

# *A Report on Application of Aerial Photography to Urban Land-Use Inventory, Analysis and Planning*

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**ABSTRACT:** *The present report is the third in a series undertaken to develop a methodology for urban analysis from aerial photography, suited to urban administration and planning. It describes the application of techniques for urban land study in the sequence of inventory, analysis and plan.*

*The city of Rockville, a small town in the suburbs of Washington, D.C., has been the test area during this investigation. Illustrated from the complete land-use inventory are portions related to commercial land.*

*The consequences of lack of planning revealed in the land-use inventory are analyzed via aerial photography, to provide a basis for remedial action and for future planning.*

**T**HIS is the third report in a continuing investigation to develop a methodology for urban analysis from aerial photography, suited to the needs of urban administration and planning.

The great advantage in using aerial photography (apart from low cost and economy for mapping) lies in providing the administrator with a powerful tool for analyzing the dynamics of growth and direction for future development.

The air photo gives to administrator a general perspective of the city and its surrounding hinterland, useful in making comparative measurements and in evaluating of the economic base. It provides him with the capability for developing detailed statistical data for the entire city on the structural arrangement, density of development, functional distribution, and pattern of movement; as well as engineering data on the topography of the site and suitability for construction and utility extension.

Such data find application in all phases of administration and planning related to zoning, utility service areas, trade areas, subdivision lay out, industrial location, traffic flow, and street pattern.

It is one thing however to make aerial surveys for mapping, and quite another to be able systematically to interpret pertinent information from air-photos, which can be measured and integrated with other data for planning and in day-to-day administration. The several reports in this series investigate methods of applying aerial survey to individual problems of urban inventory, analysis and planning.

To determine the applicability of various methods for urban analysis, a small town was selected as a test area in which various problems could be readily isolated and studied over a period of several years.

The area selected for testing was the city of Rockville, Md., a typical small town caught up in the rapid suburban expansion of a large metropolitan area. The town exhibited all the basic problems of administration and planning engendered by rapid growth, traffic congestion, inadequate facilities, small staff, and above all, lack of adequate data to meet the changing events. In the three

years since the beginning of this investigation the population has grown from 13,000 to almost 20,000 at the beginning of 1956. In 1953 the town was still thinking mainly in terms of its traditional role as the county seat of a rural county. Since then new elements, largely urbanites from Washington seeking a suburban way of life and interested in enhancing the local community, have become the moving force in its development.

The first report in this investigation (1954) discussed the basic methodological concepts of *Photo Sociometrics*,<sup>1</sup> a measurement technique for the study of land-use in aerial photography. This technique was designed to develop statistical data on major phases of urban administration and planning based on study in aerial photography of visible relationships of functional, structural, and density patterns of construction.

Illustrated were applications to the analysis of economic trade areas, utility service areas, and the dynamics of traffic drainage shed areas.

The second report (1955) covered the development of photo techniques to aid detailed ground sampling of small areas.<sup>2</sup> This sampling in turn provided air photo study criteria for city and county wide evaluations via aerial photography. The method was applied to the consideration of availability of vehicles for evacuation in event of civil defense emergency and to various patterns of movement under changing conditions of possible radio-active fallout. These data were developed by traffic drainage sheds for which the air photo was used to relate dwellings and vehicles to means of egress.

The present report details the general application of photo sociometrics to the study of land-use as applied to the sequence or urban inventory, analysis and plan.

## I. INVENTORY

Inventory is the first step in land-use study. It permits a town to take stock of its resources and to gain an over-all appreciation of its problems.

From the airphoto, data are assembled area-wise, by delineation of the built-up area, road system, functional areas, structure-types and vacant land. These are classified by number and type, and assembled as patterns which characterize the distribution of population, commerce and industry, community facilities and means for movement of people and goods.

Three principal categories of information are considered in the inventory:

1. *Location and Classification* of all features, as distribution patterns.
2. *Measurement* of size and capacity, to develop basic statistical data assemblies.
3. *Computation* of ratios of land used and land zoned, service availability and facility accessibility to residential, commercial and industrial needs.

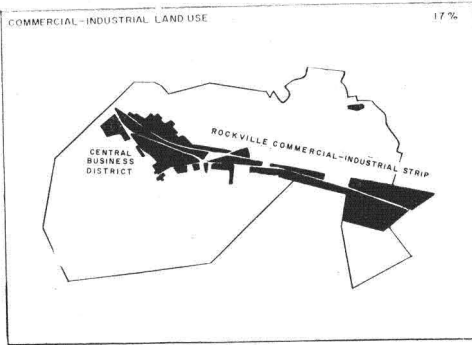
Beyond meeting the need for over-all planning data, the air photo has surprising accuracy and capability for developing detailed statistical data. Figure 1 presents a series of panels which summarize for each land use category, the scope, applicability, and accuracy of inventory data obtained from aerial photography with some ground check.

In Rockville the land-use inventory is kept as a set of overlays on photo maps and are maintained current with new photography flown at regular intervals. Changes are then transferred to the overlays and accompanying statistical tables; this has been found an economical way to supplement regularly recorded

<sup>1</sup> PHOTOGRAMMETRIC ENGINEERING, June 1954, vol. XX, no. 3.

<sup>2</sup> PHOTOGRAMMETRIC ENGINEERING, September 1955, vol. XXI, no. 4.

COMMERCIAL-INDUSTRIAL LAND-USE



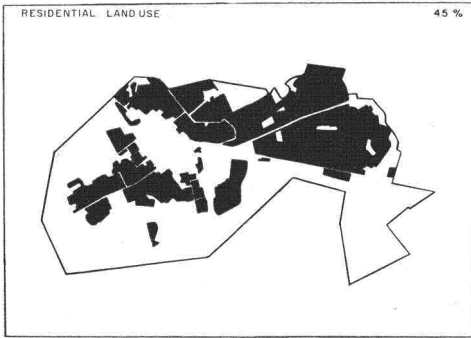
DATA OBTAINED

- \* Location and classification of all commercial industrial, parking, non-conforming and vacant areas zoned commercial-industrial.
- \* Measurement of size of commercial and industrial floor areas, parking lot spaces, and vacant space.
- \* Ratios of:  
 Zoned commercial/ Total urban area  
 Occupied and Vacant/ Zoned  
 Parking/ commercial

APPLICATION AND ACCURACY

- \* Supplied basic statistics well within required accuracy for planning of zoning changes, acquisition of parking lots, street improvement.
- \* Ground-check was required to locate non-conforming dwellings used for commercial. This class comprised less than 4% of area.

RESIDENTIAL LAND-USE



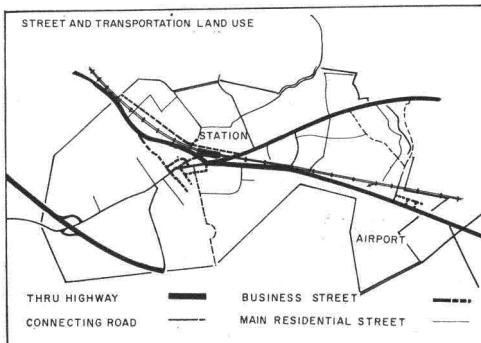
DATA OBTAINED

- \* Location and classification of all residential areas by density, structure-type, and lot size.
- \* Measurement of zoned areas occupied, number and type of dwellings, floor area per dwelling and percent of zoned area built up.
- \* Computation of population by dwelling type and area.

APPLICATION AND ACCURACY

- \* Accuracy of dwelling count, size and type of lot within 2% of ground checked sample area.
- \* Basis for changes in zoning, acquisition of school and recreation sites, trade areas, utility requirements, tax assessment among many others.

STREETS AND TRANSPORTATION LAND-USE



DATA OBTAINED

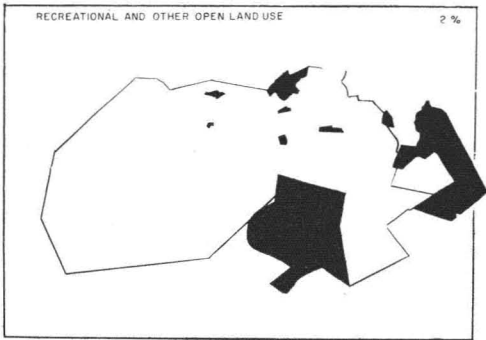
- \* Location and classification of all streets by use as through highways, primary and secondary connecting roads, business and residential streets.
- \* Location and classification of railroad, bus and airport facilities.
- \* Measurement of streets by total length, width and use type.
- \* Traffic potential according to adjacent land-use, pattern of streets, and number of dwellings, served by each street.

APPLICATION AND ACCURACY

- \* Data used for right of way acquisition street improvement, traffic flow analysis. Adequacy of railroad facilities equated to needs for proposed commuter railroad traffic.
- \* Use classification based on photo study of surrounding land use and general familiarity with the area.
- \* Street dimensions and mileage within 2% of city engineer's ground survey.

FIG. 1. Urban land inventory from aerial photography. Data obtained, application and accuracy.

RECREATIONAL AND OTHER DEVELOPED  
OPEN LAND-USE



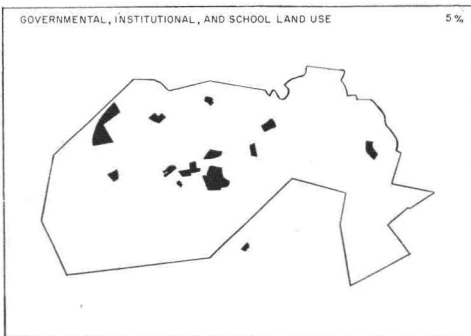
DATA OBTAINED

- \* Location and classification of all parks, golf clubs, and cemeteries.
- \* Measurement of area occupied, number type and capacity of buildings and other outdoor facilities.
- \* Ratios of available facilities to requirements per thousand inhabitants.

APPLICATION AND ACCURACY

- \* Basis for zoning changes, acquisition of new parks and facilities to meet needs of growing population.
- \* Data well within range of accuracy required for planning.

GOVERNMENTAL, INSTITUTIONAL AND  
SCHOOL LAND-USE



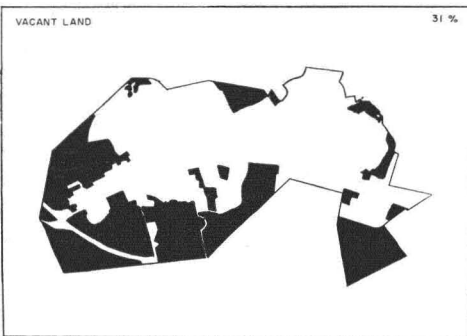
DATA OBTAINED

- \* Location and classification by type and area.
- \* Measurement of land occupied, number and type of structures and outdoor facilities.

APPLICATION AND ACCURACY

- \* Basis for school district planning particularly for new subdivisions.
- \* Ground check to determine denominations of churches, purpose of institutions and indoor facilities.

VACANT LAND (UNZONED)



DATA OBTAINED

- \* Location and classification of farm, fallow and wooded areas.
- \* Measurement of size: description of terrain in each area.

APPLICATION AND ACCURACY

- \* Basis for planning new zoned areas.
- \* Measurements well within required accuracy for planning.

FIG. 1 (Continued). Urban land inventory from aerial photography. Data obtained, application and accuracy.

data without overloading the present staff with demands for data not normally maintained.

## II. ANALYSIS

Analysis is made by combining the inventoried data (such as number of inhabitants per dwelling unit obtained by ground sampling, number of cars per dwelling unit, daily water use per capita), with planning multiplier factors—such as road capacity per thousand vehicles, school rooms and acres of recreational land per thousand people, commercial floor area per thousand dollars of sales. Detailed ground sampling and constant check of literature improve the accuracy of the multipliers. By this means pertinent data can be assembled for almost any analytic purpose.

With these data a second reading of the air photos is made to locate the reasons for outstanding existing and potential planning problems. As an example of the application of the analytic phase of study, one facet of the land use inventory and its succeeding analytic and planning considerations are illustrated:

The inventory of commercial land-use in Rockville revealed that 17 per cent of the total land area is zoned commercial, as a result of piecemeal commercial zoning over a period of years. Comparison with commercial areas in adjacent communities (Figure 2) revealed that land zoned commercial in Rockville was

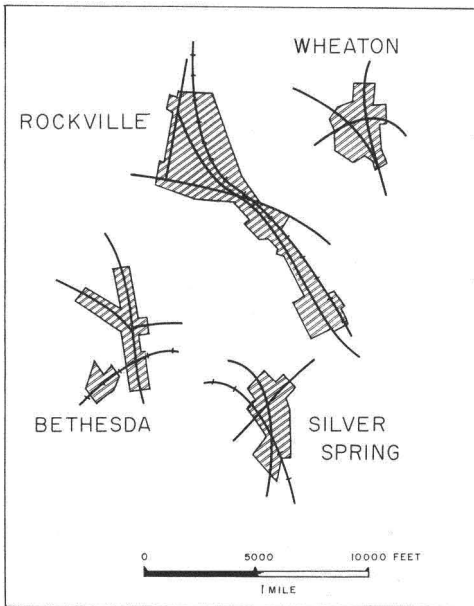


FIG. 2. Comparison of Commercial areas. By comparison with nearby competing commercial areas, it may be seen that Rockville has almost 3 times more land zones for commercial than the leading commercial area, Silver Spring. The zoned commercial area is far too large unless it is also occupied by other than retail commercial establishments. An advantage which Rockville has is a greater amount of vacant commercial land along the railroad. This points the direction for planning the proper use of the commercial area.

far in excess of any foreseeable need. One comparison revealed that Rockville had zoned three times more commercial land than Silver Spring, a commercial center currently doing more than ten times the amount of business Rockville can anticipate in the near future.

But the Rockville Business District forms only a small portion, 9 per cent, of the zoned commercial area. This business district was laid out originally to serve the older *western* portion of the city—the entire city prior to 1949—but now comprising only one-seventh of the total population. The Business Community had failed to appreciate how large and rapid the expansion would be

in the *eastern* portion of the city now comprising six-sevenths of the population. Adequate provision was not made for this trade; merchants were content with a modest increase in sales. However even this modest increase resulted in a considerable traffic congestion because roads and parking facilities were inadequate for accommodating this new trade.

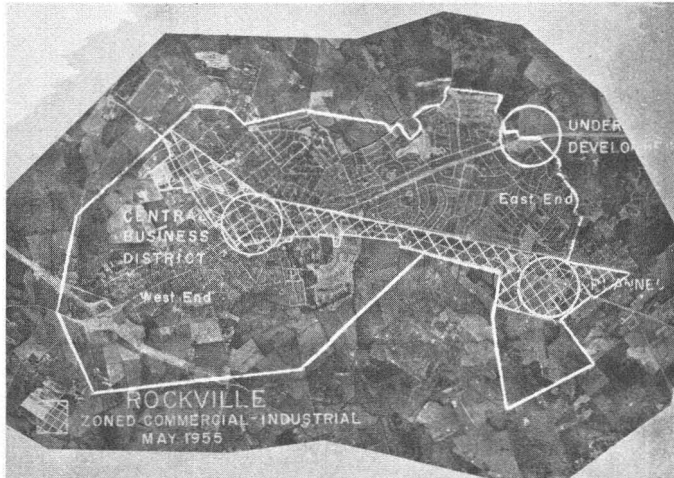


FIG. 3. Competing shopping centers. The present central business district is threatened by two new large commercial centers under development and planned. Principal justification for these new centers is the congestion, poor traffic circulation and lack of parking facilities in the central business district.

Moreover this business district was now faced with the imminent competition of two major shopping centers—one already under development and the other planned, (Figure 3). These would provide more attractive shops, better access, and more adequate parking facilities.

A detailed analysis of traffic flow and parking facilities was undertaken to improve the business district by remedial construction.

At meetings with the Board of Trade, air photos illustrated the character of the road pattern. The west end has eight routes of approach to the Rockville Business District, (Figure 4) to accommodate a vehicle traffic potential of about 1,000 cars, whereas the east end, having a six times greater vehicle traffic potential, had only one main route of approach and this was indifferently supported by a narrow road underpassing the railroad. In addition, an equal amount of traffic from outlying areas normally uses these roads. The bulk of this new traffic passed along the narrow main street, East Montgomery Ave., coming and going. Vehicles approaching from the east are required to drive the full length of the business area before being able to turn into parallel streets to reach parking areas. The heavier traffic indicates poor traffic distribution, rather than a larger volume of potential trade.

### III. PLANNING

a. *A line of remedial planning for the Business District was suggested from photo analysis* (Figure 5). The photos revealed that there was sufficient space in vacant backyards and alleys within the business district to make available more than double the existing parking capacity. The photos also revealed that traffic would be able to reach parking lots in back of shops, as the result of the

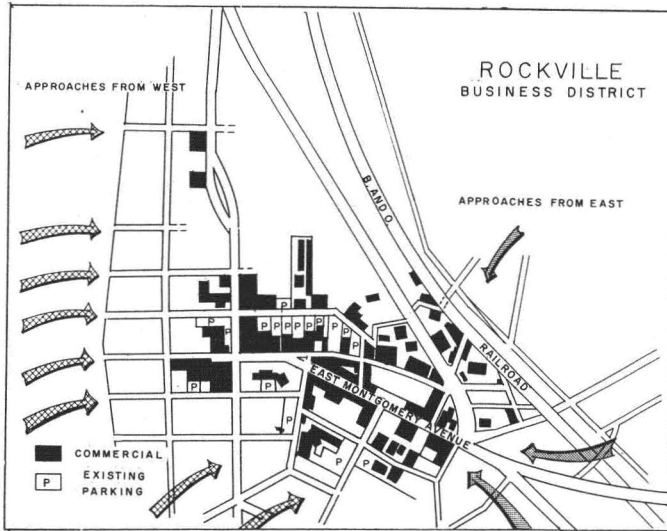


FIG. 4. Traffic patterns in central business district. The eight routes of approach to the central business district serve 1/7 of all the families. Two routes of approach from the east serve 6/7 of all the families, as well as heavy through traffic. The majority of this traffic uses the narrow main business street going and coming. The other route from the east serves only a small section of the town.

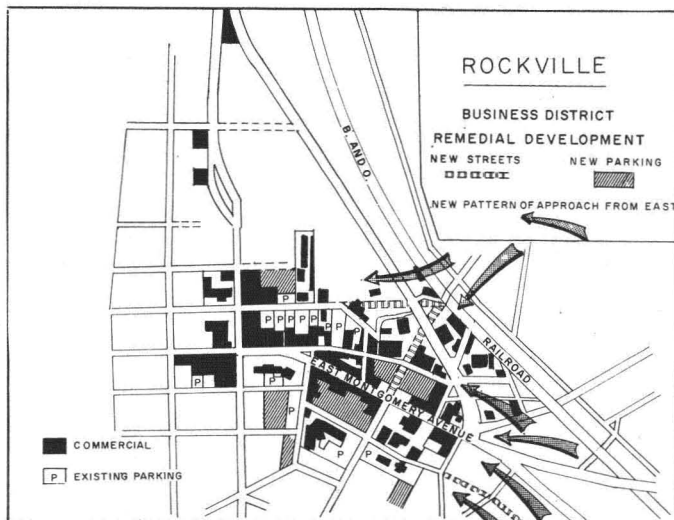


FIG. 5. Remedial traffic and parking development. Improvement in traffic circulation is possible by creating new routes of approach and proper placement of new parking lots. The air photos revealed that present parking capacity could be more than doubled by using wasted backyards, alleys and vacant lots in the business district and that new streets could be constructed without dislocating existing occupants. The new pattern of approach from the east would reduce movement on the main street yet provide equal or greater access to shops.

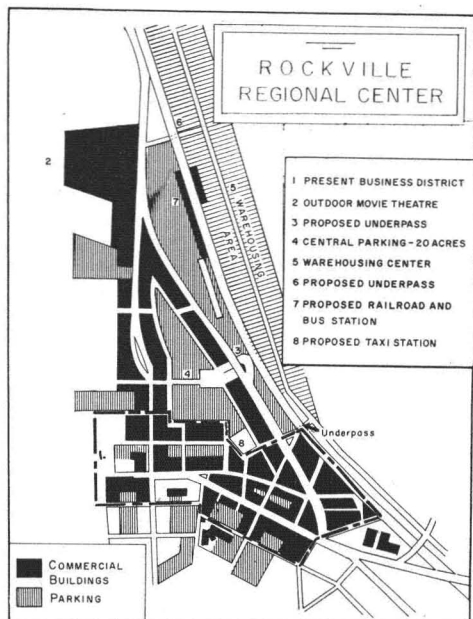


FIG. 6. Future growth. Suggested expansion of present business district onto vacant land lying to the north. The large central parking area, underpass approach; and additional parking provided by the computer parking lot adjoining the railroad would provide an attractive center with adequate parking and access routes.

construction of a few additional access streets, and by using streets paralleling the main business street. Several pass-ways between stores on the main street leading to parking lots would open the entire area to easy traffic circulation in almost all directions.

b. A study of the photos also suggested a program for long range development of a larger and more adequate trade area (Figure 6). Positions of this plan are now being implemented by private builders.

Development of the rest of the commercially zoned land would take advantage of Rockville's superb position along the main railroad line for commuter railroad traffic, wholesaling and warehousing, and light industry. Two companies dealing in wholesale building supplies are now locating in this area.

The Board of Trade and the *Montgomery County Sentinel*, the leading local newspaper, given the facts, have now undertaken carrying the burden of acquainting the public with the city's land-use problems in order to generate public support for large-scale change.

In the meantime efficient administration and progressive planning have increased the revenues, and have enabled the city to propose a decrease in tax rate, despite an increase in budget for services and improvement projects.

The final step in the photo sociometric cycle of inventory, analysis, and plan awaits the agreement of public opinion on some particular course of action based on the directions presented in the land-use survey. When public opinion has sufficiently jelled the master plan can be constructed, embodying the desires of the town in balance with the capabilities of its land and location.



#### PHOTO INTERPRETATION KIT

A new product which may have important uses under President Eisenhower's proposed "Open Sky" policy, is a new compact aerial photo interpretation kit, for

use in analyzing aerial photographs. This has been designed, engineered and manufactured by Gordon Enterprises.

The kit contains all of the devices necessary for viewing and precise measuring of aerial photographs, including three special folding stereoscopes, contour measuring devices, height finder, special drawing instruments, aerial photographic slide rules and scales, and all necessary accessory tools. The kit is being manufactured for the U. S. Air Force, U. S. Navy, and several friendly governments.