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November 1974

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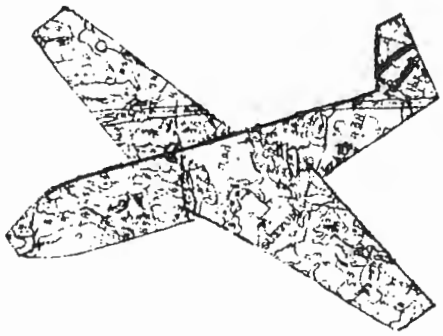
Remote Sensing 20 Years of Change in BARNSTABLE, DUKES and NANTUCKET COUNTIES Massachusetts 1951-1971



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The offset reproduction process selected for map reproduction shows all the detail of the USGS sheet in subdued tones with the land-use types shown on them in bolder tones. Maps which are clear and sharp on good paper suitable for coloring were reproduced for $.17 each in lots of 200.

LAND USE AREA STATISTICS

After the maps with the land-use types are reproduced, an atlas of four maps for each USGS quadrangle is colored to aid in acreage determination and to increase the usefulness of the maps. On one map only agricultural types are colored and the 11 agricultural types are grouped by similarity into five groups making up five broader types and each type has a separate color. On the second map the 40 forest types are reduced to seven groups, each group of similar types making up a broader type represented by a separate color. On the third map the 11 wetland types are grouped into four types for coloring and for consolidation. On the fourth map the 22 urban types are consolidated into six types for coloring. On this map the outdoor recreation facilities and mining and waste disposal types are also shown. The 15 outdoor recreation types are reduced to four while the five mining and waste disposal types are reduced to two. This kind of broader typing should prove useful to regional planners. Any user of the maps will need to color them in this pattern or in some other way to fully expose the information contained on them. Wax based crayons give most durable, uniform, and long-lasting coloring results. The maps have a color key which groups the 104 detailed types into 28 broader types for coloring and the same groups are summarized in the area statistics for those that need less detailed land-use area statistics. At a later date the 28 broader types will be mapped at a scale of 1" = 1 mile.

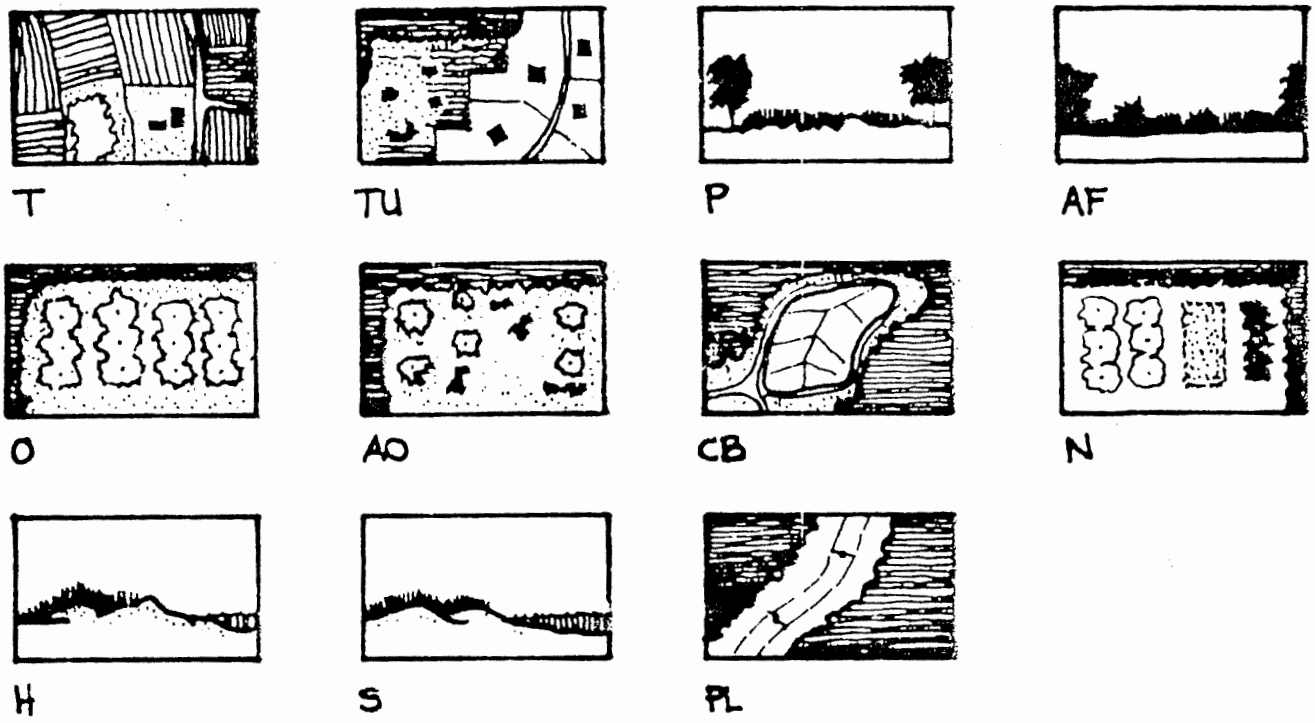
The acreage of land-use types is determined by dot grid on the colored maps and acreages are expressed by town, county, and the state. It takes about two man-days to color a map and two man-days to count dots to determine the acreage by types.

THE CLASSIFICATION SYSTEM

The classification system was made for use in southern New England and uses descriptive land-use terms common to that part of the country. Since each type is a homogeneous land-use unit, the types are comparable and therefore interchangeable with land use types used in other systems. With the addition of a few more types the system would be applicable to all New England and New York.

The classification system was devised to describe the nature of the land itself, the vegetation on the landscape, or the land use. The system includes only features that can be consistently and accurately interpreted on 1:20,000 scale panchromatic photographs taken when vegetation is in leaf. The classification system has six categories which are described below. The minimum sized typing unit is determined by the map manuscript scale and that size is three acres.

Agricultural or Open land



Type groups

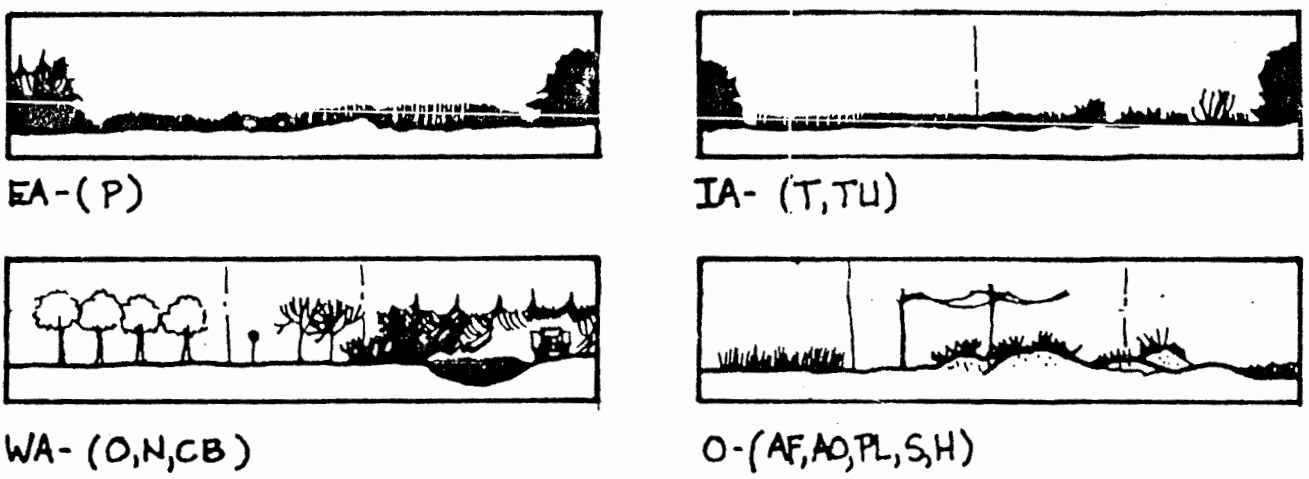


Figure 3.

Agricultural and Open Lands - 11 Types

One way to classify agricultural and open land is by the vegetation which it supports. To a degree, vegetative cover defines the land value, its aesthetic quality, its value for wildlife, and its potential for other uses. Vegetative cover, land use and the nature of the land itself are the basis of all the land classifications in this study.

T - is tilled or tillable crop land which is or has recently been intensively farmed. The boundaries on the ground are usually sharply defined and well maintained because the land is valuable. The land supporting farm buildings is included as part of this type.

TU - is unused tillable land which has not recently been tilled and is not part of an agricultural unit. This kind of land occurs near growing urban areas and it is usually mowed annually to maintain its value.

P - is pasture or wild hay land which is not suitable for tillage due to steepness of slope, poor drainage, stoniness, or lack of fertility. This land has less sharply defined boundaries and often has occasional scattered shade trees for the grazing animals.

AF - is abandoned field which is reverting to wild land. Woody vegetation and grass are abundant but tree crown cover is less than 30%. If the tree crown cover were greater than 30%, the land would be classified as forest. This land is highly productive of wildlife. Most of this land was pasture or wild hay land before abandonment.

O - is productive fruit orchard.

AO - is abandoned orchard. In addition to the decadent fruit trees, grass and woody vegetation are abundant in this type.

CB - is productive cranberry bog. Abandoned cranberry bog soon succeeds to a wetland type usually becoming shrub swamp (SS).

N - is land supporting nurseries. This type would include greenhouses and land adjacent to them as well as lands supporting horticultural specialties, ornamentals, shrubs and Christmas trees.

H - is the heath plant community as well as grass, shrubs, and other low vegetation found on poor sandy soils on Cape Cod and the adjacent islands.

S - is open sand areas which may support scattered herbaceous vegetation. Sandy beaches are a separate outdoor recreation type.

PL - is powerlines or buried telephone lines, gas or oil pipe lines or other right-of-way 100 feet or more in width maintained through wooded areas. Where powerlines cross agricultural or wetland and require no maintenance they are typed as the vegetative type or the land use permitted under them.

The 11 agricultural or open land types are grouped into five types for coloring on 1:24,000 scale maps. These five types will be used on maps made at a later date at a scale of 1:63,360 (1" = 1 mile) and the grouped types will use the symbols shown below. Next to the grouped types in parenthesis is the symbol for the types in the group and next to that is the wax-based Eagle Prismacolor or Castell color pencil used to color the type group. Since there are 28 type groups, careful selection of colors must be made in order for the eye to detect differences between them.

EA - Extensive Agriculture (P) Eagle 918
IA - Intensive Agriculture (T, TU) Eagle 941
WA - Woody Perennials (O, N. CB) Eagle 923
O - Open Areas (AF, AO, PL, S) Eagle 917
H - Heath (H) Castell 134

Forest Lands - 40 Types

Forested land is classified by a system which describes the forest by species, height and density. Species differentiation is necessary because some species have greater value for wood products, for wildlife habitat, or have a greater resistance to recreational impact than do others. Height indicates tree size, while density determines light conditions under the stand and the likelihood of lesser vegetation growing under it. Species height and density together help to determine the visual quality of the forest. Tree species groups are designated by letters as follows:

S - softwoods constitute at least 80 percent of the stand.
H - hardwoods constitute at least 80 percent of the stand.
HS - a mixture of hardwoods and softwoods with hardwoods predominating.
SH - a mixture of softwoods and hardwoods with softwoods predominating.
P - forest plantations are indicated by prefixing the symbol P to the forest type symbol.

Tree height classes are designated by the numbers 1 through 6.

1. 1 ft. - 20 ft.
2. 21 ft. - 40 ft.
3. 41 ft. - 60 ft.
4. 61 ft. - 80 ft.
5. 81 ft. -100 ft.
6. Uneven heights (three or more height classes represented)

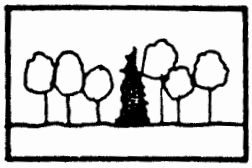
The density classes are designated by letters.

A. High density, 81 to 100 percent crown closure.
B. Low density, 30 to 80 percent crown closure.

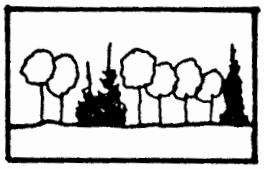
Density classes are not applied to 1 and 6 height class trees because it is difficult to interpret and not meaningful. This code method of classifying or typing forest stands lists species, height, and then density as in the following examples:

Forest Land

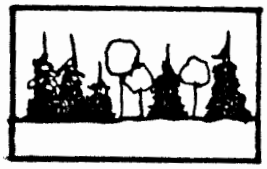
S



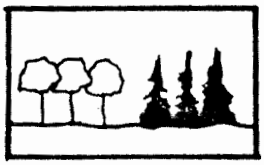
H



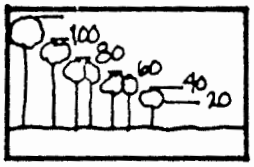
HS



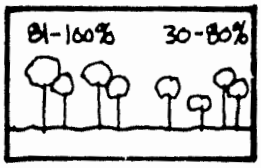
SH



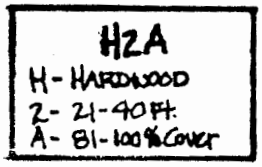
P



HEIGHT



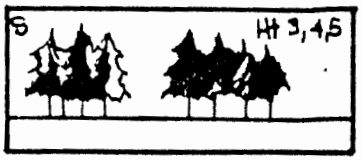
CANOPY COVERAGE



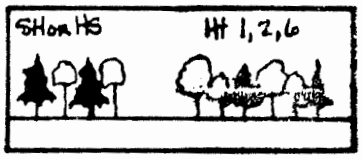
SYMBOL

Type groups

SSF

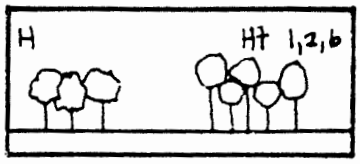


LSF

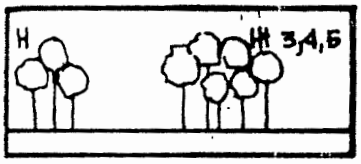


SMF

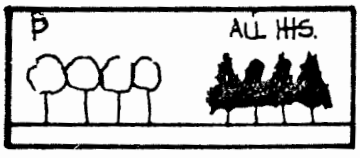
LMF



SHF



LHF



P

Figure 4.

H2A is a hardwood stand 21 to 40 feet in height with high density.
HS5A is a mixture of hardwoods and softwoods with hardwoods predominating. The stand is 81 to 100 feet tall with high density.

The 40 forest types are grouped into seven types for coloring on 1:24,000 scale maps. These seven types will also be used on maps made at a scale of 1:63,360 (1" = 1 mile) and the following group type symbols will be used:

SSF - small softwood forest (S) 1, 2 and 6 heights Castell 161
LSF - larger softwood forest (S) 3, 4 and 5 heights Castell 155
SMF - small mixed wood forest (SH and HS) 1, 2 and 6 heights Castell 167
LMF - larger mixed wood forest (SH and HS) 3, 4 and 5 heights Eagle 911
SHF - small hardwood forest (H) 1, 2 and 6 heights Eagle 913
LHF - larger hardwood forest (H) 3, 4 and 5 heights Eagle 910
PF - plantation forest (P) all plantations Eagle 944

Wetlands - 11 Types

The wetland classification is a modification of that used by the Office of River Basins of the U. S. Fish and Wildlife Service. That classification was simplified so that wetland separation could be accurately made on the 1:20,000 scale aerial photographs used in the study. Wooded swamps may be located by forest type symbols over the swamp symbols shown on the underlying U.S.G.S. map. Areas of wooded swamps are not kept separate from other forested areas in this study. The swamp situation on the U.S.G.S. maps is not verified by photo interpretation since wooded swamps cannot be interpreted on "leaves on" 1:20,000 scale air photos. They can be interpreted on 1:12,000 or larger scale "leaves off" spring photography.

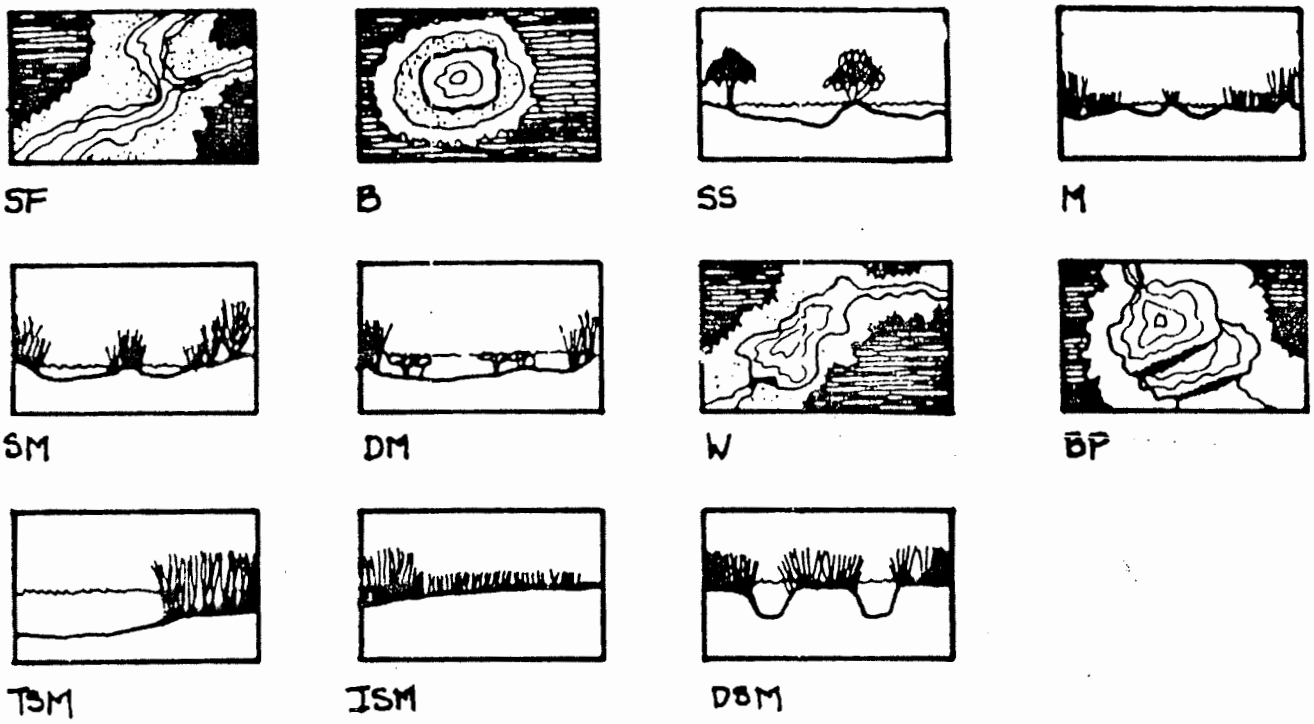
SF - is seasonally flooded basins or flats. This type occurs principally on stream floodplains and the most common plants are grasses and herbaceous species. The soil is waterlogged or covered with water during spring freshets, but well-drained during the growing season. This type is difficult to recognize on summer aerial photographs because it does not support a distinctive vegetation complex.

B - is bog. The typically acid, peaty soil is waterlogged and supports a distinctive plant community which usually includes most of the following: heath shrubs, cranberries, pitcher plants and sedges. Scattered black spruce, tamarack and red maple may be present. A mat of sphagnum moss is the most characteristic feature of bogs.

SS - is shrub swamp. The soil is waterlogged during the growing season and is often covered with as much as six inches of water. Common woody species are alder, buttonbush, dogwood and willow. Sedges are usually present in tussocks.

M - is meadow. The soil is waterlogged through most of the growing season and surface water is present only for a short period during the spring. Vegetation is predominantly grasses, rushes and sedges. Rushes, which grow in the wetter parts of many meadows, photograph very darkly making this type easy to identify.

Fresh and salt water wetlands



Type groups

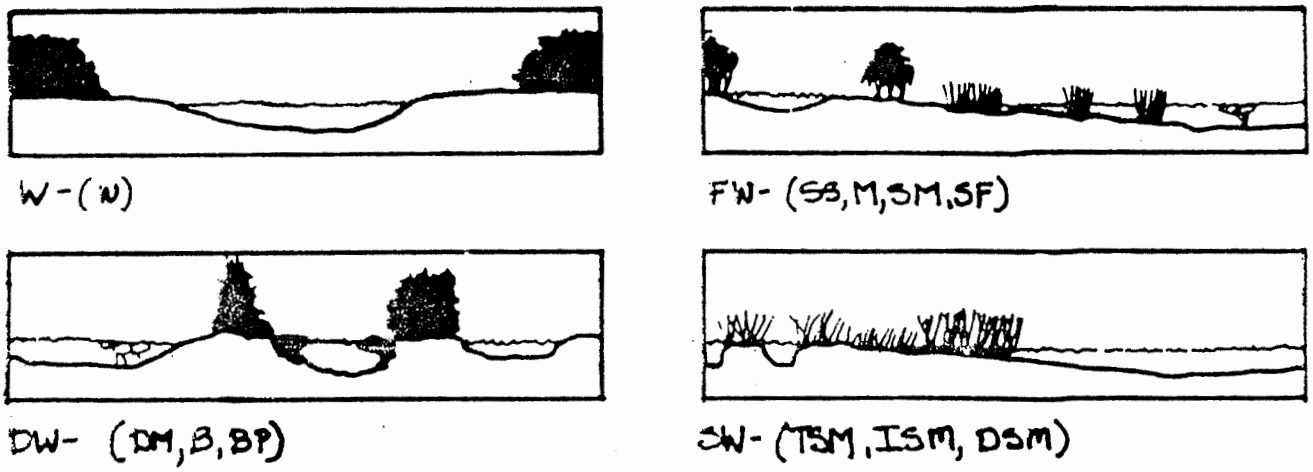


Figure 5.

SM - is shallow marsh. This type is wetter than meadow. The soil is completely waterlogged and often covered with up to six inches of water during the growing season. There is usually some open water and the predominant vegetation is emergent, including such plants as cattails, bulrushes, burreed, pickerelweed and arrowhead with some grasses and sedges present.

DM - is deep marsh. Water depth ranges from six inches to three feet. Fairly large open water areas are bordered by, or interspersed with, emergent vegetation like that found in shallow marsh. Floating and submergent plants such as water lilies, duckweed, watershield and pondweeds are also present.

W - is open water in lakes, rivers and large streams. Water depth is greater than three feet during the growing season. The boundary of coastal water is located by drawing a line at the river mouth to connect the edges of the coastline, or man-made features like roads, railroads or bridges crossing rivers or inlets are used to establish it.

BP - is beaver pond. These ponds resemble one or more of the above types but they owe their origin to beaver.

TSM - is tidal salt marsh which is flooded twice daily. Vegetation is primarily saltmarsh cordgrass.

ISM - is irregularly flooded salt meadows, flooded at monthly high tides and during severe storms. Vegetation is primarily saltmeadow cordgrass, saltgrass and black rush.

DSM - is ditched salt meadow which has been ditched for mosquito control or for agricultural purposes. Vegetation is the same as ISM.

The 11 wetland types are grouped into four types for coloring on 1:24,000 scale maps. These four types will be used on 1:63,360 scale maps employing the following group type symbols:

W - open freshwater (W) Eagle 919
FW - shallow freshwater wetland (SS, M, SM, SF) Eagle 920
DW - deeper freshwater wetland (DM, B, BP) Eagle 906
SW - saltwater wetland (TSM, ISM, DSM) Eagle 933

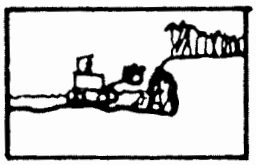
Mining or Waste Disposal Areas - 5 Types

Mining in Massachusetts is mainly for sand, gravel or stone. Waste disposal areas occupy much space and they usually have unsightly characteristics.

SG - Sand or Gravel - This land is used for the extraction of sand or gravel.

OM - Other Mining - This land is used for the extraction of stone and materia other than sand or gravel. Mining sites, though ugly to most, are fascinating to rock collectors.

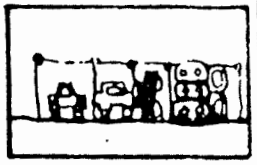
Mining and waste disposal areas



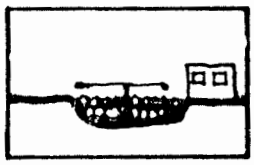
SG

OM

D



DA



FB

Type groups

M- (SG, OM)

WD-(D, DA, FB)

Figure 6.

D - Dump - This land is used for dumping waste and refuse materials such as tin cans. Active sanitary land fills would fall into this class. Once revegetated, these lands fall into one of the other land-use categories.

DA - Automobile Dumps - Automobile graveyards or active automobile junk yards.

FB - Filter Bed - This is land and associated buildings used for treating liquids containing organic or chemical matter.

The five mining and waste disposal types are grouped into two types for coloring on 1:24,000 scale maps and the following group symbols will be used on 1:63,360 scale maps:

M - Mining land (SG, OM) Eagle 914
WD - Waste disposal (D, DA, FB) Eagle 948

Urban Land - 22 Types

Land classified as urban for the most part encompasses a large number of people living and working in closely ordered structures in a confined land space. Urban limits are at the border of the block street pattern or just beyond it. Each urban type includes the access roads, parking facilities and other features which go with the complex. Industrial, commercial, residential and transportation lands make up the urban type.

UI - is heavy industrial land containing facilities for the manufacture, storage and assembly of raw or partially processed products such as machinery, metals, chemicals, petroleum, or electrical power. Such industries often have large smokestacks and large storage areas. Warehouses and transportation facilities for bulk products and an open and interrupted street pattern characterize this type. Air and water pollution as well as unsightliness are often characteristics of heavy industry.

UL - is light industrial land containing facilities for the manufacture or assembly of smaller, partially processed products such as electronics, appliances, and other secondary process products. Large smokestacks or raw material storage facilities are never present, air and water pollution are seldom a problem, and light industries are not apt to be unsightly. Many modern light industries are well landscaped and are indistinguishable from commercial activity on aerial photographs.

UC - is commercial land predominantly used for distribution, or merchandizing goods and services. Stores, hotels, offices, parking garages, apartment buildings and smaller warehouses are usually set close to streets having a close pattern. Trees are rare in downtown commercial areas. Most of the city people not living in residential areas live here. This type includes modern, landscaped commercial buildings away from the urban core.

Urban Lands

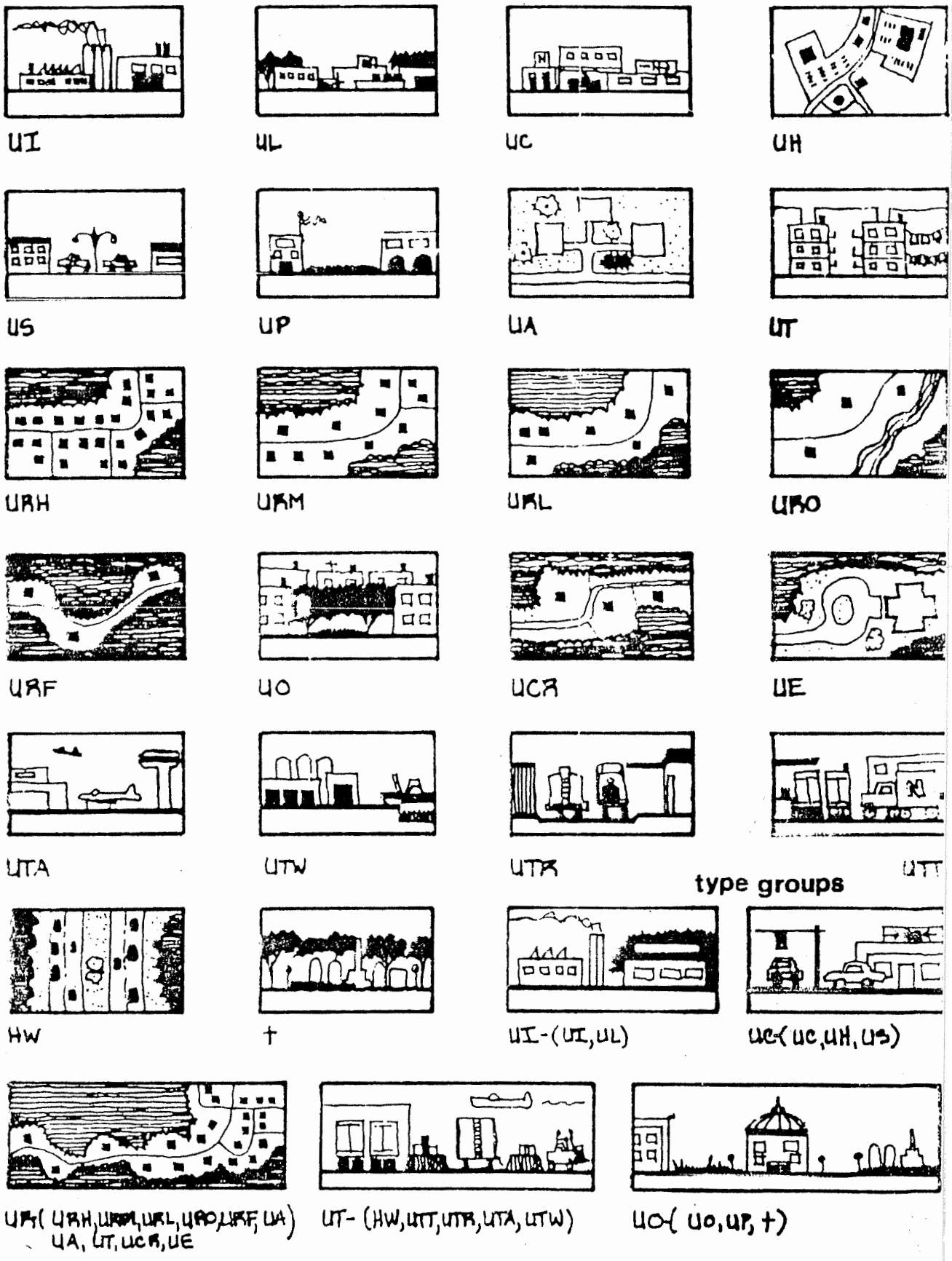


Figure 7.

UH - is highway commercial land used for merchandizing goods and services to the traveling public away from urban centers. Gas stations, motels, restaurants, drive-ins and stores located in strips along major routes of travel make up this type.

US - is shopping centers away from the urban core which are surrounded by large parking lots and may have some landscaping and trees as part of the complex. Theatres are often located in shopping centers to take advantage of the parking.

UP - is public or quasi-public land with "grounds" and green space which contains facilities to serve large numbers of people. Examples are: schools, colleges, churches, hospitals, state hospitals, prisons, etc. When located in the urban "core," public buildings without "grounds" cannot be identified on air photos and they would be classified UC.

UA - is "garden" apartments which are usually located outside the "core" city, are set back from the street, have some "grounds" and may have attached recreational facilities like swimming pools and tennis courts. Apartments without "grounds" in the "core" city are typed UC.

UT - is tenaments, town or row houses or apartment buildings set close to streets having a close pattern. They are for the most part three or more stories in height which helps distinguish them from URH, which are less than three stories tall. Some goods or services are sold here, but the area is predominantly used for high density urban living.

URH - is high density urban residential land used for homes which are spaced closely, set back from the street, and arranged in orderly rectangular patterns on lots less than 1/4 acre in size. Nearly all the street frontage for these building lots is in the vicinity of 50 feet and many of the streets are laid out at 200' intervals. There are about eight dwelling units per acre. These are usually located in older urban areas, or are cottages near the ocean, or are mobile home parks.

URM - is medium density residential land used for homes which are spaced closely and arranged in orderly curved or rectangular patterns and set back from the street on lots which are predominately 1/4 or 1/2 acre in size. Most of the street frontage is 100' in width and there are two to four dwelling units per acre.

URL - is light density residential land with lot sizes from 1/2 acre to one acre in size. Most of the lots are one acre in size and there is one dwelling unit per acre.

URO - is open, very light density residential land with large lots from one acre to two acres in size.

URF - is very light density, forested, residential land with large lots greater than one acre in size with forest cover. In this type only space for the house and a small lawn are cleared in the forest. More than 75% of the forest is left intact in this type where the lots are predominantly two acres in size.

UE - is estates three acres or more in size with extensive lawns, gardens, shrubs and other "grounds."

UCR - is clustered residential land with clusters of three to ten domestic dwellings in farming or forested areas.

UO - is open undeveloped land which is lying idle in the midst of urban areas or adjacent to them. Such land awaits an opportune time for development. This type includes land which has been cleared for urban development of an unknown kind.

UTA - is airports with landing strips, hangars, parking areas and related facilities. Small airfields without runways, hangars or other specialized facilities are not typed as airports.

UTW - is docks, warehouses and related land-based storage facilities for water transportation and commercial fishing. Liquid storage facilities like tank farms may be part of this type.

UTR - is railyards, terminal freight and storage facilities as well as rail stations for passengers. This type may include liquid storage facilities like tank farms.

UTT - is terminal freight and storage facilities for truck freight including liquid storage facilities. Bus terminals are included in this type. Transportation facilities which are part of an industrial complex are included as part of the industrial type.

HW - is divided highways with 200 feet or more of right-of-way width. Narrower roads show on U.S.G.S. maps, but do not have their right-of-way mapped or measured for area.

† - is cemeteries. The cross symbols for older cemeteries are already on the U.S.G.S. base map. New cemeteries are added to the map. The area of cemeteries greater than 3 acres in size is measured.

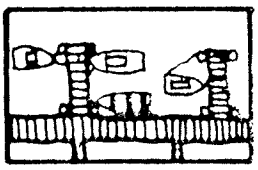
The twenty-two urban types are grouped into six types for coloring and the following group symbols will be used on 1:63,360 scale maps.

UI - Industrial land (UI, UL) Castell 127
UC - Commercial land (UC, UH, US) Eagle 922
URD - Dense, residential land (UA, UT, URH) Castell 183
URL - Low density residential land (URM, URL, URO, URF, UE, UCR) Eagle 916
UT - Transportation land (UTA, UTW, UTR, UTT, HW) Eagle 967
UO - Urban open (UO, UP, †) Eagle 908

Outdoor Recreational Facilities - 15 Types

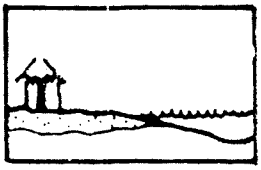
Outdoor recreation types are either water based, mainly for participation, mainly for spectators, or are environmental in character. Each recreational type includes the recreational complex: access roads, parking facilities, buildings and other related facilities. State parks, state forests, or town forests are

Outdoor recreation facilities

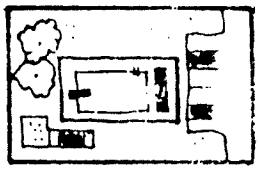


RM

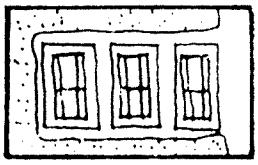
RFB



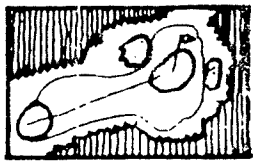
RSB



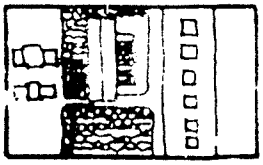
RS



RC



RG



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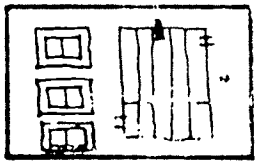
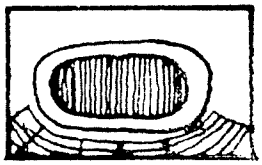
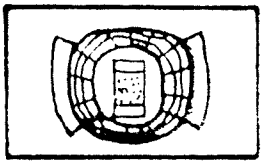


RPG

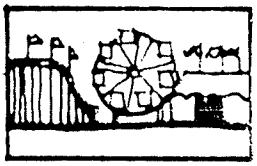
RSK



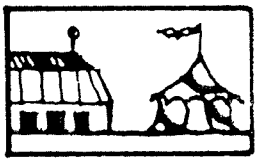
RT



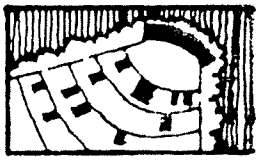
RA



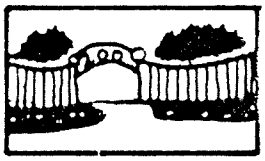
RAP



RFG

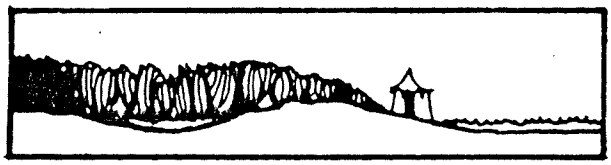


RI

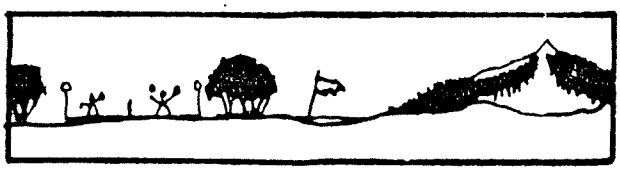


RP

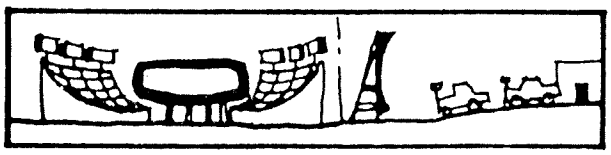
Type groups



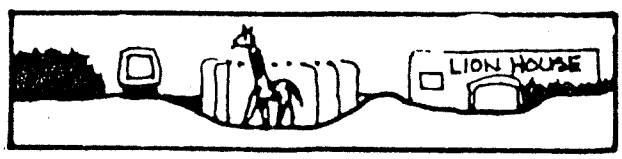
WR- (RM, RFB, RSB, RS)



PR- (RC, RG, RD, RPG, RSK)



SR- (RT, RA, RAP, RFG, RI)



ER- (RP)

Figure 8.

typed as forest land since they have no distinguishing features on aerial photographs. Many of these, however, are shown on the U.S.G.S. base maps, but their area would be computed as forest in this study. Campgrounds were not typed because they could not always be located under forest canopies.

Water based recreation

RM - is marinas or boatyards.

RFB - is freshwater sandy beach. This type includes bathhouses, parking and related facilities.

RSB - is saltwater sandy beach. This type includes bathhouses, parking and related facilities.

RS - is swimming pools. The complex including bathhouses and parking facilities must be three acres or more in size to appear on the maps.

Participation recreation

RC - is tennis courts. The complex must be three acres or more in size to be mapped.

RG - is golf courses. This type includes the club house and associated recreation facilities. If tennis or swimming facilities at country clubs exceed three acres they will be typed as RC or RS; if not, these recreation facilities will be part of the RG type.

RD - is golf driving ranges, skeet shooting ranges, archery ranges, etc.

RPG - is playgrounds. Playgrounds have a conglomeration of many types of facilities which may include tennis courts, swimming pools and athletic fields. If, however, any of these are three acres or more in size, they are separated out.

RSK - is ski areas for alpine skiing or ski jumping. This includes ski trails with the wooded space between them as well as the base facilities and parking area. Cross-country skiing trails cannot be located on air photos.

Spectator recreation

RT - is race tracks for horses, dogs or cars.
RA - is athletic fields and stadiums.
RAP - is commercial amusement parks.
RFG - is fairgrounds for agricultural fairs.
RI - is drive-in theaters.

Environmental recreation

RP - is an urban park or "common" which is intensively used "green space" in the city. A zoo would fall in this class.

The 15 recreation types are grouped into four types for coloring and the following symbols will be used on 1:63,360 scale maps:

WR - Water based recreation (RM, RFB, RSB, RS) Eagle 929
PR - Participation recreation (RC, RG, RD, RPG, RSK) Eagle 932
SR - Spectator recreation (RT, RA, RAP, RFG, RI) Castell 130
ER - Environmental recreation (RP) Eagle 934

APPLICATION OF THE LAND-USE CLASSIFICATION SYSTEM

The land-use classification system must recognize the limitations of the aerial photographs and the men and women who interpret them while striving for maximum utility of the maps and statistics produced from the photographs. More usable information is stored on the panchromatic aerial photograph than can be stored on any other kind of sensor. A number of other sensors can reveal information about land that will not appear on panchromatic photographs, but no other sensor records so much information in so usable a form. The philosophy of this project was to employ highly trained and sophisticated photo interpreters to work on standard photos with well tested specifications.

The procedure used in evolving the classification system was to set up an ideal vegetation and land-use classification based on photographic characteristics which met the requirements of the project. The next step tested the classification system extensively, dropping those types that the photo interpreters could not consistently and accurately recognize under all conditions. With eight natural resource specialists in eight different disciplines testing the system, each element of the classification system was closely examined. The 104 land-use types finally used can be recognized under all conditions on 1:20,000 scale "leaves on" panchromatic aerial photographs. Some desirable types like apartment buildings, parking garages, hospitals and other public buildings in the "core" city could not be consistently and accurately typed. The flood plains of rivers cannot be accurately typed either, so these and other desirable types were dropped from the system.

Nearly all parts of the system have been applied extensively on 1:20,000 scale, "leaves on," panchromatic aerial photographs over long periods of time at the University of Massachusetts. Some categories of land use are very easy to recognize by all trained photo interpreters while other types tax to the utmost the skill of the very sophisticated interpreter. Agricultural land, mining and waste disposal areas, urban land and outdoor recreation land are relatively easy for the trained interpreter to recognize. Wetlands are more difficult to separate while forests are very difficult for all interpreters to classify on aerial photographs. The beginning interpreter should gain experience with the simpler classifications and work up to the more difficult forest and wetland types. A continuous cycle of field reconnaissance with photos in hand, followed by analysis of the photographs under the stereoscope to type them, followed by an additional ground check of the maps made from the photographs will insure accurate photo interpretation and rapidly build the skill of the interpreter.