ERTS PROGRESS REPORT COVERING

THE PERIOD 1 FEBRUARY 1973 TO 30 SEPTEMBER 1973

PLANNING APPLICATIONS IN EAST CENTRAL FLORIDA

PROPOSAL NO. Y-10-066-001

BREVARD COUNTY PLANNING DEPARTMENT

TITUSVILLE, FLORIDA

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PROPOSAL NO. Y-10-066-001

PRINCIPAL INVESTIGATOR: JOHN W. HANNAH*

CO-INVESTIGATORS: DR. GARLAND L. THOMAS*
FERNANDO ESPARZA

COMPUTER PROGRAMMING: JAMES J. MILLARD**

*BREVARD COUNTY PLANNING DEPARTMENT

**KENNEDY SPACE CENTER

COMPUTER PROGRAMMING

One existing program has been modified and two new ones have been developed. They have been designed to receive as input the MSS data on computer compatible tapes and have been made modular in form to facilitate future modification and to provide program growth potential. Their functions are as follows:

Radiance Mapping

This program has been modified so that the region to be mapped is designated by beginning and ending scan lines and elements on the ERTS tape.

Histograms

This program generates histograms of the frequencies of occurrences of the various radiance values (expressed in sensor counts) over the sector of the scene which is under study. The user selects the bands to be checked and the beginning and ending lines and elements of the region to be covered. The resulting histograms may be presented in linear or logarithmic form.

Ratios

Ratios of the radiances of any two bands can be computed and mapped or presented as a histogram for a designated sector. The histogram is presented in logarithmic form, i.e., the logarithm of the number of occurrences is plotted against the ratio values.

URBAN AND TRANSPORTATION PATTERNS

By appropriate choice of band, intensity levels, and printout characters, it is possible to produce useful thematic maps by the density-sliced mapping program. For example, density slicing of band 5, with appropriate choice of levels and printout characters, can be used to produce a map which gives a good outline of urban patterns and a useful diagram of transportation facilities, as indicated by the cover of this report.

DAYTONA BEACH

During the period covered by this report, two additional cities, Daytona Beach and Sanford, have been analyzed by the previously described method of tracing an enlargement, using a planimeter to measure areas of the various sectors, and using a Digicol viewer to measure relative intensities of the sectors (band 5). The tracing of Daytona Beach is shown in Figure 1, and its numerical values have been added to Table 1. Daytona Beach compares favorably on a basis of the population/integrated reflectance figure. In this and the other diagrams, the numbers give the order of reflectance of the various sectors.

It will be noticed that Daytona Beach follows the development pattern characteristics of the other cities observed so far, namely: (1) development on the beach, (2) development along U. S. Highway 1, (3) central business district near U. S. 1, usually between U. S. 1 and the Indian River, (4) some new development in the vicinities of exits of interstate highways.

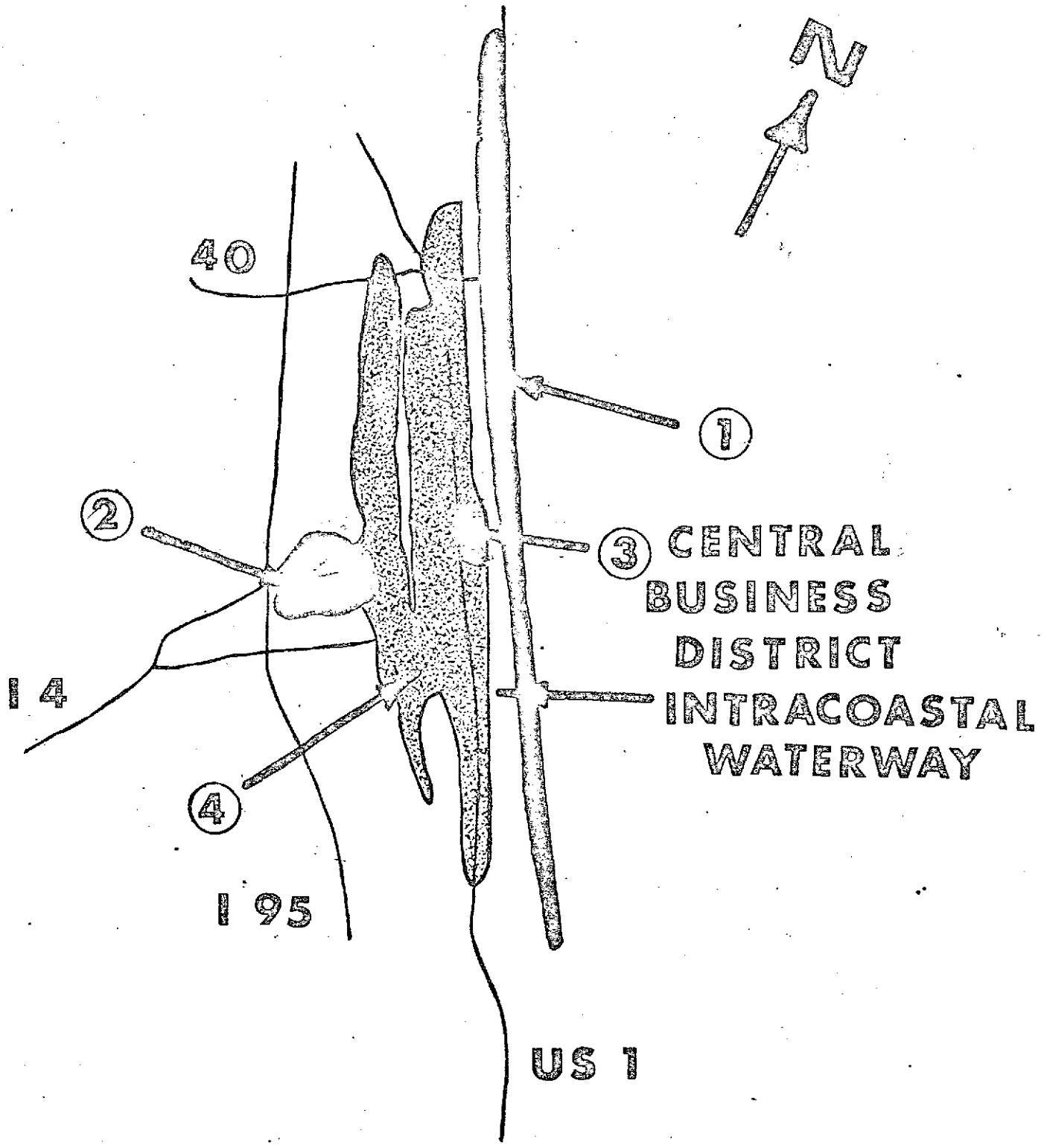


FIGURE 1 DAYTONA BEACH

REGION OR CITY	MINIMUM RELATIVE REFLECTANCE	INTEGRATED REFLECTANCE	POPULATION AREA (persons/ha)	HOUSING UNITS AREA (units/ha)	POPULATION INTEGRATED REFLECTANCE
Beach-dune area at New Smyrna Beach	.83				
Patrick Air Force Base	.65				
One sector of Orlando					
Industrial Area, Cape Kennedy Air Force Station	.58				
Port St. John	.58	1076	Area 2: 6.0 Total : 1.2	2.0 .4	1.6
Deltona	.60				
Vehicle Assembly Building, Kennedy Space Center	.54				
Merritt Island	.49	3933	4.0		8.1
Daytona Beach	.49	3910*	7.7*		19.8*
Headquarters Area, Kennedy Space Center	.48				
Titusville	.49	1987	6.1		15.4
Cocoa	.48	2090	4.4		12.7
Cocoa Beach	.48				
Sanford			3.3*		
McCoy Airport, Orlando					
Region south of Patrick Air Force Base	.41				
New Smyrna Beach	.39				
Florida Shores	.38*	318*	3.3*		10.5*
DeLand					
Disney World					

* New Data

As discussed previously, the last column of Table 1, Population/ Integrated Reflectance, appears to have some value as an environmental indicator. Integrated Reflectance values are of relative significance only, as they will vary with image-measuring instrument, sensor, sensor band, and time of observation. Within a single ERTS frame, at least for a single band, they seem to have some usefulness. Use of the values from digital tape would eliminate one of two above variables and would be relatively easy. Our histogram program, which counts points within specified radiance levels, appears suitable for this purpose, and will be applied to it, but this has not yet been done.

SANFORD

The pattern of development of Sanford is shown clearly to be along the major highways and the lake front. (Figure 2)

TITUSVILLE

A band 5 density-sliced map of Titusville is shown in Figure 3, where the levels and characters have been chosen to give the best pattern for determination of urban features. A photograph of Titusville provided by Kennedy Space Center, is shown as Figure 4 for comparison.

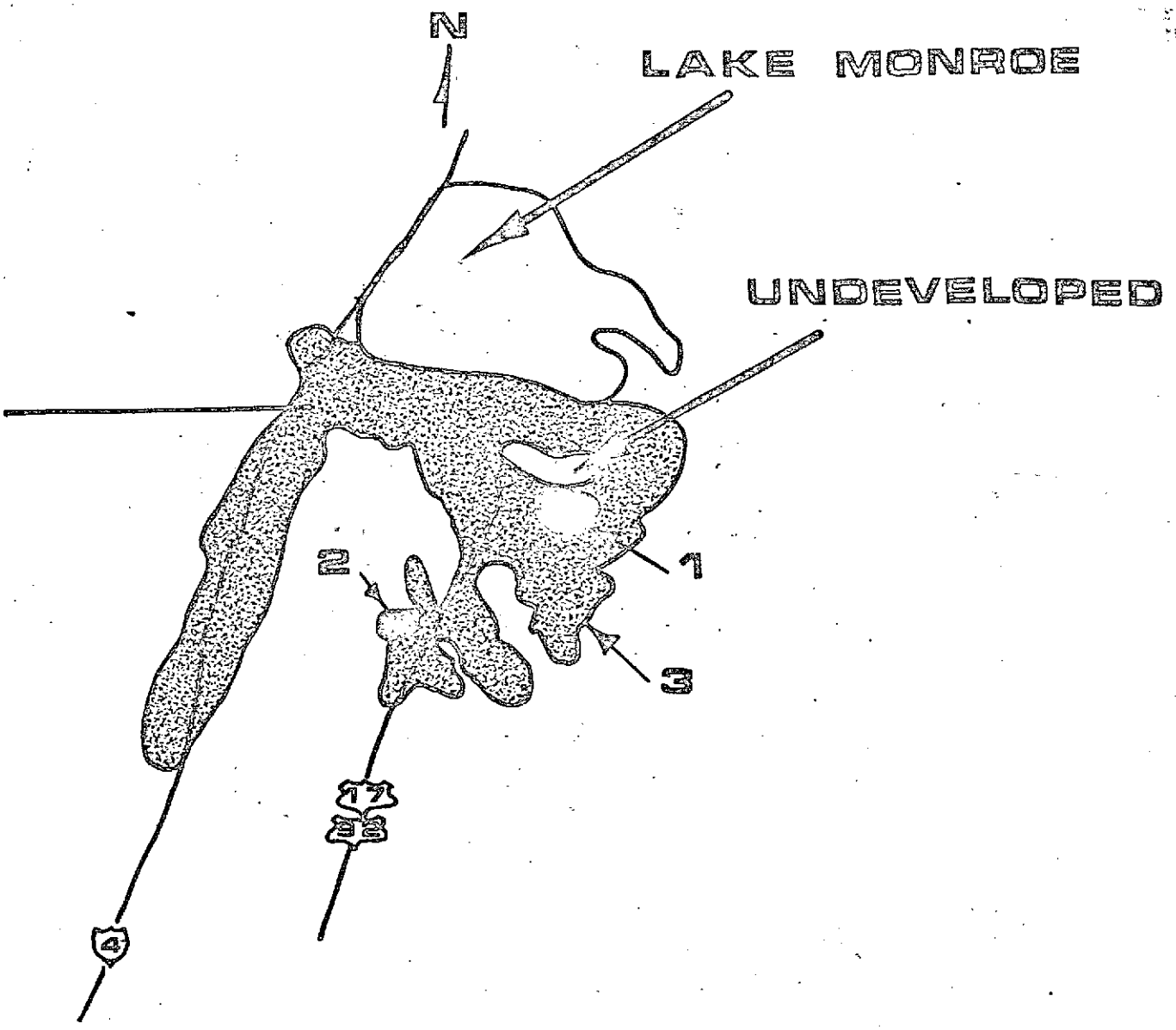


FIGURE # 2

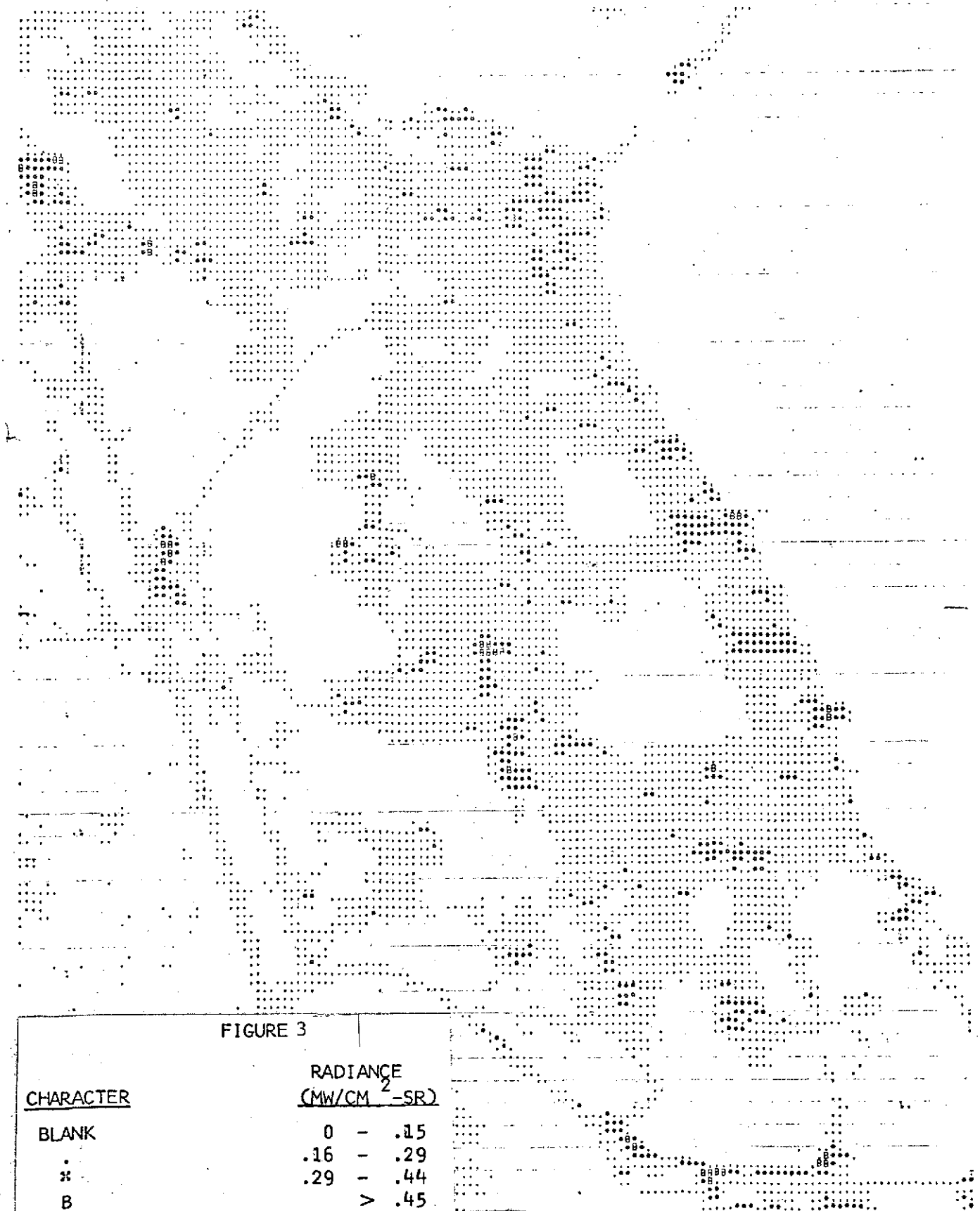
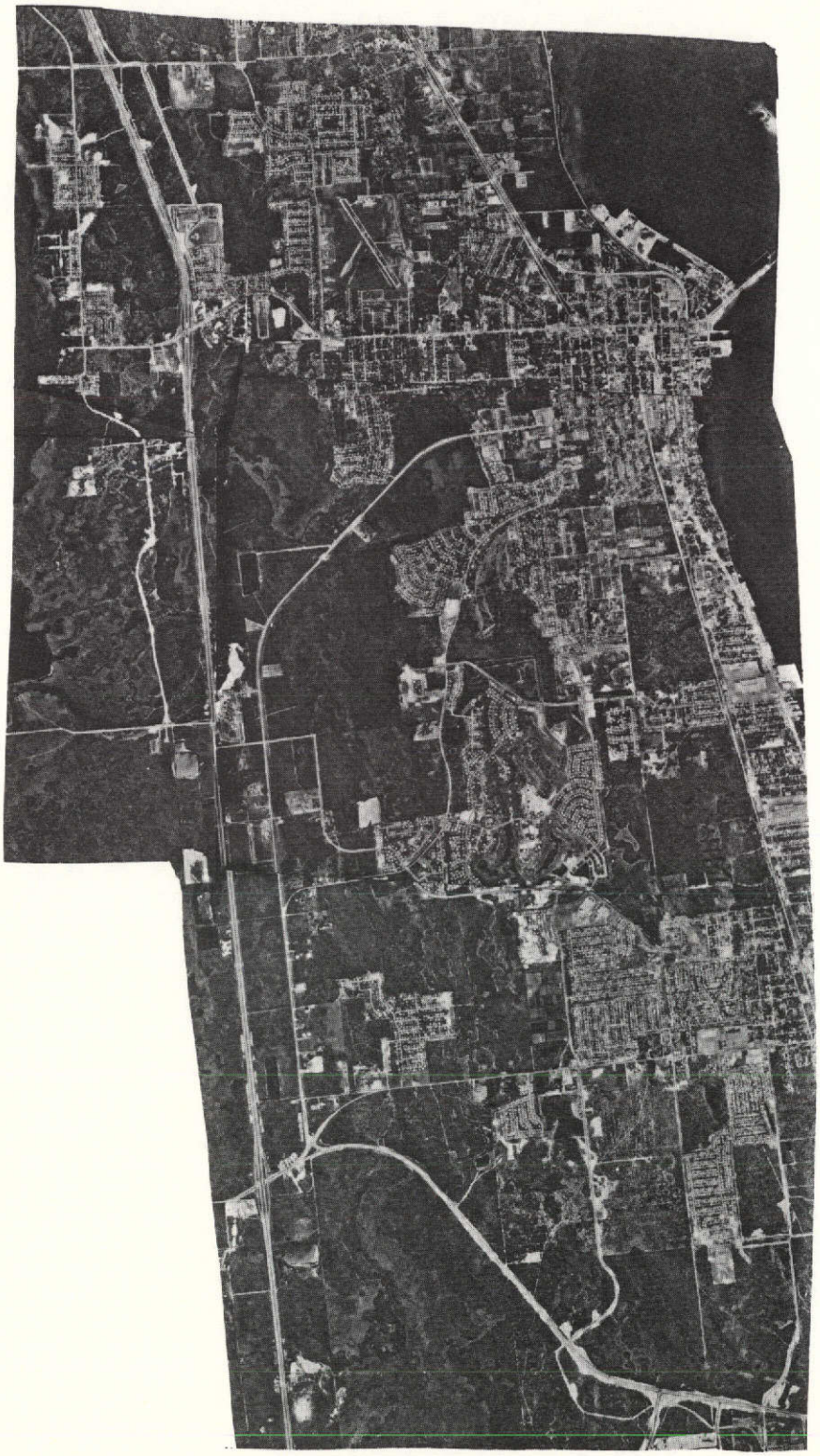


FIGURE 3

CHARACTER	RADIANCE (MW/CM^2-SR)
BLANK	0 - .15
.	.16 - .29
⌘	.29 - .44
B	> .45



PHOTOGRAPH OF TITUSVILLE

FIGURE 4

Interpretation of the printed characters for this particular map is roughly as follows:

blank: water, undeveloped land

. : residential; highways

* : commercial; semi-bare soil (or sand); small areas of bare soil (or sand); new construction

B : bare sand

Some overlap occurs between the *'s and the B's, and some knowledge of the region and some ground-checking are required; but this type of map appears useful, particularly for monitoring changes.

Major features apparent are identified by numbers as follows:

1 residential

2 undeveloped

3 river

4 central business district

5 shopping centers

6 strip commercial

7 highways

8 new construction (high school)

9 new construction (residential)

10 recently developed residential sectors

Comparison of Figures 3 and 4 shows that a computer map of this type gives a good outline of the developed portion of the city and of the commercial and industrial sectors. It also indicates that the computer map shows the general pattern of high intensity development within the central business district. To check this point further,

a walking survey of the central business district (and adjacent Garden Street) was made -- without further reference to the printout -- and shading was done on a city street map, block-by-block, to indicate regions of anticipated high reflectance (mostly high intensity development but also including vacant lots with bare sand visible). The result of this walking survey is shown in Figure 5, which may be compared to the corresponding sector of Figure 3. This result has been pursued further by using the zoom transfer scope to project Figure 5 on the printout and tracing the pattern, the results of which are shown in Figure 6. Positional discrepancies are to be expected, as neither the street map which served as the basis for Figure 5 nor the computer printout possesses cartographic precision. The printout calls attention to a somewhat unique feature of downtown Titusville which is borne out by the walking survey, namely, that the central business district does not have uniform intensity of development. Rather it has retained some of the characteristics of a country town in that the commercial areas have non-commercial, residential type uses interposed, with some trees and other vegetation. This suggests that with judicious modernization, downtown Titusville has the potential to become an aesthetically pleasant downtown area.

The printout also shows clearly three sizeable privately-owned undeveloped areas in Titusville, another somewhat unique feature which is of current value and potential long-range value to the city.

An attempt was made to identify, by ground observation, each of the "bright" spots (radiance $\geq$ .29MW/CM^2-SR). A printout with the

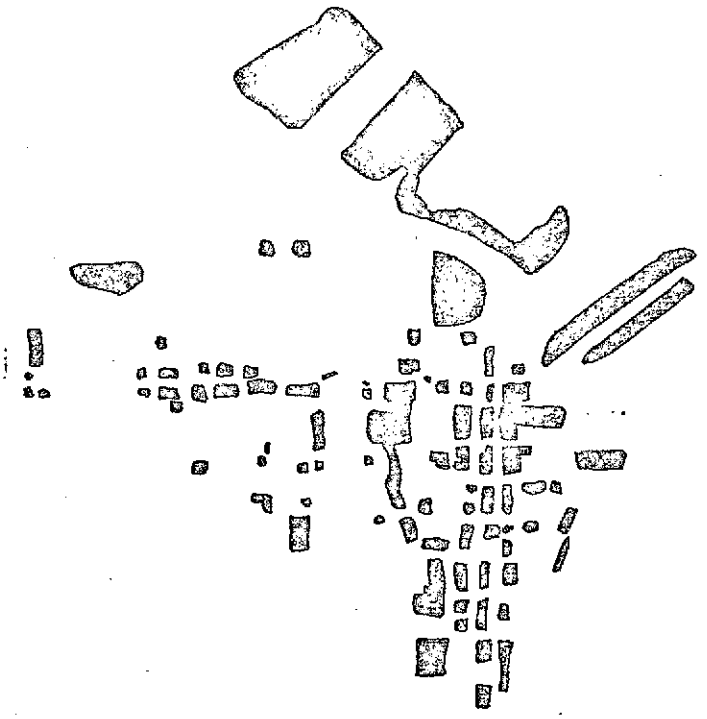


FIGURE 5

FIGURE 6

locations numbered is shown as Figure 7, and the corresponding "ground Truth" is listed in Table 2. Of the 113 "bright spots", only 8 (7%) have not been identified. By counting characters associated with each "bright spot", a tabulation of the number of characters and corresponding area associated with the various land use categories was made and is given as Table 3.

The utility to a planner of timely availability of some of the information in Table 2, and changes therein, is evident. Due to the resolution and the integrating nature of the sensor, the area values are, of course, imprecise. They should, however, be useful for comparison with similar data taken at another time.

By counting the total number of each printer character within the area of Titusville, it is possible to assign a fraction of the total area to each of the identified land use categories. This has not been done in this case, however, but will be done with the use of our histogram program, which program will tabulate the frequency of occurrence of each printout character in a designated sector.

Not so evident from the tabulations but evident to the "ground truth" observer, is the surprising number of regions of bare sand. In most of the cases where a sector was completely or almost barren, there were tracks which had been made by motorbikes and, sometimes, dune buggies. Ten such sectors were noted in Titusville, corresponding to an area of approximately 20 HA. It is clear that there is no chance of vegetation growing in the soft sand stirred up by motorbikes in such sectors. In a few cases, the environmental degradation had been

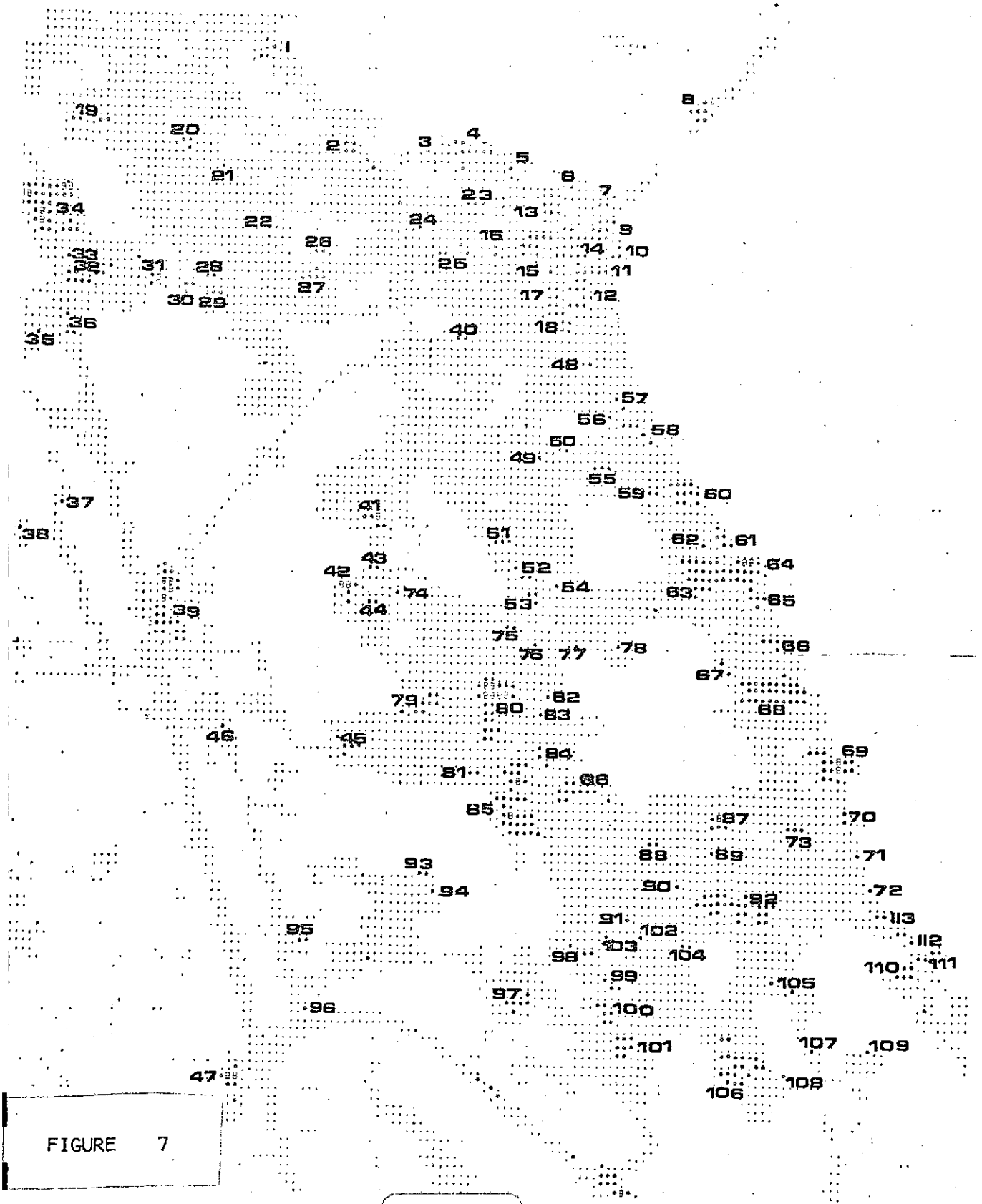


FIGURE 7

TABLE 2

LOCATION NUMBER	IDENTIFICATION
1	CHURCH, COMMERCIAL
2	INDUSTRIAL, HOSPITAL
3	INDUSTRIAL
4	INDUSTRIAL
5	PARKING LOT (SAND), BASEBALL FIELDS
6	INDUSTRIAL
7	PARKING LOT (SAND), BASEBALL FIELDS
8	PARKING LOT (SAND), BOAT LAUNCHING RAMPS
9	VACANT LOTS (SEMI-BARE SAND)
10, 11, 12 13, 14	COMMERCIAL
15	INDUSTRIAL
16	COMMERCIAL
17	COUNTY COURTHOUSE
18	COMMERCIAL
19	2 SCHOOLS
20	VACANT LOTS (UNCERTAIN)
21	INDUSTRIAL (COUNTY MAINTENANCE FACILITY)
22	AIRPORT HANGER AND PARKING STRIP
23	COMMERCIAL
24	FOOTBALL STADIUM, PARKING LOT
25	COMMERCIAL

TABLE 2 (CONT'D)

LOCATION NUMBER	IDENTIFICATION
26	CONSTRUCTION AREA
27	COMMERCIAL
28	INDUSTRIAL (CITY WATER FACILITY)
29, 30	COMMERCIAL
31	BARE SAND (MOTORBIKES)
32	BARE SOIL, COMMERCIAL
33	UNIDENTIFIED
34	NEWLY CONSTRUCTED HIGH SCHOOL (B'S REPRESENT NEW ASPHALT DRIVING COURSE, NEW ASPHALT PARKING LOT, BARE SOIL)
35	SCHOOL
36, 37	BARE SAND
38	UNIDENTIFIED
39	RESIDENTIAL DEVELOPMENT; B'S REPRESENT BARE SAND (MOTOR-BIKES, DUNE BUGGIES)
40	SHOPPING CENTER
41	BARE SAND (MOTORBIKES)
42	LOTS WITH BARE SAND (MOTORBIKES, DUNE BUGGIES)
43	CONSTRUCTION
44	CHURCH WITH PARKING LOT
45	RESIDENTIAL SECTION WITH SEVERAL SEMI-BARE LOTS

TABLE 2 (CONT'D)

LOCATION NUMBER	IDENTIFICATION
46	INDUSTRIAL
47	CONSTRUCTION
48	COMMERCIAL
49	APARTMENTS
50, 51, 52	SEMI-BARE LOTS
53	COMMERCIAL, BARE SAND (TOPSOIL REMOVED)
54	BARE SAND
55	INDUSTRIAL (SCHOOL BOARD MAINTENANCE FACILITY)
56, 57, 58	COMMERCIAL
59	HIGH SCHOOL
60, 61	COMMERCIAL
62	UNIDENTIFIED
63	COMMERCIAL
64	POST OFFICE, PARKING LOT (B'S REPRESENT PARKING LOT)
65	APARTMENT BUILDING
66, 67, 68	COMMERCIAL
69	APARTMENT BUILDING (B'S REPRESENT LARGE, SEMI-BARE SAND PARKING LOT)
70, 71, 72	COMMERCIAL
73	INDUSTRIAL
74	UNIDENTIFIED
75	CONSTRUCTION

TABLE 2 (CONT'D)

LOCATION NUMBER	IDENTIFICATION
76	ROAD CONSTRUCTION
77	NEW RESIDENTIAL CONSTRUCTION
78	SCHOOL
79	APARTMENTS, BARE LOT
80	NEW RESIDENTIAL CONSTRUCTION
81	APARTMENTS
82	UNIDENTIFIED
83	NEW RESIDENTIAL CONSTRUCTION
84	CONSTRUCTION
85	APARTMENTS, NEW RESIDENTIAL AREA WITH SOME BARE LOTS
86	BARE SAND, (MOTORBIKES) TOPSOIL REMOVED
87	BARE SAND (MOTORBIKES)
88	BASEBALL FIELD
89	UNIDENTIFIED
90	CHURCH
91	COMMERCIAL; SEMI-BARE LOT
92	COMMERCIAL
93	RESIDENTIAL CONSTRUCTION
94	BARE SAND (MOTORBIKES)
95	DRIVE-IN THEATER
96	BARE SOIL
97	BARE SAND (MOTORBIKES)
98	COMMERCIAL, APARTMENTS
99, 100, 101	BARE SAND (MOTORBIKES, DUNE BUGGIES)

TABLE 2 (CONT'D)

LOCATION NUMBER	IDENTIFICATION
102	CHURCH
103	COMMERCIAL
104	COMMERCIAL (ROLLER SKATING RINK, PARKING LOT)
105	UNIDENTIFIED
106	BARE LOTS IN NEW RESIDENTIAL DEVELOPMENT (SOME MOTORBIKE TRACKS)
107	BARE SAND, TOPSOIL REMOVED (MOTORBIKES)
108	BARE SAND (MOTORBIKES)
109	BARE SECTION OF LITTLE LEAGUE BASEBALL PARK
110	INDUSTRIAL
111, 112, 113	COMMERCIAL

TABLE 3

LAND USE CATEGORY	NUMBER OF CHARACTERS	AREA
PUBLIC*	34	15 HA.
COMMERCIAL	221	96
INDUSTRIAL	38	16
RECREATIONAL (INCLUDING ASSOCIATED PARKING LOTS)	18	8
VACANT LOTS (WITH SPARSE VEGETATION OR LESS)	106	46
CONSTRUCTION	34	15
NEWLY CONSTRUCTED BUILDINGS AND FACILITIES	42	18
RESIDENTIAL AREAS WITH RELATIVELY SPARSE VEGETATION	56	24
APARTMENT BUILDINGS (INCLUDING PARKING LOTS)	40	17

expedited by prior removal of top soil. Direct observation of these motorbike regions and consideration of their total number and area leads to the conclusion that motorbikes and dune buggies are in this way doing significant environmental damage.

Comparison of Figure 3 with a conventional land use map of the city as used by the city planners (Figure 8) shows a close correspondence. This is shown also by projecting Figure 8 on Figure 3 by means of a zoom transfer scope and tracing it. The result is shown as Figure 9.

A band 7 density-sliced map of Titusville (Figure 10) shows a different pattern and thereby provides new information, primarily related to vegetation patterns. For example, the pattern of B's in Figure 10, corresponds approximately to the pattern of residential areas, probably indicating relatively high ir reflectance by lawn grass.

Bands 5 and 7 have been most used by us, with bands 4 and 6 providing minor amounts of additional information. Our choice of primary bands is based, at least in part, on the fact that bands 4 and 6 in this frame contain some bad scan lines which affect the appearance of the images and computer maps but do not prevent the determination of patterns.

For the same reasons, bands 5 and 7 have been used for the mapping of ratio values, usually 7/5, as this gives mostly values greater than one. Such a map for Titusville is shown as Figure 11. Review of this map shows that it has most of the features of a band 5 printout with a couple of differences. An improvement is obtained in distinguishing new construction versus commercial sectors, the former appearing as

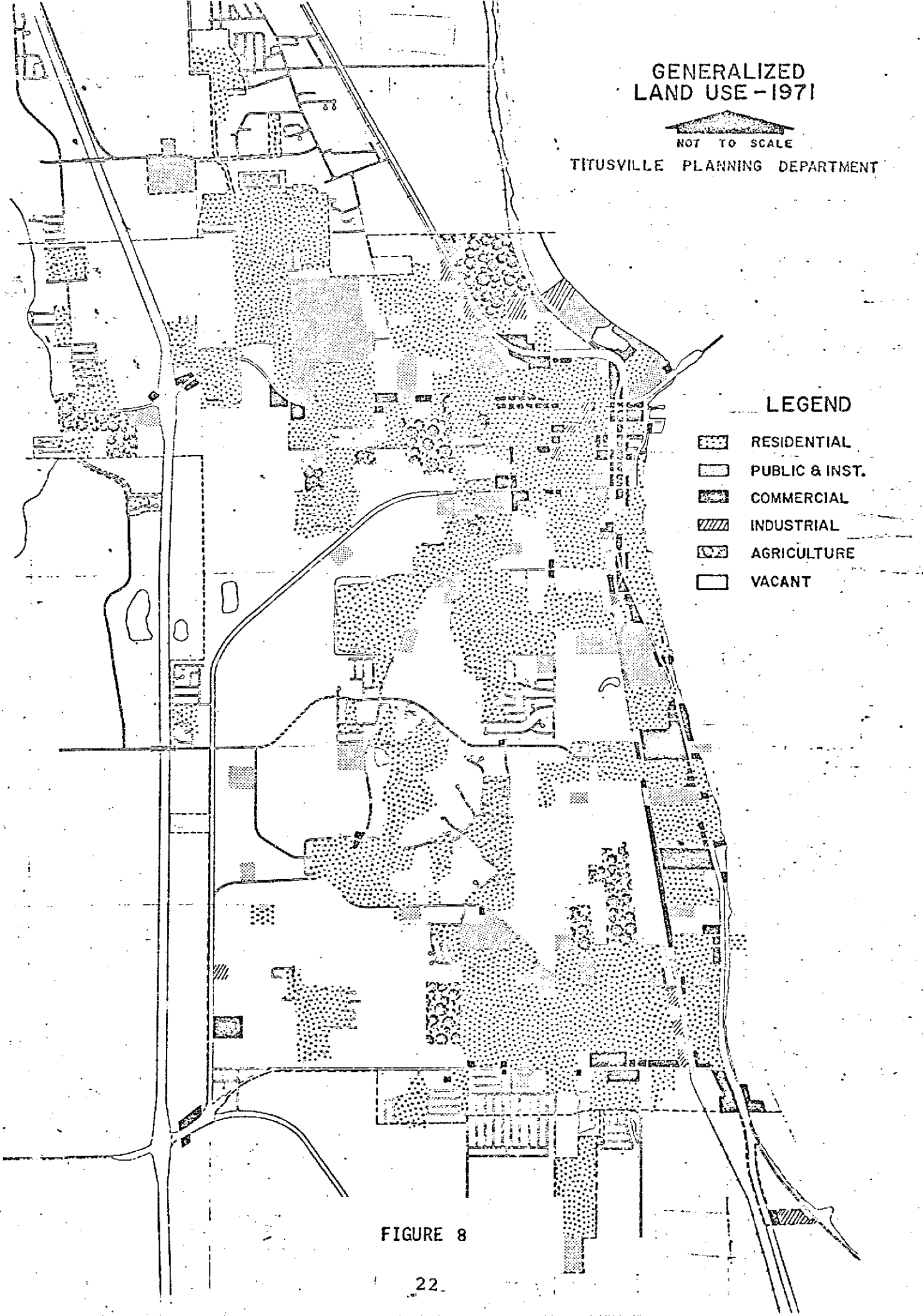

GENERALIZED
LAND USE - 1971
NOT TO SCALE
TITUSVILLE PLANNING DEPARTMENT
LEGEND
RESIDENTIAL
PUBLIC & INST.
COMMERCIAL
INDUSTRIAL
AGRICULTURE
VACANT

FIGURE 8

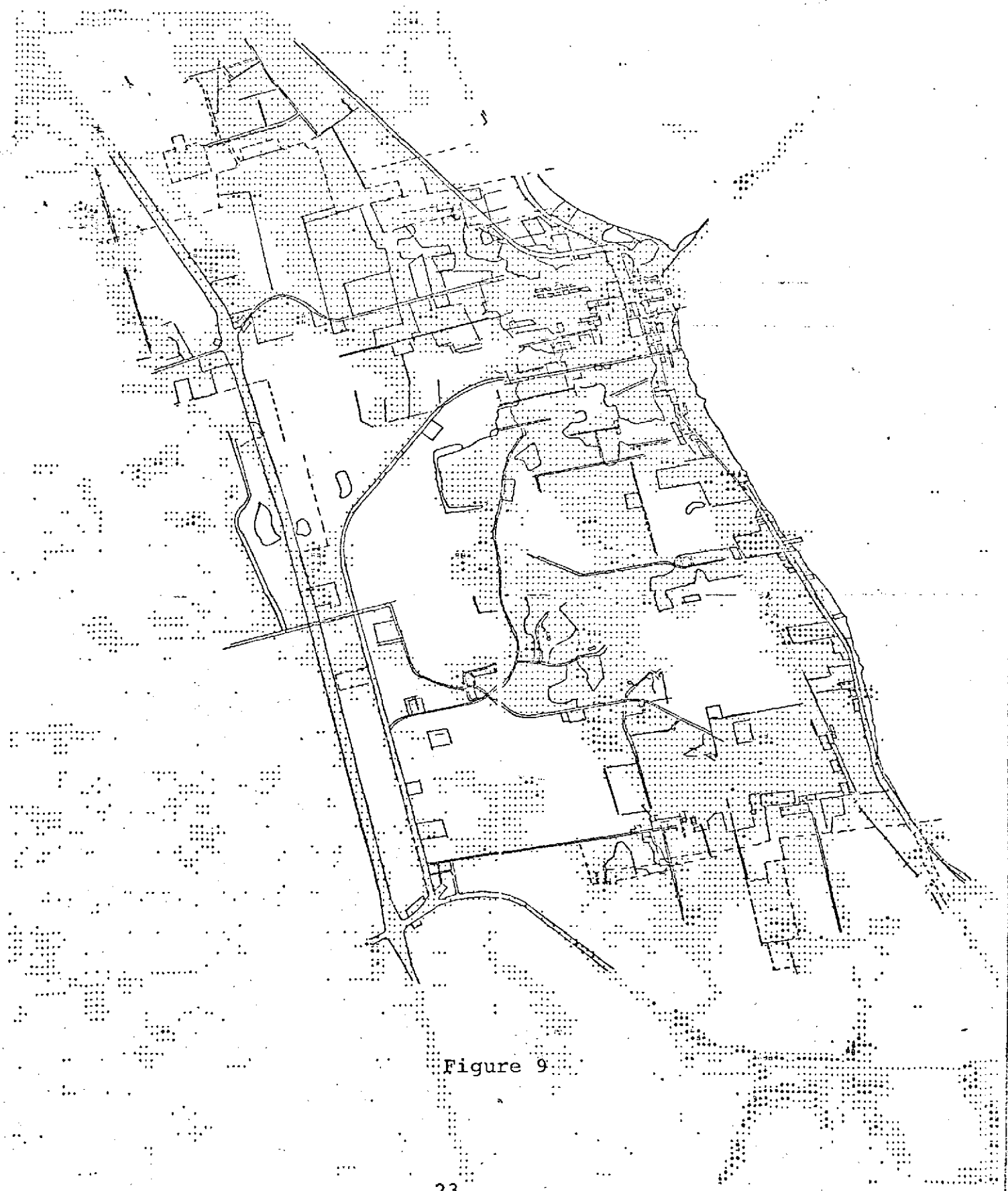


Figure 9

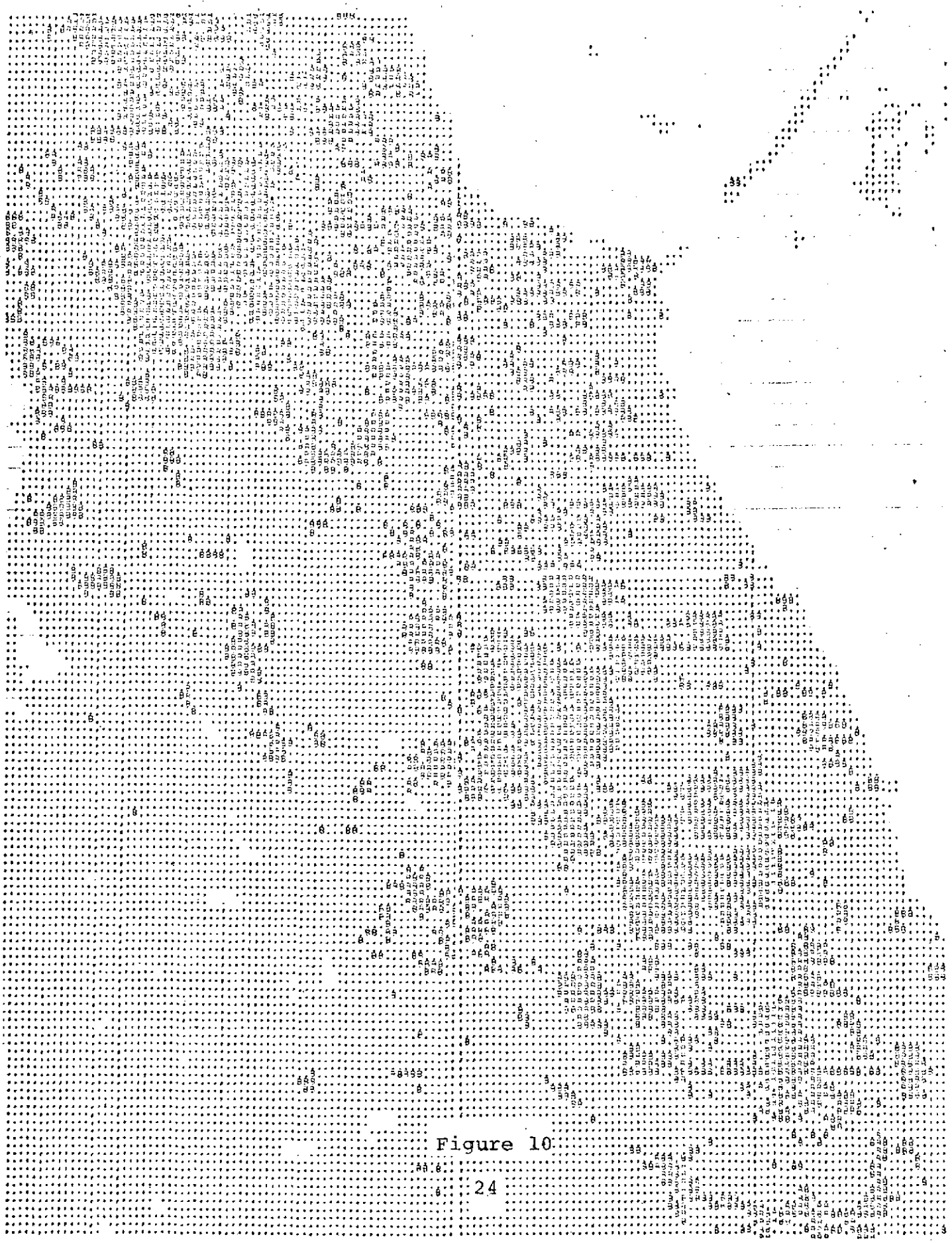


Figure 10

residential and the latter appearing as a distinct class. Also, marshy sectors have the same level of 7/5 ratio as do residential sectors. Figure 11 shows four fairly distinct classes:

blank: water

. : undeveloped

* : marsh, residential, highways

B : commercial

SIGNATURES

The use of density-sliced maps in combination with printout of radiance values (by line and element) and with histograms (which tally the numbers of resolution elements in the various intensity categories) enables some quantitative evaluations. Further, the use of a computer printer for mapping gives the information in terms of individual resolution elements, thereby using the complete resolution capability of the sensor system, and the line and element corresponding to each character is known.

For example, it is possible to give quantitative descriptions of spectral reflection characteristics (signatures) of various land-use classes. A start has been made in this direction for points chosen at random within identified sectors of Titusville. The values are given in Figures 13 to 17. As other sectors of the same frame are studied, more data can be added to this chart. These values (except possibly the ratios) will not apply to data taken at another time but are of value in deciding upon analysis methods and predicting results of density-slicing and classification methods. The divisions above on the data for an individual band indicate the classes which can be separated by the data for that band.

CHANGE MONITORING

Digital tapes have just been received for the second essentially cloud-free set of data over our area, which will enable checking for changes which have occurred during the intervening eight month period.

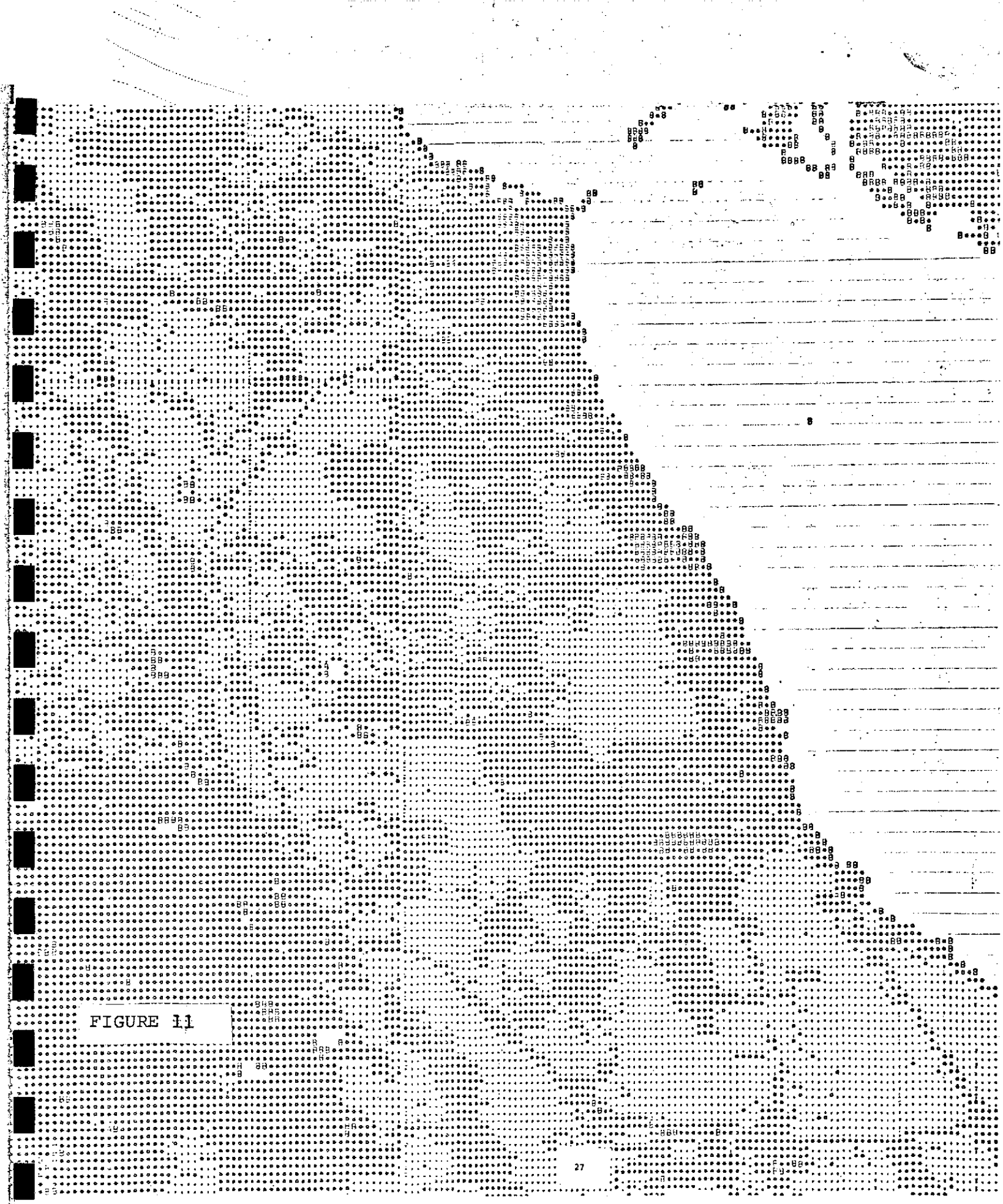


FIGURE 11

A procedure which has been found useful for land use classification within a city is the placing of a single mylar sheet over each of the five maps (for the four bands and the ratio 7/5) in turn so that when the evident features of each of the five maps are traced on the transparency, a composite pattern is obtained, as shown by Figure 12. The number designations for land use classifications shown on that figure are those recommended by the Inter-Agency Steering Committee.[1]

The classifications used on this map are listed in Table 4 for convenience of reference.

The land use map of Figure 3 has been discussed with the city planners of Titusville and a similar one for Cocoa has been discussed with the Cocoa city planner. The planners of both cities state that cities with planning staffs normally have existing land use maps which give greater detail than this type of computer map. The Titusville planners, however, find that the map will be useful to them in planning utilities extensions to regions outside the city limits, for their existing land use maps cover only the region within the city limits. Use of this map will reduce the amount of conventional field survey required.

It has been suggested that a map of this type should be useful in conceptual planning, that is, planning in the early stages of the development of a land use plan.

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[1] J. R. Anderson, E. E. Hardy, and J. F. Roach
A Land-Use Classification System for Use with Remote-sensor Data, Geological Survey Circular 671 (1972)

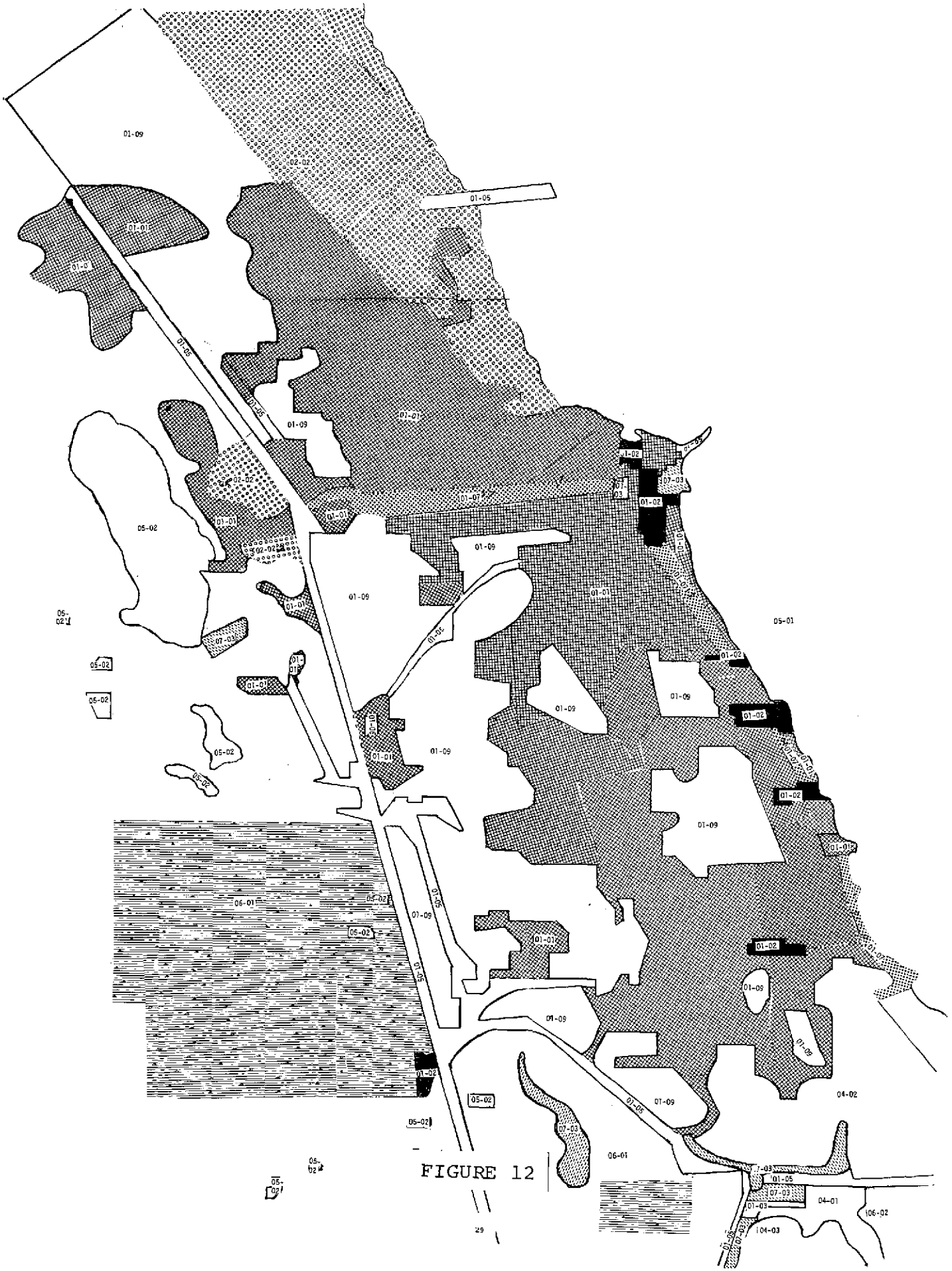
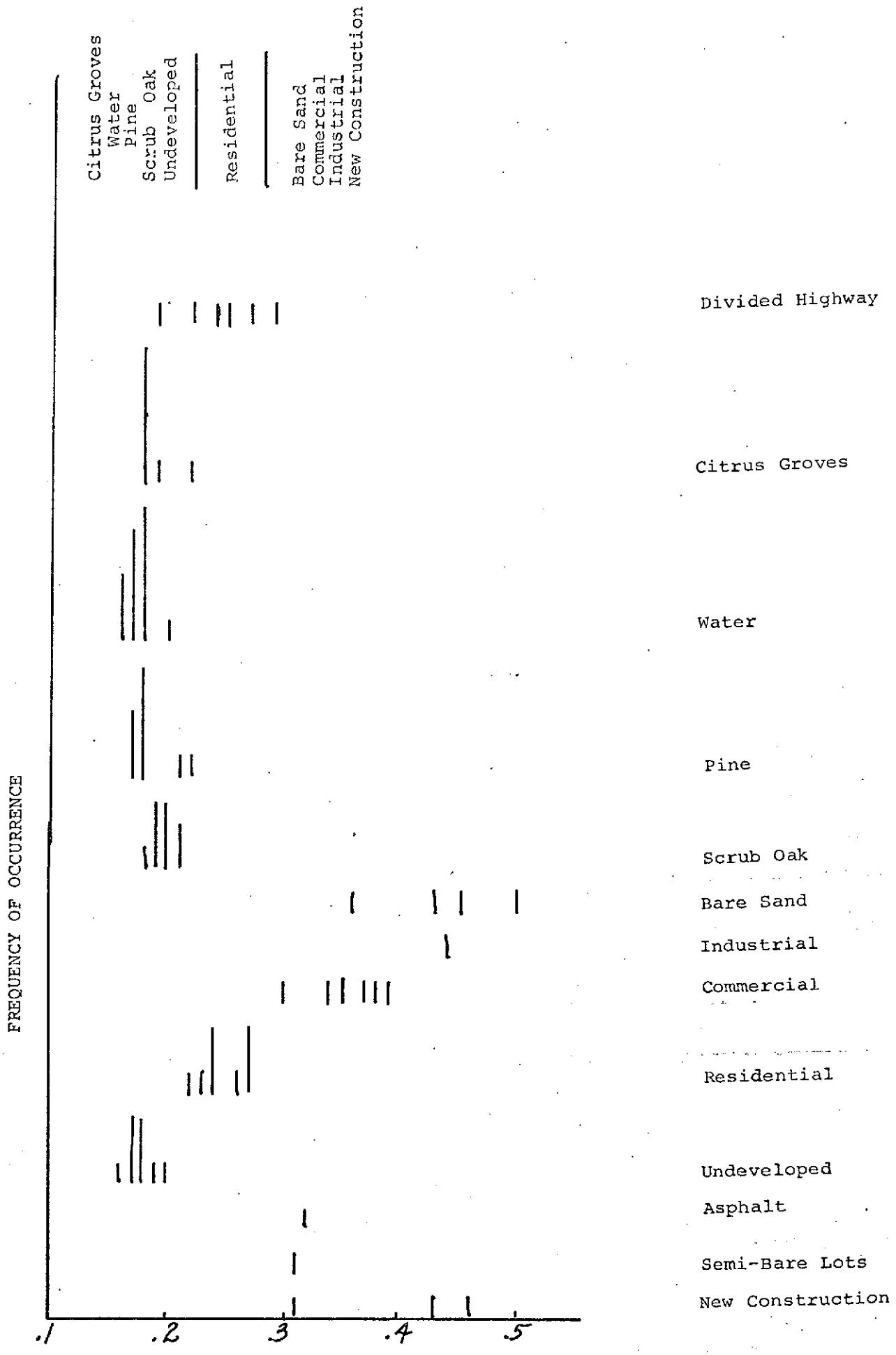

01-09
02-02
01-05
01-01
01-07
05-02
07-03
01-02
06-01
07-09
04-02
01-03
07-05
04-01
106-02
104-03

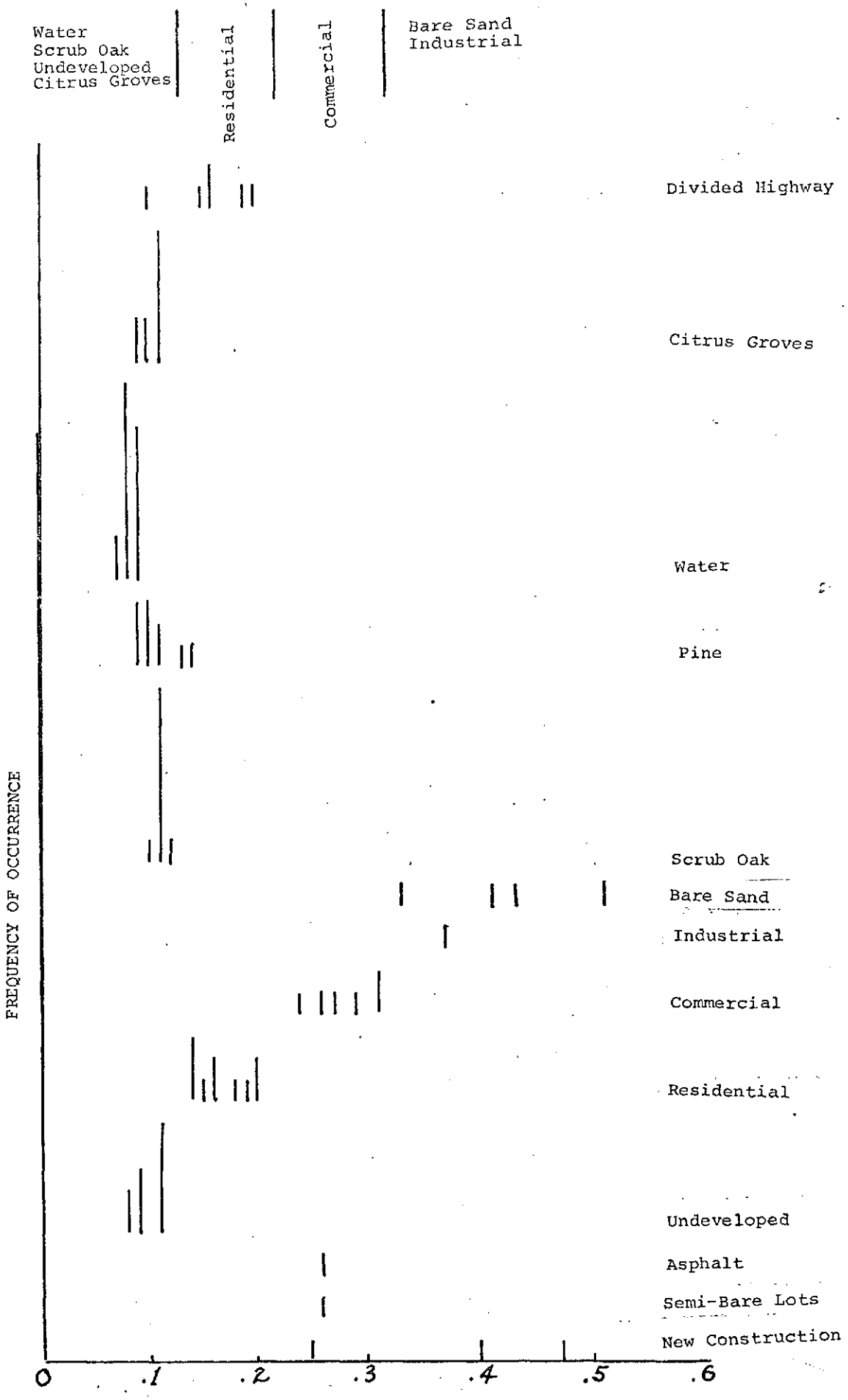
FIGURE 12

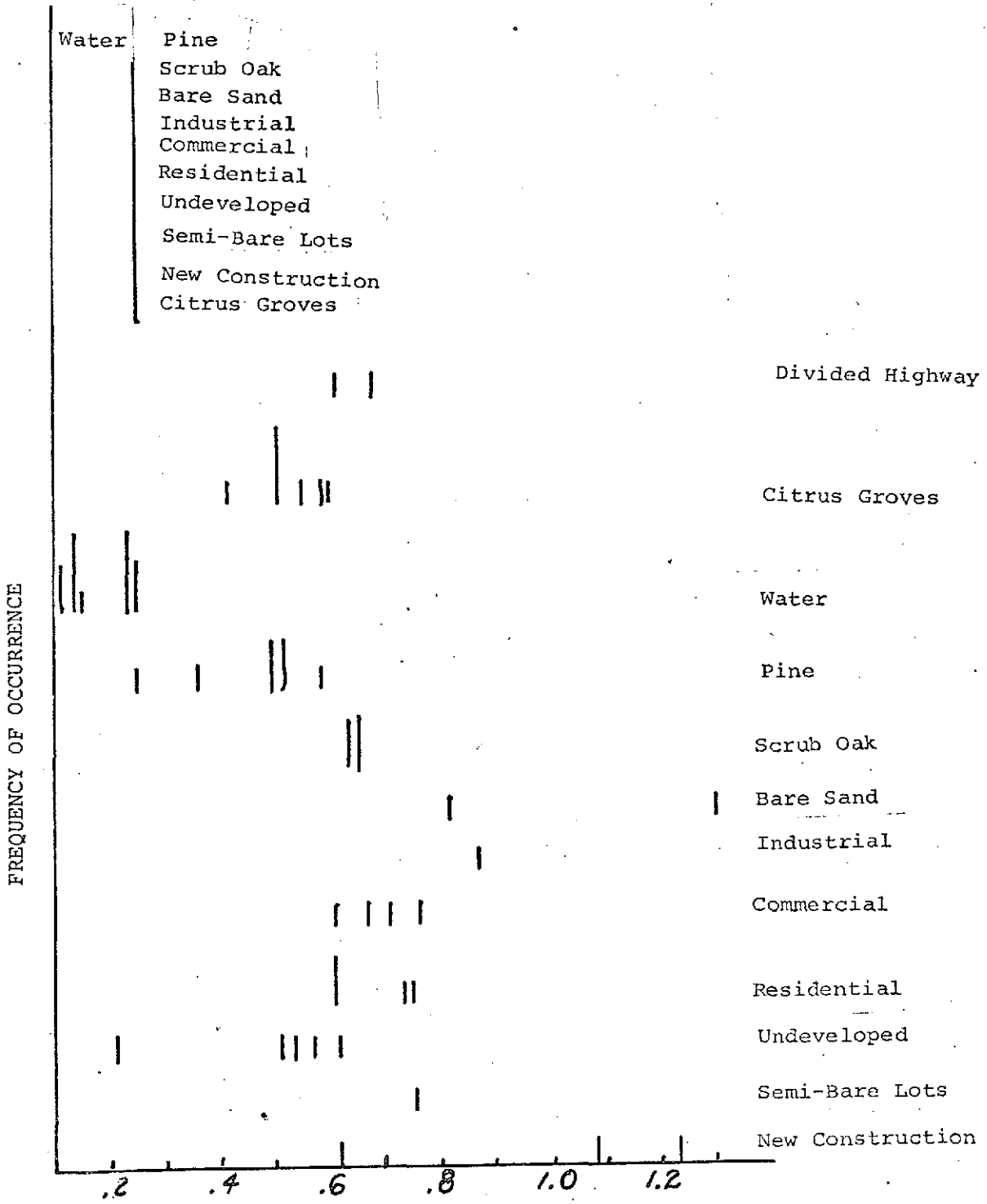
TABLE 4

LAND-USE CATEGORIES:

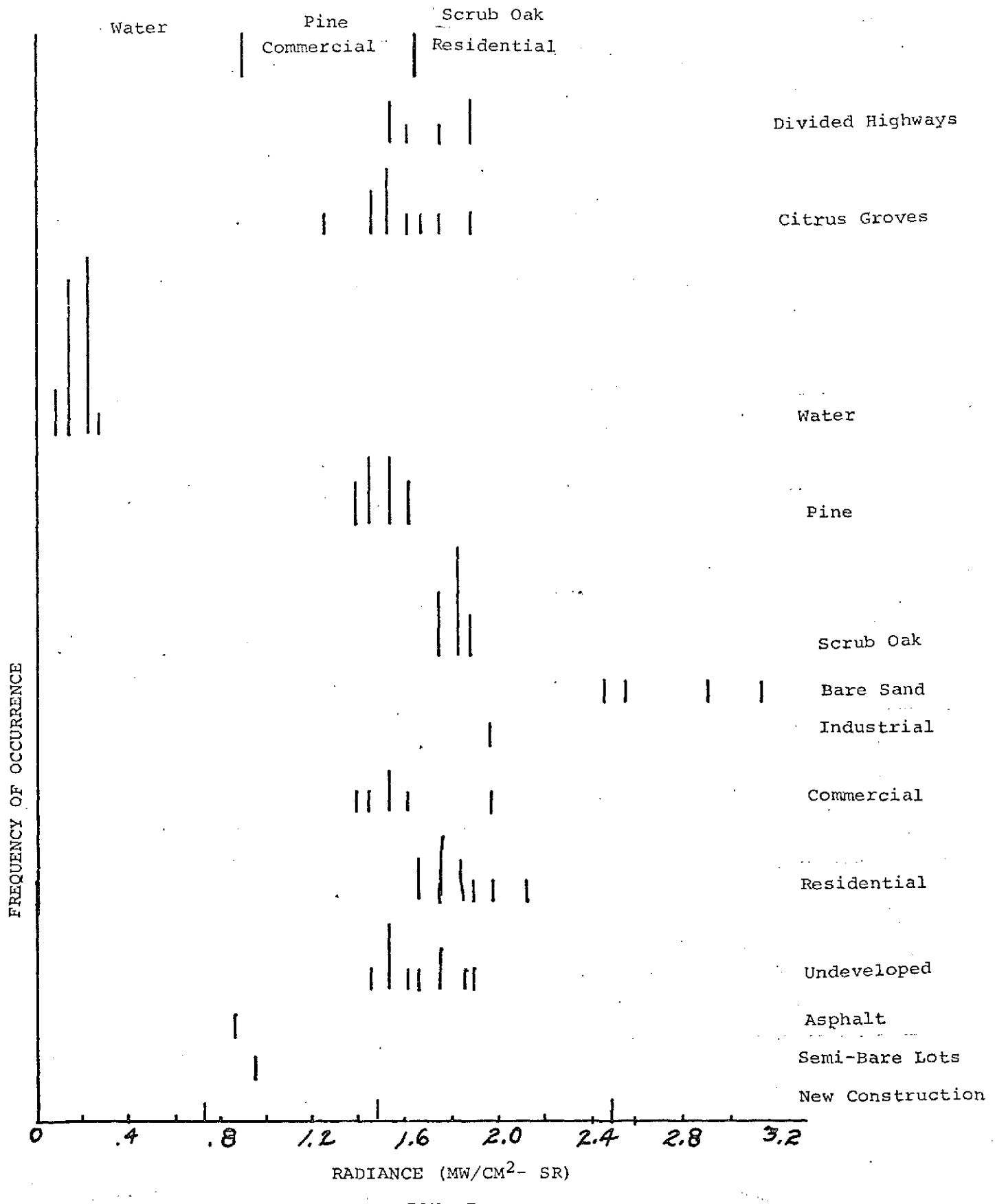
1st Pair of Digits		2nd Pair of Digits	
01.	Urban and Built-up Land	01.	Residential
		02.	Commercial and services
		03.	Industrial
		05.	Transportation
		07.	Strip
		09.	Open
02.	Agricultural Land	02.	Groves
03.	Rangeland	01.	Grass
04.	Forest Land	01.	Deciduous
		02.	Evergreen
		03.	Mixed
05.	Water	01.	Streams and waterways
		02.	Lakes
06.	Nonforested Wetland	01.	Vegetated
		02.	Bare
07.	Barren Land	03.	Sand other than beaches

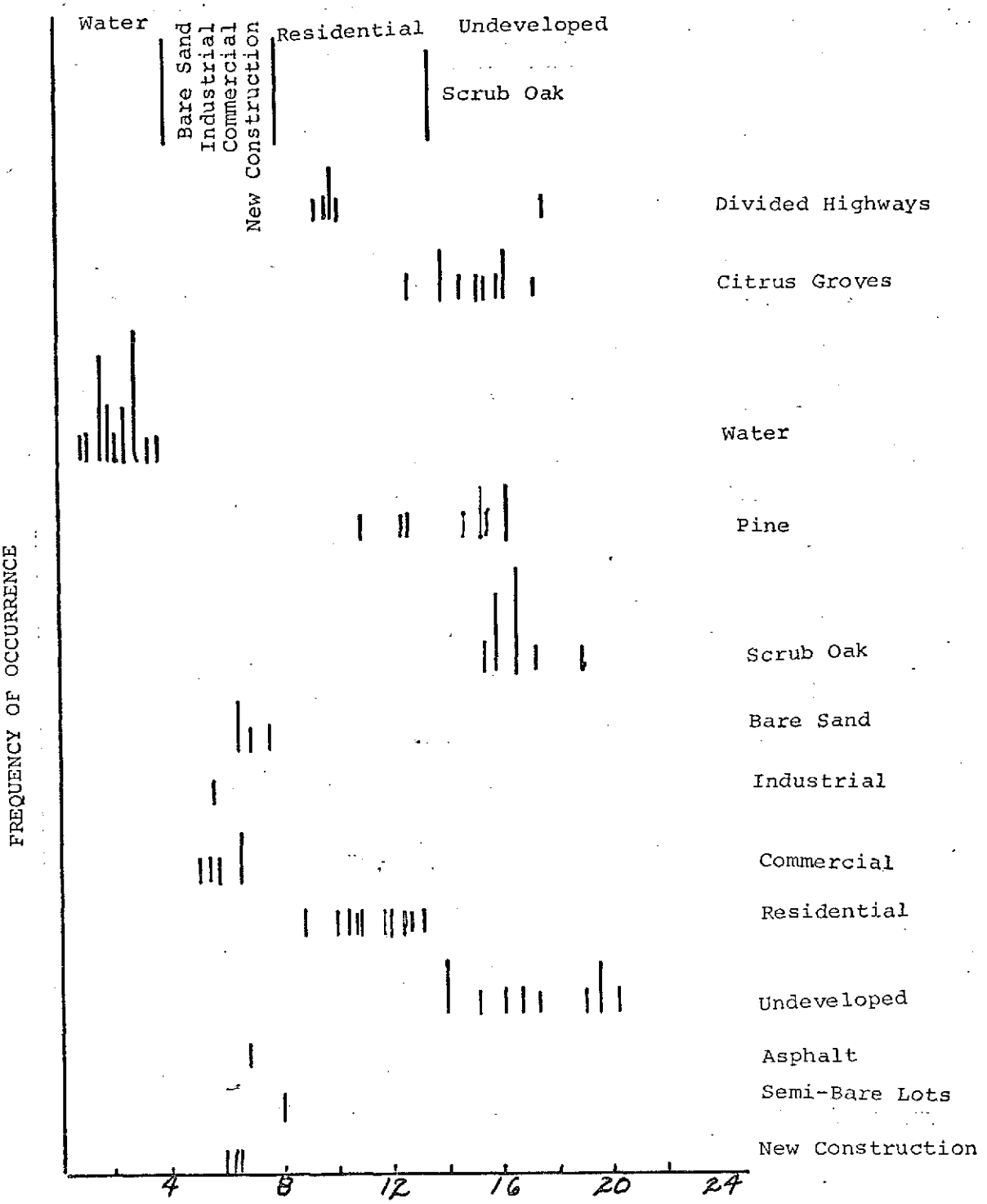

Citrus Groves
Water
Pine
Scrub Oak
Undeveloped
Residential
Bare Sand
Commercial
Industrial
New Construction
FREQUENCY OF OCCURRENCE
Divided Highway
Citrus Groves
Water
Pine
Scrub Oak
Bare Sand
Industrial
Commercial
Residential
Undeveloped
Asphalt
Semi-Bare Lots
New Construction
.1
.2
.3
.4
.5
RADIANCE (MW/CM2-SR)
BAND 4


Water
Scrub Oak
Undeveloped
Citrus Groves
Residential
Commercial
Bare Sand
Industrial
Divided Highway
Citrus Groves
Water
Pine
Scrub Oak
Bare Sand
Industrial
Commercial
Residential
Undeveloped
Asphalt
Semi-Bare Lots
New Construction
FREQUENCY OF OCCURRENCE
0
.1
.2
.3
.4
.5
.6
RADIANCE (MW/CM^2-SR)
BAND 5


Water
Pine
Scrub Oak
Bare Sand
Industrial
Commercial
Residential
Undeveloped
Semi-Bare Lots
New Construction
Citrus Groves
Divided Highway
Citrus Groves
Water
Pine
Scrub Oak
Bare Sand
Industrial
Commercial
Residential
Undeveloped
Semi-Bare Lots
New Construction
FREQUENCY OF OCCURRENCE
.2
.4
.6
.8
1.0
1.2
RADIANCE (MW/CM^2-SR)

BAND 6


Water
Pine
Commercial
Scrub Oak
Residential
Divided Highways
Citrus Groves
Water
Pine
Scrub Oak
Bare Sand
Industrial
Commercial
Residential
Undeveloped
Asphalt
Semi-Bare Lots
New Construction
FREQUENCY OF OCCURRENCE
0
.4
.8
1.2
1.6
2.0
2.4
2.8
3.2
RADIANCE (MW/CM2- SR)
BAND 7


Water
Bare Sand
Industrial
Commercial
New Construction
Residential
Undeveloped
Scrub Oak
Divided Highways
Citrus Groves
Water
Pine
Scrub Oak
Bare Sand
Industrial
Commercial
Residential
Undeveloped
Asphalt
Semi-Bare Lots
New Construction
FREQUENCY OF OCCURRENCE
4
8
12
16
20
24

7/5

Initial density-sliced mapping results indicate a significant increase in brightness of the April 28, 1973 data over the September 6, 1972 data, requiring adjustment of density levels so that unchanged features will appear the same for both dates.

LAND USE MAPPING

Density-sliced maps of bands 5 and 7 and maps of the 7/5 ratio indicate that the land use mapping technique discussed above (mylar overlay) for urban areas will be useful also for non-urban areas. Extensive, time-consuming ground truth observations will be required at least in the earlier stages of such a program.