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SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Cornell University

HOLLISTER HALL, ITHACA, N.Y. 14850

REMOTE SENSING PROGRAM

June 28, 1974

NASA Scientific and Technical
Information Facility
P.O. Box 33
College Park, Maryland 20740

Subject: NASA Grant NGL 33-010-171
Semi-Annual Status Report

Gentlemen:

In accordance with the provisions of the subject grant, we are transmitting herewith five (5) copies of our 4th Semi-Annual Report, covering the period December 1, 1973 to May 31, 1974. In addition, two (2) copies of the same report are being sent directly to the University Research and Applications Branch, Office of University Affairs, NASA headquarters, Washington, D.C. 20546. (Attention: Mr. J.A. Vitale).

Sincerely yours,

Ta Liang

TL/ja

Ta Liang
Principal Investigator

cc: Mr. J.A. Vitale, NASA Headquarters
Mr. J.R. Jeshow, NASA Headquarters
Deans E.T. Cranch and A.R. Seebass
Mr. T.R. Rogers/Mr. P.F. Mather
Director W.R. Lynn

SEMI-ANNUAL STATUS REPORT
of the
NASA-Sponsored
Cornell University Remote Sensing Program
December 1, 1973 - May 31, 1974

NASA Grant NGL 33-010-171

Principal Investigator: Ta Liang

Co-Investigators: Donald J. Belcher
Arthur J. McNair

Research Associate: Warren R. Philipson

Remote Sensing Program
Hollister Hall
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June 1974

2<

INTRODUCTION

The staff of the Cornell University Remote Sensing Program has endeavored to seek out, develop and demonstrate benefit-producing applications of remote sensing to various Federal, State, county and local agencies, public and private institutions, and the University community. Instruction, a weekly seminar and a monthly newsletter have complemented Program research efforts by stimulating greater interest and communication in remote sensing.

The major activities of the Program staff, from December 1, 1973 to May 31, 1974, are described in this fourth Semi-Annual Status Report. Background information has been provided in three earlier Program status reports, submitted to NASA in December 1972, June 1973 and December 1973.

COMMUNICATION AND INSTRUCTION

Contacts and Cooperators--Over the past six months, the Program staff has worked closely or been in contact with many colleagues from the College of Engineering and the College of Agriculture and Life Sciences, the latter including personnel from the N.Y.S. Cooperative Extension Divisions. Off-campus cooperators on specific projects have included representatives of the Environmental Protection Agency, Eastman Kodak Company, the St. Lawrence Seaway Development Corporation, the Temporary State Commission on Tug Hill, the N.Y.S. Geological Survey, the N.Y.S. Departments of Health, Transportation, Parks and Recreation, and Environmental Conservation, the Highway Departments of Wayne and St. Lawrence Counties, New York, the Department of Planning of Delaware County, New York, and the Museum of History and Art of Cayuga County, New York (Appendices E and F).

In an effort to initiate new cooperative projects, members of the Program staff have entered into discussions with representatives of the N.Y.S. Adirondack Park Agency and with the heads of several county organizations in Saratoga and Monroe Counties, New York.

Over the past six months, the number of requests for Program imagery and facilities, and for staff consultations, has remained high. The N.Y.S. Department of Environmental Conservation, for example, is exploring the possibility of arranging for the Program to become its regular consultant in developing and implementing a remote monitoring capacity; and the Program staff was recently requested to assist the University in planning and contracting for an airborne thermal survey, designed to detect leaks in the campus system of steam lines.

Newsletter--The Cornell Remote Sensing Newsletter is received monthly by approximately two hundred individuals and groups (Appendices H and I). As a vehicle for highlighting remote sensing activities at Cornell while reporting other items of general interest, the Newsletter has elicited and retained the interest of the University community, at large, and provided a regular link with the Program's on-campus and off-campus cooperators.

Seminar--The Program-sponsored Seminar in Remote Sensing is a one-credit hour course in the School of Civil and Environmental Engineering (Appendix G). Each week a different topic on current research, developments and applications of remote sensing is presented by an invited specialist from government, industry, Cornell or another institution. The spring semester registration in the course totaled 20 students from Agronomy, Natural Resources, Geology, Urban Planning and Development, and Civil and Environmental Engineering. Reflecting both the high quality of the speakers and the publicity provided through the Newsletter, special announcements and, occasionally, the local newspaper, the audiences averaged about 30, with representation from some 25 Cornell divisions, local industry and the general public.

Instruction--In addition to the Seminar and the regular courses in Photogrammetry and Aerial Photographic Studies, a new, three-credit hour course, "Remote Sensing," was offered by the Program staff during the spring semester. Ten students from Civil and Environmental Engineering and Geology registered in the course, and several other students audited. The course is now listed with the regular offerings of the School of Civil and Environmental Engineering.

DATA AND FACILITIES

As discussed in previous reports, research and instruction in remote sensing are heavily dependent upon the availability of remote sensing data and facilities for data analysis.

With the assistance of the NASA Office of University Affairs, the Program is receiving ERTS imagery of the Northeast; selected Skylab images of New York State were obtained from Houston, and NASA high altitude photography of the Northeast was received from Ames. In direct support of Program research, NASA-Houston has flown several multisensor missions over test sites in New York State, and one additional mission is scheduled for the summer. Sample imageries of the Northeast have also been acquired from the Rome Air Development Center, the St. Lawrence Seaway Development Corporation, Environment Canada, the U.S. Geological Survey, the U.S. Department of Agriculture and several commercial firms; and, to support several cooperative Cornell investigations, the Environmental Protection Agency provided the Program with four dates of multispectral photographic coverage of selected test sites in the Finger Lakes Region of New York State.

In an effort to increase data analysis capabilities, the Program is purchasing a small color additive viewer and a more efficient zoom stereoscope. In addition, the Program recently obtained the computer analysis routines developed by investigators at Pennsylvania State University. These are being installed on the Cornell computer, and experimentation will soon proceed using ERTS tapes supplied by NASA. One principal objective is to enable more users to have access to digital analysis facilities, in order to more fully utilize NASA data products.

RESEARCH COMPLETED

ERTS-mapping of Tug Hill waterways--As a follow-up to the ERTS study on waterway mapping that the Program performed for the N.Y.S. Department of Parks and Recreation (see 3rd Semi-Annual Status Report), Messrs. Willian Teng and Frederick Voigt compiled an ERTS-map of interconnected waterways in the Tug Hill Region of New York State. As described in their report (Appendix A), the work was requested by the Executive Director of the Temporary State Commission on Tug Hill, and the information will be used by the Commission in formulating a specific plan for recreational development. In addition to providing direct input to the Commission's recommendations, which will be submitted to the State Legislature for enactment, Messrs. Teng and Voigt were able to demonstrate the utility of ERTS-derived data.

Photo-archeological investigation of Great Gully, New York--At the request of Professor Walter Long, Historian of Cayuga County and Curator of the Cayuga Museum of History and Art, Mr. Thomas Erb identified and inventoried suspected sites of Indian occupation along the Great Gully, New York. As outlined in Mr. Erb's report (Appendix B), the aerial photographic study relied on 1968 panchromatic coverage and 1973 color and color infrared coverage; the more recent photography being contracted for and provided by the Environmental Protection Agency. Field investigations by several citizen's and historical groups will be carried out over the next few months and directed by Professor Long, with Program staff assistance. If the field checks confirm the photographic study, attempts will be made to acquire, preserve and develop the Great Gully as a "Forever Natural" area of New York State.

Evaluation of selected highway impacts using aerial photography--A preliminary investigation of remote sensing input to highway environmental impact statements was performed by Mr. Richard Ackley, working in conjunction with the Region 6 Office of the N.Y.S. Department of Transportation (Appendix C). By focusing on a proposed highway between Horseheads and Watkins Glen, New York, Mr. Ackley was able to establish a minimum level of sensor data applicability to the evaluation of residential displacements, air and noise pollution, and visual and neighborhood impacts. Future studies are being considered, and these would attempt to make greater use of aircraft and satellite-derived data.

RESEARCH IN PROGRESS

Six major projects are presently being carried out by, or in conjunction with, members of the Program staff. Listed in order of their expected completion date, they are:

1. Survey and acquisition of highway contruction materials.
2. Selection and acquisition of sanitary landfill sites.
3. Winter recreational planning with satellite imagery.
4. Detection and analysis of sensitive clay soils.
5. Evaluation of disease infestation in apple orchards.
6. Remote sensing techniques for lake condition assessment.

5<

The background and status of each investigation is described briefly, as follows.

1. *Survey and acquisition of highway construction materials*

-cooperators/users: Town and County Highway Depts., Wayne and St. Lawrence Counties, N.Y.
-benefit/action: Location of highway construction material for county acquisition
-expected completion date: September 1974

Virtually all of the known deposits of sand and gravel in Wayne and St. Lawrence Counties have been or are being exploited, and shortages are forecast for the near future. At the request of the Superintendent of Highways from each County, the Program staff began county-wide surveys for highway construction materials, using the existing panchromatic aerial photographic coverage (1968, 1:24,000). (Correspondence from Wayne and St. Lawrence Counties is included in Appendix E.)

A map depicting probable sites of suitable materials will be compiled and submitted to the County Highway Departments. Upon ground verification by the Counties and their towns, proceedings for immediate site or material acquisition will be initiated. The application of high altitude and satellite imageries to an inventory of sand and gravel will then be investigated, and the findings extrapolated to Saratoga County, New York.

2. *Selection and acquisition of sanitary landfill sites*

-cooperator/user: Dept. of Planning, Delaware Co., N.Y.
-benefit/action: Location of suitable landfill sites for county acquisition
-expected completion date: September 1974

At the request of, and in conjunction with the County Director of Planning, the Program staff is performing a county-wide survey for potential landfill sites in Delaware County, New York. The need for suitable landfill sites in this County is acute. All sites recommended by the Program staff will be examined comprehensively by the County and its consultants and, if acceptable politically, proceeding for site acquisition will be initiated. (Correspondence from Delaware County is included in Appendix E.) The application of high altitude and satellite imageries to the selection of sanitary landfill sites will then be investigated, and the findings extrapolated to Saratoga County, New York.

3. *Winter recreational planning with satellite imagery*

-cooperator: N.Y.S. Dept. of Parks and Recreation
-users: N.Y.S. Dept. of Parks and Recreation; various public and private recreational planning groups
-benefits: More comprehensive methodology for planning winter recreational facilities; resultant increase in revenue to facility owners and State
-expected completion date: September 1974

The existing data on snow cover in New York State are scattered and insufficient for detailed recreational planning. At the request of the Director of Research of the N.Y.S. Department of Parks and Recreation, the Program staff is examining the extent to which ERTS and Skylab imageries can be utilized in selecting sites for winter recreational development.

A comprehensive methodology is being developed and tested in the western portion of New York State, and the methodology should be directly transferable to other areas of the United States.

4. *Detection and analysis of sensitive clay soils*

- -cooperator: N.Y.S. Dept. of Transportation
- -users: N.Y.S. Dept. of Transportation; various State, county and Canadian planning and eng'g. agencies.
- -benefits: Route and site design to accommodate hazardous soil areas, preventing losses to property and lives.
- -expected completion data: September 1974

Various marine and lacustrine soil deposits, occurring throughout the northeastern United States and Canada, are susceptible to catastrophic failure. These deposits are of special interest to engineering and planning agencies, in that knowledge of their precise location would greatly affect route and site selection or design.

A review of the literature is being finalized and, with the cooperation of the N.Y.S. Department of Transportation, pertinent engineering soils data were gathered for the St. Lawrence and Albany districts of New York State--areas with known deposits of sensitive soils. NASA-Houston has provided multispectral imagery of the test sites which, together with ERTS and other available aircraft coverage, is currently being related to the field data.

5. *Evaluation of disease infestation in apple orchards*

- -primary sponsor: Eastman Kodak Company
- -cooperators: Depts. of Plant Pathology, Entomology and Agronomy, and Cooperative Extension, Cornell; N.Y.S. Agricultural Experiment Station at Geneva, N.Y.; various apple growers in Wayne Co., N.Y.
- -potential users: Apple growers; private consultants; N.Y.S. Cooperative Extension Bureau; N.Y.S. Dept. of Agriculture and Markets
- -potential benefits: To consumer, apple growers, and New York State economy.
- -expected completion date: December 1974

The project is funded primarily by Eastman Kodak Company. Although the project is considering a number of apple diseases, the focus is on fire blight, a common disease that was especially severe in

New York State during the 1972 growing season. The objectives are to detect and monitor disease infestation, and to provide techniques or a basis for evaluating orchard management and assessing damage.

In an effort to determine the optimum film-filter combinations for disease detection, spectral readings of leaves and branches from control and artificially infected trees were obtained with a spectrophotometer supplied by Eastman Kodak. The raw data were calibrated on Kodak's IBM 360 computer.

Staff of Cornell's Department of Plant Pathology and their Extension Division selected a number of test orchards in Wayne County, New York, and arrangements were made with the orchard owners to study various management techniques and/or obtain ground data in their orchards throughout the growing season. Field and laboratory assistance has also been provided by personnel from the Departments of Agronomy and Entomology at Cornell, as well as from the N.Y.S. Agricultural Experiment Station at Geneva.

Periodic low altitude (500 and 1000 feet) photographic missions were flown by Kodak, and NASA-Houston has provided thermal and smaller scale photographic coverage of the test orchards. The imagery, together with detailed tree, soil, and climatological data, are currently under analysis.

One spin-off benefit that has resulted from this investigation, is the realization of a new extension tool for demonstrating the removal of fire blight cankers from infested apple trees. In brief, during the field studies it was found that close-range, 35mm color infrared photographs of infested trees provide a greatly enhanced view of the cankers. Various means for incorporating this technique into extension training are presently being considered.

6. *Remote sensing techniques for lake condition assessment*

- -cooperators: N.Y.S. Dept. of Health; E.P.A.; Cornell Depts. of Agronomy and Natural Resources; Eastman Kodak Company.
- -users: N.Y.S. Dept. of Health; E.P.A.; public and private agencies concerned with weedbeds and other aspects of lake water quality.
- -benefits/actions: More efficient and more accurate methodology for assessing various facets of lake water quality; techniques to be adopted by N.Y.S. Dept. of Health and other agencies.
- -expected completion date: Total program--September 1975.

With design and coordination provided by the Program staff, the Environmental Protection Agency sponsored a series of multispectral, multiscale photographic missions over four of New York State's Finger Lakes, during the summer of 1973. At the time of these flights, water and weedbed sampling was carried out by teams from the N.Y.S. Department of Health and Cornell's Departments of Agronomy and Natural Resources. All costs for field sampling and laboratory water quality analyses were covered by the participating groups, at no expense to the Program. Selected data, correspondence and general background material on this work are contained in Appendix D.

The three parameters of lake water quality that are being examined are: color, weedbeds and outflows. Spectral data derived from the photographs will be compared and correlated with chlorophyll a and secchi disc measurements in an effort to develop a scheme for rating lakes (i.e., relative quality) on the basis of color. All required densitometric values will be provided by the E.P.A.

With regard to weedbeds, photo-derived maps of the submergent and emergent vegetation in Canadarago Lake and the south end of Cayuga Lake were compiled by the Program staff and submitted to the cooperating investigators (Appendix D). They, in turn, are using the maps to upgrade their field-derived information, and the data will be input to studies of phosphorus loading, fish distribution and weed control for recreation. In order that major weedbed changes and, thus, major changes in lake condition may be assessed, photographic coverage obtained in 1968 has been provided by Eastman Kodak Company.

All existing coverage of Canadarago Lake is being examined to determine the number, location and general characteristics of lake outflows. Toward this end, NASA-Houston has flown one multisensor mission, and a second is scheduled for mid-summer 1974 (see THE THIRD YEAR, below).

The overall objective of this investigation is to demonstrate remote sensing technqiues that are applicable in lake data collection. Emphasis has been placed on practical techniques that could be adopted easily by the N.Y.S Department of Health, the Agency charged with sampling the more than 4,000 lakes in New York State. In order to derive actual and immediate benefits, the efforts of the Program staff have been largely confined to Canadarago Lake, a eutrophication-demonstration lake that has received local, State, National and International attention.

THE THIRD YEAR

General

For the third year of operation, the basic Program will be continued with increased emphasis on soliciting, developing, and demonstrating benefit-producing applications of remote sensing. Communication and instruction, the weekly seminar and monthly Newsletter, provide requisite discussion within and beyond the University community. They serve to publicize NASA's efforts in remote sensing, they provide an awareness of user interests and needs, and they ensure that a wide range of research topics, as well as expertise, are available. These activities will be continued.

Research

Five of the six ongoing projects--the systematic search of highway construction materials, sanitary landfill site selection, winter recreational planning, detecting landslide-susceptible soils, and evaluating apple diseases--will be completed during the third year of operation; the first two should produce immediate action on the part of the cooperating counties. The sixth project--lake condition assessment--will likely extend beyond the third year; however, some shorter term results are expected, especially as concerns the N.Y.S. Department of Health adopting remote sensing techniques for State-wide weedbed and lake outflow analyses. In addition to benefits associated with the ongoing projects, suspected Indian sites along the Great Gully will be field-checked over the next few months, and follow-up action by the County or State is expected to take place during the Program's third year.

Based on discussion with user groups and cooperators, two projects are being scheduled for the third year, and two others are under consideration. These projects are described briefly, as follows:

1. *Monitor of lechate from sanitary landfills*

-cooperators/users: E.P.A.; N.Y.S. Dept. of Environmental Conservation; Cornell Dept. of Agricultural Engineering

The Environmental Protection Agency will contract for periodic photographic and thermal missions to be flown over Program-selected landfills, between Syracuse and Cortland, New York. As part of a larger research effort, the N.Y.S. Department of Environmental Conservation will award a research grant to Cornell to cover the costs of ground sampling and required chemical analyses.

The principal objective of this investigation is to develop methods for monitoring lechate from landfills and other solid waste disposal areas. The secondary objectives are to assess the quality and distribution of lechate from specific landfills, typical of those in the Northeast, and ultimately, to use this information as a basis for decision-making in the selection and development of new landfill sites. If necessary, the State will take regulatory action against the particular landfills under study.

2. *Outflow inventory of Canadarago Lake, New York*

-cooperator/user: N.Y.S. Dept. of Health

As one of the several demonstration projects to be undertaken in conjunction with the N.Y.S. Department of Health (see "Remote sensing techniques for lake condition assessment," above), the Program staff will attempt to determine the number, location, and general characteristics of outflows entering Canadarago Lake, New York. In support of this work, NASA-Houston has flown one multi-sensor mission over the Lake, and a second is scheduled for July or August 1974. Personnel from the State Health Department will field-check all identified outflows, and immediate measures will be taken to eliminate any which constitute a source of pollution.

3. *Constraint mapping for zoning in the Adirondack State Park*

-cooperator/user: N.Y.S. Adirondack Park Agency

A major reason for the creation of the Adirondack Park Agency was that most of the 92 towns and 15 villages within the Adirondack State Park lacked the zoning and related ordinances necessary to control Park development. Functionally, the Agency plans and controls large-scale projects, and projects in sensitive areas, via development permits. Municipalities may regulate moderate-scale projects in Agency-designated areas, if they have an Agency-approved local plan and set of building regulations.

In preliminary discussions with Program staff, members of the Adirondack Park Agency outlined their data needs for project review and zoning, and remote sensing seemed the most effective approach to rapidly fulfilling these needs. Further discussion with the Agency is scheduled for the near future.

4. *Determination of principal ice stresses along St. Lawrence Seaway*

-cooperator: St. Lawrence Seaway Development Corporation
(U.S. Depart. of Transportation)

Based on the Program's work with time-sequential ice mapping, the St. Lawrence Seaway Development Corporation is considering a more comprehensive analysis of principal stresses in the Seaway ice cover. This data would be required for re-designing ice control structures, a requisite step for navigation season extension. To support this investigation, the SLSDC is also considering the award of a research grant to the Program.

PROGRAM STAFF

The regular staff of the Program consists of the principal investigator, Prof. T. Liang, two co-investigators, Profs. D.J. Belcher and A.J. McNair, one research associate, Mr. W.R. Philipson, and two graduate research assistants, Messrs. T.L. Erb and F.C. Voigt. Mrs. G.F. Santner, formerly with the Laboratory for Applications of Remote Sensing at Purdue University, recently joined the Program staff as a data analyst, and Prof. J. Felleman, of the N.Y.S. College of Environmental Science and Forestry, who has had wide experience with State and private environmental and planning agencies has been retained as a consultant for agency liaison work. Dr. E.E. Hardy, of Cornell's Department of Natural Resources, remains as a general consultant to the Program and, for specific projects, assistance has been provided by various Cornell and non-Cornell personnel. Among these, special mention is due Prof. D.A. Sangrey and Mr. Carl Diegert, both of the Department of Environmental Engineering.

Over the past six months, the Program has provided and received direct support from a number of graduate and undergraduate students. Among those who have worked closely with the Program staff are W.L. Teng, H.T. Jarrett, A.S. Marshall, R.A. Weigand, L.S. Zall and B.M. Sorensen.

LIST OF APPENDICES

APPENDIX A

ERTS-MAPPING OF
WATERWAYS IN THE TUG HILL
REGION OF NEW YORK STATE

ERTS-Mapping of Waterways
in the Tug Hill Region
of New York State

Remote Sensing Program
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June 1974

14<

PREFACE

This work was performed by Messrs. William L. Teng and Frederick C. Voigt, at the request of the Temporary State Commission on Tug Hill and with support provided by NASA Grant NGL 33-010-171. Mr. Warren R. Philipson assisted in the preparation of the final report.

Ta Liang
Professor of Environmental
Engineering and
Principal Investigator,
Remote Sensing Program

INTRODUCTION

The Tug Hill Region of New York State covers approximately 1,340,000 acres.* Much of the Region is undeveloped, making the land attractive to large development corporations. To ensure that the Region is developed in an orderly manner, that will not destroy the natural assets of the area, the New York State Legislature created the Temporary State Commission on Tug Hill.

Two major tasks of the Commission are to study the conservation and development of natural resources of the Region, and to investigate the need for strengthening management, acquisition and land use policy. Upon completion of the study, the Commission will report to the State Legislature, recommending specific goals with steps to achieve them.

One segment of the Commission's study concerns the development of outdoor recreation. Recreation is an important industry throughout New York State, and waterways, for canoeing and fishing, are a vital resource to the recreation industry.

The existing data on waterways in the Tug Hill Region are inadequate to plan for their recreational use. The work described in this report was undertaken to upgrade the waterway information available to the Commission. Imagery obtained by NASA's first Earth Resources Technology Satellite (ERTS-1) was employed as the basic tool for analysis.

METHODS AND MATERIALS

Study Area

The Tug Hill Plateau is a distinct physiographic province of northwestern New York State (Fig. 1). It is an extensive highland mass, bounded on the south by the lowlands of the Ontario Lake Plain and Upper Mohawk Valley Provinces, on the west by the Ontario Plain Province, on the north by the St. Lawrence Valley Province, and on the east by the Adirondack Province.

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* All background information on the Tug Hill Region was taken from the references listed at the conclusion of this report.

In general, the topography of the area is gentle. The central portion is very flat and swampy, and about 1800 feet above sea level. The maximum elevation of 2111 feet occurs on Gomer Hill, in the Town of Turin, Lewis County. There is a gradual northeasterly ascent of about 1900 feet from Ontario and Oneida Lakes to the top of the plateau. On the eastern edge of the plateau, there is a steep descent over a series of high terrace fronts, intersected by deep ravines or "gulfs," of which the best known is the Whetstone Gulf.

The bedrock geology of Tug Hill is relatively simple. In general, the rock formations dip from northeast to southwest. Most of the area is underlain by Ordovician sandstones, siltstones, shales and limestones, originated from the vast quantities of sediments that were washed into a sea covering Tug Hill and most of New York State from about 550 to 225 million years ago. At this time, the Appalachian Revolution raised most of New York State above sea level, and the Tug Hill is an erosion remnant of that uplift. The capping formation is the resistant Oswego sandstone.

The depositional history of the surficial material is relatively complex due to glacial influences. Much of the surficial material is undifferentiated glacial till, especially at high elevations; while kames, terraces and other glacial features are found along the sides and floors of the valleys.

Tug Hill's average annual precipitation of about 45 inches is one of the highest in New York State. A great portion of this is in the form of snowfall which, on the average, exceeds 200 inches annually. Hydrologically, this snow accumulation is extremely important because it is the source of most of the annual streamflow. Despite the great volume of water available, however, the system of waterways is not well developed, due to past glacial activities.

ERTS Imagery and Enhancement

In order to provide a seasonal comparison, the ERTS scene of Tug Hill from 11 October 1972 (E1080-15180) and that from 9 April 1973 (E1260-15190) were both included for study. Of the four spectral images available for each date, those from bands four, five and seven were enlarged photographically to a scale of 1:250,000, and positive and negative image transparencies were produced. Color diazo foils were then processed for each transparency, with yellow being assigned to the positive and negative enlargements of band four, magenta to the enlargements of band five, and cyan to the enlargements of band seven. The 12 diazo foils were overlaid in various combinations, and the best expression of waterway detail was obtained with a composite of the three positive images from the April scene (Fig. 2).

Waterway Mapping

The Tug Hill waterways were traced on matte acetate, overlaid on the ERTS color composite. The waterways delineated were limited to those distinguishable without excessive subjectivity, so as to minimize the confusion with other similar-toned, linear features. Since the color composite had been formed from enlarged images, only low magnification could be used to aid the work.

The waterways overlay was compared to the 1:250,000 scale U.S. Geological Survey topographic map. Those waterways that appeared on the overlay, but did not appear on the topographic map, were checked on 1:24,000 scale, panchromatic aerial photographs, obtained in April 1968. In certain cases, the 1:24,000 scale U.S.G.S. topographic maps were used to assist in locating the waterways in the photographs.

RESULTS AND DISCUSSION

The corrected map of Tug Hill waterways is shown in Figure 3. The numbered waterways are listed in Table 1, the names having been obtained from the 1:24,000 U.S.G.S. topographic maps.

Many of the waterway segments that were traced from the color composite and confirmed on the aerial photographs were missing from the 1:250,000 scale U.S.G.S. map, and several were also missing from the 1:24,000 scale maps. These inaccuracies point out that the priority of topographic mapping is topography and not waterways. On the other hand, it is also possible that the waterways are seasonally affected, or that they have developed or changed course subsequent to the date of mapping, making the repetitive nature of satellite coverage especially valuable.

Linear features that were traced as waterways but were not, in fact, waterways are shown in Figure 4. Although one of these features was a stand of coniferous trees, situated among deciduous trees, virtually all others were linear trending swampy areas. These swampy areas, in addition to the resolution limitations of ERTS, resulted in some of the waterways being discontinuous on Figure 3. Most of the waterways that were not checked--those appearing on the 1:250,000 scale U.S.G.S. map but not on the color composite--probably exist, but could not be resolved by ERTS.

CONCLUSIONS

To be navigable to canoeists, a waterway need only by slightly wider than the canoe, with water depths of only several inches. The resolution of ERTS data (roughly 80 meters) as well as other limiting factors (e.g., overhanging vegetation, confusing linear features and weather conditions) indicate that ERTS imagery cannot be used to define all canoeable waterways. As demonstrated, however, ERTS imagery can be used to assist in identifying and delineating the basic network of interconnected waterways.

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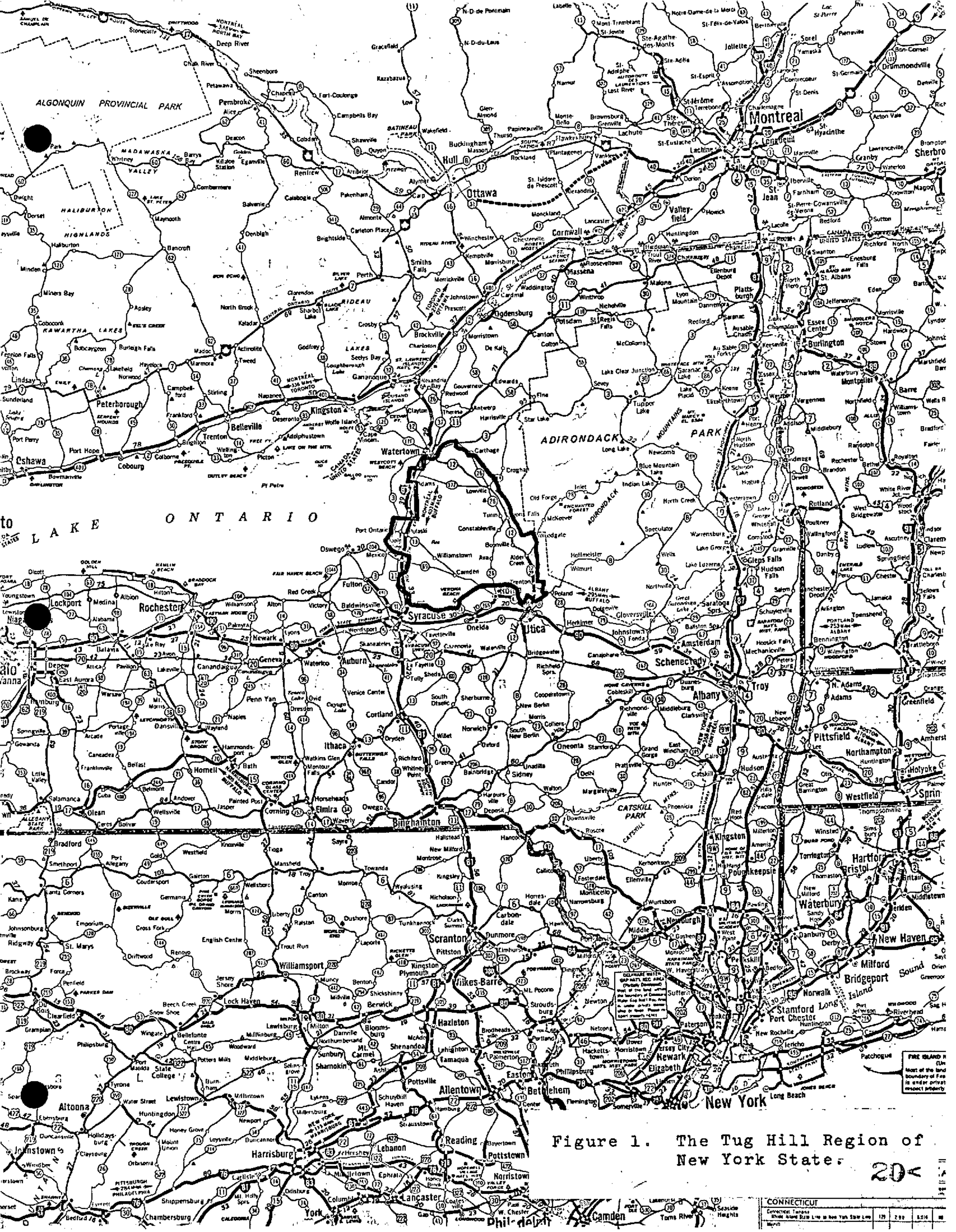


Figure 1. The Tug Hill Region of New York State.

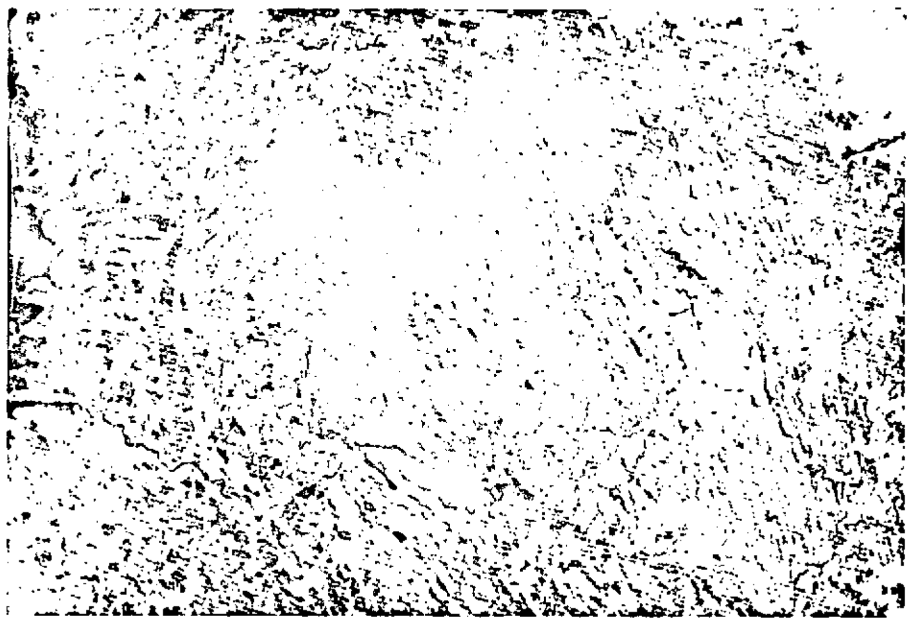
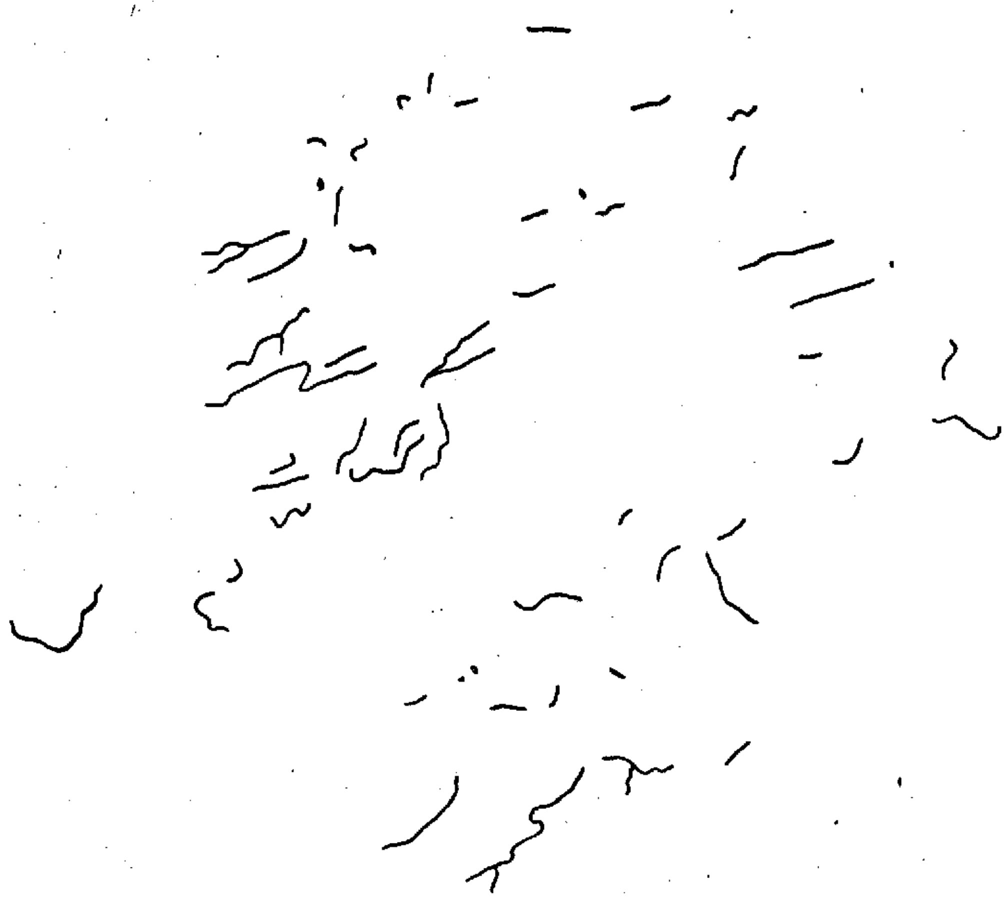


Figure 2. ERTS color composite of the Tug Hill Region. (Scene E1260-15190, at 1:250,000).

1. Salmon River Reservoir
2. Salmon River
3. North Branch of Salmon River
4. Cottrell Creek
5. Mad River
6. Bea Creek
7. Cold Brook
8. Castor Brook
9. Mill Stream
10. Stony Brook
11. Prince Brook
12. Baker Brook
13. Fall Brook
14. Smith Brook
15. East Fork of Salmon River
16. East Branch of Fish Creek
17. Sucker Creek
18. Alde Creek
19. Pringle Creek
20. Sevenmile Creek
21. North Branch of Mad River
22. Whetstone Creek
23. Roaring Brook
24. West Branch of Deer River
25. Deer River
26. South Sandy Creek
27. Fox Creek

Table 1. Tug Hill waterways shown on Figure 3.



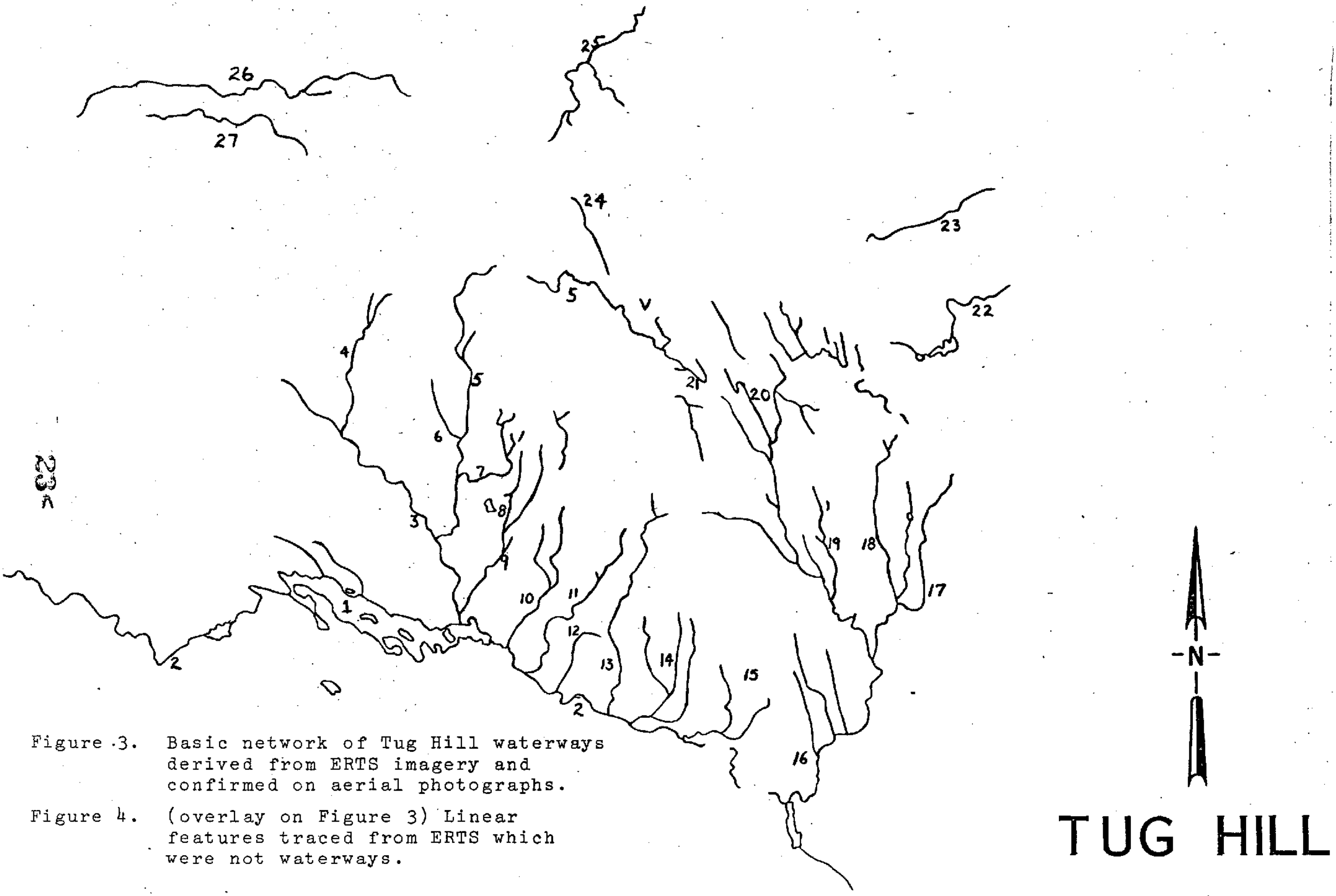


Figure 3. Basic network of Tug Hill waterways derived from ERTS imagery and confirmed on aerial photographs.

Figure 4. (overlay on Figure 3) Linear features traced from ERTS which were not waterways.

APPENDIX B

PHOTO-ARCHEOLOGICAL
INVESTIGATION OF GREAT
GULLY, NEW YORK

CAYUGA MUSEUM OF HISTORY AND ART
AUBURN - NEW YORK
W. K. LONG - DIRECTOR

June 22, 1974

Professor Ta Liang
Remote Sensing Program
Hollister Hall, Cornell University
Ithaca, New York 14850

Dear Professor Liang:

It was a great pleasure to work with your staff and I would like to thank you for the privilege. Their demonstrations of the use of remote sensing in archaeologgical investigations were very successful.

We centered our interest upon Great Gully and the aerial photo analysis prepared by Mr. Erb made it possible to study the area carefully and identify potential Indian sites that we were not aware of, as well as foundations and abandoned roads.

Very careful field trips to the Indian sites will be carried out over the next few months and I look forward to your continued cooperation.

As you are aware, our intent is to acquire and preserve the Gully as a "Forever Natural" area. I am sure that the information that you have provided will re-enforce the need to do so. Later I will contact you regarding the loan of some of this material for a museum display on the Great Gully at the Cayuga Museum of History and Art.

Sincerely,

Walter K. Long

Professor Walter Long
Director

WKL/cl

PHOTO-ARCHEOLOGICAL
INVESTIGATION OF
GREAT GULLY, NEW YORK

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14850

March 1974

26<

ACKNOWLEDGMENTS

This pilot study was supported by NASA Grant NGL 33-010-171 and performed at the request of Professor Walter Long, Cayuga County Historian and Curator of the Cayuga Museum of History and Art.

To supplement the existing panchromatic aerial photographs of the study area, the U.S. Environmental Protection Agency arranged for color and color infrared aerial photographic coverage to be obtained during the summer and early fall of 1973.

The study was carried out by Mr. Thomas L. Erb with assistance provided by various members of the Remote Sensing Program.

Ta Liang

Professor of Environmental Engineering and
Principal Investigator,
Remote Sensing Program

INTRODUCTION

Aerial photographs have been shown to be an effective tool for archeological investigations, particularly, in the more arid regions of the world (Reference List II). A pilot study was undertaken to examine the feasibility of detecting and delineating archeological or historical sites in Cayuga County, New York. This report summarizes the findings of the initial phase of the investigation--the photographic analysis.

STUDY AREA

The area selected for study consists of land adjacent to the Great Gully, a five-mile long ravine whose stream flows into Cayuga Lake at a point about two and one-half miles south of Union Springs, New York (Fig. 1). Located within this area was Goi-o-gouen, the principal village of the Cayuga Nation of the Iroquois Confederacy. It is also quite probable that this area was the site of earlier, pre-historic settlements.

Neither the Iroquois nor their predecessors in the region employed any method of physical documentation. Therefore, the records of explorers, missionaries and settlers, along with previous archeologic studies of the Indian settlements, provide the background data for this study. The records and histories of the Iroquois culture vary widely; however, the general characteristics of the Indian settlements that might constitute keys for the photographic analysis can be deduced from studies by Morgan (1851) and Ritchie (1965).

For strategic reasons, villages were typically situated atop knolls or gentle ridges, at least one mile from major waterways. Although distant from major waterways, the villages were immediately adjacent to water sources, such as springs and streams, since wells were not employed.

The villages consisted of houses, clustered in relatively random orientation and spacing. In some cases, the settlements were encircled by one or two rows of timber post and earthwork fortifications, roughly elliptical in plan and enclosing anywhere from two to ten acres of land. The layout and construction materials for housing also varied. Earlier structures were multi-family "longhouses" of bark and timber poles, and they ranged from 15 to 35 feet in width and 20 to over 200 feet in length. Later structures were constructed of logs and were commonly square in plan, resembling the houses built by early European settlers. Vertical timber supports for all types of structures were rarely embedded more than two feet into the ground.

The cutting of timber for structures and fuel, and the cultivation of numerous vegetables and fruits, produced several hundred acres of cleared land surrounding the villages. When nearby timber and soil resources were exhausted, the settlements were relocated. Storke (1879) reports these movements at intervals of from 10 to 30 years.

Although customs varied, wastes were commonly buried in pits adjacent to the houses, and provisions were stored in shallow pits within the houses. Burial customs also varied considerably among cultural phases of the Indian civilization, ranging from single, flexed burials to multiple, extended burials in mounds or shallow graves. One account describes a ritual in which fires were kept burning over grave sites for three days after burial.

MATERIALS AND METHODS

The types and sources of aerial photographic coverage utilized for this investigation are listed in Table 1. All photographic materials were analyzed for features, anomalous to the present environment, that might conform with any of the settlement characteristics described above. The basic approach was through conventional photographic interpretation techniques (Reference List II; most notabley, Solecki, *et al.*, 1960, for work with panchromatic photography, and Harp, 1968, and Strandberg, 1968, for work with other film types).

RESULTS

The study area and general locations of Figures 2 and 3 are shown in Figure 1, portions of the Union Springs and Scipio Center, New York, U.S.G.S. 7.5-minute topographic maps. Possible sites of Indian occupation are noted in Figure 2 (copies of two

Table 1. Aerial photographic coverage utilized for analysis of Great Gully, New York.

PHOTOGRAPHY	DATE	SCALE	SOURCE	REMARKS
Panchromatic, 9x9, contact prints	Apr 1967	1:24000	Lockwood, Kessler & Bartlett, Inc.	
Color, 9x9 in, film transparencies	Aug 1973	1:5000	EPA/Cornell Remote Sensing Program	lacks complete stereoscopic coverage
	Sept 1973	1:20000	idem	idem
Color Infra-red, 70mm, panoramic film transparencies	Aug 1973	1:20000 plus (variable)	idem	idem
	Sept 1973	1:20000 plus (variable)	idem	idem, film under-exposed

of the 1967 photographs) and Figure 3 (a black-and-white copy of one of the August 1973 color photographs).

It is emphasized that any of the features in Areas 1 through 8 (Fig. 2a) may be associated with either Indian or early settlers, and the latter possibility is supported by the presence of the "Old Quaker Cemetary" marked on Figure 1.

Areas 1 through 3 contain dark-toned squares, indicative of house foundations. The distinct feature within Area 1 was measured on the photographs and calculated to be 30 feet by 30 feet, a common Indian house size, as reported by Morgan (1851). Features within Areas 4 through 8, although not as distinctive as features within Areas 1 through 3, suggest the existence of several buildings within each area.

Areas 9 and 10 are located near the site of the last known Iroquois encampment in the study area (Figs. 2b and 3). In general, the features resemble Indian settlements, as described by Ritchie (1965): elliptical in plan, situated atop mounds or ridges, and, often, with surrounding fortifications. Dashed lines on Figure 3 designate areas of disturbed soil and crop patterns which might also be indicative of previous occupation.

CONCLUSIONS

As expected, the identification of archeological features in the Great Gully study area is complicated by the severity of the weathering environment and the extensive present-day cultural features which act to "erase" traces of past settlements. In addition, the area is characterized by complicated relief and soil tone patterns, produced by several stages of Pleistocene glaciation and a series of high-level, post-glacial lakes. Overall, however, it is felt that aerial photographs are an excellent tool for rapidly surveying and analyzing any type of environment; and, as such, they can provide valuable information to supplement ground-based investigations.

Because the soil is generally frozen and snow-covered in winter and covered with crops during the growing season, field checking of designated areas must be accomplished in early spring or late fall. Results of the field analysis will be used to further refine the photographic analysis techniques and to provide additional input to the design of future photo-archeological investigations.

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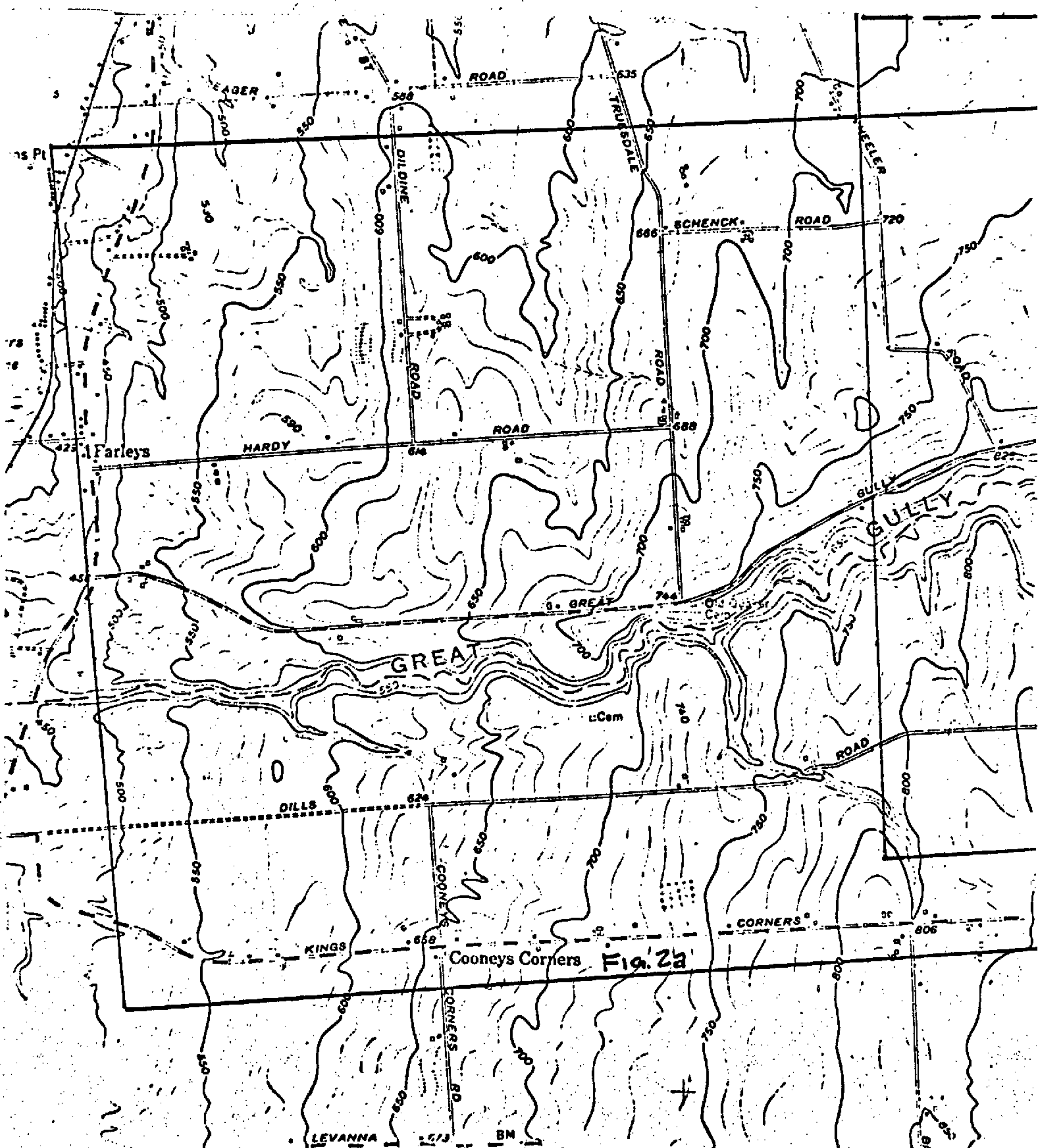
EAGER
ROAD
588
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SCHENCK
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HARDY
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GULLY
GULLY
GREAT
Cem
DILLS
626
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COONEYS
KINGS
CORNERS
ROAD
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CORNERS
RD
LEVANNA
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Fig. 2a

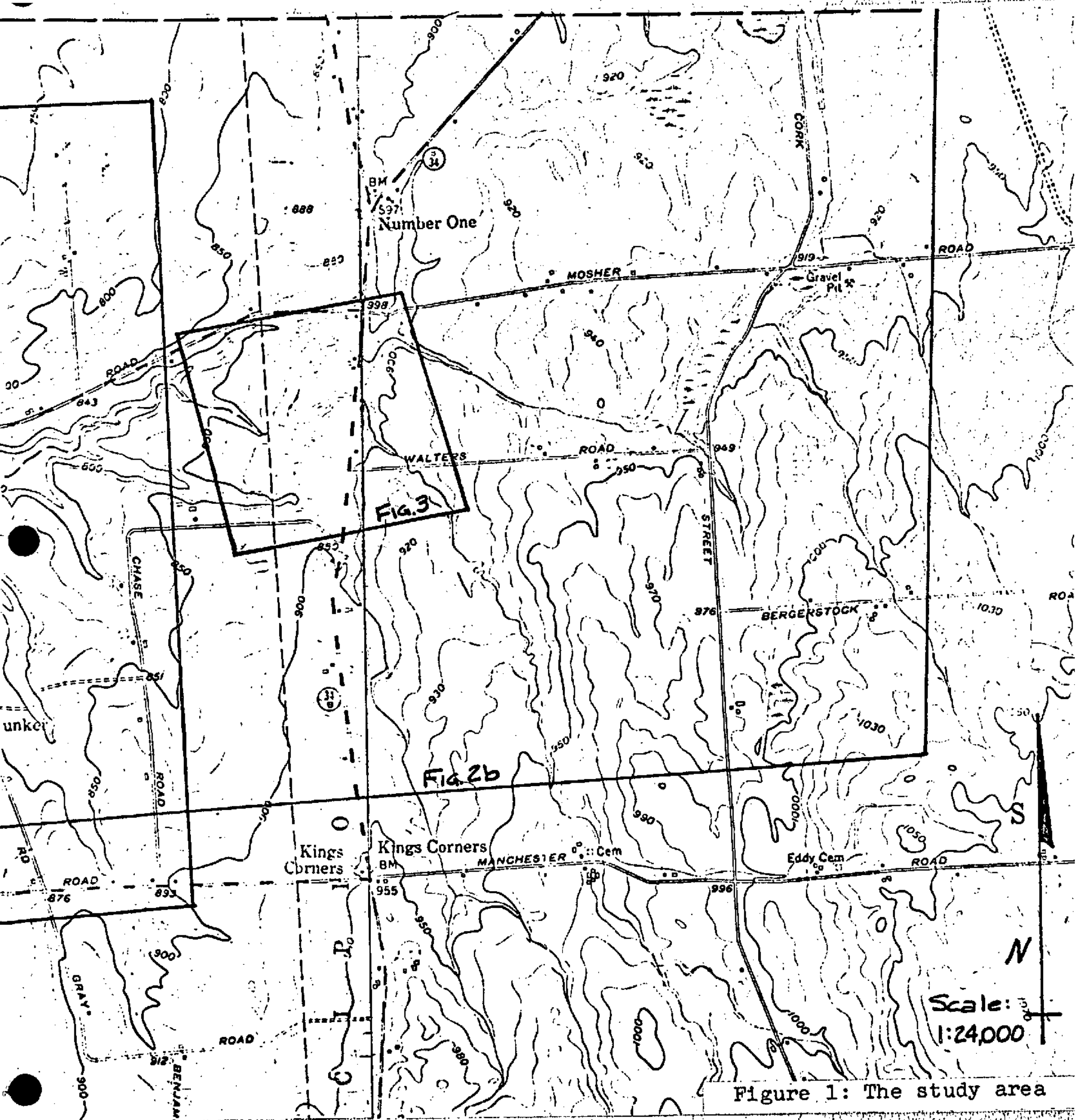

Figure 1: The study area

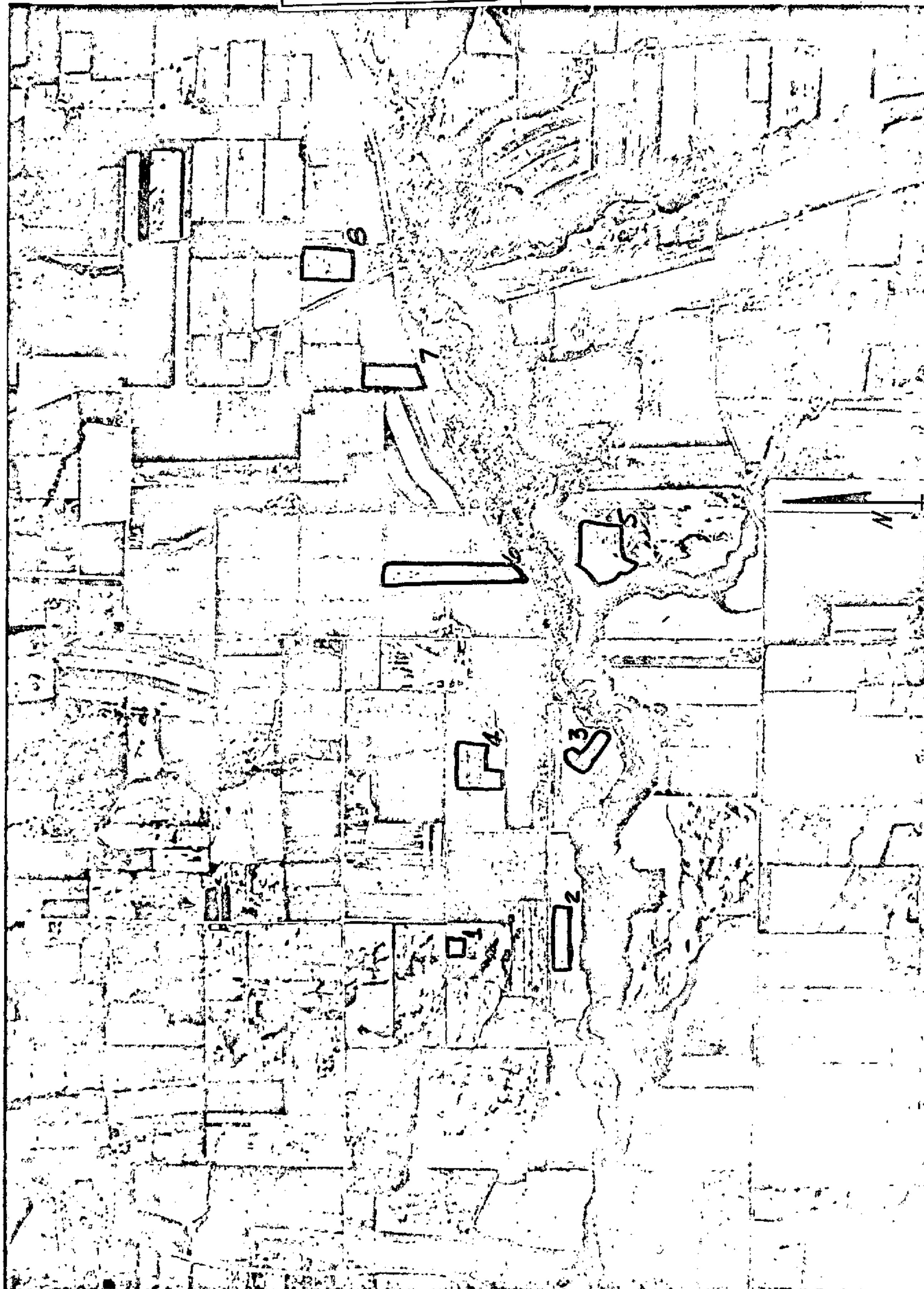

Figure 2a

Figure 2b

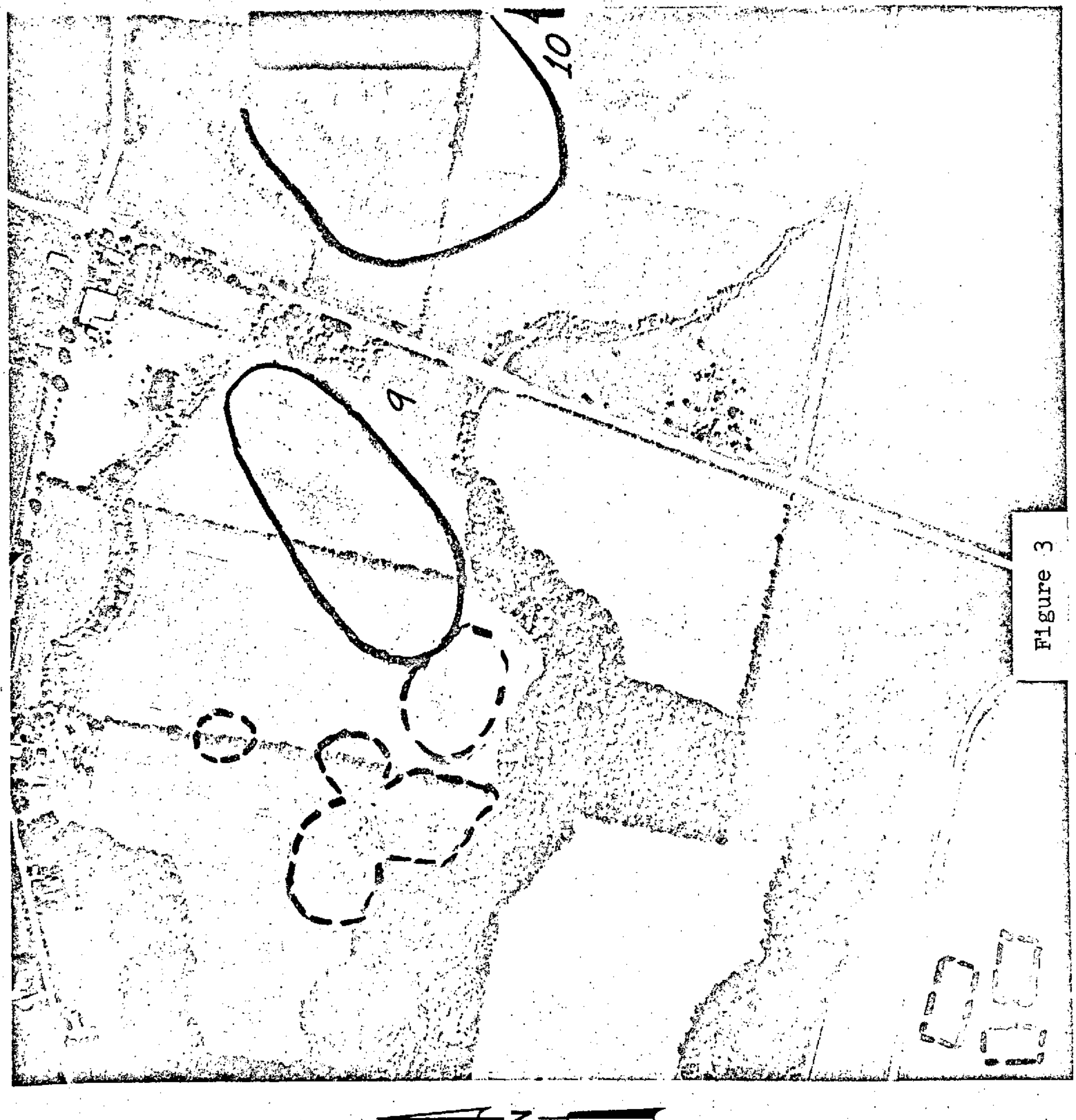

Figure 3

APPENDIX C

EVALUATION OF SELECTED HIGHWAY IMPACTS USING AERIAL PHOTOGRAPHY

THE APPLICATION OF REMOTE SENSING TO HIGHWAY ENVIRONMENTAL IMPACT STATEMENTS

-Preliminary Investigation-

Evaluation of Selected Impacts
Using Aerial Photography

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14850

January 1974

PREFACE

This study was supported by NASA Grant NGL 33-010-171 and performed by Mr. Richard Ackley, in conjunction with the Region 6 Office of the New York State Department of Transportation.

This preliminary investigation establishes a minimum level of sensor data applicability to the evaluation of selected highway impacts. Future studies will consider these and other impacts, attempting to make greater use of aircraft and satellite-derived data.

INTRODUCTION

Many of today's environmental impact statements (EIS) are lacking in objective data (1). Since a great deal of objective data can be obtained rapidly from aerial photographs, they should be of great value in the production of an EIS. The use of aerial photographs is not new to most highway agencies; however, their use has been largely confined to the determination of engineering and economic factors in highway planning. This report examines methods by which aerial photographs can be employed to more quantitatively assess the environmental impact of highway construction. The specific impacts that are dealt with include: displacement of housing, neighborhood impact, air pollution, noise pollution and visual degradation or enhancement. Although the emphasis of this investigation is on the development of workable techniques, the study focused on a proposed highway in New York State.

MATERIALS AND METHODS

Study Area

The present two-lane highway, connecting Watkins Glen with Horseheads, New York, has been found inadequate for future traffic needs, and a four-lane highway is being planned by the N.Y.S. Department of Transportation (2). This highway, a section of N.Y.S. Route 14, was selected for study chiefly because the alternative routes involved the acquisition of both rural and urban land (Fig. 1). Background information and the location of the proposed highway routes were supplied by the Region 6 Office of the N.Y.S. Department of Transportation.

Aerial Photography

All analyses were based on contact prints from 1968, 1:24,000 scale, panchromatic aerial photography. The photography was flown by Lockwood Mapping, Inc., in conjunction with the New York State Land Use and Natural Resources Inventory.

Displacement of Housing

For an EIS to be complete in its presentation of residential displacements, it should report more than the number of homes displaced. It should also include the types of homes (mobile home, conventional or apartment house) and the types of communities in which the homes are located (rural, village, city).

The number and type of residences displaced by each alternative route, for each type of community, were determined by assuming a 150ft right-of-way and extracting the information directly from the aerial photographs.

Neighborhood Impact

The boundaries of neighborhoods were identified on the aerial photographs by the spatial locations of residences, businesses, institutions, and natural as well as artificial barriers. Once each neighborhood was delineated, the relative impact of a new highway dividing the neighborhood was gauged from the following equation:

$$\text{Neighborhood Impact} = 50(Ad/At + As/Al)$$

where: Ad = area of highway right-of-way within the neighborhood; As = area of smaller portion of neighborhood which remains after highway construction; Al = area of larger portion of neighborhood which remains after highway construction; and At = total area of neighborhood = Ad+As+Al.

Air Pollution

A new highway introduces a zone of high air pollution, and residences located within this zone will be impacted adversely. To determine the number of affected residences it is necessary to estimate the level of pollutants that will be generated on the highway (source strength) and the dispersion with distance from the highway.

The source strength, q, for each alternative route was calculated from: $q = VE$; where V is the vehicle density (vehicles/meter), and E is the emission rate per vehicle (grams/second) as estimated for 1976 emission levels at 60mps (3). The vehicle density for each route was determined from the average traffic speed in meters (from 60mph) and the hourly traffic (vehicles/hr) which, in turn, was computed by assuming a design hourly traffic equal to 24% of the 1990 estimated average annual daily traffic for each route (2).

For calculations of pollutant dispersion, the effective emission height was assumed to be zero. In addition, the alternative routes were assumed to behave like infinite line sources, where lateral dispersion from one segment of the line is compensated by dispersion in the opposite direction, for adjacent segments. With the latter assumption, horizontal dispersion may be disregarded, and the vertical dispersion coefficient can be calculated from a simplified version of the Sutton equation (4); $s = kq/uC$, where s is the vertical dispersion coefficient, k is a constant (0.798), q is the source strength, u is wind speed, and C is the pollutant concentration (gas or aerosol).

The coefficient of vertical dispersion, s, is dependent upon the distance downwind and the stability of the atmosphere, and this relationship has been developed as a series of curves (4). Using these curves, the distance downwind can be read directly for any value of s and for any of six classes of atmospheric stability.

For calculation of s, wind speed, u, was derived from the records of an airport in the vicinity of the proposed highway (Broome County Airport). An average daily wind speed of 6mph was selected, since this speed is exceeded 90% of the time and would thus provide conservative estimates. Values of pollutant concentration, C, were based on the national ambient air quality standards for hydrocarbons, carbon monoxide and nitrogen oxide. The one-day tolerance factors were used (5).

With values for s, the distance from the highway at which adversely high concentrations of pollutants could be expected were then determined, using the curve associated with the most serious class of atmospheric stability (Class D). Based on the assumptions that the wind was directed perpendicularly to the highway, and that each side of the highway is affected equally, the distances were then used to delineate a corridor, centered on the highway. The residences located within this corridor were counted on the aerial photographs, and the results were tabulated for each alternative route.

Noise Pollution

To determine the number of residences that are affected adversely by noise from a new highway, it is necessary to determine the noise levels at which residents are adversly affected, the noise levels generated by the traffic, and the degree to which the noise is dissipated to either side of the highway.

The criteria used to define adverse noise levels were based on outside, daytime conditions. The permissible noise levels for various structures were: residences and hospitals, 50dBA; schools and churches, 55dBA; and commercial buildings, 60dBA. These levels may not be exceeded more than 50% of the time at the design traffic levels.

The noise levels generated by traffic were derived from a series of curves developed by the National Cooperative Highway Research Program (6). These curves are used to predict noise levels as a function of hourly automobile and truck volume and average vehicle speed. The predicted levels are those at 100ft from the highway, and they may be exceeded 50% of the time at design traffic levels. The hourly automobile volume was assumed to be 15% of the 1990 estimated average annual daily traffic (2), and the percentage of heavy truck traffic was estimated from a traffic count on the present highway. The average speed of all traffic was assumed to be 60mph.

Given the levels of noise generated on the highway, the distances from the highway at which particular noise levels would be encountered were then calculated with a specially written computer program (Appendix).

In the first step of the program, the total level of noise on each alternative route was obtained by adding the respective automobile and truck noise levels, while accounting for the fact that decibels are logarithmic values.

Using the total noise levels, the distances of preselected noise levels from the highway were then computed from the following equations:

$$Dn = 100 \exp(-0.154D) \qquad \text{for } Dn \text{ from 0 to 300ft}$$

$Dn = 60 \exp(-0.230D)$ for Dn over 300ft

where, Dn is near-lane distance, and D is the difference between the noise level at the highway and the noise level at a specific distance from the highway. These equations represent linearized sections of a NCHRP curve that relates noise level to distance from the source (6). The curve chosen corresponds to a 100ft roadway width.

The equations could be employed to provide distances for constructing contours of noise from the highway; however, the computed distances would normally be overly conservative since they make no allowance for barriers that impede noise propogation.

Maekawa (7) has developed a basic design curve for relating noise attenuation by a knife-edged barrier to the wavelength of the sound and to a geometric parameter, $\underline{d}$, where: $\underline{d} = X+Y-Z$, and where: X is the line-of-sight distance between the source and the peak of the barrier; Y, the line-of-sight distance between the barrier peak and the observer; and Z, the line-of-sight distance between the observer and the source (Fig. 2).

Since Maekawa's model is applicable only to point sources, his curves were linearized (6) and described analytically as follows:

$$Dbba = 4.35\ln(0.8\underline{d}) + 13.0$$

where Dbba is the noise attenuation in decibels, and where the wavelength of the noise has been assumed to be 2.5ft.

Re-defining $\underline{d}$ in terms of the highway cross-section illustrated in Figure 2, one finds that:

$$\underline{d} = X+Y-Z = ((De-Db)^2 + Hh^2)^{\frac{1}{2}} + (Db^2 + Ho^2)^{\frac{1}{2}} - ((Ho-Hh)^2 + De^2)^{\frac{1}{2}}$$

where: De = horizontal distance between barrier and source;

Db = " " " " " observer

Hh = vertical " " " " source

Ho = " " " " " observer

In order to determine De and Db, the highway cross-section was assumed to have a 120ft roadway, a 10ft shoulder, and a 2:1 slope, on either cut or fill. With these assumed values:

$$Db = Dn - (10 + 2Hh)$$

The distance De closely approximates the geometric mean of the distances from the observation point to the nearest and farthest lane centerlines, respectively; or,

$$De = (Dn(Dn + 100))^{\frac{1}{2}} = (Dn^2 + 100Dn)^{\frac{1}{2}}$$

Values of Hh were obtained by fitting highway profiles to vertical profiles derived from a 7½-minute USGS topographic map; and values of Ho were computed from: Ho = Db(tan B), where the angle B was also obtained by fitting a line to profiles of the natural terrain. Since Db is approximately equal to Dn, values for Dn were used in computing Ho.

The computed values of noise attenuation, Dbba, were subtracted from the original noise levels for automobiles in order to obtain new, barrier-adjusted noise levels. The noise levels associated with truck traffic were not reduced as greatly since the source of truck noise is at a greater height above ground. The noise level adjustment for trucks was assumed to be 5 decibels less than for automobiles. The maximum value of attenuation was assumed to be 15 decibels.

The revised noise levels for automobile and truck traffic were again added, and new values of Dn were calculated. Utilizing these new values, the decibel levels were again adjusted. This iterative procedure was followed until the values converged, and "contours" of equal noise levels could be produced from the barrier adjusted values of Dn.

Before the final noise contours were established and the number of impacted structures tallied, additional adjustments were made to account for the effects of structures and trees.

The shielding by buildings and structures was assumed to be approximately 4 decibels (8). This shielding was considered effective only for the first two rows of houses, and where the structures were not very dense, the adjustment was decreased.

In adjusting for trees, a noise reduction of 5 decibles was assumed for each 100ft depth of moderate to large trees. If the trees were sparsely planted or less than 15ft tall, the noise adjustments were lessened. The total noise reduction for trees was assumed to be less than 10 decibles.

Once the final noise contours were drawn on the aerial photographs, the number of adversely impacted structures was determined for each highway section.

Visual Impact

The visual impact of a highway is basically twofold: the impact of the highway on the surrounding residents, and the impact of the surrounding terrain on the highway users. Although no evaluation of aesthetic qualities can be totally objective, a systematic approach can be developed and utilized.

In assessing impact on the surrounding residents, it was judged that the adverse effect would increase as the distance between the highway and the observer decreases. An unobstructed view of 1000ft was selected as the criterion for deciding whether a resident would be adversely affected. The views of residences within 1000ft of each alternative route were examined on the aerial photographs, and if no significant barrier to sight were identified, the residence was tallied as adversely impacted.

In evaluating the visual impact of the surroundings on the highway user (Table 1), the views most frequently encountered from the highway were listed and assigned a rating from -3 (negative impact) to +3 (positive impact, highly scenic). The visual impact of each route was then determined by identifying the dominant views along the route from the aerial photographs. A relative value for each route was calculated from the following:

$$\text{Relative Visual Impact} = \left(\sum_{i=1}^{n} R_i L_i\right)/L$$

where:

R_i = visual impact rating of highway segment i

L_i = length of highway segment i

n = number of rated highway segments along route

$L = \sum_{i=1}^{n} L_i$ = total length of highway route

The visual impact on the highway user is dependent upon the kinds of views that are encountered, but it is also dependent upon the variety of views. Two methods were employed to gauge this parameter: all rated highway segments were counted, and only categories (e.g., panorama, dump, etc.) were counted.

RESULTS

The alternative routes for the proposed highway between Watkins Glen and Horseheads, New York, are shown in Figure 1.

All routes were examined to determine the number of homes that would be displaced by a 150ft right-of-way. As reported in Table 2, the homes were classified according to their type and to the community in which they were located.

The neighborhoods which are affected appreciably by any of the alternative routes are listed in Table 3. If a neighborhood were not crossed by a highway, the impact would be zero; if the neighborhood were cut in half and all residences displaced, the relative impact would equal 100.

The effects of noise and air pollution were analyzed for each alternative route in the manners described, and the numbers of adversely impacted residences are reported in Table 4. The impact of air pollution is based entirely on hydrocarbon emission since hydrocarbons were found to affect the greatest number of residences.

Quantitative assessments of visual impact on both highway users and surrounding residents were made for each alternative route (Table 5). The relative impact on highway users was evaluated in terms of the kinds and variety of views encountered.

SUMMARY

The aim of this investigation was to develop techniques for more quantitatively assessing the environmental impact of a highway. The displacement of housing, neighborhood impact, air and noise pollution, and visual impact were evaluated for a proposed highway between Watkins Geln and Horseheads, New York, using aerial photographs as the basic tool for analysis.

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Figure 1. Study area

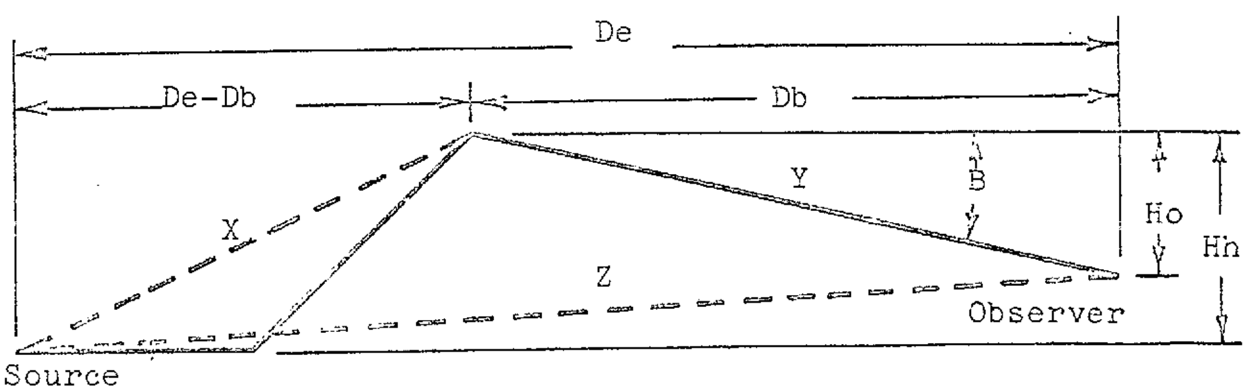

Figure 2. Highway cross-section with geometric variables.

Table 1. Classification and relative rating of dominant views.

CLASS	RATING
large lake or ocean	3
canyon	3
walled valley	3
panoramic view	3
forest	2
vineyard	2
orchard	2
creek	2
river	2
marsh	2
pond or small lake	2
non-urban residential	1
public buildings	1
cropland	1
pasture	1
nursery	1
golf course	1
cemetary	1
urban residential	0
brush land	0
inactive land	0
urban commercial	-1
industrial	-2
mobile home park	-2
excavation	-2
junkyard	-3
dump	-3

Table 2. Number of residences displaced by 150ft right-of-way.

	BY TYPE		BY COMMUNITY			
ROUTE	HOUSE	MOBILE	SUBURB	RURAL	VILLAGE	TOTAL
1	118	63	0	114	37	181
2	43	0	16	12	15	43
3	55	0	16	24	15	55
4	24	0	0	12	12	24
5	36	0	0	24	12	36
6	26	0	0	12	14	26
7	38	0	0	24	14	38
8	12	5	0	0	17	17
9	11	5	0	0	16	16

Table 3. Number of residences impacted adversely by air and noise pollution.

ROUTE	1	2	3	4	5	6	7	8	9
By Air	412	208	222	159	173	149	163	60	71
By Noise	659	405	415	303	313	271	281	235	230

Table 4. Number of residences impacted adversely by view of highway, and ratings of dominant views to highway users.

ROUTE	1	2	3	4	5	6	7	8	9
Residences Impacted	264	224	214	184	174	175	165	115	119
Relative Visual Impact	0.85	1.28	1.14	1.14	1.03	1.18	1.07	1.38	1.39
Number Rated Segments	35	58	60	51	53	45	47	52	48
Number Classes	13	15	17	15	17	15	16	12	12

Table 5. Relative impact of highway on neighborhoods.

NEIGHBORHOOD	IMPACT	ROUTES
Ridge Road development	10	2,3
Mobile home park in southern portion of Pine Valley	35	1
Central section of Pine Valley	35	1
Mobile home park in northern portion of Pine Valley	32	1
Millport	56	1
Watkins Glen	12	1,2,3,4,5,6,7

APPENDIX D

LAKE CONDITION ASSESSMENT

HOLLIS S. INGRAHAM, M.D.
COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF HEALTH

NEW SCOTLAND AVENUE
ALBANY, NEW YORK 12201

DIVISION OF LABORATORIES AND RESEARCH
DONALD J. DEAN, D.V.M.
DIRECTOR

ENVIRONMENTAL HEALTH CENTER
G. WOLFGANG FUHS, Dr. sci. nat.
DIRECTOR

May 13, 1974

Dr. Ta Lang
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Ithaca, New York 14850

Dear Dr. Ta Lang:

Enclosed is a justification for further aerial surveillance of Canadarago Lake as requested by Mr. W. Phillipson. In order to explain our program on Canadarago Lake I have enclosed a copy of the goals of the Organization for Economic Cooperation and Development in which our unit is participating and the information sheet concerning the involvement of the Health Department on Canadarago Lake with respect to the North American Project. The basis of our study, site selection and study goals should give you an overview of the work we have undertaken. Through this type of project, our unit also investigated modernization of research methods and instrumentation which could be of further use in future projects.

At Canadarago Lake and at Lower St. Regis Lake, another lake under study, our unit is observing a cause and effect relationship between nutrient input and biological production. The sewage that formerly was discharged untreated is now undergoing treatment, which includes phosphorus removal, prior to release of the effluent into the lakes. In both lakes, phosphorus was found to be the limiting nutrient. Previously, both lakes experienced large scale algal blooms (blue-green nuisance types). Although it is still too early to note with any certainty the effect of phosphorus removal on the lake phytoplankton, there were indications in both lakes last summer that the treatment is having a positive effect in reducing the algal blooms. When the algal population declines, it provides an opportunity for higher aquatic vegetation to increase. This is the case in Canadarago Lake as a greater amount of submerged vegetation has been noted. The reasoning behind this being that rooted aquatics have the ability to take nutrients through both the roots and shoots, that portion of the plant extending from the mud-water interface. Reducing nutrient input to the water column, with increase in the amount of light, through less shadowing by plankton, the submerged vegetation has a competitive advantage and may end up being predominant.

I am aware that the evaluation of weed beds is a minor section in the total study but without it the impact on the ecological chain is not fully complete.

It is hoped that aerial surveillance will play an important role in our continued studies. Aerial work provides us with a capability to assess the productivity of both submerged and emergent rooted vegetation. The amounts of emergent vegetation can be determined through a time consuming lake survey which would have to incorporate many sites and distance measurements. These measurements are at best very poor due to the fact that the measuring platform is a rocking boat. If we combine aerial photographs with selected species identification, from ground surveys, we have an accurate picture of the extent and types of vegetation which are present. The role of aerial surveillance is extremely important in the detection of submerged plants. The navigational and detectional problems here become even greater, sonar tracking is extremely difficult and visual estimations are impeded by glare and turbidity. In studying submerged vegetation, detection divers are impractical and cost prohibitive, with the exception that divers or large dredges could be used to recover plants for species identification and biomass studies. Photographic missions in combination with field measurements and observations together with laboratory chemical and microscopic analysis allow one to: 1) portray the abundance of a particular nutrient or nutrients, 2) denote the degree of eutrophication of the lake, and 3) classify the lake in relationship to other lakes so that problem lakes can receive attention first.

A detailed study of the fisheries of Canadarago Lake was initiated by Cornell University's Department of Natural Resources in cooperation with N.Y.S. Department of Environmental Conservation. An effort is being made to measure changes in the structure and dynamics of the fish population in an eutrophic lake following a reduction in cultural eutrophication. The increase in weed growth is anticipated to have an effect on spawning success of the fish. With a definition of percentages of rooted vegetation (submerged and emergent), the success could be defined in terms of both fish species and population numbers. The weed density required for spawning success has not been defined by research and this may be an opportunity to study this requirement.

Remote sensing has other valuable application to our Eutrophication Studies Program:

1. In a lakes classification program as required by the Environmental Protection Act of 1969 with amendments it would be advantageous to locate, through pre-survey reconnaissance, the most significant discharges and evaluate their severity as well as extent (by noting visual alterations in the lakes). It would be of value here to utilize thermal remote sensing to discover previously unknown discharges. These discharges could be from leaking septic systems, natural runoff or springs. This type of sensing could eliminate the need for timely dye studies of home and industrial septic systems to detect faulty units.

With reference to pre-survey reconnaissance, the photographic data would bring the study group up-to-date as to changes in land usage as well as other changes in the lakes and surrounding drainage basins. This is especially significant, since many of the United States Geological Survey maps were last updated in the late forties or early fifties.

2. It seems possible that comparative evaluations can be made as to the degree of eutrophication by aerial determinations of macrophyte and or phytoplankton concentrations. This approach's potential has not been researched as far as we know. If this were possible, and it does not appear to be that remote, then a greater number of lakes (New York State alone has over 4,000) could be basically classified, with more extensive studies (problem areas) carried out at a future date.

The potentials of remote sensing and its application to the type of studies, which we are conducting, have not been utilized to the degree which we think they possess. Applications such as prediction of hydrology and climatic conditions comes to mind as one of the other uses to estimate the availability of nutrients to lakes.

I have attempted to outline our programs and the uses we have in the field of remote sensing. In cooperating with your Remote Sensing Program at Cornell University I feel we can evaluate and expand the uses of remote sensing as it applies to eutrophication studies. The aim of these studies is to increase (or at least maintain) the quality of New York State's water for public use both as recreation sites and as drinking water supplies. We make no claims to prevent or reverse the natural aging of lakes, but hope to decelerate that part of eutrophication which is attributed to man.

Very truly yours,

Lindsay W. Wood

Lindsay W. Wood
Senior Research Scientist

(William C. Ahearn
Res. Lab. Tech. Asst.)

LWW/sw

cc: Dr. Fuhs
Dr. Harr, EnCon
Ms. Allen
Mr. W. Phillipson

STATE OF NEW YORK

DEPARTMENT OF HEALTH

DIVISION OF LABORATORIES AND RESEARCH

MEMORANDUM

January 29, 1974

look good!
G. W. F.
JAN 30 1974

To: Dr. G. W. Fuhs, Director

From: William C. Ahearn, Res. Lab. Tech. Asst. WA

Subject: Remote Sensing Program

I visited Mr. Warren Philipson and Professor Ta Liang of Cornell University's Remote Sensing Program on January 24, 1974. We discussed the "73" photographic missions over Canadarago Lake. The Aquatic Biology section had participated in the ground phase of this program by sampling for lake chlorophyll content on July 25 and September 27 and conducting the mapping of aquatic vegetation on June 14, 15 and October 9, 10, 1973. The over-flights took place on July 23, 25 and September 27. The photographs from the July 25th flight have the best clarity.

I gave Mr. Philipson the sketch map from the August 1968 vegetation survey and will up-date that map with the observations made on 1973 surveys. Mr. Philipson will try to fill in the vegetative areas which were observed from the photographic missions. Because the missions and field surveys were conducted late in the growing season, due to technical and communication problems, the period of maximum productivity was not observed.

The comparative studies of water quality on Owasco, Skaneatles, Cayuga, and Canadarago Lakes are still in the preliminary stages with the raw chemical data just being received. Therefore, the merits of this type of comparison are still being discussed and evaluated. Both their group and our group feel that in future work more sites should be sampled and analyzed for better comparison with the photographs.

I discussed the prospects for 1974 with Mr. Philipson. We feel that a photographic mission, combined with field observations and analysis, conducted near the time of maximum vegetation bloom would be a sound approach for determining the types and extent of the vegetation. Submerged vegetation can be detected from the aerial photographs, a capability which we did not have in the 1968 survey. Combining this information with chemical analyses of plants, sediments, water column and tributary inputs, it would portray the abundance of any particular nutrient. This information would also give us the capability for estimating the nutrient availability for algal growth during overturn.

The remote sensing group has requested a mission in one or more lakes utilizing thermal remote sensing in an attempt to discover previously unknown discharges. These discharges could be from leaking septic system, natural runoff or springs. This type of sensing could eliminate the need for timely dye studies of home and industrial septic systems to detect faulty units.

This service from the Remote Sensing Program at Cornell University is an approach which we should consider utilizing for studies such as the Lakes Classification Program. Possible applications in our program include:

1. The determination of land usage and the total area of the various drainage basins.

2. Use in pre survey reconnaissance to locate the most significant discharges and evaluate their severity (by noting visual alterations in the lakes).

3. Comparative evaluations as to the degree of eutrophication in various lakes and rivers. This includes the determination of macrophytic and/or phytoplankton concentrations.

4. The use in hydrology for predicting runoff due to snow or various climatic conditions.

I would like our group to participate in the 1974 missions in order to evaluate the potentials of this type of sensing.

WCA:lam
Copy to: Dr. L. Wood
Dr. T. Harr
Mr. Philipson

PRELIMINARY DRAFT

North American Project

Canadarago Lake, Otsego County
State of New York

PHASE I

By

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Environmental Quality Research Unit
New York State Department of Environmental Conservation
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and

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57<

PRELIMINARY DRAFT

SECTION I

INTRODUCTION

A. OECD GOALS

To better understand the problems of eutrophication, the accelerated aging of bodies of water, and its rate of evolution, particularly that part attributable to man-associated pollution, OECD, Organization for the Economic Cooperation and Development, an Independent International Organization, through its Water Management Section Group Environmental Committee requested its member nations to develop a plan for the achievement of comparability of data on nutrient budgets, chemical balances, and biological productivity in water bodies. The aim of this achievement is viewed as an essential step in an economic assessment of the effects of eutrophication and the introduction of control measures necessary to abate them.

The goal is being achieved through project groups, each embracing a family of water bodies. A plan has been formulated to collect a sufficient range of comparable data for developing evidence on the degree and extent to which nutrient loading is correlatable with the eutrophic state and to measure the rate at which eutrophication is developing.

Since geographic, ecological and morphometric factors are of major importance in eutrophic conditions, a regional approach has been utilized. A plan has been developed to coordinate regional cooperative projects for the collection and collation of information on eutrophication using an agreed system of measurements.

The countries participating in the projects are:

Nordic Project	- Denmark, Finland, Norway, Sweden
Alpine Project	- Austria, France, Germany, Italy, Switzerland
North American Project	- Canada, United States
Reservoir and Shallow Lakes Project	- Belgium, Germany, Netherlands, Spain, United Kingdom, United States

The countries participating in the Nordic Project present reasonably comparable conditions. They share the cool climatic zone of the Baltic and North Sea area. Their lakes resulted from the retreat of the great quaternary glaciers. They possess comparable ecological conditions and an equivalent level of economic development with its polluting consequences. Furthermore, these countries have very close political, cultural and scientific links in Nordforsk.

58<

The Alpine regions, due to the quality and abundance of their water, provide the source for a large part of European waters. Their ecology is characterized by an exceptional variety of species and thus is very vulnerable and sensitive to man's interventions. The participants in the Alpine Project, irrespective of their political borders, present similar hydrological conditions due to very comparable geographic, geological and ecological factors. They share in certain common river basins and commissions: Bodensee Commission, Commission du Leman and Italo-Swiss Commission, Lakes Maggiore and Lugano. These Alpine waters, which represent a great natural amenity and a considerable source of national and international tourism, are of great economic and social significance.

The Reservoir and Shallow Lakes Project includes man-made lakes, reservoirs, and other comparable water bodies such as shallow lakes, lagoons and estuarine waters. These water bodies are often relatively shallow and generally have great economic and soical value, serving as reserve water supplies, supporting water sports, fishing, navigation, etc., and representing amenities. Furthermore, owing to their morphometry and structure, the control of water quality by manipulation of certain hydrological or other factors, is certainly more feasible than for larger water bodies.

The North American Project, contrasting to the three European Projects, is not dedicated to study specific types of water bodies. This project consists of assessing water bodies of vastly different characteristics so that detailed comparisons can be made among the water bodies in the North American Project and those in the European Projects. As in the European Projects, an objective is to study a relatively small number of water bodies in great detail rather than a large number in lesser detail.

B. NORTH AMERICAN PROJECT STUDY OBJECTIVES

The major goal of the North American Project is similar to the three other projects being conducted by OECD which is to determine the degree of correlation between nutrient loading and trophic state of a body of water.

The specific objectives are as follows:

1. Develop detailed nutrient (phosphorus and nitrogen) budgets for a given selected number of water bodies.

2. Assess the chemical, physical, and biological characteristics of these water bodies.

3. Relate the trophic state of the water body to the nutrient budgets and to limnological and environmental factors.

4. Synthesize, based on data from all projects, an optimal strategy for controlling the rate of eutrophication.

Previously only limited data were available for detailed comparison. These projects will provide the necessary indepth studies for statistically sound comparisons and synthesis of control strategies.

C. WATER BODY STUDIED

This preliminary report presents a summary of the data that the New York State Departments of Health and Environmental Conservation have developed over a five year intensive study of cultural eutrophication using Canadarago Lake as a pilot area. This lake, situated in east-central New York State, is a highly euthrophic, hard water lake and typically represents the condition of a number of lakes within the State.

1. Basis for Study

For a number of years, New York State scientists and engineers have been aware of the eutrophication, or natural aging, of the Great Lakes and the many other lakes located within the boundaries of the state. Although eutrophication is normally a slow process, almost immeasurable within the normal span of human life, within the past three decades this process has shown a marked increase and has resulted in a keener recognition of this problem by mankind who became concerned and has sounded an alarm. Although it appears that little can be done to prevent the natural aging of lakes, significant efforts have been taken in some areas to deaccelerate that part of eutrophication that is attributable to man-associated pollution. Loss of asthetic attractiveness of natural bodies of water, together with ever increasing observations of dense algae formation, excessive weed growths, generation of obnoxious odors, and the decline in recreational qualities of these waters has brought an ever increasing demand from the public that additional effective action be taken to rectify these problems.

Creation of accelerated aging of lakes is most often blamed on the diversion or discharge of excessive quantities of nutrients into them. Leading the list of nutrients, which have been assigned dominant roles, are nitrogen and phosphorus. Although these nutrients are present in natural waters, in soils, plants, animals, and precipitation, they are often added to water in large quantities in both domestic and industrial wastes and from fertilizers and wastes applied to the land which ultimately enter water courses and enrich those standing bodies of water, altering their natural, physical, and chemical properties, and encourage growth of algae and aquatic weeds and development of obnoxious odors that may be associated with them.

Scientists and engineers must predict limnological changes that will result from nutrient loading to these natural standing bodies of water, the critical concentration values for algal development, and the effects of fertilizers on aquatic life. The contributions from various nutrient sources must be ascertained. The production rates of aquatic crops and the nitrogen and phosphorus content or concentration in plants and animals must be obtained. The nutrient culprit then must be identified and appropriate action taken to overcome the damage that has been done to the natural water resource.

The accelerated eutrophication observed within the past three decades can be partially attributed to the progress mankind has achieved in making modern living more comfortable. The ending of World War II triggered the advent of the development of a magnitude of new products that were conceived to make modern living much simpler, more enjoyable, and provide mankind with additional leisure time. Among these many products were synthetic laundry detergents which contained relatively high concentrations of phosphates to assist in making clothes laundering produce a "whiter and brighter wash", dishwasher detergents for producing "sparkling glassware" and china that could "reflect a mirror image", and a host of other household cleansing products, designed primarily for the home to make homemaking easier, with less work, and all contained high concentrations of phosphates. In addition, at the same time, rapid progress was also being made in the production and use of synthetic fertilizers, insecticides, pesticides, and other new products that resulted from the application of new technologies developed during and immediately after the war. Many of these products contained phosphates, nitrates and numerous other inorganic and organic chemicals that were applied to the land and sprayed into the air. Large residues of these products found their way into flowing streams and were transported to natural bodies of standing water. The increased concentrations of these pollutants in the waters resulted in massive accelerated eutrophication evidenced by growths of algae and aquatic weeds, production of disagreeable odors and deterioration of the asthetic, recreational and sporting values of the water body which, in some cases, inflicted severe economic damage to the surrounding community. Thus, while mankind was creating the living atmosphere that he wanted, at the same time he was creating an even greater environmental problem, the accelerated eutrophication of the world's natural waters, that would need to be confronted and overcome in his lifetime.

New York State Department of Environmental Conservation is keenly aware of the eutrophic condition of the State's many lakes, of which there are over 4,000, and the dire effects that can result from continual neglecting of the accelerated eutrophication that is caused by uncontrolled, man-associated pollution.

2. Site Selection

In 1968 a bold step was taken to do something about this problem which demonstrated the great concern that existed relative to this condition. It was in 1968 that Canadarago Lake was selected by the New York State Department of Environmental Conservations's Environmental Quality Research and Development Unit for conducting a detailed pilot plant study in order to gain a better understanding of the eutrophication problem so that an effective control program could be planned and implemented. Canadarago Lake is a eutrophic, hard water lake located in Otsego county in east-central New York State, with the Village of Richfield Springs to the north and Schuyler Lake to the south. The condition of this lake was rather typical of a number of lakes within the state and its morphometric characteristics are similar, in many respects, to the Finger Lakes.

The advanced state of eutrophication that existed in this lake, the necessity of modifying one major source of pollution, the Richfield Springs wastewater treatment facility, the interest and concern of the local and part-time residents, the concern of sportsmen and visitors who used the area for recreational purposes, the potential economic disaster that could result to the community from loss of this lake as a tourist and recreational area, the State's concern about lake eutrophication and the desire to do something about this condition, and the fact that Canadarago Lake typically represents the condition of a number of lakes within the State were among the many influencing factors, together with its size and location, that caused Canadarago Lake to become a logical candidate on which to conduct a pilot study for obtaining information on the causes, effects, and development of effective control measures that could be applied to this lake, as well as a number of other lakes within the State which suffer the same advanced aging symptoms.

3. Project Goals

The goals of this effort, known as the Canadarago Lake Eutrophication Project, are numerous, but totally interrelated with the overall objective of obtaining an integrated solution for controlling accelerated eutrophication of lakes and other natural bodies of water. Included among the many logical goals leading to this ultimate objective are the systematic pursuit of the following:

1. Selection of a representative New York State lake, which is in an advanced eutrophic condition, for a pilot study to gain a better understanding of the eutrophication problem,

2. Systematic investigation of all parameters and utilization of every feasible means to determine the causes and provide solutions to the eutrophication problem,

3. Determination of the sources and rates of discharge of polluting substances and nutrients into the selected lake and determination of their rates of transport, storage, and decay in the study area,

4. Development and demonstration of capabilities for the establishment of nutrient budgets for lakes and for management of nutrient input into lakes that are subject to accelerated eutrophication,

5. Obtaining answers to numerous other scientific and engineering problems relating to the eutrophication process including, among others, those associated with relationships of land use to nutrient land run-off, estimating sediment load run-off to lakes, and determining the dynamic effects of nutrient reduction by these parameters on the lake's eutrophic state,

6. Development of expertise in the eutrophication problems related to New York State lakes,

7. Generation of methodology for performing the evaluation of eutrophication problems with a minimum amount of field work,

62<

8. Development of engineering and control mechanisms which will reduce the effects of the eutrophication process on the lake selected for investigation,

9. Evaluation of the effectiveness of the engineering and control mechanisms as they are applied to the lake selected for evaluation,

10. Determination of means to evaluate the nature and effects of agricultural drain-off and creation of means to control this parameter,

11. Evaluation of the eutrophication process effects on fish and other aquatic plant and animal life,

12. Development of improved mathematical descriptions of natural water systems subject to pollution and mathematical modeling of the trophic state of lakes,

13. Application of control mechanisms to other lakes in a similar state of eutrophication,

14. Development of a model relating the lake's eutrophic state to man's activities which could be used in lake management.

This preliminary report reflects the efforts that have been put forth to determine the eutrophic condition of the lake and describes the conditions existing in the lake prior to any effort being taken to control the accelerated eutrophication attributed to man-associated pollution. With this condition documented and the effort of Dr. G. Wolfgang Fuhs at the New York State Department of Health resulting in the identification of phosphorus as the limiting nutrient relative to algal growth, present efforts are being directed to limiting the input of this nutrient to the lake by methods that are controllable by man. It is intended that the final report on the Canadarago Lake Eutrophication Project will describe the engineering and control mechanisms employed to overcome the effects of accelerated eutrophication, the results of the application of these techniques to Canadarago Lake and a description of methodology that can be employed for determining the eutrophic state of water sources.

4. Contributors

This scientific investigation, an effort to understand and control accelerated eutrophication of lakes, is conducted jointly by the Environmental Quality Research and Development Unit of the New York State Department of Environmental Conservation and the Environmental Health Center, Division of Laboratories and Research, of the New York State Department of Health. However, the success that has been achieved has been the results of the combined efforts of a number of people, from many organizations, conducting seemingly individual, isolated investigations which, when combined into an integrated program, have all contributed to the achievement of the end goals of this project. A listing of the organizations participating in this program and their contribution is presented in Appendix A.

indicative of methane fermentation, can be observed in the northern half of the lake, increasing in intensity from mid-lake to the northern shore. The phenomenon is observed when an anchor (or a hollow, concrete block used as a makeshift anchor) is dropped from a boat during surveys. Spontaneous gas release has not been observed, e.g. as gas accumulation in the inverted reference compartment of sediment traps.

A preliminary study of sulfate reduction (58) showed organic matter, not sulfate, to be the limiting factor in bacterial sulfate reduction in the sediments.

L. W. Wood (59) found indication of oxidation of Rhodamine B dye in the sediments, presumably by microbes.

Coliform contamination of the lake during the years of raw sewage discharges presumably was significant.

6. Bottom flora

No bottom flora studies of major significance have been undertaken in Canadarago Lake as yet. Algae attached to rocks located near shore, October 1973, included:

CHRYSOPHYTA
- *Navicula* sp.
- *Cymbella* sp.

CHLOROPHYTA
- *Spirogyra* sp.
- *Oedogonium* sp.

7. Macrophytes

Canadarago Lake supports emergent, floating, and submersed aquatic macrophytes around its periphery. The main species observed between 1968 and 1973 were:

Emergent
1. Softstem bulrush - *Scirpus validus* Vahl.
2. Harstem bulrush - *Scirpus acutus* Muhl.
3. Pickerelweed - *Pontederia cordata* L.
4. Narrow-leaved cattail - *Typha angustifolia* L.
5. Bur reed - *Sparganium eurycarpum* Engelm

Floating
6. Yellow water lily - *Nuphar variegatum* Engelm.
7. (White) water lily - *Nymphaea odorata* Ait.

Submersed
8. Narrow-leaved pondweed - *Potamogeton* spp.
9. Water milfoil - *Myriophyllum* sp.
10. Waterweed - *Anacharis canadensis* (Michx.) Planchon
11. Coontail - *Ceratophyllum demersum* L.
12. Curly-leaf pondweed - *Potamogeton crispus* L.

The plants ranking highest in lake surface area coverage in 1968 and 1969 were the two bulrush species and yellow water lily. The location of greatest abundance of emergent plants is at the southwestern end of the lake where hardstem bulrush, yellow lily, and pickerelweed predominate. A great increase in the amount of submersed vegetation occurred between 1969 and 1973. Water milfoil (June, October), curly-leaf pondweed (June), narrow-leaved pondweed (October), and water weed (October) predominated. The submersed plants existed around almost the entire periphery in water 10 ft. or less in depth. Areas of greatest density were primarily the northeastern end, where milfoil was extremely abundant, and secondarily the southwestern end.

In 1968 and 1969 the phosphorus content of the emergent aquatic macrophytes was determined by means of field surveys, aerial photographs, and chemical analyses. A value of 232 mg of phosphorus per m^2 of weed area (meaning the surface area of the lake covered by aquatic vegetation) was obtained in 1968 and an estimated value of 349 in 1969. The average value for these years was 291 mg P/m^2. At the peak of the 1968 vegetation period approximately 35 kg of phosphorus were bound by higher aquatic plants concentrated on approximately 15 ha or 2 percent of the lake surface. In 1969 approximately 50 kg of phosphorus were present on 14 ha.

Areal coverage, total phosphorus bound, and phosphorus bound per unit area distributed among species as follows:

Species	1968 Area covered by species (m^2)	1968 Kg P bound	1968 $\frac{Mg\ P}{m^2}$	1969 Area covered by species (m^2)	1969 Kg P bound	1969 $\frac{Mg\ P}{m^2}$
Softstem bulrush	4855	0.4	88	41496	3.9	95
Hardstem bulrush	85850	22.4	261	25336	6.2	243
Yellow water lily	34152	4.7	137	39938	6.1	153
White water lily	2187	0.1	38	3594	0.3	77
Pickerelweed	14883	4.5	300	14274	3.0	213
Cattail*	5144	2.1	418	16337	30.0	1838
Bur reed	1737	0.3	193	1883	0.3	179

*The number of cattail plants per m^2 in 1969 was approximately 4.4 times that in 1968.

Close to the time of the field surveys 2306 kg and 1504 kg of phosphorus respectively were present in the lake as suspended matter. During peaks of algal blooms, suspended matter amounted to 2782 kg and 1910 kg of phosphorus respectively. Phosphorus bound in the stem, leaf, and inflorescence parts of emergent higher aquatic vegetation, therefore, equaled 1 percent in 1968 and 3 percent in 1969 of the phosphorus bound in all living matter in the water column.

65<

ACTIVE PROJECTS

PURE WATERS RESEARCH

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ENVIRONMENTAL QUALITY
RESEARCH AND DEVELOPMENT UNIT
AUGUST 1973

66<

Information Sheet

Environmental Quality
Research and Development Project
New York State Department of Environmental Conservation

Project Title - Canadarago Lake Eutrophication Study

Principal Investigators - Dr. Leo J. Hetling, Director, Research & Development Unit
N.Y. State Dept. of Environmental Conservation

Dr. G. Wolfgang Fuhs, Division of Laboratories and Research, N.Y. State Dept. of Health

Where Conducted - Canadarago Lake, one mile south of Richfield Springs, N.Y.

Date Project Initiated - April 1968

Funding Information*

Fiscal Year	Personal and General Overhead	Equipment, Supplies and Contract	Source
1968-69	$14,000	$5,000	N.Y. State Dept. of Health
1969-70	43,000	17,000	N.Y. State Dept. of Health
1970-71	27,000	23,000	N.Y. State Dept. of Env. Conservation
			N.Y. State Dept. of Health
			New England Interstate Water Pollution Control Commission
			Grumman Aircraft Engineering Corporation
1971-72	35,000	31,000	N.Y.S. Dept. of Env. Conservation
			N.Y.S. Dept. of Health
			New England Interstate Water Pollution Control Commission
1972-73	35,000	49,400	N.Y.S. Dept. of Env. Conservation
			N.Y.S. Dept. of Health
			New England Interstate Water Pollution Control Commission

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67<

Funding Information* (continued)

Fiscal Year	Personal and General Overhead	Equipment, Supplies and Contract	Source
1973-74	$35,000**	$48,500***	N.Y.S. Dept. of Env. Conservation
			N.Y.S. Dept. of Health

*These numbers do not include cost of studies and services provided by Cornell University's Department of Agronomy, The Cooperative Extension Service and the U. S. Department of Agriculture's Soil Conservation Service.

**Anticipated

***Includes $24,000 to be reimbursed by the Dingell-Johnson Federal Government Project

Description of Project -

One of the most pressing problems in water quality management is the accelerating rate of eutrophication or aging of lakes. Within the past decade, data have indicated that the rate of eutrophication is significantly increased by man's activities. However, the exact relationship between man and the eutrophication process is not clear. In order to gain a better understanding of the problem so that an effective control program can be carried out on a State-wide basis, the Department of Environmental Conservation is conducting a detailed pilot demonstration study on Canadarago Lake located in Otsego and Herkimer Counties.

The first phase of this program began in 1968 when several preliminary field surveys of the lake were made to determine some of its more important physical, chemical and biological characteristics. In 1969, an extensive lake and tributary chemical, biological and hydrological sampling program was carried out as well as laboratory algal growth potential studies. Utilizing this data, phosphorus was evaluated as the probable nutrient causing excessive algae growth. A nutrient balance was also constructed and the temporal and spatial variations in nutrient loading to the lake have been determined. Utilizing this data, the Richfield Springs Sewage Treatment Plant has been determined to be the primary source of phosphorus to the lake system with land run-off as the major secondary source.

A detailed study of the fisheries of the lake was initiated in 1972 by Cornell University's Department of Natural Resources. This study, which is expected to continue for a period of 5 years, will measure changes in the structure and dynamics of fish populations in a highly eutrophic lake following a reduction in cultural eutrophication.

Construction on a completely new sewage treatment plant for the Village of Richfield Springs was initiated in the spring of 1972. In November 1972, the plant began operation as a secondary treatment plant and in January 1973, with the completion of the tertiary system for removal of phosphorus, full operation of the facility as a tertiary treatment plant was initiated.

68<

Present efforts in this program are directed toward:

1. Determining the dynamic effect of nutrient reduction at the sewage treatment plant on the lake's eutrophic state.

2. Determining the relationship of land use to nutrient land run-off, and devising means to control run-off by land use practices. The work is being carried out under a cooperative study with Cornell University's Department of Agronomy.

3. Determining the contribution of nutrients being discharged to the lake from residences located around the perimeter of the lake by means of a sanitary sewage system survey.

4. Monitoring the sewage treatment plant performance to determine the most effective techniques and chemical additions in operating it and to investigate the feasibility of chemical additions for phosphorus removal at small treatment plants.

5. Estimating sediment load run-off to lakes. This work is being carried out under a cooperative study with the U. S. Dept. of Agriculture's Soil Conservation Service.

Future efforts in this study will be directed to:

1. Determine the dynamic effect of nutrient reduction by land run-off control on the lake's eutrophic state.

2. Develop a model relating the lake's eutrophic state to man's activities which could be used in lake management.

To accomplish these, continual surveillance of the biological, chemical and hydrological system over the next several years is planned, as well as several specific studies. Research on the lake's geology is recognized as desirable but is not planned due to lack of resources.

69<

The following is a portion of this paper.

TECHNICAL PAPER NUMBER 8

CANADARAGO LAKE EUTROPHICATION STUDY
LAKE AND TRIBUTARY SURVEYS 1968-1970
METHODOLOGY AND DATA

G. WOLFGANG FUHS

WITH CONTRIBUTIONS FROM

SUSAN P. ALLEN, THOMAS B. LYONS III
AND EDWARD J. LA ROW

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ENVIRONMENTAL QUALITY
RESEARCH AND DEVELOPMENT UNIT
DECEMBER 1972

PHOSPHORUS CONTENT OF EMERGENT HIGHER AQUATIC VEGETATION IN CANADARAGO LAKE

Introduction

On August 28 and 29, 1968 and August 13 and 14, 1969, field surveys were conducted on Canadarago Lake to identify the higher aquatic vegetation and to determine the species percent area coverage and the number of plants or leaves/m^2 for each species. Aerial photographs were taken of the lake close to the time of the 1968 survey. Infrared radiation detection was employed to manifest the weed areas near the lake shore. Representative plants of each species were returned to the laboratory for determination of phosphorus content. By utilizing all these pieces of information, it was possible to estimate the phosphorus content of the higher aquatic vegetation in Canadarago Lake. Some submerged vegetation was noted in deep water off shore but could not figure in our calculations since determining its density was not feasible and, more importantly, the aerial photographs would not detect such vegetation.

The main species of floating or emergent higher aquatic vegetation recorded at Canadarago Lake during these surveys were:

1. Softstem bulrush - _Scirpus validus_ Vahl.
2. Hardstem bulrush - _Scirpus acutus_ Muhl.
3. Yellow water lily - _Nuphar variegatum_ Engelm.
4. (White) water lily - _Nymphaea odorata_ Ait.
5. Pickerelweed - _Pontederia cordata_ L.
6. Narrow-leaved cattail - _Typha angustifolia_ L.

71<

7. Bur reed - Sparganium eurycarpum Engelm.

Materials and Methods

The higher aquatic vegetation around the shoreline of Canadarago Lake was investigated from a small boat and on foot using waders. Representative samples of each species were collected and returned to the laboratory for identification and for determination of phosphorus content by means of the alkaline persulfate method (Fuhs 1971). The sources used for species identification were Fassett (1957) and Muenscher (1944). The procedure for obtaining the phosphorus content of the aquatic vegetation is given elsewhere in this report under the chemistry section.

As we proceeded around the shoreline the weed areas were numbered and the boundaries of each site were marked on a large map of the lake. The vegetation within each site was recorded as to the percent area coverage of each species. In order to determine the relative density of each species, a "quadrat sampler" was used. The base of this open-ended wire mesh box enclosed an area of $1/4\ m^2$. By placing the open end over a patch of weeds of one species and making a visual count, we derived the number of plants or floating or emergent leaves within $1/4\ m^2$ of lake surface. From this number could be calculated the density/m^2. Areas of typical density were generally selected, but in some instances it was necessary to record the densities of both light and heavy growths of a species at the same site and derive an average density. After a number of measurements, average densities correlating to light, moderate, and heavy growths could be assigned to each species where needed; however, frequent check counts were made. Density of the two species of bulrush and the cattail was recorded as the number of plants within the quadrat. Density of the two species of water lily was recorded as the number of floating leaves within the quadrat.

The average number of floating leaves per plant for each species was calculated. Density of the pickerelweed and bur reed was recorded as the number of emergent leaves within the quadrat. The average number of emergent leaves per plant was also calculated for these species. The densities expressed in number of leaves/m^2 divided by the average number of leaves per plant yielded the number of plants/m^2.

The aerial photographs of the lake using infrared radiation detection outlined the higher aquatic vegetation at the surface of the lake. Figure 1 is a reproduction of the best aerial photograph and reveals the weed patterns within each numbered site. By use of a planimeter the actual surface area of the weed locations was calculated. As no aerial photographs were taken in 1969, the surface area of the lake covered by weeds at the time of that survey was approximated from the 1968 data.

Results

The following tables incorporate the field and laboratory data used to determine the phosphorus content of the emergent higher aquatic vegetation in Canadarago Lake. These calculations yielded a value of 232 mg of phosphorus per m^2 of weed surface (meaning the surface area of the lake covered by aquatic vegetation) in 1968 and an estimated value of 349 in 1969. The average value for these years was 291 mg P/m^2. At the peak of the 1968 vegetation period approximately 35 kg of phosphorus were bound by higher aquatic plants concentrated on approximately 15 ha or 2% of the lake surface. In 1969 approximately 50 kg of phosphorus were present on 14 ha.

Areal coverage, total phosphorus bound, and phosphorus bound per unit area were distributed among species as follows:

Species	1968 Area covered by species (m^2)	1968 Kg P bound	1968 $\frac{Mg\ P}{m^2}$	1969 Area covered by species (m^2)	1969 Kg P bound	1969 $\frac{Mg\ P}{m^2}$
Softstem bulrush	4855	0.4	88	41496	3.9	95
Hardstem bulrush	85850	22.4	261	25336	6.2	243
Yellow water lily	34152	4.7	137	39938	6.1	153
White water lily	2187	0.1	38	3594	0.3	77
Pickerelweed	14883	4.5	300	14274	3.0	213
*Cattail	5144	2.1	418	16337	30.0	1838
Bur reed	1737	0.3	193	1883	0.3	179

Data presented elsewhere in this report show that close to the time of these surveys 2306 kg and 1504 kg of phosphorus respectively were present in the lake as suspended matter. During peaks of algal blooms, suspended matter amounted to 2782 kg and 1910 kg of phosphorus respectively. Phosphorus bound in the stem, leaf, and inflorescence parts of emergent higher aquatic vegetation, therefore, equaled 1% in 1968 and 3% in 1969 of the phosphorus bound in all living matter in the water column.

*The number of cattail plants per m^2 in 1969 was approximately 4.4 times that in 1968.

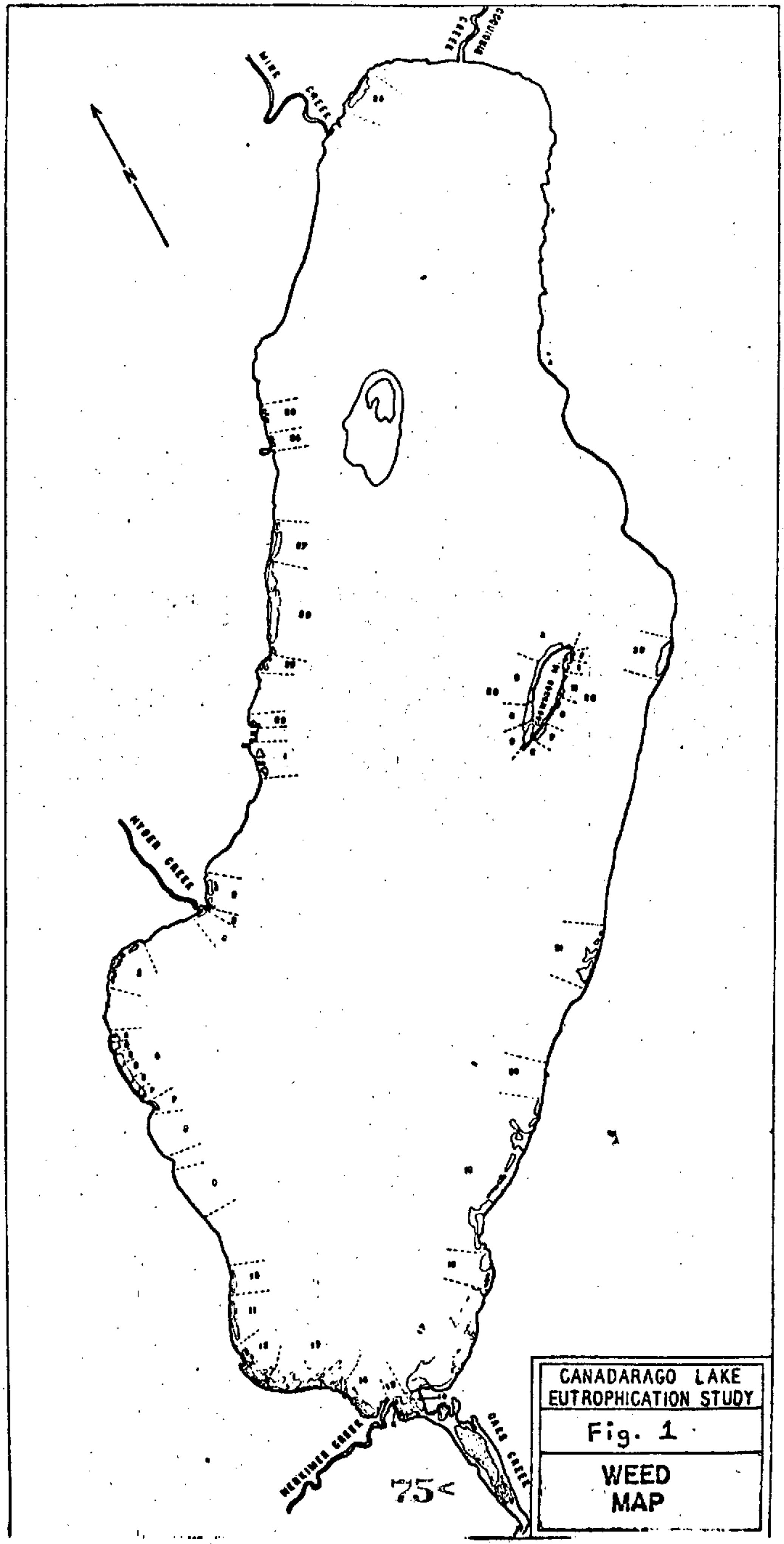
CANADARAGO LAKE
EUTROPHICATION STUDY
Fig. 1
WEED
MAP
HYDER CREEK
HERKIMER CREEK
OAKS CREEK

Table 1

Emergent Higher Aquatic Vegetation - 1968

Site no.	Weed surface area (m^2)☆	Species	Percent area coverage of species	No. of plants per m^2☆☆	Phosphorus conc. in one plant (mg)	Phosphorus conc. in species (mg)
1	1,628	Yellow water lily	100	7	24,823	282,883
2	1,934	" " "	100	3	24.823	144,023
3	204	" " "	100	3	24.823	15,192
4	468	Hardstem bulrush	100	200	2.045	191,412
5	2,076	" "	50	56	2.045	118,872
	2,076	Yellow water lily	50	8	24.823	206,130
6A	916	Hardstem bulrush	40	200	2.045	149,858
	916	Yellow Water lily	40	3	24.823	27,285
	916	Pickerelweed	20	7	29.643	38,014
6B	814	Hardstem bulrush	85	140	2.045	198,091
	814	Yellow water lily	5	3	24.823	3,031
	814	Pickerelweed	10	7	29.643	16,891
6C	1,282	Hardstem bulrush	65	140	2.045	238,574
	1,282	Yellow water lily	15	3	24.823	14,320
	1,282	White water lily	5	4	9.429	2,418
	1,282	Pickerelweed	15	14	29.643	79,805
6D	204	Hardstem bulrush	70	140	2.045	40,884
	204	Pickerelweed	30	14	29.643	25,398
6E	204	Hardstem bulrush	40	140	2.045	23,362
	204	Yellow water lily	25	3	24.823	3,798
	204	Pickerelweed	35	14	29.643	29,631
6F	1,343	Yellow water lily	40	3	24.823	40,005
	1,343	Pickerelweed	60	14	29.643	334,409
7	407	Yellow water lily	95	3	24.823	28,793
	407	White water lily	5	4	9.429	768
10	672	Hardstem bulrush	15	36	2.045	7,421
	672	Yellow water lily	20	7	24.823	23,353
	672	Pickerelweed	50	6	29.643	59,760
	672	Bur reed	15	12	16.051	19,415
11	2,137	Yellow water lily	80	7	24.823	297,062
	2,137	White water lily	5	4	9.429	4,030
	2,137	Pickerelweed	15	6	29.643	57,012
12	6,106	Hardstem bulrush	10	36	2.045	44,952
	6,106	Yellow water lily	50	7	24.823	530,492
	6,106	Pickerelweed	40	6	29.643	434,400
13	13,840	Softstem bulrush	20	100	0.883	244,414
	13,840	Yellow water lily	40	7	24.823	961,941
	13,840	Pickerelweed	40	14	29.643	2,297,451
14	4,885	Softstem bulrush	5	100	0.883	21,567
	4,885	Yellow water lily	15	7	24.823	127,323
	4,885	Pickerelweed	20	14	29.643	405,457
	4,885	Cattail	55	10	41.783	1,122,605
	4,885	Bur reed	5	12	16.051	47,045
15	4,885	Softstem bulrush	5	100	0.883	21,567
	4,885	Yellow water lily	14	7	24.823	118,835
	4,885	White water lily	21	4	9.429	38,691

15	4,885	Pickerelweed	10	6	29.643	86,884
	4,885	Cattail	50	10	41.783	1,020,550
15A	916	Softstem bulrush	5	100	0.883	4,044
	916	Yellow water lily	2	7	24.823	3,183
	916	White water lily	3	4	9.429	1,036
	916	Pickerelweed	10	6	29.643	16,292
	916	Bur reed	80	12	16.051	141,146
16	285	Softstem bulrush	5	100	0.883	1,258
	285	White water lily	20	4	9.429	2,150
	285	Pickerelweed	35	6	29.643	17,741
	285	Cattail	5	10	41.783	5,954
	285	Bur reed	35	12	16.051	19,213
17	44,777	Hardstem bulrush	95	140	2.045	12,178,672
	44,777	Pickerelweed	5	6	29.643	398,197
18	3,257	Yellow water lily	100	4	24.823	323,394
19	13,637	Hardstem bulrush	95	140	2.045	3,709,059
	13,637	Yellow water lily	5	4	24.823	67,702
21	4,071	Hardstem bulrush	100	100	2.045	832,520
22A	2,849	Hardstem bulrush	100	78	2.045	454,444
22B	3,460	Hardstem bulrush	100	78	2.045	551,905
22C	2,239	Hardstem bulrush	100	52	2.045	238,095
22D	3,053	Hardstem bulrush	95	200	2.045	1,186,243
	3,053	Bur reed	5	12	16.051	29,402
22E	1,018	Hardstem bulrush	100	100	2.045	208,181
22F	2,443	Hardstem bulrush	85	100	2.045	424,654
	2,443	Bur reed	15	12	16.051	70,583
22G	2,443	Hardstem bulrush	95	120	2.045	569,537
	2,443	Yellow water lily	4	3	24.823	7,277
	2,443	White water lily	1	4	9.429	921
22H	814	Hardstem bulrush	40	100	2.045	66,585
	814	Yellow water lily	22	3	24.823	13,336
	814	White water lily	3	4	9.429	921
	814	Pickerelweed	35	6	29.643	50,672
22I	814	Hardstem bulrush	60	100	2.045	99,878
	814	Yellow waterlily	8	3	24.823	4,849
	814	White water lily	32	4	9.429	9,824
22J	814	Hardstem bulrush	25	100	2.045	41,616
	814	Yellow water lily	12	3	24.823	7,274
	814	White water lily	28	4	9.429	8,596
	814	Pickerelweed	30	6	29.643	43,433
	814	Bur reed	5	12	16.051	7,839
23	4,071	Hardstem bulrush	100	100	2.045	832,520
24	611	Yellow water lily	100	5	24.823	75,834
25	611	Yellow water lily	100	5	24.823	75,834
26	2,443	Yellow water lily	100	5	24.823	303,213
27	2,646	Softstem bulrush	47	100	0.883	109,812
	2,646	Yellow water lily	46	5	24.823	151,068
	2,646	White water lily	2	4	9.429	1,996
	2,646	Pickerelweed	5	6	29.643	23,531
28	5,903	Softstem bulrush	5	100	0.883	26,062
	5,903	Yellow water lily	85	5	24.823	622,753
	5,903	White water lily	5	4	9.429	11,132
	5,903	Pickerelweed	5	6	29.643	52,495
29	1,221	Yellow water lily	100	5	24.823	151,544
30	407	Yellow water lily	100	5	24.823	50,515
			TOTAL mg P			34,552,009
			TOTAL WEED SURFACE AREA (m^2)			148,808

☆ Refers to the surface area of the lake covered by aquatic vegetation.

☆☆ The number of floating or emergent leaves/plant was estimated as follows: Yellow water lily-6; White water lily-5; Pickerelweed-7; Bur reed -11.

mg P/m^2 = 232 mg P/m^2

Table 2

Emergent Higher Aquatic Vegetation - 1969

Site no. 1969#	Site no. 1968#	Weed surface area(m^2)*	Species	Percent area coverage of species	No. of plants per m^2**	Phosphorus conc. in one plant (mg)	Phosphorus conc. in one species (mg)
1 A-C	30	407	Yellow water lily	100	6	24.823	60,618
2	29	1,221	Yellow water lily	100	6	24.823	181,853
3	28	5,903	Hardstem bulrush	1	150	2.045	18,107
		"	Yellow water lily	94	6	24.823	826,430
		"	Pickerelweed	5	8	29.643	69,993
4	27	2,646	Hardstem bulrush	40	212	2.045	458,859
		"	Yellow water lily	50	6	24.823	197,045
		"	Pickerelweed	10	8	29.643	62,748
5	25	611	Yellow water lily	100	6	24.823	91,001
6	24	611	Yellow water lily	100	6	24.823	91,001
7	23	4,071	Hardstem bulrush	100	116	2.045	965,723
8	22 I+J	1,628	Hardstem bulrush	9	120	2.045	35,956
		"	Yellow water lily	27	6	24.823	65,467
		"	Pickerelweed	64	7	29.643	216,199
9	22 H	814	Hardstem bulrush	15	126	2.045	31,462
		"	Yellow water lily	19	6	24.823	23,035
		"	White water lily	43	23	9.429	75,908
		"	Pickerelweed	23	7	29.643	38,848
10	22 E,F,G	5,904	Hardstem bulrush	95	152	2.045	1,743,439
		"	Cattail	5	44	41.783	542,711
11	one-third of 22B plus C+D	6,445	Hardstem bulrush	100	135	2.045	1,779,303
12	22A + two-thirds of B	5,156	Hardstem bulrush	100	64	2.045	674,817
13	1	1,628	Yellow water lily	100	6	24.823	242,471
14	2	1,934	Yellow water lily	100	6	24.823	288,046
15	3,4	672	Hardstem bulrush	92	180	2.045	227,574
		"	Bur reed	8	11	16.051	9,492
16-24	5, area in between, 6A-F,7 (assume area in between equals 5)	(9,322)	Softstem bulrush	9	60	0.883	44,449
		"	Hardstem bulrush	22	53	2.045	222,280
		"	Yellow water lily	48	6	24.823	666,432
		"	White water lily	1	5	9.429	4,395
		"	Pickerelweed	17	7	29.643	328,835
		"	Bur reed	3	12	16.051	53,866
25	9, (assume 9 equals 6C,D,E,F)	(3,033)	Softstem bulrush	8	60	0.883	12,855
		"	Yellow water lily	53	5	24.823	199,514
		"	Pickerelweed	18	7	29.643	113,283
		"	Bur reed	21	11	16.051	112,457
26	10,11	2,809	Yellow water lily	95	5	24.823	331,207
		"	White water lily	5	5	9.429	6,622
27	12	6,106	Softstem bulrush	5	80	0.883	21,566
		"	Yellow water lily	54	5	24.823	409,237
		"	White water lily	6	13	9.429	44,907

27	12	6,106	Pickerelweed	35	7	29.643	443,450
28	13	13,840	Softstem bulrush	2	80	0.883	19,553
		"	Yellow water lily	54	6	24.823	1,113,103
		"	White water lily	14	5	9.429	91,348
		"	Pickerelweed	30	7	29.643	861,544
29,30	14	4,885	Softstem bulrush	3	80	0.883	10,352
		"	Yellow water lily	64	12	24.823	931,280
		"	White water lily	2	10	9.429	9,212
		"	Pickerelweed	5	15	29.643	108,605
		"	Cattail	26	44	41.783	2,335,018
31	15,16	6,086	Softstem bulrush	14	80	0.883	60,188
		"	Yellow water lily	13	6	24.823	117,837
		"	White water lily	10	8	9.429	45,908
		"	Pickerelweed	26	7	29.643	328,341
		"	Cattail	22	44	41.783	2,461,540
		"	Bur reed	15	11	16.051	161,183
32	17	44,777	Softstem bulrush	65	120	0.883	3,083,971
		"	Pickerelweed	5	7	29.643	464,564
		"	Cattail	30	44	41.783	24,696,110
33	18 + one-third of 19	(7,803)	Softstem bulrush	67	80	0.883	369,307
		"	Yellow water lily	33	4	24.823	255,676
34	one-third of 19	(4,546)	Softstem bulrush	99	80	0.883	317,918
		"	Yellow water lily	1	4	24.823	4,514

TOTAL mg P 49,880,533
TOTAL WEED SURFACE AREA (m^2) 142,858

mg P/m^2 = 349 mg P/m^2

1968 = 232 mg P/m^2
1969 = (349) mg P/m^2

Ave. = 291 mg P/m^2 weed surface

* Refers to the surface area of the lake covered by aquatic vegetation.

** The number of floating or emergent leaves/plant was estimated as follows: Yellow water lily-5; White water lily-4; Pickerelweed-7; Bur reed-8.

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Muenscher, W. C. 1944. Aquatic Plants of the United States. Comstock Publishing Associates, Ithaca, New York.

APPENDIX E

SELECTED CORRESPONDENCE

DEPARTMENT OF TRANSPORTATION
ST. LAWRENCE SEAWAY DEVELOPMENT CORPORATION
WASHINGTON, D.C. 20590 MASSENA, NEW YORK 13662

800 Independence Avenue, SW
Washington, D. C. 20591
June 19, 1974

Professor Ta Liang
Principal Investigator
School of Civil and Environmental Engineering
Cornell University, Hollister Hall
Ithaca, New York 14850

Dear Dr. Liang:

I wish to take this opportunity to express our appreciation for the work which you and your staff have been pursuing in regards to the analysis of vertical aerial photography of ice on the St. Lawrence River. Based on the briefing which you provided me at our recent meeting in Ithaca it is obvious that your study of our photography has clearly demonstrated the feasibility of producing useful and highly detailed maps of ice types sequentially throughout the winter. These maps provide significantly more detail than has here-to-fore been available from the observations of airborne observers.

Based in large measure on the results of your successful analyses, we plan to expand our remote sensing efforts on the St. Lawrence River during the forthcoming winters. In addition, I am rather excited about the use of your mapping techniques to assist in defining those reaches of the river in which ice control structures will be required. As soon as I have developed a scope of work for a specific project to address this problem I shall be in further contact with you.

My compliments again to you and to Warren Phillipson and Tom Erb for their excellent work.

Yours very truly,

David C. N. Robb
Director
Office of Comprehensive Planning

UNIVERSITY OF CALIFORNIA, RIVERSIDE

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO | SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF EARTH SCIENCES | RIVERSIDE, CALIFORNIA 92502

May 1, 1974

Mr. Warren R. Phillipson
469 Hollister Hall
Cornell University
Ithaca, NY 14850

Dear Mr. Phillipson:

I have recently been in contact with Dr. Charles Paul at the Jet Propulsion Laboratory concerning a report in which a cost-benefit analysis was performed utilizing grid cell size, resolution, information return, and labor input, etc. It appears as if some of the information and techniques would be useful in our contract work. Unfortunately, I cannot refer to the report by name, but would appreciate receiving a copy as Dr. Paul is unable to supply one.

Sincerely,

David Nichols
Staff Research Associate

DN/gl

ST. LAWRENCE COUNTY
DEPARTMENT OF HIGHWAYS

72 MAIN STREET, BOX 299
MASSENA, NEW YORK 13662

May 31, 1974

Cornell University
School of Civil & Environmental Engineering
Hollister Hall
Ithaca, New York

ATTENTION: Professor Ta Liang, Principal Investigator

Dear Sir:

Please excuse me for my belated reply to your letter and telephone request.

As we discussed on the phone, the St. Lawrence County Highway Department has urgent need to develop at least four sources of materials "Gravel Pits" in various areas in the County. The location of the areas where this material is readily available is a major concern of mine. Up to this point in time the only means at our disposal to locate these sources is to talk with local residents and dig test holes, if time allows. The inadequacy of this method is obvious.

I can assure you that when suitable sources of materials are located, that this Department will acquire either the land or materials and immediately move in to process materials. This Department has the capability to crush and process materials and has all of the necessary equipment to perform this function As of this writing, we do not have any source of material in the County.

As I stated to you on the telephone it is specifically stipulated by the State Highway Law that it is the responsibility of the Superintendent to locate and develop sources of road building materials.

For obvious reasons we annually expend sums in excess of \$1,500,000.00 in construction, reconstruction and maintenance of County Highways in this County. Not having adequate stocks of road building materials on hand puts our operation in a vulnerable position as far as costs are concerned and by lost time in negotiating and developing small sources of supply as the occasion arises.

Your assistance and help with this major problem is most appreciated and I can assure you we will immediately move on developing sources at the conclusion of your study.

If this Department can do anything to assist you in this study, don't hesitate to call.

Kindest personal regards.

Very truly yours,

John Cook
Co. Supt. of Highways

JC:el

STATE OF NEW YORK

TEMPORARY STATE COMMISSION
ON TUG HILL

N.Y.S. OFFICE BUILDING
317 WASHINGTON STREET
WATERTOWN, NEW YORK 13601
(315) 782-0100

May 9, 1974

Professor Ta Liang
Remote Sensing Program
Hollister Hall
Cornell University
Ithaca, New York 14850

Dear Professor Liang:

We certainly appreciate the work being done by members of your staff under the direction of Mr. Fred Voight on possible canoe routes in the Tug Hill region, using ERTS imagery.

Information on the streams and river system of the region is sketchy at best, and any research done by Mr. Voight on waterways which could be used for possible canoe routes would be extremely valuable to the Tug Hill Commission.

Recreation is one of the important aspects of the region that the Commission was mandated by the New York State Legislature to study, and we have had definite interest indicated in new canoe routes being proposed to connect the Tug Hill area with the Fulton Chain of lakes and other canoeable waters in the State.

We look forward to receiving Mr. Voight's report, which we feel will be of definite assistance in preparing our recommendations to Legislature for possible future enactment in the area of outdoor recreation. A copy of our Interim Report is enclosed for your information.

Thank you very much for your help in this project.

Sincerely,

B P Coe

Benjamin P. Coe
Executive Director

86<

BPC:chr

May 17, 1974

Dr. Ta Liang
Remote Sensing Program
School of Civil and Environmental
Engineering
Cornell University, Hollister Hall
Ithaca, NY 14850

Dear Dr. Liang:

We wish to thank you and Fred Voigt for your studies conducted through your NASA Remote Sensing Program including the work done for us on interconnected waterways in the Adirondacks.

The study did show to us the value of remote sensing and ERTS imagery in identifying interconnected waterways. I feel this method will be especially useful in extensive undeveloped areas where these waterways have not been previously mapped in detail or where new information is sought. Locating these waterways on conventional aerial photography could be expensive and time consuming as well as hampered by the limited dates of photo coverage. The ERTS imagery will provide a reasonable alternative to this method. The work presently being done delineating innerconnected waterways in the Tug Hill will be another example of its usefulness.

I would like to thank you for your work and ask that you keep us informed of your work in this area.

Sincerely,

Ivan P. Vamos, Director
Planning and Research

IPV:NAP:kb

cc: F. Voigt

PHILIP A. RICE, P.E.
COUNTY SUPERINTENDENT

PHONE
[illegible] — 331-3220

WAYNE COUNTY
DEPARTMENT OF HIGHWAYS
Box 111, Rt. 31
LYONS, N. Y.
14489

May 13, 1974

Professor Ta Liang
Cornell University
Hollister Hall
Ithaca, New York 14850

Dear Professor Liang,

Our meeting last Wednesday was a start towards a cooperative venture that should bring tangible benefits to Wayne County and it's towns.

In these days of inflated prices and diminishing highway materials, it is imperative that we utilize all of the expertise that is available to minimize the effect of these factors.

As I stated to you, of all the listed possible projects, the location and exploration of construction materials would be most beneficial to us. Both the county and towns are involved in the reconstruction of roads, which requires a considerable amount of gravel. Presently, many of the haul distances are extensive. The location of additional sources could cut the haul distances and thus lessen the cost of the material in place.

The Planning Department is gathering all of the local ordinances that relate to gravel pits so that we can review and possibly modify these ordinances to take advantage of newly located pits.

Judging by the positive response that I have received from the Town Superintendents, I am sure that there will be both short and long range benefits accrued from the project.

You will have our full cooperation in attempting to make this project a worthwhile endeavour.

Sincerely yours,

Philip A. Rice

PHILIP A. RICE
Co. Sup't. of Highways

APPENDIX F

TRAVEL SPONSORED
BY NASA GRANT

TRAVEL SPONSORED BY NASA GRANT*
December 1, 1973-May 31, 1974

DESTINATION	PURPOSE	NBR. DAYS	NBR. OF PERSONS/ NATURE OF EXPENSES
Great Gully, New York	Field check for archeological study	1/2	2/road mileage
Watertown, New York	Discuss cooperative study on ERTS-mapping of interconnected waterways with N.Y.S. Commission on Tug Hill	1	2/road mileage and meals
Albany, New York	Discuss cooperative study on remote sensing of sensitive soils with N.Y.S. Dept. of Transportation	1-1/2	1/road mileage, lodging & meals
State College, Pennsylvania	Visit facilities and consult with Penn State personnel regarding computer analysis routines	2	2/road mileage
Delhi, New York	Discuss cooperative study on sanitary landfill site selection with Dept. of Planning, Delaware County	1	3/road mileage & meals
Washington, D.C.	Confer with NASA, NSF and AID personnel regarding remote sensing investigations	2	1/airfare lodging & meals
St. Louis, Missouri	Attend Convention, American Society of Photogrammetry	5	1/airfare, lodging & meals
Ann Arbor, Michigan	Attend International Symposium on Remote Sensing	4	1/airfare lodging & meals

*List does not include travel funds for seminar speakers.

APPENDIX G

SEMINAR IN REMOTE SENSING
(CEE 2496)

NASA-Sponsored Remote Sensing Program

CEE 2496: SEMINAR IN REMOTE SENSING

LIST OF SEMINARS

1973-1974

Date	Speaker	Topic
Sept 5	Organizational Meeting	Movie on the Brazilian Radam Project
Sept 12	Mr. Homer Jensen Director of Development Aero Service Corp. Philadelphia, Pa.	Surveying with Synthetic Aperture, Side-Looking Airborne Radar
Sept 19	Prof. Donald J. Belcher School of Civil and Environmental Eng'g. Cornell University	Status of Remote Sensing in South Africa
Sept 26	Mr. S.A. Raje Systems Development Engineer General Electric Space Div. Valley Forge, Pa.	ERTS Data Handling and Applications
Oct 3	Mr. Roger C. Haas Environmental Sciences Dept. Calspan Corp. Buffalo, N.Y.	Calspan's Operations with Thermal Scanners
Oct 10	Prof. Elmer S. Phillips College of Agriculture and Life Sciences Cornell University	Photographic Enhancement of Satellite Imagery
Oct 17	Mr. Lester E. Garvin Principal Scientist Raytheon/Autometric Wayland, Mass.	Development of a Natural Resource Information System
Oct 24	Dr. J. Colin Jones Chief, EREP Integration Martin Marietta Corp. Denver, Colorado	Earth Resources from Skylab
Nov 7	Dr. Paul A. Mohr Smithsonian Astrophysical Observatory Cambridge, Mass.	ERTS-1 Imagery and the Structural Geology of The African Rift System
Nov 14	Dr. Peter A. Murtha Forest Management Institute Canadian Forestry Service Ottawa, Ontario	A Train Wreck, SO_2 and Spruce Budworm: Image Interpretation of Forest Damage

Date	Speaker	Topic
Nov 28	Mr. Merrill Conitz Office of Science and Technology U.S. Agency for International Development Washington, D.C.	Remote Sensing in Developing Countries
Dec 5	Dr. Robert K. Vincent Environmental Research Institute of Michigan Ann Arbor, Mich.	Spectral Ratio Imaging Methods for Geological Remote Sensing from Aircraft and Satellites
Jan 30	Dr. Yngvar W. Isachsen Geological Survey N.Y.S. Museum and Science Service Albany, New York	Spectral Geological Content of ERTS-1 Imagery over a Variety of Geological Terranes in New York State
Feb 6	Prof. Ralph Bolgiano, Jr. School of Electrical Engineering Cornell University	Radio-Sensing of Atmospheric Structure
Feb 13	Mr. Thomas W. Wagner Environmental Research Institute of Michigan Ann Arbor, Michigan	The Multispectral Environment
Feb 20	Mr. C. Philip McCabe Special Consultant U.S. Environmental Protection Agency Washington, D.C.	Control and Exploitation of Photographic Images for Environmental Monitoring
Feb 27	Mr. Donald S. Lowe Environmental Research Institute of Michigan Ann Arbor, Michigan	Multispectral Scanners: Design, Capabilities and Limitations
Mar 6	Prof. Edward M. Mikhail School of Civil Engineering Purdue University West Lafayette, Indiana	Hologrammetry: Concepts and Applications
Mar 20	Dr. Eugene L. Peck Director, Hydrologic Research Laboratory National Weather Service, NOAA Silver Spring, Maryland	Airborne Gamma-Ray Surveys

Date	Speaker	Topic
Mar 27	Dr. Clifford W. Greve Senior Scientist Raytheon/Autometric Arlington, Virginia	Digital Rectification of Side-Looking Radar
Apr 24	Mr. James C. Barnes Environmental Research and Technology, Inc. Lexington, Massachusetts	Snow and Ice Observations from Space
May 1	Dr. Per Gloersen National Aeronautics and Space Administration Goddard Space Flight Center Greenblelt, Maryland	Remote Sensing of the Earth's Atmosphere and Surface by Imaging Microwave Radiometry
May 8	Mr. Howard L. Heydt Consulting Engineer, Remote Sensing General Electric Space Div. Valley Forge, Pa.	Machine-Aided Analysis of Remotely Sensed Data

APPENDIX H

NEWSLETTER RECIPIENTS

CORNELL REMOTE SENSING NEWSLETTER

LIST OF RECIPIENTS

A. CAMPUS GROUPS AND INDIVIDUALS*

1. Aerospace Studies (Air Force R.O.T.C.)

2. Agricultural Economics

   B.F. Stanton (Chairman; Prof.)
   D.J. Allee (Prof., Resource Economics; Assoc. Dir., Water Resources and Marine Sciences Center)
   H.E. Conklin (Prof., Land Economics)
   G.L. Casler (Assoc. Prof.)
   J.J. Jacobs (Research Assoc.)
   A.G. Colmenares (Research Asst.)

3. Agricultural Engineering

   E.S. Shepardson (Chairman; Prof.)
   G. Levine (Prof.)
   R.C. Loehr (Dir., Environmental Studies; Prof., Civil and Envir. Eng'g. and Agr. Eng'g.)
   D.C. Ludington (Assoc. Prof.)
   D.A. Haith (Asst. Prof., Civil and Envir. Eng'g. and Agr. Eng'g.)
   L.H. Irwin (Asst. Prof.)
   E.G. Srinath (Research Assoc.)

4. N.Y.S. Agricultural Experiment Station (Ithaca)

   J.F. Metz, Jr. (Assoc. Dir. of Research, N.Y.S. College of Agr.; Assoc. Dir., Agr. Exp. Station; Prof.)

5. Agronomy

   M.J. Wright (Chairman; Prof.)
   M. Drosdoff (Prof., Soil Science)
   M.G. Cline (Prof., Soil Science)
   D.R. Bouldin (Prof., Soil Science)
   E.R. Lemon (Prof., Soil Science; Supervisory Soil Scientist, U.S.D.A.)
   P.J. Zwerman (Prof., Soil Conservation)
   R.W. Arnold (Assoc. Prof., Soil Science)
   W.B. Duke (Assoc. Prof., Soil Science)
   G.W. Olson (Assoc. Prof., Soil Science)

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* 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.

C.7

Agronomy (Cont)

L.H. Allen Jr. (Soil Scientist, U.S.D.A.)
J.H. Peverly (Asst. Prof., Eutrophication)
D.A. Lauer (Research Assoc.)
G.F. Kling (Research Asst.)
L.A. Daugherty (Research Asst.)

6. Anthropology

R. Ascher (Prof., Anthropology and Archaeology)

7. Applied and Engineering Physics

A.F. Kuckes (Prof., Applied Engineering Physics)

8. Architecture

H.W. Richardson (Asst. Prof.)

9. Astronomy

M.O. Harwit (Chairman; Prof.)
F.D. Drake (Dir., Nat'l. Astronomy and Ionosphere Center; Assoc. Dir., Center for Radiophysics and Space Research; Prof.)
Y. Terzian (Asst. Dir., Center for Radiophysics and Space Research; Assoc. Prof.)
C. Sagan (Acting Dir., Center for Radiophysics and Space Research; Prof.)
J. Berger (Sr. Computer Programmer)

10. Atmospheric Sciences

B.E. Dethier (Prof.)
W.W. Knapp (Assoc. Prof.)
A.B. Pack (Climatologist, National Weather Service, N.O.A.A., U.S.D.C.; Asst. Prof.)

11. Biological Sciences

12. College of Agriculture and Life Sciences

W.K. Kennedy (Dean; Prof., Agronomy)
J.W. Spencer (Assoc. Dean; Prof., Agr. Eng'g.)

13. College of Engineering

E.T. Cranch (Dean; Prof., Theoretical and Applied Mechanics)
A.R. Seebass (Assoc. Dean; Asst. Prof., Mech, and Aerospace Eng'g.)
F.J. Ahimaz (Asst. Dean; Asst. Dir., Program on Science and Technology)

14. Communication Arts

15. Computer Science

16. Cornell Energy Project

17. Design and Environmental Analysis

    G.J. Coates (Asst. Prof.)

18. Ecology and Systematics

    L.C. Cole (Prof., Ecology)
    G.D. Likens (Prof., Ecology)
    J.P. Barlow (Assoc. Prof., Oceanography)
    P.F. Brussand (Asst. Prof., Ecology)
    P.L. Marks (Asst. Prof., Biology)

19. Economics

20. Education

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

21. Electrical Engineering

    N.M. Brice (Prof.)
    S. Linke (Asst. Dir., Lab. of Plasma Studies; Prof.)
    G.J. Wolga (Prof.)
    R.A. McFarlane (Assoc. Prof.)
    J.M. Ballantyne (Assoc. Prof.)

22. Entomology

    D. Sliwa (Survey Entomologist)
    A. York (Research Asst.)

23. Floriculture and Ornamental Horticulture

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

24. Geological Sciences

    J.E. Oliver (Chairman, Prof.)
    J.M. Bird (Prof.)
    G.A. Kiersch (Prof.)
    S.S. Philbrick (Prof.)
    J.W. Wells (Prof.)
    A.L. Bloom (Assoc. Prof.)
    B.L. Isacks (Assoc. Prof.)
    W.B. Travers (Asst. Prof.)
    B. Bonnichsen (Asst. Prof.)

25. Human Development and Family Studies

26. Industrial Engineering and Operations Research

27. International Agricultural Development

28. Center for International Studies

N.T. Uphoff (Asst. Prof., Govt.; Chairman, Rural Development Committee, Gov't)

29. Material Science and Engineering

30. Mechanical and Aerospace Engineering

31. Military Science (Army R.O.T.C.)

32. Natural Resources

W.H. Everhart (Chairman, Prof.)
L.S. Hamilton (Prof.)
R.J. McNeil (Assoc. Prof.)
R.R. Morrow (Assoc. Prof.)
H.B. Brumsted (Assoc. Prof.)
B.T. Wilkins (Asst. Prof.; Program Leader, Sea Grant Advisory Service)
A. Dickson (Assoc. Prof.)
A.W. Eipper (Assoc. Prof., Fishery Biology; Leader, N.Y.S. Cooperative Fishery Unit)
A.N. Moen (Assoc. Prof.)
R.T. Oglesby (Assoc. Prof.)
D.Q. Thompson (Assoc. Prof.; Head, N.Y. Cooperative Wildlife Research Unit)
J.W. Kelley (Asst. Prof.)
G. Reetz (Asst. Prof.)
E.E. Hardy (Sr. Research Assoc.)
C.S. Hunt, Jr. (Research Assoc.)
W.R. Schaffner (Research Assoc.)
J. Skaley (Research Assoc.)
J.W. Caslick (Extension Assoc.)
J. Glaser (Research Asst.)
R. Wulff (Research Asst.)
J. McKenna (Research Aide)

33. Naval Science (Navy R.O.T.C.)

34. Plant Pathology

D.F. Bateman (Chairman; Prof.)
H.D. Thurston (Prof.)
S.V. Beer (Assoc. Prof.)
O.E. Schultz (Assoc. Prof.)
P.A. Arneson (Asst. Prof.)

35. Policy Planning and Regional Analysis

B.G. Jones (Chairman; Prof.)
S. Saltzman (Prof.)
W.W. Goldsmith (Asst. Prof.)
L. Caplan (Research Asst.)

36. Pomology

37. Poultry Science

R.J. Young (Chairman; Prof., Animal Nutrition)

38. Rural Sociology

H.R. Capener (Prof., and Head, Rural Sociology)
F.W. Young (Prof.)
W. Saint (Research Asst.)
P.H. Gore (Research Specialist)

39. Sociology

P.S.K. Chi (Assoc. Prof., Program Assoc., Int'l. Population Program)

40. Thermal Engineering

F.K. Moore (Prof.)
T.A. Cool (Assoc. Prof.)

41. U.S. Plant, Soil and Nutrition Laboratory

42. Urban Planning & Development

S.W. Stein (Chairman, Prof.)
H.M. Hammerman (Asst. Prof.)

43. Civil and Environmental Engineering

W.R. Lynn (Dir., School of C.E.E.; Dir., Center for Environmental Quality Management; Prof., Envir. Eng'g.)
G.B. Lyon (Acting Asst. Dir.; Assoc. Prof., Envir. Eng'g.)
R.H. Gallagher (Prof. and Chairman, Structural Eng'g.)
C.D. Gates (Prof. and Acting Chairman, Envir. Eng'g.)
V.C. Behn (Assoc. Prof., Envir. Eng'g.)
D.J. Belcher (Prof., Envir. Eng'g.)
P.L. Bereano (Assoc. Prof., Envir. Eng'g.; Exec. Secy., Program on Science, Technology, and Society)
J.J. Bisogni (Asst. Prof., Envir. Eng'g.)
W.H. Brutsaert (Assoc. Prof., Envir. Eng'g.)
L.B. Dworsky (Dir., Water Resources and Marine Sciences Center; Prof., Envir. Eng'g.)
G.P. Fisher (Prof., Envir. Eng'g.)
R. Gergely (Assoc. Prof., Structural Eng'g.)
J.N. Kay (Asst. Prof., Envir. Eng'g.)
A.W. Lawrence (Assoc. Prof., Envir. Eng'g.)

43. Civil and Environmental Engineering (Cont)

T. Liang (Prof., Envir. Eng'g.)
J.A. Liggett (Prof., Envir. Eng'g.)
D.P. Loucks (Assoc. Prof., Envir. Eng'g.)
A.J. McNair (Prof., Envir. Eng'g.)
W. McGuire (Prof., Structural Eng'g.)
A.H. Meyburg (Asst. Prof., Envir. Eng'g.)
A.H. Nilson (Prof., Structural Eng'g.)
C.S. Orloff (Asst. Prof., Envir. Eng'g. and Eng'g. Basic Studies)
T. Pekoz (Asst. Prof., Mgr. Structural Research, Structural Eng'g.)
D.A. Sangrey (Assoc. Prof., Envir. Eng'g.)
R.E. Schuler (Asst. Prof., Envir. Eng'g. and Economics)
R.G. Sexsmith (Assoc. Prof., Structural Eng'g.)
C.A. Shoemaker (Asst. Prof., Envir. Eng'g. and Entomology)
F.O. Slate (Prof., Structural Eng'g.)
S. Stidham, Jr. (Asst. Prof., Operations Research and Envir. Eng'g.)
P.R. Stopher (Asst. Prof. Envir. Eng'g.)
H.M. Taylor (Assoc. Prof., Envir. Eng'g. and Operations Research)
R.N. White (Prof., Structural Eng'g.)
G. Winter (Prof., Structural Eng'g.)
S.C. Hollister (Emeritus Prof., Civil and Envir. Eng'g.)
W.R. Philipson (Research Assoc., Envir. Eng'g.)
L.S. Zall (Teaching Asst., Envir. Eng'g.)
B. Coskun (Teaching Asst., Envir. Eng'g.)
B.J. Tucker (Research Asst., Envir. Eng'g.)
M.F. Layese (Research Asst., Envir. Eng'g.)
T.L. Erb (Research Asst., Envir. Eng'g.)
F.C. Voigt (Research Asst., Envir. Eng'g.)

B. OFF-CAMPUS GROUPS AND INDIVIDUALS

1. Mr. William C. Ahearn
   Environmental Health Center
   Division of Laboratories and Research
   N.Y.S. Department of Health
   Albany, New York

2. Mr. James C. Barnes
   Manager, Earth Resources Studies
   Environmental Research and Technology, Inc.
   Lexington, Mass.

3. Mr. Jack L. Barrick
   State Resource Conservatonist
   S.C.S., U.S.D.A.
   Syracuse, N.Y.

4. Prof. Robert H. Brock
   N.Y.S. College of Forestry
   Syracuse University
   Syracuse, N.Y.

5. Calspan Corporation
   Buffalo, N.Y.
   a) K.R. Piech
   b) J.E. Walker
   c) R.C. Ziegler
   d) R.C. Haas
   e) B. McMichael

6. Canada Center for Remote Sensing
   Ottawa, Ontario

7. Mr. Merrill Conitz
Office of Science and Technology
U.S. Agency for International Development
Washington, D.C.

8. Mr. Robert Crowder
N.Y.S. Office of Planning Services
Albany, New York

9. Dr. Wolfram Drewes
International Bank for Reconstruction & Development
Washington, D.C.

10. Environmental Research Institute of Michigan
Ann Arbor, Mich.
a) Dr. R.K. Vincent
b) Mr. T.W. Wagner

11. Dr. Murray Felsher
Office of Technical Analysis
Environmental Protection Agency
Washington, D.C.

12. Dr. Robert B. Forrest
Bendix Research Labs.
Southfield, Mich.

13. Dr. G. Wolfgang Fuhs
Director, Environmental Health Center
Division of Laboratories and Research
N.Y.S. Department of Health
Albany, New York

14. Mr. Lester E. Garvin
Raytheon/Autometric
Arlington, Va.

15. Dr. Per Gloersen
Earth Observations Branch, Code 652
NASA, Goddard Space Flight Center
Greenbelt, Maryland 20771

16. Dr. Clifford W. Greve
Raytheon/Autometric
Arlington, Va.

17. Mr. Philip Guss
Project Manager, Ecological Services
Lockwood, Kessler & Bartlett, Inc.
Syosset, N.Y.

18. Mr. William Hall
Joseph S. Ward & Associates
Caldwell, N.J.

19. Ithaco, Inc.
Ithaca, N.Y.

20. Mr. Homer Jensen
Aero Service Corp.
Philadelphia, Pa.

21. Dr. Jack D. Johnson
Office of Arid Lands Studies
University of Arizona
Tucson, Arizona

22. Mr. Raymond Krieg
R & M Engineering and Geological Consultants
Fairbanks, Alaska

23. Dr. Thomas Lillesand
N.Y.S. College of Forestry
Syracuse University
Syracuse, N.Y.

24. Prof. Walter K. Long
Cayuga Museum of History and Art
Auburn, N.Y.

25. Dr. John Lukens
Consultant in Remote Sensing and Lecturer
Rhode Island School of Design

26. Mr. C. Philip McCabe
Eastman Kodak Co.
Rochester, N.Y.

27. Dr. Robert B. McEwen
U.S. Geological Survey
Washington, D.C.

28. Dr. Robert H. Miller
National Program Staff
A.R.S., U.S.D.A.
Washington, D.C.

29. Dr. Paul A. Mohr
Smithsonian Astrophysical Observatory
Cambridge, Mass.

30. N.Y.S. Agricultural
    Experiment Station
    Geneva, N.Y.

31. N.Y.S. Dept. of Environmental Conservation
    Albany, New York
    a) R. Pedersen
    b) J. Harmon
    c) C. Mason
    d) D. Romano
    e) S. Schwartz

32. N.Y.S. Geological Survey
    Museum and Science Service
    Albany, N.Y.
    a) J.D. Davis
    b) R. Dineen
    c) R.H. Fakundiny
    d) D.W. Fisher
    e) S. Forster
    f) Y.W. Isachsen
    g) L.V. Richard

33. Prof. Neville A. Parker
    Dept. of Civil Engineering
    Howard University
    Washington, D.C.

34. Dr. Charles K. Paul
    Advanced Projects Group
    Jet Propulsion Laboratory
    Pasadena, Calif.

35. Dr. Eugene L. Peck
    Asst. Dir., Hydrologic Research Lab.
    NOAA/NWS
    Washington, D.C.

36. Prof. Elmer S. Phillips
    Ithaca, N.Y.

37. Purdue University
    School of Civil Engineering
    W. Lafayette, Ind.
    a) Prof. E.M. Mikhail
    b) Prof. G.W. Marks

38. Mr. S.A. Raje
    Systems Design Engineer
    General Electric Space Division
    Valley Forge, Pa.

39. Dr. Rene O. Ramseier
    Inland Water Directorate
    Environment Canada
    Ottawa, Ontario

40. Dr. Harold T. Rib
    U.S. Dept. of Transportation
    Washington, D.C.

41. Mr. David Robb
    Office of Comprehensive Planning
    St. Lawrence Seaway Dev. Corp.
    Washington, D.C.

42. Rome Air Development Center
    Griffis Air Force Base
    Rome, N.Y.
    a) E. Hicks
    b) A.J. Stringham

43. Dr. L. Sayn-Wittgenstein
    Program Coordinator
    Canadian Forestry Service
    Ottawa, Ontario

44. Dr. Ronald L. Shelton
    Michigan State Univ.
    East Lansing, Mich.

45. Dr. Clifford A. Spohn
    Director, Office of Operations
    NOAA/NESS
    Suitland, Md.

46. Dr. Dieter Steiner
    Univ. of Waterloo
    Waterloo, Ontario

47. Dr. Paul G. Teleki
    Coastal Eng'g. Research Center
    Fort Belvoir, Va.

48. U.S. Coast Guard
    Dept. of Transportation
    Pollution Prevention Projects Branch

49. Mr. Ivan Vamos
    Director of Research
    N.Y.S. Dept. of Parks and Recreation
    Albany, New York

50. Mr. Joseph A. Vitale
    Office of University Affairs
    NASA Headquarters
    Washington, D.C.

51. Dr. Roy A. Welch
    Univ. of Georgia
    Athens, Ga.

52. Dr. Janice M. Whipple
    U.S. Geological Survey
    Albany, N.Y.

53. Prof. Edward F. Yost, Jr.
    Science Eng'g. Research
      Center
    Long Island Univ.
    Greenvale, N.Y.

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.

CEE 2489--SCHEDULE CHANGE

"Remote Sensing," a new 3-credit hour course in the School of Civil and Environmental Engineering, will meet on Tuesdays and Thursdays at 9:05 A.M. and on Thursday afternoons from 2:00 to 4:30. This schedule was reported incorrectly in the December Newsletter as well as in the University Course Roster.

As noted in the December Newsletter, students who register in CEE 2489 will be urged to co-register in the Seminar in Remote Sensing (see below). Further information regarding the course or the Seminar can be obtained by contacting Mr. W.R. Philipson, in 464 Hollister Hall.

SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing (CEE 2496) is a one-credit hour course that meets once each week to discuss current research, issues and applications in remote sensing. Speakers who have been tentatively scheduled for the spring semester are listed below. It is emphasized that this list is incomplete and subject to change. Students and other interested parties should consult future Newsletters and seminar announcements for more definite scheduling and topics.

30 Jan	Dr. Ingvar W. Isachsen, Geological Survey, N.Y.S. Museum and Science Service, Albany, N.Y. (Topic--ERTS, geology)
6 Feb	Prof. Ralph Bolgiano, Jr., School of Electrical Engineering, Cornell University (Topic--Radio sensing of atmospheric structure)
13 Feb	Mr. Thomas W. Wagner, Environmental Research Institute of Michigan, Ann Arbor, Mich. (Topic--ERTS, soils and hydrology)
20 Feb	Mr. C. Philip McCabe, Special Consultant to the Environmental Protection Agency from Eastman Kodak (Topic--Overhead photographic monitoring)
27 Feb	Mr. Donald S. Lowe, Environmental Research Institute of Michigan, Ann Arbor, Mich. (Topic--Multispectral scanners)
6 Mar	Prof. Edward M. Mikhail, School of Civil Engineering, Purdue University, W. Lafayette, Ind. (Topic--Hologrammetry)

-continued, p.2-

20 Mar Dr. Eugene L. Peck, Ass't. Director, Hydrologic Research Lab, National Weather Service, N.O.A.A., Silver Spring, Md. (Topic--Airborne gamma ray surveys)

27 Mar Dr. Clifford W. Greve, Autometric Operation, Raytheon Co., Arlington, Va. (Topic--Side-looking airborne radar)

3 Apr Prof. Edward F. Yost, Jr., Science Engineering Research Group, Long Island Univ., Greenvale, N.Y. (Topic--Multispectral photography)

24 Apr Mr. James C. Barnes, Manager, Earth Resource Studies, Environmental Research & Technology, Inc., Lexington, Mass. (Topic--ERTS & Skylab, snow and ice)

1 May Dr. Per Gloersen, Earth Observations Branch, N.A.S.A. Goddard Space Flight Center, Md. (Topic--Passive microwave)

8 May (to be scheduled)

SELECTED ARTICLES

Fritz, L.W. 1973. A complete comparator calibration program. Photogrammetria. 29:4:133-149.

Kubik, K., E.R. Bosman, E. Clerici, and D. Eckhardt. 1973. Systematic image errors in aerial triangulation. Photogrammetria. 29:4:113-131.

Kumar, R. and L. Silva. 1973. Light ray tracing through a leaf cross section. Applied Optics. 12:12:2950-2954.

Lyons, W.A. and S.R. Pease. 1973. Detection of particulate air pollution plumes from major point sources using ERTS-1 imagery. Bul. of Amer. Meteorological Soc. 54:11:1163-1170.

Pilon, R.O. and C.G. Purves. 1973. Radar imagery of oil slicks. IEEE Trans. on Aerospace and Electronic Systems. AES-9:5:630-636.

Rogers, C.E. 1973. Thermal mapping for shock tunnels. Calspan Research Trends. 29:1:14-15.

Swonger, C.W. 1973. Reading fingerprints automatically. Calspan Research Trends. 29:1:8-13.

The NEWSLETTER is made possible through a grant from the NASA Office of University Affairs. If you wish to be included on or removed from the mailing list, or if you know of any item or article that may be of interest to our readers, please contact Mr. Warren R. Philipson, Remote Sensing Program, 464 Hollister Hall, Cornell University, Ithaca, N.Y. - (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.

PHOTO-DETECTION OF INDIAN SETTLEMENTS

Working with Prof. Walter Long, Historian of Cayuga County and Curator of the Cayuga Museum of History and Art, the Remote Sensing Program has undertaken a study to detect and delineate historical/archeological sites in Cayuga County. The area selected for a pilot project is the Great Gully--a 5-mile stream, along which Iroquois, and possibly pre-historic, Indians are known to have settled. (continued, p.2)

ICE-COVER MAPPING

The St. Lawrence Seaway Development Corporation is investigating the feasibility and ramifications of extending the navigation season on the Seaway into the winter months. The Remote Sensing Program was requested to assist these efforts, initially, by assessing the extent to which panchromatic aerial photography could provide useful information on ice cover. Based on previous studies and the availability of photography and supporting ice-measurement data, the project was defined as having two immediate objectives: (1) to classify photo-distinguishable ice types, and (2) to produce time-sequential maps, depicting ice-type distribution. (continued, p.2).

CEE 2496: SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing is held on Wednesdays, at 4:30 p.m., in 162 Hollister Hall. Any interested party is welcome to attend. Tentative speakers and topics for the month of February are as follows:

Wed, 6 Feb	Radio-sensing of atmospheric structure: Prof. Ralph Bolgiano, Jr., School of Electrical Engineering, Cornell University.
Wed, 13 Feb	The multispectral environment: Mr. Thomas W. Wagner, Research Associate, Infrared & Optics Technology Applications, Environmental Research Institute of Michigan, Ann Arbor, Mich.
Wed, 20 Feb	Overhead photographic monitoring: Mr. Robert Holmes, Environmental Protection Agency, Washington, D.C., and Mr. C. Philip McCabe, Special Consultant to the E.P.A. from Eastman Kodak.
Wed, 27 Feb	Multispectral scanners--Design, capabilities and limitations: Mr. Donald S. Lowe, Deputy Director, Infrared & Optics Div., Environmental Research Institute of Michigan, Ann Arbor, Mich.

GREAT GULLY...cont'd.

To supplement the existing panchromatic aerial phtotgraphs of the Great Gully, the Environmental Protection Agency provided color and color infrared aerial coverage, flown during the past summer and early fall. All imagery is being analyzed, and suspected sites are being annotated for further evaluation. Field checking will commence in the spring, and it is expected to extend into the summer months.

ICE MAPPING..cont'd.

The study is focusing on a 17-mile stretch of the Seaway from Nevins Point to the Iroquois Control Dam. The analyses are based on more than 400 contact prints from 22 photographic missions over the study area. Each mission consisted of one flight line along the centerline of the Seaway, with 12 missions flown between January and April 1972, and 10 missions flown between January and March 1973. Photographic scales ranged from 1:4,000 to 1:24,000.

In mapping ice cover, the overlapping prints are laid out in their respective flight line and overlaid with a single sheet of acetate. The prints are examined stereoscopically, and all information is traced onto the overlay. The photo-mapping units include: uniform ice, brash, floes, refrozen brash, refrozen floes, frazil slush, shore fast ice, snow-covered ice, ice ridges and cracks, and open water. In order to rectify and reduce the data to a common scale, each flight line overlay is projected onto a 1:30,000 scale nautical chart, using a B&L Zoom Transfer Scope, and the information is re-compiled on a map overlay. All ice-cover information is thereby referenced to a readily available base map, and it can be analyzed for a given flight date or for any combination of flight dates. Overlaying the acetate sheets provides a visual display of time-sequential ice cover.

To date, ice-cover mapping from the 1972 photographs has been completed, and mapping from the 1973 photographs will be completed within the next few weeks. The work is being carried out by Mr. Thomas Erb, with the assistance of Messrs. Thomas Jarrett and William Teng.

RECENT ARTICLES

Gennis, I.F. and J.P. Alessandri. 1973. County agencies combine map programs, save money. Civil Engineering. 43:12:45-48.

Photogrammetric Engineering. Dec 1973. v. 34, n. 12.
- Reinheimer, C.J. et al. Detection of petroleum spills.
- Lo, C.P. and F.Y. Wong. Micro-scale geomorphology features.
- Davies, M.E. Mariner 9: Primary control net.
- Colvocoresses, A.P. and R.B. McEwen. EROS cartographic progress.

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NOTES ON SKYLAB

Data obtained with the Earth Resources Experimental Package (EREP) on Skylab are being used to test visible, infrared and microwave remote sensing techniques from orbital altitudes. The EREP data users program is composed of approximately 165 individual tasks to be accomplished by Principal Investigators in 32 states and 19 foreign countries. In New York State, Skylab Investigators include Dr. W.J. Pierson, Jr. of New York University (sea state and wind velocity), Dr. Edward Yost of Long Island University (oceanographic charts; relate ground spectra to satellite imagery), Dr. Kenneth R. Piech of Calspan (lake turbidity and eutrophication), and Dr. Ernest E. Hardy of Cornell University (land use information).

PAN AMERICAN SYMPOSIA

The Mexican Society of Photogrammetry, Photointerpretation, and Geodesy will sponsor the 1st Pan-American and 3rd National Congresses of Photogrammetry, Photointerpretation and Geodesy, in Mexico City, from 7 to 12 July 1974. The Congresses are aimed at the interchange of knowledge and experiences in cartography and resource evaluation, and symposia are planned on urban and large scale mapping and remote sensing. Further information can be obtained by writing: I Congreso Panamericano y III Nacional de Fotogrammetria, Fotointerpretacion y Geodesia, Apt. Postal 25-447, Mexico 13, D.F., Mexico.

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Wed, 6 Mar	Hologrammetry--concepts and applications: Dr. Edward M. Mikhail, Prof. of Photogrammetry, School of Civil Eng'g., Purdue Univ., W. Lafayette, Ind.
Wed, 13 Mar	(No Seminar, Amer. Soc. Photogram. Convention)
Wed, 20 Mar	Gamma-ray surveys: Dr. Eugene L. Peck, Ass't. Director, Hydrologic Research Lab., National Weather Service, N.O.A.A., Silver Spring, Md.
Wed, 27 Mar	Side-looking airborne radar: Dr. Clifford W. Greve, Autometric Operation, Raytheon, Arlington, Va.

MEETINGS AND SYMPOSIA

Annual Convention, Amer. Soc. Photogram.-Amer. Cong. Surveying & Mapping; 10-15 March; Chase-Park Hotel, St. Louis: J. Harris or W. Tucker, Box 12209, Soulard Sta., St. Louis, Mo. 63157.

Conf. on Remote Sensing of Earth Resources; 25-27 March; Univ. of Tenn. Space Institute: Dr. F. Shahrokhi, Univ. of Tenn. Space Inst., Tullahoma, Tenn. 37388.

Int'l. Symp. on Remote Sensing of Environment; 15-19 Apr; Univ. of Mich.: J.J. Cook, E.R.I.M., P.O. Box 618, Ann Arbor, Mich. 48107.

Canadian Symp. on Remote Sensing; 29 Apr-1 May; Univ. of Guelph: J. MacDowall, Canada Centre for Remote Sensing, 2464 Sheffield Rd., Ottawa, K1A 0E4, or Prof. S. Collins, School of Eng'g., Univ. of Guelph, Guelph, Ont., N1G 2W1.

RECENT ARTICLES

Julesz, B. 1974. Cooperative phenomena in binocular depth perception. *Amer. Scientist*. 62:1:32-43.

Politch, J. and B. Schmutter. 1974. Measurements on images retrieved from holograms. *Applied Optics* 13:1:140-145.

Veverka, J. and C. Sagan. 1974. McLaughlin and Mars. *Amer. Scientist*. 62:1:44-53.

Photogrammetric Engineering. Jan 1974. v. 35, n. 1:
- Garofalo, D. and F. Wobber. Solid waste and remote sensing.
- Gausman, H. *et al*. Plant size, etc., and aerial films.
- Bernstein, D. Are reforestation surveys with aerial photographs practical?
- Polis, D. *et al*. Hydrographic verification of wetland delineation by remote sensing.
- Barr, D. and M. Hensey. Industrial site study with remote sensing.
- Piech, K. and J. Walker. Interpretation of soils.

Photogrammetric Engineering. Feb 1974. v. 35, n.2:
- Beaver, R. and J. Wood. Aerial infrared locates solid ground over mine.
- Meyer, M. *et al*. Waterfowl management using color ir.
- Eppes, T. and J. Rouse. Viewing-angle effects in radar images.
- Gausman, H. Leaf reflectance of near infrared.
- Kratky, V. Cartographic accuracy of ERTS.

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ON AUTOMATIC IMAGE PROCESSING

During the recent American Society of Photogrammetry convention in St. Louis, Prof. Arthur McNair presided over a panel discussion on "Automated Imagery Processing: Understanding User Requirements." The lead-off speaker, Dr. Paul Rosenberg, President of Paul Rosenberg Associates, presented a list of imagery applications that are either being automated or might be automated in the near future. Listed in their approximate order of increasing difficulty of accomplishment, the applications are: (1) image enhancement (e.g., gradient processing) to aid non-automatic recognition and interpretation in general; (2) character recognition (excluding cursive script); (3) conversion of remotely-sensed telemetered data into imagery (e.g., ERTS); (4) classification of terrain types; (5) thematic mapping in remote sensing; (6) change detection in radar & aerial photos; (7) image matching (correlation) for topographic mapping; (8) identification of finger prints; (9) recognition of cursive script; (10) recognition of images in aerial photographs; (11) recognition of radar images; (12) interpretation of medical x-rays; (13) recognition of human faces; and (14) photo-interpretation.

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Wed, 3 Apr	Multispectral photographic remote sensing--techniques and applications: Dr. Edward F. Yost, Jr., Professor of Engineering and Director, Science Engineering Research Group, Long Island University, Greenvale, N.Y.
10 Apr	(No Seminar--Spring vacation)
17 Apr	(No Seminar--Michigan Symposium)
Wed, 24 Apr	Snow and ice observations from space: James C. Barnes, Manager, Earth Resource Studies, Environmental Research and Technology, Inc., Lexington, Mass.

SENSING KEYS: OPEN! WHAT?
(Machine Design, 7 March)

A lock that opens to code words spoken by authorized voices will be available within two years for less than $100. Comparable voice-actuated locks now cost up to $100,000, and they require fairly large computers and numerous frequency filters. The low-cost lock, being developed by Westinghouse, uses different, but fewer filters and much more compact circuitry.

CALL FOR PAPERS

The 1974 Earth Environment and Resources Conference will be held at the Marriott Motor Hotel in Philadelphia, from 10 to 12 September. Sponsored by the U.S. Environment and Resources Council, the Institute of Electrical and Electronics Engineers, and the Univeristy of Pennsylvania, the Conference will underscore environment and resources crises, and examine remedial actions being taken by government agencies, industry, universities and professional societies. Technical papers should be responsive to the broadening need for community awareness of the extensive ongoing research and development programs. Authors should submit a 35-word abstract and 15 copies of a 300-500 word summary to: E.P. Mercanti, 12415 Shelter Lane, Bowie, Md. 20715, before 30 April.

SELECTED ARTICLES

American Society of Photogrammetry, 105 N. Virginia Ave., Falls Church, Va. 22046
- -Proceedings of 4th Biennial Workshop on Color Aerial Photography in the Plant Sciences. 1973. ($5-members/$10-others)
- -Proceedings of 40th Annual Meeting. 1974. ($2.50-members/$5-others)

Applied Optics. March 1974. 13:3
- -Goldberg and Klein. Radiometer to monitor low levels of ultraviolet irradiance.
- -Smith, W.L. et al. Nimbus-5 ITPR experiment.
- -Wark, D.Q. et al. Satellite observations of atmospheric water vapor.

Blankenship, J.R. and R.C. Savage. 1974. Electro-optical processing of DAPP meteorological satellite data. Bull. Amer. Meteor. Soc. 55:1:9-15.

Cannell, G.H. and C.W. Asbell. 1974. The effects of soil-profile variations and related factors on neutron-moderation measurements. Soil Science. 117:2:124-127.

Gedney, L. and J. VanWormer. 1974. In Alaska: Remote sensing of seismic hazards. Geotimes. 19:2:15-17.

Parry, J.T. and J.A. Beswick. 1973. The application of two morphometric terrain-classification systems using air-photo interpretation methods. Photogrammetria. 29:5:153-186.

Photogrammetric Engineering. March 1974. 35:3.
- -Landen, D. Progress in orthophotography.
- -Kreitzer, M.H. Direct additive printing.
- -Torlegard and Lundaly. Underwater analytical system.
- -Malan, D.G. Color balance of color-ir film.

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THE CANADIAN RESORS

The Technical Information Service of the Canada Centre for Remote Sensing is operating RESORS (REmote Sensing On-line Retrieval System), a computer-based system for retrieving references in remote sensing. RESORS was developed by the Division of Systems Engineering at Carleton University, and the present data base is structured with six major categories under "Applications" (geological sciences, water resources, atmospheric conditions, biological sciences, geographical sciences, integrated environmental studies) and 11 major categories under "Systems and Techniques" (platforms, sensors, sensing physics, sensing and communications path, data processing and interpretation, data storage and data retrieval, technical project and design analysis, program planning and policy, legal aspects, sensing techniques, pattern recognition). Further information on the system can be obtained from the Technical Information Service, Canada Centre for Remote Sensing, 2464 Sheffield Rd., Ottawa, Ont. K1A 0E4 (tel. 613-993-3350).

CEE 2496: SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing is held on Wednesdays, at 4:30 p.m., in Hollister Hall. Any interested party is welcome to attend. The final speakers and topics for the spring semester are as follows:

Wed, 1 May	Remote sensing of the earth's atmosphere and surface by imaging microwave radiometry: Dr. Per Gloersen, National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
Wed, 8 May	(Topic on digital image processing; title to be announced): Mr. Howard Heydt, Consulting Engineer-Remote Sensing, General Electric Company, Valley Forge Space Center, Pa.

CALL FOR PAPERS

An URSI Specialist Meeting on Microwave Scattering and Emission from and below the earth's surface will be held in Berne, Switzerland, from 23 to 26 September 1974. Papers reporting on theoretical or experimental activities are invited, with suggested topics including microwave scatter and emission from random interfaces, air-water interfaces, soil, vegetation, snow, ice, and other natural or man-made earth-surface scatterers. Authors should submit a 200 to 500 word summary to: Dr. A.W. Biggs, 2291 Irving Hill Rd., Univ. of Kansas, Lawrence, Kansas 66045, before 15 June 1974.

RECENT ARTICLES AND PUBLICATIONS

Bryan, M.L. 1974. Radar remote sensing for geosciences: An annotated and tutorial bibliography. (298 pages w/383 citations from open literature) Environmental Research Institute of Michigan, P.O. Box 618, Ann Arbor, Mich. 48107. ($6.50).

The Journal of Environmental Sciences. Mar/Apr 1974. v. 17, no. 2. Special issue on ERTS (spacecraft, sensors, operations, data processing, selected experiments in agriculture, forestry, land use, geology, etc.).

Photogrammetric Engineering. April 1974. v. 35, no. 4.
- -Klemas, V. et al. Inventory of Delaware's wetlands.
- -Driscoll, R. and M. Coleman. Color for shrubs.
- -Turinetti, J. and O. Mintzer. Low-cost computerized land-use classification.

SHORT COURSES

Applications of Remote Sensing: Georgia Tech; 14-15 May. $80. (Director, Dep't. Continuing Education, Georgia Inst. of Tech., Atlanta, Ga. 30332).

Image Processing for Scientists, Engineers and Management: Wintek Corp; 20-24 May; W. Lafayette, Ind. $395. (Wintek Corp., 605 Lingle Ave., Lafayette, Ind. 47901).

Machine Processing of Remotely Sensed Data: Purdue Univ; 3-7 June. $475. (C. Jenks, Div. of Conferences, 116 Stewart Center, Purdue Univ., W. Lafayette, Ind. 47907).

Air Photographic Interpretation and Terrain Analysis: Harvard Univ. Graudate School of Design; 17-21 June. $425.

Infrared Technology: Univ. of Michigan. (I) Fundamentals, 8-12 July; (II) Advanced, 15-19 July. $300 each course. (W. Lawrence, Dept. 75, Chrysler Center, North Campus, Ann Arbor, Mich. 48105).

SUMMER VACATION

Volume II of the Newsletter ends with this May issue. As planned, Volume III will begin next September. (Volume IV will begin the September following Volume III.)

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