N 1J5 Canada (\$40).

The Newsletter is made possible by a grant from the NASA Office of University Affairs. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, New York 14853 (tel. 607-256-4330).

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

#### LANDSAT ANALYSIS OF LAND COVER FOR PHEASANT MANAGEMENT

In a NASA-sponsored study conducted for the New York State Department of Environmental Conservation (DEC), the staff of Cornell's Remote Sensing Program examined the value of Landsat multispectral scanner data for separating five land cover types in central New York. These cover types--alfalfa, corn, other (small) grains, beans and truck crops--had not been differentiated in the statewide Land Use and Natural Resources Inventory, and were being considered for inventory under the DEC's pheasant habitat management program. The desirability and potential feasibility of using Landsat rather than aircraft data were established by the probable need for periodic inventory of these and other cover types over a major portion of the state (Finger Lakes and Lake Plains Regions), with a minimum mapping unit of four hectares.

To verify Landsat interpretations, ground data were collected at three Finger Lakes test areas. The areas ranged in size from 15 to 35 km<sup>2</sup>; the data consisted of field observations of the cover types present in 1977, and interview-derived data on the cover types present in 1976. A crop calendar was also compiled.

The initial attempts to discriminate the cover types made use of Landsat computer-compatible tapes (CCTs). Failure to spectrally differentiate the cover types with digital data would indicate that manual (visual) analyses would also be unsuccessful, whereas the reverse is not necessarily true. A July 15, 1977, Landsat scene was chosen for analysis because most fields would have crops on this date. The CCT of an August 24, 1976, scene, on hand for an unrelated investigation, was also analyzed. The test areas in both scenes were categorized using non-parametric, supervised classification procedures (ORSER's minimum distance and parallelepiped classifiers), with and without pre-processing (canonical analysis, ratioing). It was found that few of the cover types of interest could be reliably separated on a single date of Landsat data. The study then adopted a multi-date ("time sequential") approach. (continued, page 2).

#### WASHINGTON, D.C., LAND COVER MAPS

The U.S. Geological Survey has published a "Folio of Land Use Maps of the Washington Urban Area" (Map Folio I-858; \$11.75). Included are four previously published 1:100,000 scale maps (I-858-A through -D) showing Land Use, 1970, derived from high altitude aerial photographs, Annotated Orthophoto, 1970, Census Tracts, 1970, and Land Use Change, 1970-72. Two new maps in the folio show land cover compiled by computer classification of 1972 and 1973 Landsat data. One map is overprinted with locational features and place names (I-858-E; \$2.75), and the other is overprinted with 1970 census tracts and the 1972 urban boundary (I-858-F; \$2.75). All maps can be purchased from the USGS Branch of Distribution, 1200 South Eads St., Arlington, VA 22202. For further information, contact the Land Information and Analysis Office, MS 710, USGS National Center, Reston, VA 22092.

#### SHORT COURSES

Remote Sensing Technology & Applications; offered first full week of each month through 4-8 June 1979; Contact: D. Morrison, LARS/Purdue Univ., 1220 Potter Dr., W. Lafayette, Indiana 47906.

Image Processing & Pattern Recognition; 27 Nov-1 Dec; \$495; Contact: Continuing Education in Eng'g. and Mathematics, P.O. Box 24902, UCLA Extension, Los Angeles, Calif. 90024.

## 2 Landsat Study (continued)

Multidate analysis of Landsat data can take advantage of cropping patterns as well as reflectance differences, and are therefore potentially more accurate than single date analyses. Images instead of tapes were used for the multi-date analysis because of the relatively high cost of CCTs and computer analyses, and lesser likelihood of implementation by the DEC. Photographic enlargements of the test areas in the band 5 (red) and band 7 (near-infrared) images were made for three 1977 scenes, May 22, June 27 and August 2. These enlarged transparencies, (positive and negative) were analyzed in an additive-color viewer, applying various spectral band/date/color assignments. In general, only gross assessment of the spectral content of the agricultural fields could be performed through visual methods since only three or four levels of gray could usually be distinguished on any image. At best, three groups of cover types were separable: (1) alfalfa, (2) corn, beans and truck crops, and (3) small grains (oats and wheat).

It was concluded that neither the single dates of Landsat, analyzed digitally, nor the combination of dates, analyzed manually, could provide adequate separability of all cover types of interest. Supervised classification of Landsat digital data from two dates would likely prove successful, and some improvement in separability with manual methods would likely accompany improvements in the quality of the imagery. These approaches as well as others are now being considered by the DEC.

The study was conducted by Brian L. Markham with assistance from several other staff members of the Remote Sensing Program. For further information, contact Warren R. Philipson at Cornell, or Peggy R. Sauer, Supervising Wildlife Biologist, N.Y.S. Dept. of Environmental Conservation, 50 Wolf Road, Albany, NY 12233.

### APPALACHIANS/LANDSAT DATA SOUGHT

Dr. George Rabchevsky, Research Scientist at the American University, is establishing a collection and list of available/published Landsat geologic interpretations of the Appalachian orogen. The work is part of an NSF project, "Application of Plate Tectonics to the Location of New Mineral Targets in the Appalachians." He would like to obtain/purchase reports, maps and other information on this topic. Of special interest are lineament/fracture maps and analyses related to stress fields and metallogeny. Please contact: Dr. George A. Rabchevsky, The American Univ., Beeghly Hall, Washington, D.C. 20006.

### SELECTED ARTICLES AND PUBLICATIONS

- El-Ashry, M.T. (editor). 1977. Air photography and coastal problems. Dowden, Hutchinson & Ross, Inc. Stroudsburg, Penn. 425 pp. (\$32).
- Soetanto. 1978. Aerial photography in Indonesia. Photogrammetria 34:3:79-87.
- ITC Journal 1978. no. 1
- van Genderen et al. Guidelines for using Landsat data for rural land use surveys in developing countries.
- Tempfli & Makarovic. Transfer functions of interpolation methods.
- Bergsma, E. Field boundary gullies in the Serayu River Basin, Central Java.
- Miller, V.C. Solar stereo Landsat imagery.
- Leberl, F. Current status and perspectives of active microwave imaging for geoscience application.

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The Newsletter is made possible by a grant from the NASA Office of University Affairs. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, New York 14853 (tel: 607-256-4330).

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#### RESOURCE INFORMATION LABORATORY--NEW PROGRAMS

In response to a significant increase in the interest of local governments and citizen's groups in the use of remotely sensed data for resource management decision-making, the Resource Information Laboratory (RIL), of Cornell's College of Agriculture and Life Sciences, has greatly expanded its training activities. Functioning as a unit of the New York State Cooperative Extension, RIL has developed and tested several programs, which are now ready for general use. Among these are a new approach to county resource inventory wherein the organizational problems are dealt with by working directly with local government officials to explain the need for inventories; working with volunteer groups to train them in inventory techniques; preparing the local population to accept new kinds of information; and, finally, working with decision makers in the use of the new information sources.

The New York State Land Use and Natural Resources Inventory (LUNR) continues to be a major component of the RIL information collection. Although LUNR data are based largely on 1968 aerial photography, interest in their use is still strong. Substantial effort has also been expended in obtaining new resource materials. Of major importance is the acquisition of a collection of New York State aerial photographs, flown for the U.S. Department of Agriculture since 1954. Together with LUNR, these photographs will provide opportunities for development of trend-line data, with as many as four or five dates available for much of the State.

For additional information concerning RIL and its services, contact: E.E. Hardy, Director, or Ms. E.M. Barnaba, Manager of Technical Services, at tel. 607-256-6520 or -6529. Mailing address: Resource Information Laboratory, Cornell Univ., Roberts Hall, Box 22, Ithaca, N.Y. 14853; site location: Brown Road (Tompkins County Airport road).

#### CALL FOR PAPERS FOR POSTER PRESENTATIONS

The 13th International Symposium on Remote Sensing of Environment will be held in Ann Arbor, Michigan, 23 to 27 April 1979. In addition to sessions of invited papers, the symposium will feature numerous poster sessions. Persons interested in contributing to a poster session should submit 30 copies of a 300 to 1,000 word summary to: Dr. Jerald J. Cook, Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, Mich. 48107 (tel. 313-994-1200). The summaries should designate a specific topic or subject area for evaluation, and they must be received by 1 December 1978.

#### SMALL-SCALE PHOTOS OF FINGER LAKES REGION

In support of several projects of Cornell's Remote Sensing Program, NASA flew high-altitude, aerial photographic coverage of New York's Finger Lakes Region on 26 May and 18 August 1978. Color and color-infrared coverage were obtained at a scale of approximately 1:120,000, over the area from N42°15' to 43°00' and W75°45' to 77°40'. The area photographed is comparable to that flown earlier during a NASA high-altitude, color-infrared photographic mission, on 7 May 1975.

As with all remotely sensed aircraft and satellite data acquired by NASA, the photographic coverage may be purchased from the U.S. Geological Survey, EROS Data Center, Sioux Falls, South Dakota 57198. Members of the Cornell Community who are conducting or planning investigations that might benefit from the use of the 1975 or 1978 photography should contact Dr. Warren R. Philipson, 464 Hollister Hall, 6-4330.

- Chance, J.E. and E.W. LeMaster. 1978. Plant canopy light absorption model with application to wheat. Applied Optics 17:16:2629-2636.
- Colcord, J.E. 1978. Thermal infrared imagery use in urban energy surveys. Transportation Eng'g. Jour., ASCE 104:TE5:637-651.
- Gordon, H.R. 1978. Remote sensing of optical properties in continuously stratified waters. Applied Optics 17:12:1893-97.
- Canadian Journal of Remote Sensing 1978. v.4., n.2.  
(available from Canadian Aeronautics & Space Institute, 77 Metcalfe St., Ottawa, Canada K1P 5L6.)
- Bush & Ulaby. Crop inventories with radar.
  - Starr & Mackworth. Exploiting spectral, spatial and semantic constraints in the segmentation of Landsat images.
  - Alfoldi & Munday. Water quality analysis by digital chromaticity mapping of Landsat data.
  - Ahearn et al. Simultaneous microwave and optical wavelength observations of agricultural targets.
  - Goodenough et al. Feature subset selection in remote sensing.
  - Lowry & Brochu. An interactive correction and analysis system for airborne laser profiles of sea ice.
  - Wadhams, P. Sidescan sonar imagery of sea ice in the Arctic Ocean. Photogrammetric Eng'g & Remote Sensing 1978. v.44, n.5 (May).
  - Kratky, V. Reflexive prediction and digital terrain modelling.
  - Snyder, J.P. The Space Oblique Mercator projection.
  - Fleming, J. Exploiting the variability of Aerochrome Infrared film.
  - Brothers & Fish. Image enhancement for vegetative pattern change analysis.
  - Johnson, R.W. Mapping of chlorophyll a distribution in coastal zones.
  - Paul, C.K. Internationalization of remote sensing technology. Photogrammetric Eng'g & Remote Sensing 1978. v.44, n.6. (June).
  - Spencer, R.D. Map intensification from small format camera photography.
  - Sheldon, J.W. In situ measurement of water transparency.
  - Jensen et al. High-altitude versus Landsat imagery for digital crop identification.
  - Sauchyn & Trench. Landsat applied to landslide mapping. Remote Sensing of Environment 1978. v.7, n.2.
  - Doda & Green. Spectral sunphotometry using a compact spectrometer.
  - Bristow, M. Airborne monitoring of surface water pollutants by fluorescence spectroscopy.
  - Smith et al. Use of Landsat-1 imagery in exploration for Keweenaw-type copper deposits.
  - Huntington & Raiche. A multi-attribute method for comparing geological lineament interpretations.
  - Burns & Brown. The human perception of geological lineaments and other discrete features in remote sensing imagery.
  - Pratt et al. Recent advances in the applications of thermal infrared scanning to geological and hydrological studies. The Photogrammetric Record 1978. v.9, n.51.
  - Scogings, D.A. The experimental recording of petroglyphs and archaeological sites.
  - Spencer, R.D. Film trials of aerial photography for forestry in Victoria, Australia.

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The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330).

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### ENGINEERING SYSTEMS--A CHALLENGE FOR REMOTE SENSING

by  
Kam W. Wong

*Dr. Wong, Professor of Civil Engineering at the University of Illinois at Urbana-Champaign, received his M.S. and Ph.D. in Photogrammetric and Geodetic Engineering at Cornell, in 1966 and 1968, respectively. The views expressed here are those of Dr. Wong and do not necessarily reflect the views or policy of the Cornell Remote Sensing Program.*

Timely information on the physical environment, at an affordable price, is an invaluable asset for the design and planning of engineering systems. The complexity of modern societies has prompted the rapid development of rational and analytical decision making methods for the planning of engineering systems; however, the ability to reach an optimal plan and design for any problem depends on the quality and quantity of the data base. Thus, in addition to social, economic and technical data, information on the physical environment--land use, vegetative covers, surficial soils, topography, etc.--is of vital importance to the planning process. Can current remote sensing technology fulfill this need? Can it do so in the near future?

One is tempted to quickly answer, "Yes!" to both of these questions. The fact is, however, that after a decade of intensive research and development, remote sensing technology has made very little impact in the area of systems planning and design. The Landsat program has provided valuable data for mineral exploration, general land use classification, crop inventory, mapping of shallow seas, and many other endeavors. But in the planning and design of engineering systems, the gathering of data on the physical environment still depends largely on the tedious and conventional methods of photo interpretation and photogrammetry. (continued, page 2).

### CORNELL'S LANDFORM SERIES

The Cornell University-U.S. Navy "Landform Reports" is an airphoto interpretation reference consisting of six volumes with approximately 600 pages and 600 photographs. Completed in 1951 by Ta Liang and others under the direction of Donald J. Belcher, the Landform Series has sections on: general analysis; sedimentary, igneous and metamorphic rocks; and waterlaid, glacial and windlaid materials. If a sufficient number of buyers can be located, this reference will be reproduced. Interested individuals should contact Mary McElroy, Head Librarian, Engineering Library, Carpenter Hall, Cornell Univ., Ithaca, NY 14853 (tel. 607-256-4318). The cost for the six volume set, with unmounted photographs, would be about \$120 to \$150.

### CALL FOR PAPERS--MACHINE PROCESSING

The 5th Purdue Symposium on Machine Processing of Remotely Sensed Data will be held at Purdue University, 27-29 June 1979. Authors wishing to contribute a "long" paper should submit a 1,000-word summary by 15 December 1978. A limited number of "short" papers will be accepted on the basis of a one-page, double-spaced, typed abstract, received by 1 March 1979. Four copies of the long or short paper proposal should be sent to: Dr. Luis A. Bartolucci or Dr. L.F. Silva, Laboratory for Applications of Remote Sensing, Purdue Univ., 1220 Potter Dr., West Lafayette, Ind. 47906 (tel. 317-749-2052).

The 5th Annual William T. Pecora Memorial Symposium will be held in Sioux Falls, So. Dakota, 11-15 June 1979. The symposium is sponsored by the American Water Resources Association and various other organizations, and its theme is satellite hydrology. Sessions of conventional and poster presentations will focus on: meteorology; snow and ice; surface water; ground water; soil moisture; environmental monitoring; coastal zone hydrology; and water use and management. Those wishing to contribute to the symposium should submit five copies of a 200-word, titled abstract to: Morris Deutsch, EROS Program, U.S. Geological Survey, 1925 Newton Square East, Reston, VA 22090 (tel. 703-860-7872), before 31 January 1979. Abstracts should include the name(s) and affiliation(s) of the authors, with an asterisk denoting the senior author. Authors must also enclose a separate page which lists their full mailing address(es) and telephone number(s).

Remote Sensing Challenge (continued)

Although conventional photo interpretation and photogrammetric mapping techniques can provide much of the data that is needed for engineering planning purposes, these techniques are heavily human-dependent; and time consuming processes are required to convert the collected data into computer compatible forms. Remote sensing techniques such as spectral analysis can yield data directly in digital form. To obtain data at an adequate level of resolution, however, huge quantities of data must first be processed. Such processing requirements test even the full capability of the most advanced computer systems. In addition, there is little indication that fully automatic techniques can soon be developed for the mapping of topography and surficial soils.

The challenge to the field of remote sensing remains to be met. Efficient systems for gathering medium to high resolution data should be developed. More efficient analysis techniques are needed to reduce the computational burden associated with spectral analysis. The problems of data storage and retrieval need in-depth study with the ultimate objective of creating integrated environmental data banks. Finally, there is need for a system of computed-assisted photo interpretation with which much of the data correlation tasks can be automated, leaving the human operator to perform the indispensable tasks of interpretation and identification.

SELECTED ARTICLES

Remote Sensing of Environment. 1978. v.7, n.3

- Stewart et al. The use of thermal imagery in defining frost prone areas in the Niagara fruit belt.
- Tucker, C.J. Post senescent grass canopy remote sensing.
- Hirosawa et al. Cross-polarized radar backscatter from moist soil.
- Robinove, C.J. Interpretation of a Landsat image of an unusual flood phenomenon in Australia.
- Abiodun & Adeniji. Movement of water columns in Lake Kainji.
- Viollier et al. Airborne remote sensing of chlorophyll content under cloudy sky as applied to the tropical waters in the Gulf of Guinea.
- Maul, G.A. Locating and interpreting hand-held photographs over the ocean; A Gulf of Mexico example from the Apollo-Soyuz Test Project.
- Anderson, A.C. Remote sensing in sea search and rescue.
- Hiso et al. Wheat yield estimation by albedo measurement.

\*\*\*\*\*  
 Season's Greetings from the staff of the Remote Sensing Program!!!  
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 The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330).

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