Aerial Photography and Photogrammetry In Georgia

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● BEFORE 1940 county maps, U.S. Geological Survey quadrangle sheets, and other maps of Georgia were few, of scattered areas, and inadequate for any type of highway planning or location.

In order to do any amount of planning or location, it was necessary for the field parties to make a survey and prepare a map of the area between control points before any initial work could be started.

In 1940 the State contracted for 1,200 mi of aerial photographs of some of the main primary routes for reconnaissance work, and again from 1946 to 1950 other contracts were let for photography as required.

Realizing the value of aerial photography and knowing that the demand for this service would increase, an aerial photography department was organized. Aerial cameras and photographic processing equipment were purchased and a plane was chartered. In 1950 a single-engine Cessna plane was purchased; in 1952 a full-time pilot was employed.

Since the department was orgainzed, the demand for aerial photography had increased to such an extent that in 1955 a new building was built specifically designed for processing aerial photographs. In 1957 a twin-motored Aero Commander airplane was purchased, and in 1958 a building was completed for the purpose of stereo-plotting, computing, and tracing. Figure 1 shows the organization chart of the photogrammetry section, and Figure 2 shows the physical layout of the buildings and parking facilities.

PHOTOGRAPHY

Building

Figure 3 shows the floor plan of aerial photography building.

Airplane

The plane used for aerial photography is a 1957 Aero Commander, 560-A especially modified for a Wild RC-8 camera. In this modification, the aperture for vertical photography is in the floor of the plane directly behind the co-pilot's seat. The baggage compartment door is modified to open inward, and it can be removed for oblique photography.

Cameras

The majority of all vertical photography is taken with a Wild RC-8 camera with 6-in. F5.6 Avignon lens, which was delivered in March 1958. Other types of cameras used for varied kinds of photography are as follows:

Fairchild K-17B camera with 6-in. lens, calibrated for mapping;
Fairchild K-3-B camera with 8¼-in. lens;
Fairchild K-17 camera with 12-in. lens;
Keystone F-8 camera with 15-in. lens;
Cine Kodak Special II 16-mm movie camera with F1.4 lens;
Bell and Howell model 200 16-mm movie camera with 1.9 lens;
Pacemaker Speed Graphic 4 x 5 press camera;

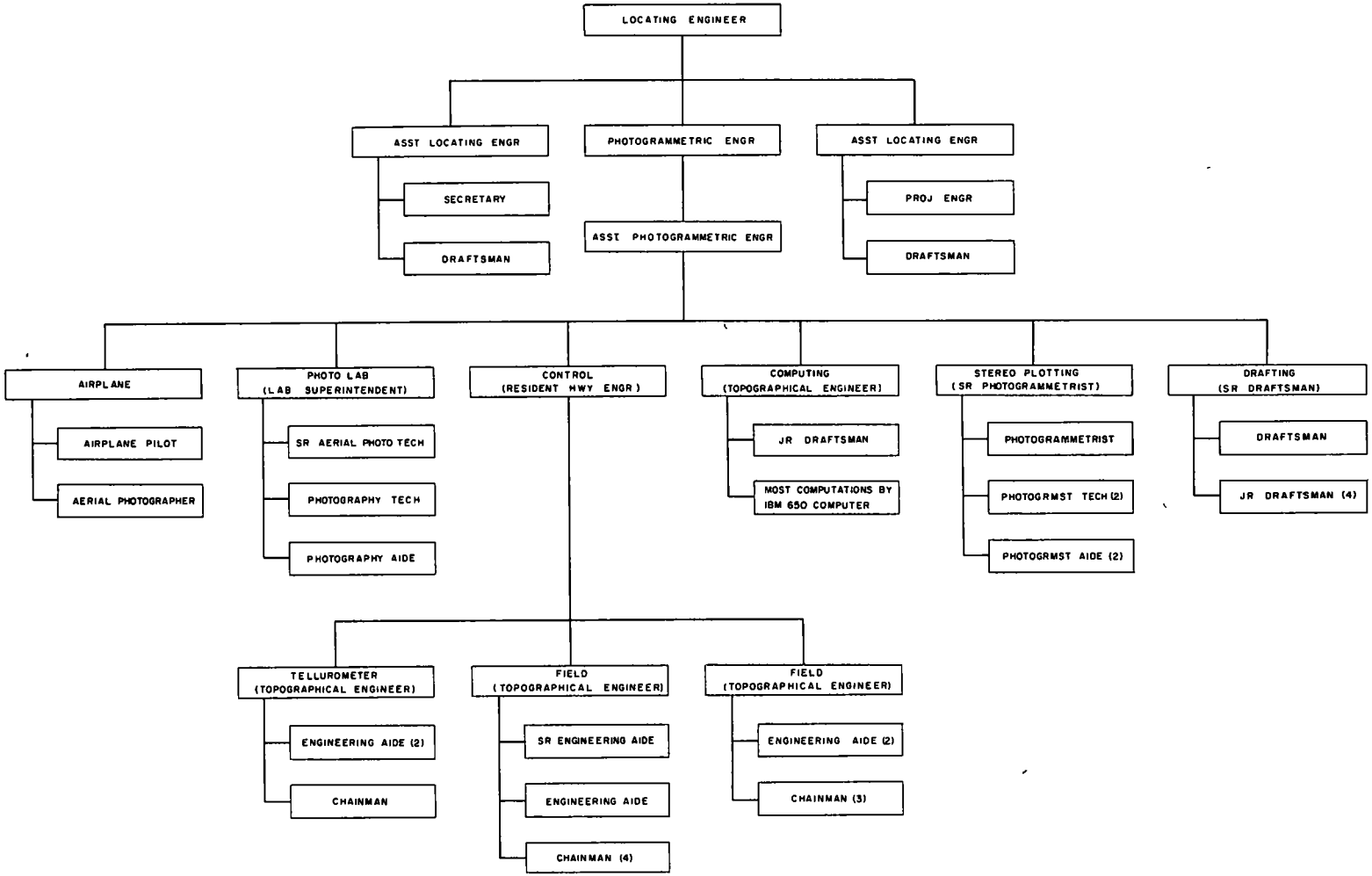

Figure 1. Organization chart.

Leica IIIF 35-mm camera with F1.5 lens;
Calumet 8 x 10 copy camera with 14-in. lens and copy stand;
TDC Instructor No. 500, 35-mm slide projector;
Filmsound, Bell and Howell No. 202, 16-mm movie projector with 12-in. speaker; and
Custom-built copy camera with overhead tracks, 70- x 50-in. copy frame, 27- x 27-in. negative holder, Artar F11, 24-in. lens, arc lamps, and Luxometer electronic timer.

All these instruments are equipped with the necessary accessories for production work: that is, magazines, filters, tripods, light meters, view finders, etc.

The photographic processing equipment in use is as follows:

2 custom-built oak film viewing tables, 110 x 36 x 24 in. with glass tops and fluorescent lamps;
1 Smith automatic film stabilized air dryer;
1 Pako Drycab model 2 small sheet film dryer;
1 A-7 aerial film dryer with heating element;
1 set of custom-built stainless steel sinks, 3 compartments 53½ x 48 in., one compartment 48 x 24 in.;
1 custom-built stainless steel sink 130 x 27 x 38½ in.;
1 Omega DII printer with 135-mm Wollensak enlarging lens;
1 Morse 11- x 14-in. contact printer;
1 Morse 10- x 10-in. contact printer;
1 Logetronic contact printer model CP 10-S;
2 Oscar Fisher 20- x 24-in. automatic rocker trays;
1 60-in. circular stainless steel washer;
1 Pako Pakolux revolving print washer;
1 Pako economy model 48-paper dryer;
1 custom-built air dry rack with 16 racks 48 x 71 in.;
1 Morse electrical unit for developing aerial film;
1 Auld electrical unit for developing aerial film;
1 Pako 50-gal chemical mixer; and
3 tower-mounted stainless steel 25-gal storage tanks with plastic pipes and gravity flow to all developing trays.

Numbering System

The beginning of each flight is shown on the first picture and the ending on the last flight picture. The North and South flights are numbered from West to East and the East and West flights are numbered from North to South. The individual pictures are numbered consecutively from South to North and West to East throughout the job, regardless of the direction flown. The identification shown on the left edge of each picture, in the forward direction, is the date of photography, scale per inch, county code number, State route number, or other special designation as C.R. (county road), F.D. (flood damage), S.M. (Stone Mountain), and flight number and picture number.

Filing System

All photography is numbered according to the county code number and flight numbers. A master record of photography is kept on a county map. On this record are kept the flight numbers, scale per inch, and date of photography.

A card record of all photography is kept by counties. On this card are shown the same identification that appears on each picture, a description of the coverage, and the number of the film roll.

Each roll of exposed and numbered film is numbered consecutively as completed and is filed in a custom-made file rack. A record showing the request and disposition of any photography or mapping is kept on a work card. This card follows the processing through the plant and is then filed as a permanent record.

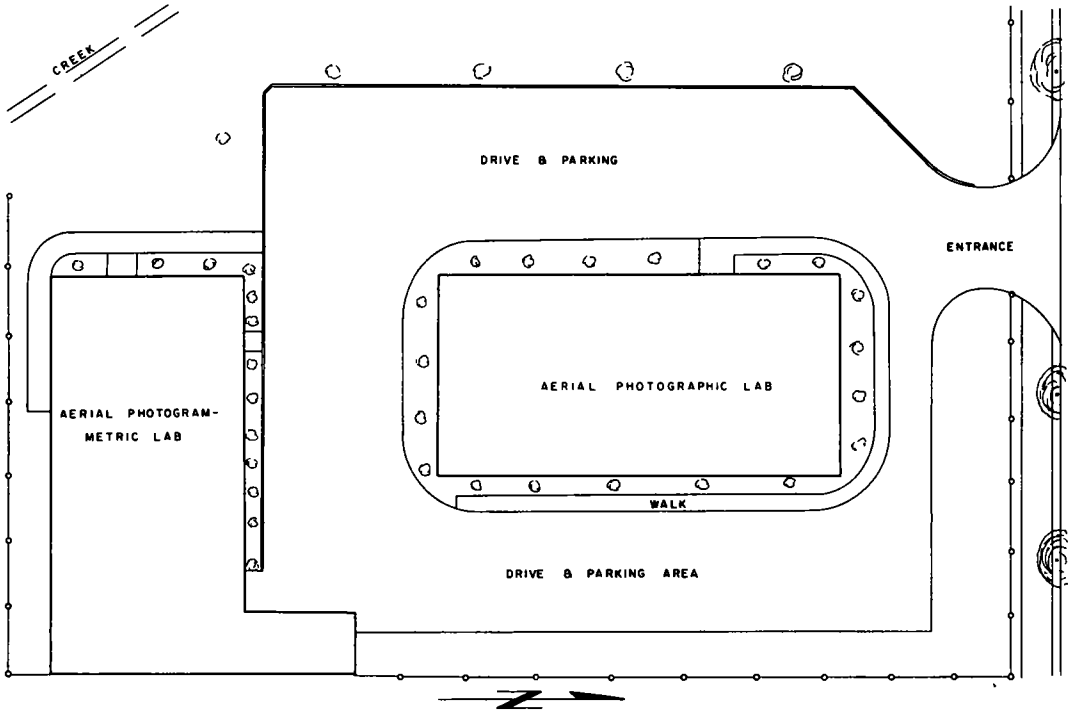

Figure 2. Physical plant, Division of Surveys & Aerial Mapping (scale: 1 in. = 20 ft).

MAPPING

In 1958 a photogrammetric section was established. For the purpose of photogrammetric mapping, layouts, computations, and tracing, a specially designed building was constructed. Figure 4 shows the floor plan of this building.

Controls

All controls are by ground methods. At the present time, no bridging is done. The equipment for ground controls is as follows:

2 Wild T-2 theodolites;
3 Zeiss self-leveling levels;
1 Wild precise level;
1 Tellurometer, master (microwave measuring instrument);
2 Tellurometers, remote (microwave measuring instruments);
1 Friden square root calculator, Model SRW;
1 Monroe calculator model No. 8N213;
1 K and E 30-sec transit;
1 K and E Wye level; and
1 K and E plane table and alidade.

With these items, the necessary accessories for running precise surveys—calibrated chains, thermometers, barometers, psychrometers, line rods, tripods, optical plummets, etc.—are furnished. There is a 650 IBM computer available for making coordinate computations.

Photographic, vertical, and horizontal points are selected on photographs by stereoscopic study in the office and furnished to the field parties.

Concrete posts 5 x 5 x 36 in. with a 3-in. brass identification in the top are used as permanent markers. These are set along and near the proposed survey centerline at intervals of not less than 1 mi.

On large jobs, the field notes are sent to the General Office to be computed by the IBM 650 computer.

Stereoplotting

All plotting is done by Kelsh stereoplotters, 5x magnification, with 6-in. lens cones. All maps are compiled to the Georgia coordinate system on "Moldrite," a 0.01-in. thick stabilized vinylite with a polished matte surface.

All compilation sheets are filed by consecutive numbers in a custom-made rack. A card record and a reduced photographic index map are kept of each job. A progress chart of each job is kept showing the step-by-step progress.

Tracing

All drafting is done in ink on tracing linen, over-all size, 30 x 42 in., inside border, 26½ x 38½ in. This size was selected for ease in filing. Each linen is thoroughly edited for errors and omissions before it is considered completed.

APPLICATION TO LOCATION AND DESIGN

Reconnaissance

Reconnaissance is considered the most important phase of location and design of the proposed improvement of any highway, and the one most frequently neglected.

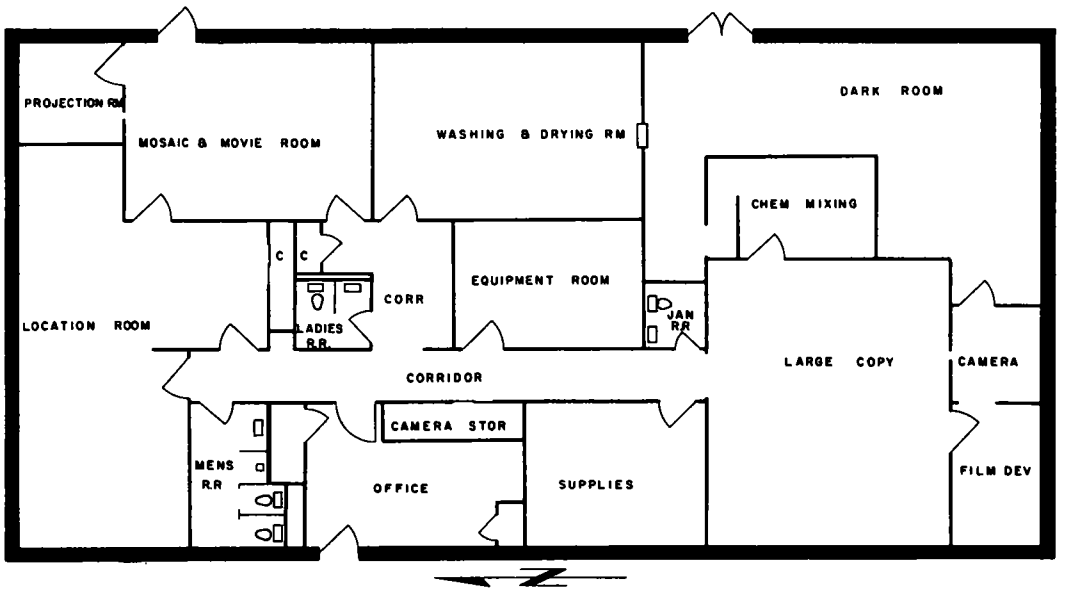

Figure 3. Aerial Photographic Laboratory (scale: 1/8 in. = 1 ft).

The flight lines of the area to be covered are between control points and are furnished to the pilot for photographing. The photography for reconnaissance purpose is usually to a scale of 1 in. = 800 ft in rural areas, and 1 in. = 400 ft and 1 in. = 200 ft in urban areas. This scale was selected for the reason of the direct proportion to enlarging to a scale of 1 in. = 200 ft, 1 in. = 100 ft and 1 in. = 50 ft for more detailed studies.

The prints are stripped up by counties covering the area between control points, and lined up side by side on drafting tables. The area of photography usually covers a width of one-fourth to one-third the length between control points. A visual study is

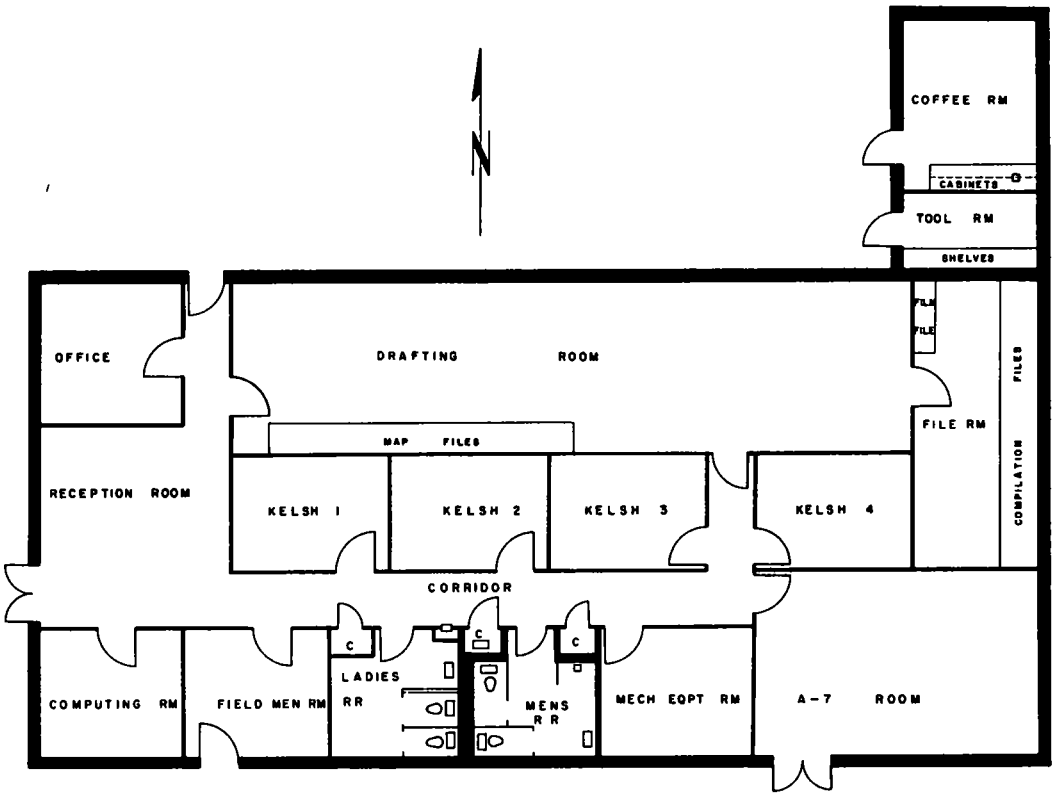

Figure 4. Aerial Photogrammetric Laboratory (scale: 1/8 in. = 1 ft).

made of the entire area photographed. The lines found most desirable are studied by pairs of pictures under a stereoscope to select the lines or combination of lines thought most practical.

All preliminary work is coordinated with the Materials and Tests Department, Roadway Design Department, the Division of Highway Planning, and the Bureau of Public Roads to determine the factors involved in the selection of the final route. The most important factors are (a) service to traffic, populations, and industrial areas; and (b) directness; (c) type of terrain; (d) interchange of main highways; and (e) stream and railroad crossings.

All practical locations are then field-checked with the aid of the photographs. Further stereoscopic study is made and the least desirable routes eliminated. Studies are then made of the route selected, both in the field and by stereoscope. At this point a field inspection is made with a representative of the Bureau of Public Roads. Any necessary revisions are then made.

A reduced index map, usually 1 in. = 1,600 ft with the recommended line in ink, is sent to the Bureau of Public Roads for review with a letter requesting approval of general location.

Photogrammetric Mapping

After tentative approval of the general route by the Bureau of Public Roads, the area to be mapped is narrowed to the width thought necessary for contour mapping. A thorough reconnaissance study is helpful in determining the width of the area to be mapped.

Photography is taken as nearly as possible along the centerline of the proposed location at a scale appropriate for the finished map scale and at a contour interval needed

for highway location and design. The scale of this photography is usually 1 in. = 1,000 ft, 1 in. = 500 ft, and 1 in. = 250 ft. The respective altitudes of these flights are 6,000, 3,000, and 1,500 ft above the mean ground elevation. In urban areas, most of the mapping is done to a finished scale of 1 in. = 50 ft with 1-ft contour interval. In less congested areas, mapping is done to a finished scale of 1 in. = 100 ft with 2-ft contour interval. In rough terrain, for location and preliminary design, mapping is done to a finished scale of 1 in. = 200 ft with 5-ft contour interval. There is very little mapping done for reconnaissance work except in very mountainous country.

After delivery of the photography, picture points are determined, field control is accomplished on the ground, and computation is made of vertical and horizontal values. The horizontal order of accuracy is never less than 1 in 15,000 and on one project of 15 mi it was 1 in 52,000.

Coordinate grid lines are drawn, and the manuscript map is made by means of a Kelsh plotter on 0.01-in. thick "Moldrite." The finished map is then traced in ink on linen sheets and edited for errors.

When the prints of the contour maps are made, they are laid out continuously on large drawing tables, and weighed down by shot weights for the purpose of selecting the final location.

The final location is made by establishing the intermediate control points and marking on the map other important points of the location. A spline line 12 ft long is placed along the maps, and it is held by spline weights as near the desired location as visual inspection can determine. After the spline is shifted and adjusted to fit the terrain and culture, a line is drawn the length of the spline for a trial location.

A profile is drawn of the line and studied for any shifts that can be made to better the vertical alignment. After many trial lines have been tried and profiles plotted, the final location is selected. This is refined by plotting in the tangents and curves.

In preliminary work preceding the selection of the final location, all trial lines and corresponding profiles are numbered alphabetically. Profiles are plotted by direct vertical projection methods along the tangents and scaled around the curves. This method avoids stationing and equalities.

Field Procedure

The prints of the proposed location are furnished to the field parties for staking out the centerline. Each tangent is established on the ground and blocked out to intersection throughout the entire project. Each intersection point is tied to the State plane coordinate system. The line is staked out on the ground and profile levels are taken along the line. Permanent markers are set at the intersection points, and iron pins set at points on tangents. Concrete posts with bronze markers are set for permanent bench marks and geodetic positions.

Extra copies of prints are furnished to the field parties for right-of-way information, such as property corners and property ownership. The information is plotted on the prints in the field. Photographs are also furnished as an aid in locating property lines.

Large drainage areas are plotted on county maps and checked in the field for correctness; small drainage areas are plotted from contour maps. The stationing of location structures is determined on the contour sheets and checked in the field.

Design

Topographic sheets showing alignment, coordinate points of intersections, delta angles, degree of curvature, bearing of lines, bench marks, other permanent markers, and stationing of drainage structures are furnished the design department together with all field notes, drainage maps, and property line maps.

Trial grade lines are laid and preliminary design is started. All cross-section data are scaled off the contour sheets and adjusted to the elevation of the field level notes. Grade elevations are computed and construction plan quantities are computed by the electronic computer. When the preliminary construction plans are completed, the Bureau of Public Roads is requested to make a joint P.S. and E. inspection.

After this inspection, the plans are revised as necessary, and prepared in detail for letting the project to contract.

Additional Services

Although the Photographic and Photogrammetric Section of the Georgia Highway Department was established primarily as an aid in highway location, we are constantly receiving requests for work from other State agencies such as the State Department of Commerce, Stone Mountain Memorial Association, Department of State Parks, State Forrestry Commission, Mineral Leasing Commission, State Ports Authority, Georgia Institute of Technology, Department of Public Safety, Atlanta Airport, Atlanta Federal Penitentiary, State Toll Bridge Authority, State Toll Road Authority, and the State Bridge Authority of Georgia.

Photographs are furnished various agencies as a valuable aid in highway planning studies, urban studies, property locations, road inventories, right-of-way procurement, condemnation cases, highway accidents, parking facility studies (in use and planned), bridge location studies (streams and railroads), stream, highway, and railroad crossing studies, traffic studies, drainage areas and location of drainage structures, revision and correction of county maps, city planning, progress reports, highway exhibits, and county fair exhibits.

Movies and slides are furnished for publicity purposes and highway conferences.

SOME UNUSUAL USES OF PHOTOGRAMMETRY IN GEORGIA

Highway

Rectified photographs produced on continuous tone film are being used as a base for right-of-way maps. They save considerable time in field surveys and drafting. The film is printed reversed. Emulsion is on one side and drafting on the other. Centerline, property lines, and owner's names are added. Blue line prints are run. They are especially valuable in condemnation cases before juries not familiar with the property involved.

The same basic practice, photograph on continuous tone film base is being used as base for design and construction drawings on resurfacing and widening projects.

State Department of Commerce—Industrial Development Branch

Vertical B and W and color oblique photographs are being used to aid in securing new industry, promote better interest rates on city and State government bond issues, and make studies of value of airrights of railroad yards for City of Atlanta.

State Department of Commerce—Aviation Branch

Vertical and oblique photographs and topographic maps are being used for determining location of new airports and also for construction progress records of Atlanta Airport.

Stone Mountain Memorial Commission

The most unusual request ever made of the mapping division was for contour maps of the partially completed vertical Stone Mountain Memorial. After unsuccessful attempts with two standard types of airplanes and one helicopter, photographs suitable for plotting topographic maps were finally obtained with the use of an 86-ft hydraulically operated ladder mounted on a mobile unit. The aerial photographer ascended the ladder with an aerial camera, and the ladder was raised over the ground targets previously placed on a base line approximately 300 ft from the carving. The aerial photographs obtained in this unorthodox manner had the proper overlap for stereoplotting, and contour maps with 0.25 contour interval were plotted and furnished the Stone Mountain Memorial Commission.

State Surveyor General—Mineral Leasing Commission

The Secretary of the State of Georgia, who is also the State's Surveyor General, is making a study to determine possible lease areas and mean low tide, and to establish definitely the 3-mi limit to Georgia's eastern coastline.

The aerial mapping division is now making, when weather and time permits, complete aerial coverage of the 2,400 sq mi of coastline required by the Secretary to complete the study.

The photographs are being taken with a Wild RC-8 camera to a scale of 1 in. = 2,000 ft. The finished prints are rectified to existing Geological Survey sheets, then laid as a controlled mosaic.

Proposed Improvements

It is proposed to purchase in the near future a first-order stereoplotter for bridging controls and making maps for cities and counties from high altitude photography.

It is also planned to purchase steel towers to be used in connection with an electronic device for measuring distance by means of microwaves. The towers will increase the efficiency of the units and materially reduce the time required by field parties to measure great distances for basic horizontal control work. Future plans also include the purchase of a modern rectifying copy camera.