社会開発協力部報告書

No. 2 1

THE KINGDOM OF THAILAND
MINISTRY OF INTERIOR
DEPARTMENT OF TOWN AND COUNTRY PLANNING

CITY PLANNING MANUAL

VOLUME II MAPPING

THE STUDY ON APPLIED TECHNOLOGY FOR MAKING CITY PLAN

JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

THE KINGDOM OF THAILAND
MINISTRY OF INTERIOR
DEPARTMENT OF TOWN AND COUNTRY PLANNING

CITY PLANNING MANUAL

VOLUME II MAPPING

THE STUDY ON APPLIED TECHNOLOGY FOR MAKING CITY PLAN

JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

VOLUME II

MAPPING

(Table of Contents)

DETAILED TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

INTRODUCTION

INTRODUCTION

The city and town as a unit feature of the earth's surface has, like all other features, two associated aspects. The first is location or position and the second is form and internal structure.

It is axiomatic that location can only be understood through urban function: what a city and town does, or did in the past, determine its location and control its growth.

Location and distribution features of urban geography can be represented on the map by conventional symbols and scale, with photogrammetric technics and other methods.

Therefore, a map contains many items of information concerning urban facilities, urban characteristic patterns and geographical features, and these items of information are collectively a major facet of city and town planning.

Maps may be divided into many classes or categories depending upon objectives, repression, methods, etc.

Most popular classifications are based on the graphical representation on the map.

One type is the "Planimetric map". These maps geographically represent in the plan such natural and artificial features as streams, lakes, boundaries, conditions and establishments of culture of land, public works.

Another type is the "Topographic map", which includes not only some of the preceding features but also represents the relief or contour of the ground.

Maps of large areas, which show the location of towns, geographical featured, and boundary lines are called "geographic maps".

Maps, which show the general location of some kind of built element human being, are designated by the name of the elements represented.

Maps of this type, which emphasize a single topic and where the entire map is devoted to show the geographic distribution of a specific subject, are called "thematic maps".

The topographic map or existing land use map may occupy the most important place in thematic maps.

Illustrated maps are often called "analytical maps" when they include information about special problems which have been thoroughly analyzed.

Note : the item "thematic map" is often used interchangeably with "analytical map.

Different Types of Maps

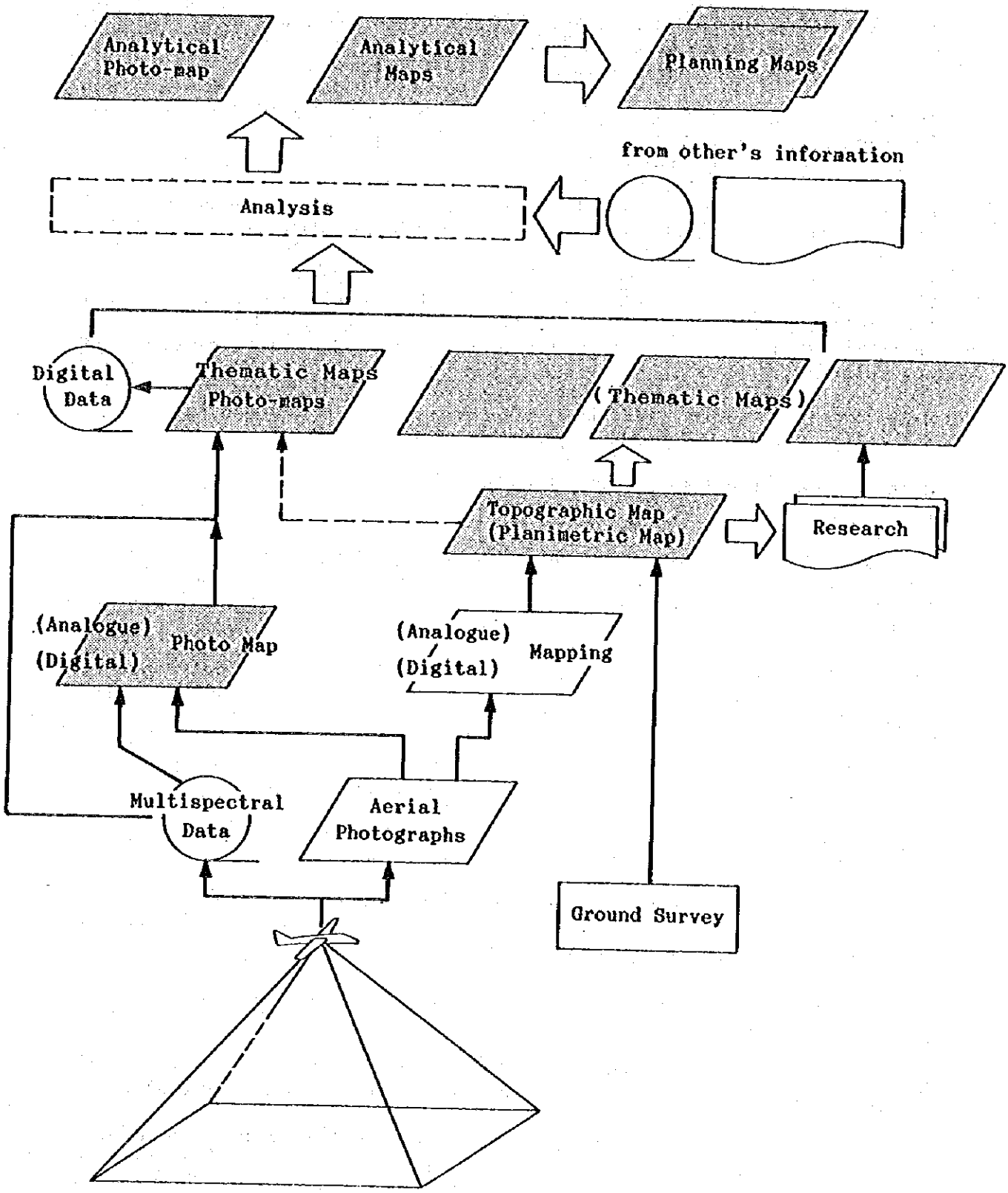


Fig. 1-1 GENERAL IMAGE OF MAPS

The above relations hips among the above mentioned maps are shown in Fig. 1-1.

The manual is produced in such a manner as to accommodate as far as possible, the specific suggestions and current problems of the Mapping Division of DTCP.

The manual is divided into three parts and two appendices.

Chapter 1 contains basic definitions and descriptions of the various kinds of maps.

Chapter 2 describes the manner and procedure of mapping.

In this chapter, the kinds of methods used (including new methods), and the way of measurement are presented.

It includes the actual mathematical introduction to concepts of the new-adjustment method, surveying accuracy and allowance.

It also deals with the taking of aerial photographs and its planning, and standard materials.

"Methods of determining area from maps" are covered in chapter 3.

Its also summarized in "Technical manual of case study".

In summary, this manual presents various topics of current mapping practices and various technical developments in the field of mapping and surveying.

Chapter 1

Basic Maps for City Planning

Chapter 1

Basic Maps for City Planning

1.1 The application of maps for city planning

Maps of urban areas can serve many purposes as follows[1]:

(1) Municipal programs
(2) Planning
(3) Traffic Engineering
(4) Highway and Street Engineering
(5) Water Supply, Storm and Sanitary Sewer Engineering
(6) Utilities Location and Management
(7) Parks and Recreation
(8) Emergency Services
(9) Others

There are many kinds of maps used for planning. The basic maps for the above applications are the topographic map and the thematic map which is produced for each objective. The relationships among relevant studies and maps are as follows:

(1) Municipal programs

Communities have a wide variety of agencies and organizations that use maps. Moreover, a wide variety of programs affecting the community require the support of adequate maps to be effective. Funds for the programs may come from local or State sources or a combination of sources. A set of properly designed community maps can satisfy all these needs, and they can be produced at far less cost than would be incurred if each map-using agency or program tried to satisfy its own needs without reference to other community interests.

(2) Planning

Planning is carried out at many levels and by many offices such as country planning, city planning, redevelopment planning, community development planning, regional planning, etc. Comprehensive planning requires interrelating local details with areawide systems, therefore, it would be impractical to recommend a single map scale to meet the needs of all planners. For studies where topography is important, as in engineering improvements and extensive public land projects, a topographic map with contours at appropriate intervals provides a good base for information.

(3) Traffic Engineering

For generalized studies, information on traffic flow, accidents, street widths, street jogs, street grades, and grade separations can be

(1) Large-scale Mapping Guideline, by American Society for Photogrammetry and Remote Sensing and the American Congress on Surveying and Mapping, 1986.

presented on the area maps. Traffic engineers concerned with corridors, expressways, signalization, offstreet parking, and street widenings throughout a metropolitan area need detailed maps.

(4) Highway and Street Engineering

A map is convenient for master plan transportation studies. All significant ground detail and the precise location and depth of all underground utilities should be shown on the maps. Since the exact mapping of utilities can be expensive, a practical method for preliminary location is to show all utilities in the area from recorded information only. Thus, the highway or street engineer will have the approximate location of all utilities for his preliminary work. Later, when the specific alignment of a particular transportation corridor or a highway interchange has been determined, the horizontal and vertical positions of the utility lines can be surveyed precisely in the limited area to be affected.

(5) Water Supply, Storm and Sanitary Sewer Engineering

Maps required by a municipal water-supply office are important partricularly with regard to scale and contour interval. For storm and sanitary sewer engineering, a topographic map will provide the information vital to a project. One significant additional factor, however, is that in designing a storm drainage system, a much larger watershed area must be considered to make allowance for all runoff that can affect the system. The proper disposal of storm water usually requires downstream terrain information and therefore larger areas of topographic map coverage.

(6) Utilities Location and Management

Both municipal and private utility companies or departments are prime users of area wide maps, and often private utility companies are willing to financially support coordinated mapping programs for common areas of interest.

Utility companies require high accuracy in the base maps, and some detailed fieldwork is usually needed to produce an adequate map with the individual utility lines shown in their proper horizontal and vertical positions.

(7) Parks and Recreation

Map requirements for parks and recreational purposes are usually met by a combination of small-scale area-wide maps and specific site maps with contours.

(8) Emergency Services

Police and fire department need maps showing all street and address-numbering systems.

(9) Others

Tax assessment and collection are a responsibility in some localities. The assessor's office has a coordinated set of maps of the entire country. The maps may vary widely in scale, age, accuracy, reliability, and content; but they should be considered in designing a new set of maps of the community since they may contain much usable data.

The city surveyor's office benefits greatly from a set of accurate topographic maps. The city surveyor's office, which is usually responsible for a wide variety of field surveys for many purposes, often finds that work is substantially reduced by the availability of accurate maps.

1.2 Basic Map Components

For a map to become a valuable source of information or a basis for planning, it should contain certain statements that will enable users to interpret clearly the data or informational reflected in the map. This is usually contained in a portion of the map known as the title block/column. The following information generally appear in the title block/column of maps:

(1) Map Title

The map title defines the information and purpose of the map. An example of map title is "URBAN LAND USE MAP." The example clearly shows that the map carries information on the different land uses of the urban center of a certain municipality.

(2) Legend

Legend contains the key to the codes and symbols used in the map. Without it, the features on the map would be useless source of information.

(3) Scale

The scale is the relationship of the distance between any two points on the map to the horizontal distance between the same two points of the ground. The scale enables users to measures the actual distance and location of the information reflected on the map. The scale is often expressed in two ways: the numerical and the graphical.

Numerical Scale - is the relationship of the map distance with that of the actual ground distance expressed in ratio form. For example, the map has a scale of 1:2000. it means that for every unit of map distance, there are 2,000 units of actual ground distance.

Graphical Scale - a graphical scale is a line or bar subdivided into map distance corresponding to the numerical scale.

(4) Area Coverage

Area coverage indicates the area, location, boundaries of the planning area expressed through political boundaries or natural boundaries. For purposes of systematic recording and referral, however, the coordinates as reference points in the map are being used.

Geographic Coordinates - the location of any point on the earth has been fixed by angular measurements from two planes of reference at right angle passing through the center of the earth. These two planes are known as latitude and longtitude and express in degrees. All points on earth surface has been fixed through geographic coordinates with a common reference point on the globe.

Plane Coordinates - plane coordinates are sued for small areas and are projected from a fixed position of a local system. Ways, however, have been devised for it to conform to the geographic coordinates.

(5) Date and Author

For the map to be of value, it should have the name of the author/maker of the map as well as the date of survey or period covered. The date or period would show that the information reflected on the map were true for the period concerned. A land use map, for example, drawn in 1975, would not necessarily mean that the information would still be true for the current period.

(6) North Orientation

Maps are generally oriented towards the north. However, the shape of the area covered may make other orientation preferable. The north orientation provides the user the proper perspective in interpreting the information on the map.

(7) Explanatory Text

For purposes of further clarification, interpretation and evaluation of the contents of the maps, an explanation may be made.

1.3 Different Types of Maps and Their Uses[1]

According to contents, maps may be classified as (1) general, (2) thematic, and (3) analytical.

A general map will show a complex of physical and cultural features. Most of the maps used in the classrooms which are physical and political in nature are general maps.

A thematic map is a simple outline map depicting one single feature of the earth's surface. The map may show population distribution, political units, soil, weather, forests and others depending upon the requirement of such map.

Analytical map is a map that illustrates the results of an analysis and synthesis of two or more variables/factors according to desired output, e.g. analysis of soil and slope characteristics of an area delineates land subject to erosion.

1.3.1 General Maps

1.3.1.1 Base Map

a. Characteristics

Base map is drawn using appropriate scales from the primary information derived from topographic maps. Base map is characterized by the information reflected on it. Such information are the following:

1) The boundaries of the area of study such as the political boundaries of municipality, province or special study area;

2) The permanent physical features of the study area such as major roads, harbors, streams, rivers and lakes etc.; and

3) Other pertinent information repeatedly shown in other maps such as map orientation, graphical scale, project titles or name of municipality, and legend and key symbols.

b. Uses in Land Use Planning

The base map serves as a working sheet for the preparation of various maps. It may also be used for the analysis of the characteristics and development within the area of study. Different types of information may be reflected and overlayed in the base map that would enable the user to visually relate development trends, constraints, etc. in the area of study.

---

(1) In the existing literature and in scientific communications, maps are classified according to different criterial.

Fundamental idea and explanation of each map in this chapter is quoted from a Town Planning Guideline and Standards (Mapping): Volume6 edited by the Human Settlements Regulatory Commission (HSRC) of the Republic of Philippines.

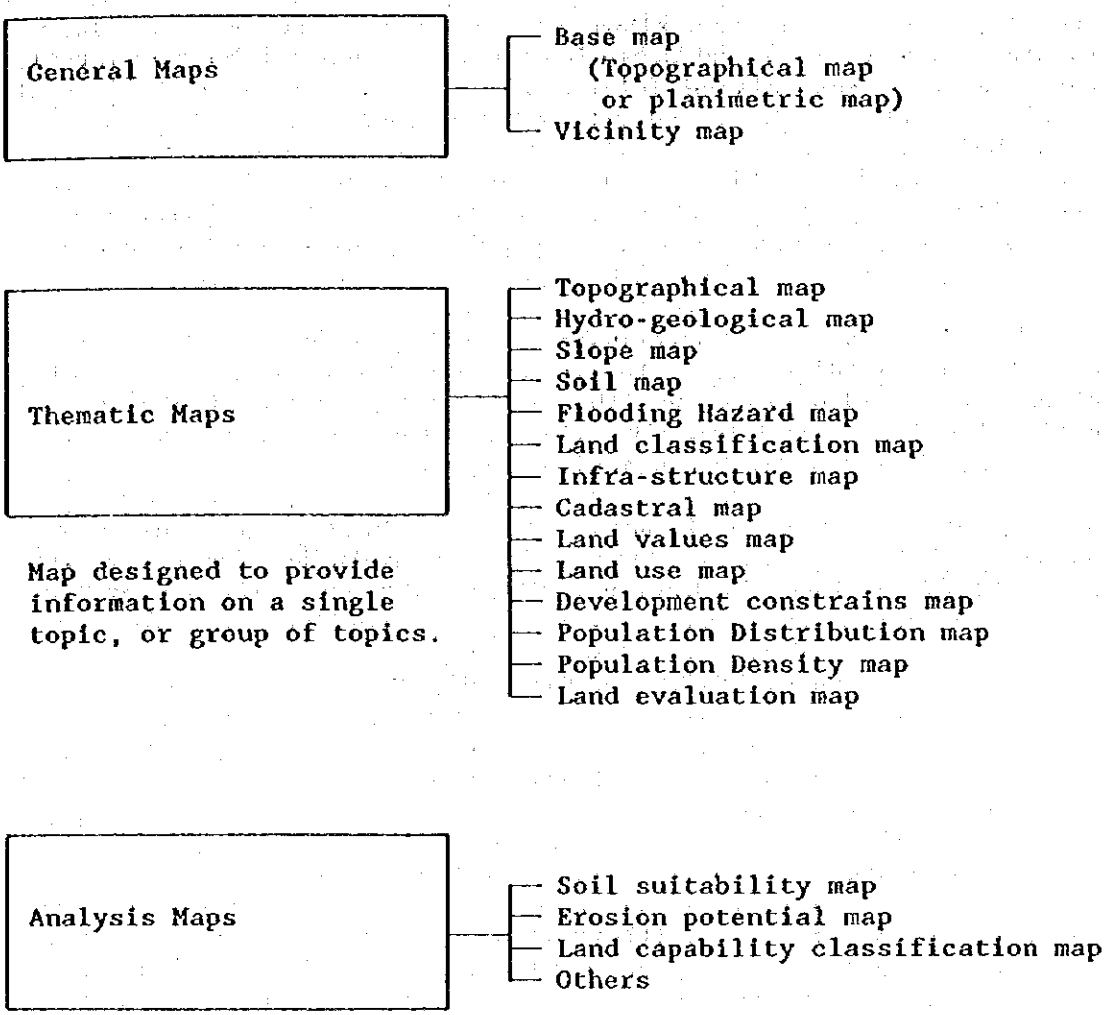


Fig. 1-3.1 CLASSIFICATION OF MAPS FROM THE PLANNING POINT OF VIEW

Generally, there are two kinds of base map prepared for land use planning: the general and urban base map, A general base map reflects broad and more generalized information. It is prepared in a smaller scale and reflects the boundaries of the whole study area, the major roads, built-up area and the important natural features such as streams, rivers and lakes. This map is used for general land use planning especially in the preparation of analysis map,k general land uses and for illustration purposes such as population distribution and density maps.

An urban base map, on the other hand, provides a more detailed information regarding urban areas. Prepared in a much larger scale, it reflects the road network and other important permanent features such as institutional sites, (schools, church, municipal halls, hospitals), monuments, playgrounds, parks and open space.

As a general rule, the scale of the base map should permit representation of needed details with reasonable precision. Suggested scales to be used in the various levels and nature of planning are as follows:

National Planning	1:1,000,000
Regional Planning	1:250,000/1:500,000
Provincial Planning	1:50,000
Metropolitan Planning	1:25,000
City/Town Planning	
a. General Use	1:10,000/1:20,000
b. Urban Use	1:2,000/1:4,000

(Note: For purposes of illustration and presentation as well as uniformity, the commission has standardized the size of the map rather than the scale for different mapping documents. The scale of the map is dependent on the scale appropriate for the map size).

1.3.1.2 Vicinity Map

a. Description

The geographic location of the study area in relation to the province/region is shown in the vicinity-location map. The extent of influence of the planning area is the basis for the encompassing area shown in the vicinity map. Often, the coordinates are indicated to show the specific location of the study area. In most cases however, the geographical location in relation to certain established reference points like provincial or regional boundary is enough to indicate location. The study area is distinguished from the rest of the vicinity map through the use of boundaries, political or otherwise, and by hatching or coloring.

b. Use in Land Use Planning

As the name of the map implies, the vicinity map is used to pinpoint specific location of the study area. The vicinity map could also be used as a tool for analysis on the influence and limitation of the planning area. It visualizes the effect of development and plans of the study area on the outlying municipalities/communities.

1.3.2 Thematic Maps

1.3.2.1 Topographic Map

a. Characteristics

The distinguishing characteristics of a topographic map are:

1) representation of the configuration of the earth's surface;

2) all man-made physical changes on the earth's surface such as houses, roads, buildings, cultivation and airports; and

3) natural features such as vegetation and bodies of water.

b. Interpretation

The most important feature of the topography is the relief which shows the elevation of the earth's surface. This is represented by contour lines. The contours are imaginary lines on the ground surface at a constant elevation above mean sea level. On the topographic map, successive contour lines represent elevation and the distances between each contour line is called contour interval which have fixed vertical distance such that the approved intervals for large and medium scale maps are 5, 10, 20, 40 and 80 meters. Thus, from these contours, the height of each hill, the depth of each valley and the approximate elevation and slope of the ground at any point can be determined.

Additional information are also represented by appropriate topographic map symbols and legend reflected in the map such as type of read surface, type of land vegetations, nature and use of structures. The political boundaries are not indicated in the topographic map.

c. Uses in Land Use Planning

1) Topographic map presents information on physical features which are important in the initial appreciation of the potentials and the limitations of land development.

2) It gives information of land forms, elevations, gradients and other data essential on the preparation of other analytical maps like the land capability and soil suitability maps.

3) Primary information needed in the preparation of base maps such as roads and other permanent features of the study area are taken from the topographic map.

4) It provides information on past land uses indicating structural changes influenced by the physical characteristics in the study area.

5) In the conduct of land use survey, it is more convenient to use topographic maps as working sheets to initially plot the different land uses. Contour lines in the map serve as reference points in the delineation of geographic boundaries

of various land uses. Moreover, topographic maps reflect such information as the location of roads, rivers, and other land marks which are useful reference points in the conduct of land use survey.

1.3.2.2 Hydrogeologic Map

a. Description

A hydrogeologic map carries data on fault zones, bedrock formation and the surface and ground water. The fault zones are areas where there is an observable amount of displacement below the earth surface. This indicates that the area is under constant stress and prone to earthquakes. The type of rocks/bedrock foundation shows the predominant rock classification of the land and the type of sedimentation that occurred in the area.

The surface water refers to lakes, rivers, and their tributaries and other water bodies on the earth surface.

The information on ground water include the following:

1) Water level contour - refers to the depth and area whereby ground water is available;

2) Piezometric Level - is the elevation to which an artesian aqulfier (water bearing rock structure) will rise in a well. This will show areas where water will rise naturally to the ground and areas where wells will have to be dug to a considerable depth as well as areas where natural well are not possible. Artesian aquifers are recharged with water through the capability of rainfall to readily infiltrate and percolate through the soil profile. There are five(5) categories of Aquifer Recharge Zones based on importance.

   a) crystalline rocks
   b) shale, siltstone, well bed tuff
   c) sand stone tuff
   d) rocky limestone
   e) buried valleys*

3) Permeability - refers to the case with which a fluid may pass through a perous medium expressed quantitatively as the coefficient of permeability. The permeability of the soil formation determines the availability and volume of ground water.

4) Bedrock quality type - refers to the stability and permeability of the underlying rock structure. The following shows four(4) categories of bedrock foundation based on compressive strength:

   a) fault/shear zones, alluvium
   b) nearly limestone and poorly consolidated sediments
   c) pyroclastic, shale and sandstone
   d) sediments, crystalline rocks, basic lava flows

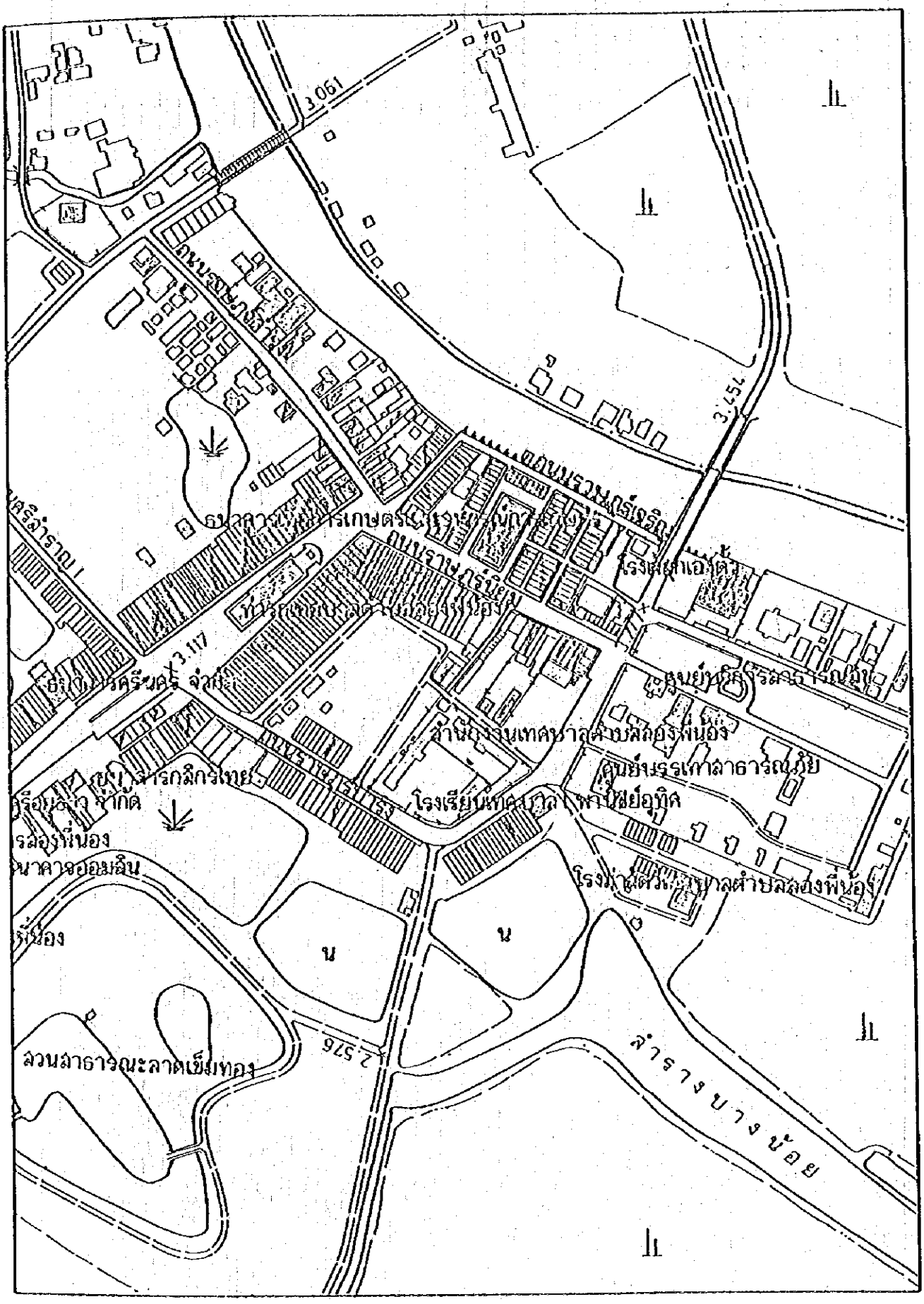


Fig. 1-3.2 TOPOGRAPHICAL MAP (1)

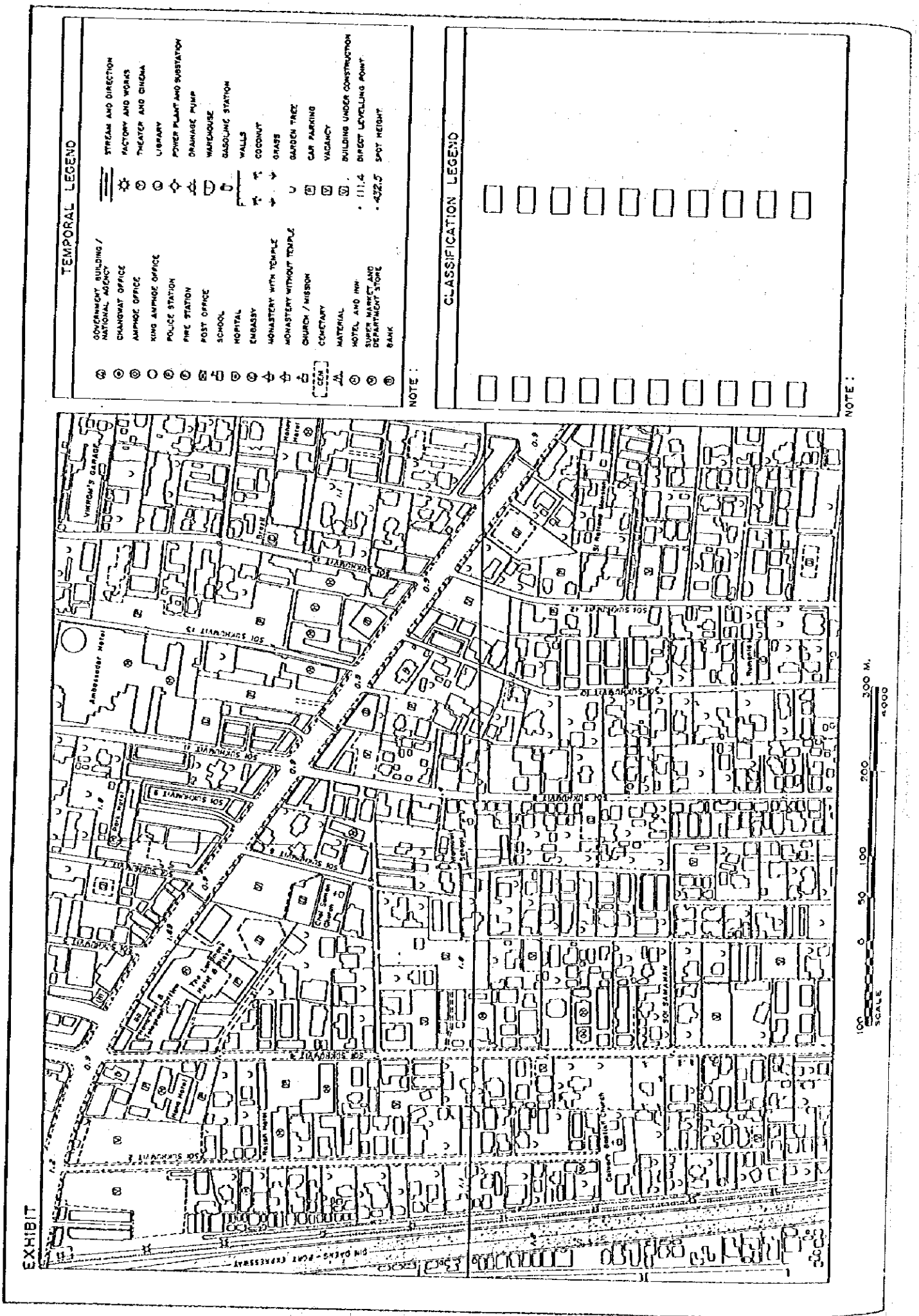


Fig. 1-3.3 TOPOGRAPHICAL MAP (2)

Table 1-3.1 Availability of Ground Water

I	IN POROUS FORMATION	PERMEABILITY
1.	Extensive and rich aquifers; alluvial deposit, mostly sand, gravel and silt; tuffaceous sandstone and silt stone	frequently high
2.	Local or disconnected aquifers; alluvial deposits, mostly sand, silt and clay; Agglomerate, sandy tuff, and beds Conglomerate and sandstone and silt stone	variable
II	IN FISSURED ROCKS	
1.	Local or disconnected aquifers; basalt and limestone; Marbelized limestone	frequently high
III	REGIONS IN GENERAL WITHOUT OR ONLY VERY LITTLE GROUND WATER	
1.	But not exceeding ground water at greater depth; conglomerate, shale, tuff and andesite; shale, sandstone, and conglomerate	low to very low
2.	Not even at great depth; volcanic rocks, andesite; diorite; undifferentiated volcanic rocks	

The presence of fault zones in the map indicates that the area is environmentally critical being readily subject to earth movements and absorption of pollutants from ground to soil sub-stratum.

b. Uses in Land Use Planning

1) Information of the availability and location of ground water would give users an insight on the ground water potential of the study area. This would be vital in locating structures and projects that would require or affect the availability of ground water. Examples of such projects are:

a) The establishments of water-work system may require the tapping of ground water. Locating reservoir would be dependent on ground water contour so as to assure continuous supply of water and prevent outflow of stored water.

b) The ground water potential is important source of water for irrigation needs of agriculture.

c) Locating industries and drainage system would require knowledge of the ground water contour so as to prevent seepage of pollutive substances to the ground water. Ground water could also be a vital source of water for industries.

2) The compressive strength of rocks could help determine location of industrial complexes, built-up areas and the type of structures to be put up.

3) The fault zone will show earthquake prone areas.

c. Map Preparation

The hydrogeologic map of a given municipality can be lifted from the maps prepared by the Bureau of Mines.

1.3.2.3 Slope Map

a. Description

The slope map shows the degree of inclination of a given area. This is expressed in percentage rise of land relative to its ground distance. The slopes are divided into categories based on the degree of inclination. The slope classifications are as follows:

Table 1-3.2 Slope Classification

0 - 3%	- board to level to nearly level land
3 - 5%	- gently sloping areas with land sloping in one general direction
5 - 8%	- gently undulating and rolling land sloping in more than one general direction
8 - 15%	- moderately undulating and gently rolling land sloping in more than one direction
15 - 18%	- steeply undulating and rolling land sloping in many directions
18% and over	- very steeply sloping and rolling land in many directions

b. Uses of Slope Map in Land Use Planning

1) The slope map gives an idea of the topographic characteristics of the study area.

2) It is an important input in determining suitable sites for urban development.

3) It is also important in determining land capability/suitability for various agricultural uses.

c. Map Preparation

1) Superimpose over the topographic map tracing paper large enough to cover the whole study area.

2) Delineate the boundary of the study area.

3) Starting from one point of the study area determine the slope categories by placing the slope template on the superimpose sheets adjusting to the distance between two contour lines.

4) Draw the boundaries separating different slope categories and make sure the slope categories are indicated to avoid confusion.

5) Continue following all the contours noting down slope category boundaries until the whole study area is covered.

6) Transfer the slope data to a municipal base map. If the scale of the maps are different, enlarge or reduce as the case maybe and identify the different slope categories using color codes or symbols.

1.3.2.4 Soil Map

a. Description

The soil map shows the different soil classification units found in a given area. These are grouped on the basis of their external or internal characteristics which include the soil series, soil type and soil phase.

A series as a group of soils that have the same genetic horizons, similar important morphological characteristics and similar parent material. It comprises soils having essentiality the same color, structure, consistency, range of relief, natural drainage condition and other important internal and external characteristics. In the establishment of a series, a geographic name is selected, which is usually the name of the locality or the names of the localities as the case maybe where the soil was first identified. A soil series has one or more soil types, defined according the texture of the surface soil. The class name, for instance, sand, sandy loam, or clay, is added to the series name to form the complete name of the soil. For example, Paete Clay loam is a soil type within the Paete series. The soil type, therefore, has the same general characteristics as the soil series, except for the texture of the surface soil. The soil type is the principal unit of mapping. Because of its certain specific characteristics, it is usually the unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, differing from the soil type only in some minor features, generally external that may be of special practical significance. Differences due to relief, stoniness, and extent or degree of erosion are shown as phases. A minor difference in relief may cause a change in agricultural operation or in the kind of machinery to be used. The phase of type with a light degree of accelerated erosion may need a fertilizer requirement and other cultural practices different from those of the real soil type. A phase of a type due mainly to degree of erosion, degree of slope, and amount of gravel and stones on the surface are usually segregated on the map if the area can be delineated.

The soil complex is a soil association composed of such intimate mixtures of series, types, or phases that cannot be indicated separately on a map.

b. Uses of Soil Map in Land Use Planning

The soil map is essential in determining land use suitability. The soil cover is primarily important in determining appropriate crops for certain areas as well as suitable fertilizer/additives in enriching the soil. It is also an important factor in infrastructure programs and urban development in determining strength and capability of the area to

hold and maintain infrastructure development. This may include the soil capability to hold water, erosion, susceptibility, etc.

c. Map Preparation

The soil map of a given municipality can be listed from the map prepared by authorities concerned.

1.3.2.5 Flooding Hazard Map

a. Description

The flooding hazard map shows areas where flooding usually occur or most likely to occur. Flooding is mainly caused by tidal fluctuation and intense rainfall.

The capability of the soil to absorb water and/or the capacity of natural/man-made drainage systems affect the susceptibility of an area to flooding. Low level areas and valleys are generally flood-prone areas.

A rough estimate of the degree of flooding hazard may be determined by soil drainage capability and the slope of the area. The five(5) categories of the capability to drain are as follows:

Table 1-3.3 Hazard Classification

Category	Soil Absorption Capability	Slope
1 no flooding hazard	well drained moderately drained poorly drained	any slope 5% over 8% over
2 slight flooding hazard	very poorly drained moderately drained poorly drained	15% over 3%-5% 5%-8%
3 moderate flooding hazard	very poorly drained moderately drained poorly drained very poorly drained	8%-15% 0-3% 3%-5% 5%-8%
4 severe flooding hazard	poorly drained very poorly drained	0-3% 3%-5%
5 very severe flooding hazard	very poorly drained	0-3%

b. Land Use in Planning

The flooding hazard map may be used in identifying environmentally critical areas that would require attention (like areas where stagnant waters may cause sanitation/health problems and urban areas occasionally under flood). It could also be used in determining the type and capacity of drainage and other environmental projects.

c. Map Preparation

1) Superimpose a tracing paper on the municipal soil map. Study the profile characteristics of each soil type to determine drainage capacity.

2) Draw the boundary lines to separate soils with different drainage capacities.

3) Examine each drainage capacity-slope combination formed and identify flooding hazard category.

4) Superimpose the drainage capacity map over the slope map of the same scale.

5) Indicate boundary of each area with different flooding hazard category.

6) Transfer flood hazard data to a municipal base map and use color coding to differentiate each category.

1.3.2.6 Land Classification Map

a. Description

Land classification map shows the various land classification as determined by the Bureau of Forest Development. The major categories of land classification are:

1) Forest Reserve
2) Parks and Wildlife Sanctuaries
3) Commercial Forest
4) Mossy Forest
5) Logged Over Areas
6) Alienable and Disposable Land
7) Swamp Lands/Water Bodies

b. Uses in Land Use Planning

Land classification map may be used in the following manner:

1) Identification of control measures regarding use development

2) Helps identify physical constraints of expansion areas for development

3) Identify the limits of alienable and disposable land or land that could be owned by private individuals

c. Map Preparation

The land classification map of a given municipality can be lifted from the maps prepared by the Bureau of Forest Development.

1.3.2.7 Infrastructure Map

a. Description

The infrastructure map serves as a chart of the location, distribution, volume and type of infrastructure utilities within the planning area. The most common infrastructure maps are the following:

1) Transportation Map - Indicates data on circulation system within the planning area. These includes bridges, roads, railways, ports, harbors, air-ports and navigable water bodies. The location, type and make of transportation infrastructures are also indicated.

2) Utilities/Facilities Map - indicates the different facilities/utilities within the planning area. Also indicated are the type and make of facilities/utilities. The most commonly used are:

   a) Power Supply
   b) Waterworks
   c) Telecommunications
   d) Drainage/Sewerage
   e) Schools/Public Libraries
   f) Hospitals/Clinics/Centers
   g) Fire/Police Stations/Facilities
   h) Religious Institutions

3) Irrigation Map - reflects the area coverage, type, and location of the existing irrigation systems. The three(3) types of irrigation system are:

   a) National Irrigation System - a system which is operated by the Office of the Special Projects of the Irrigation Development.

   b) Private Irrigation System - a system which is owned and managed by private individuals but with permit and technical advice secured from Irrigation Department.

4) Special Project Map - reflects the different infrastructure projects planned to be undertaken within the study areas such as dams, flood control projects, etc.

b. Uses in Land Use Planning

Infrastructure maps provide guide in:

1) determining infrastructure requirements/demands
2) locating infrastructure projects
3) identifying infrastructure adding improvement

c. Map Preparation

Power

1. Indicate the location of powerlines of the municipality on a base map by using the appropriate symbols.

2. Indicate also the generating capacity of the powerlines, source by using appropriate legend for the purpose.

Water

1. Indicate the location of the water district/waterworks system on a base map.

2. Indicate the capacity of the water

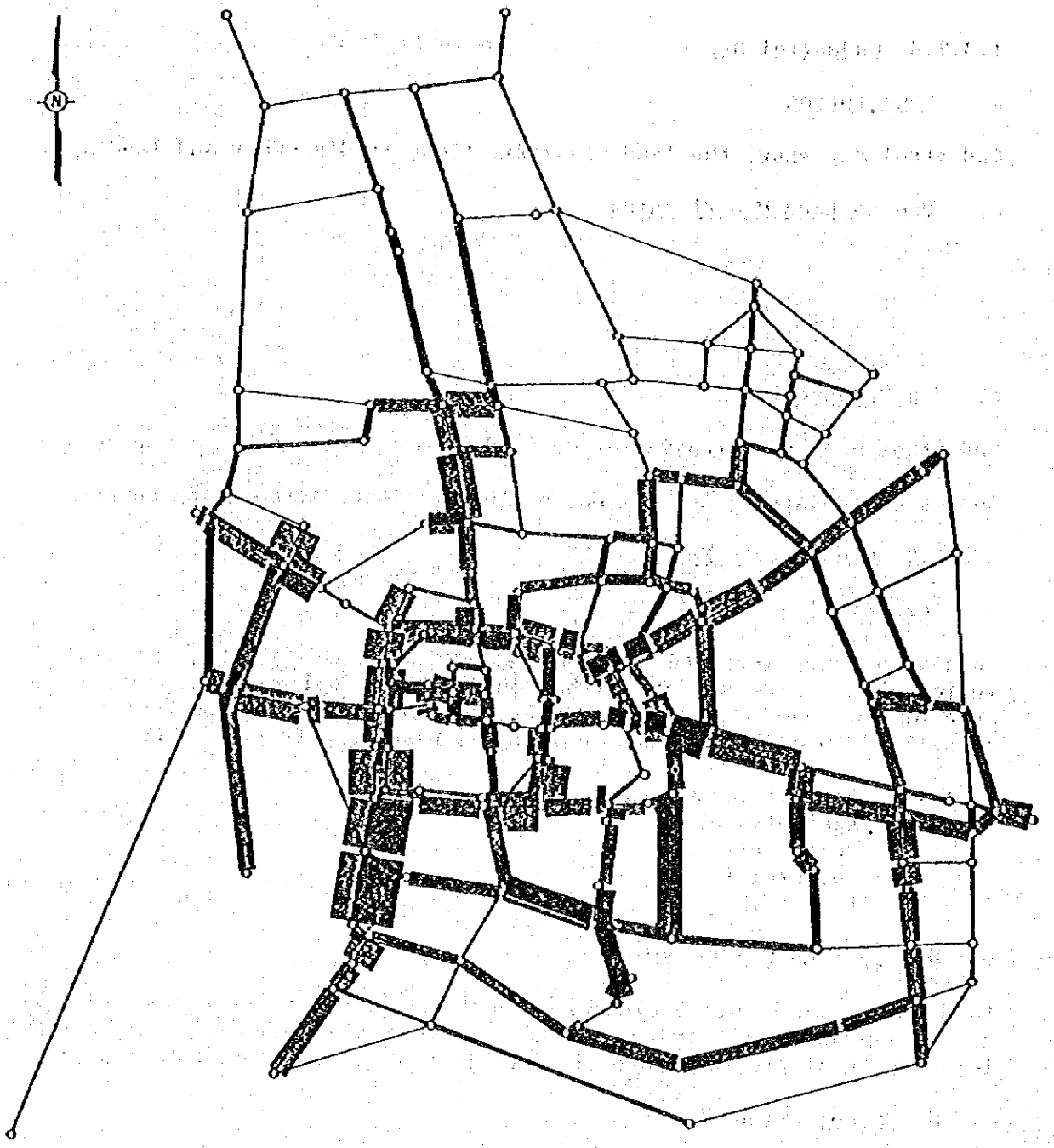


Fig. 1-3.4 TRAFFIC VOLUME MAP AT CHIANG MAI

1.3.2.8 Cadastrol Map

a. Description

Cadastrol Map shows the land classification, land's owner and land area.

b. Use in Land Use Planning

c. Map Preparation

Cadastrol maps are prepared or derived from actual cadastrol map survey.

Copies of cadastrol maps may be obtained from the Authorities concerned.

1.3.2.9 Land Values Map

a. Description

Land values map indicates relative prices and value of land in a given municipality. The map shows the boundaries of all real properties and area of each for appropriate valuation. Valuation of the land may be classified into five(5) broad categories based on its potential use:

1) natural resources
2) agricultural
3) residential
4) commercial
5) industrial

b. Use in Land Use Planning

Land values influence decisions on site selection for projects as well as for making proposals on the uses of land. It provides information for costing of projects involving utilization of additional land areas.

c. Map Preparation

Land values map are prepared from data/information on land values which can be obtained from the provincial/municipal assessor's office.

Applied Thematic and Analytical Maps

Isopleths of Land Values

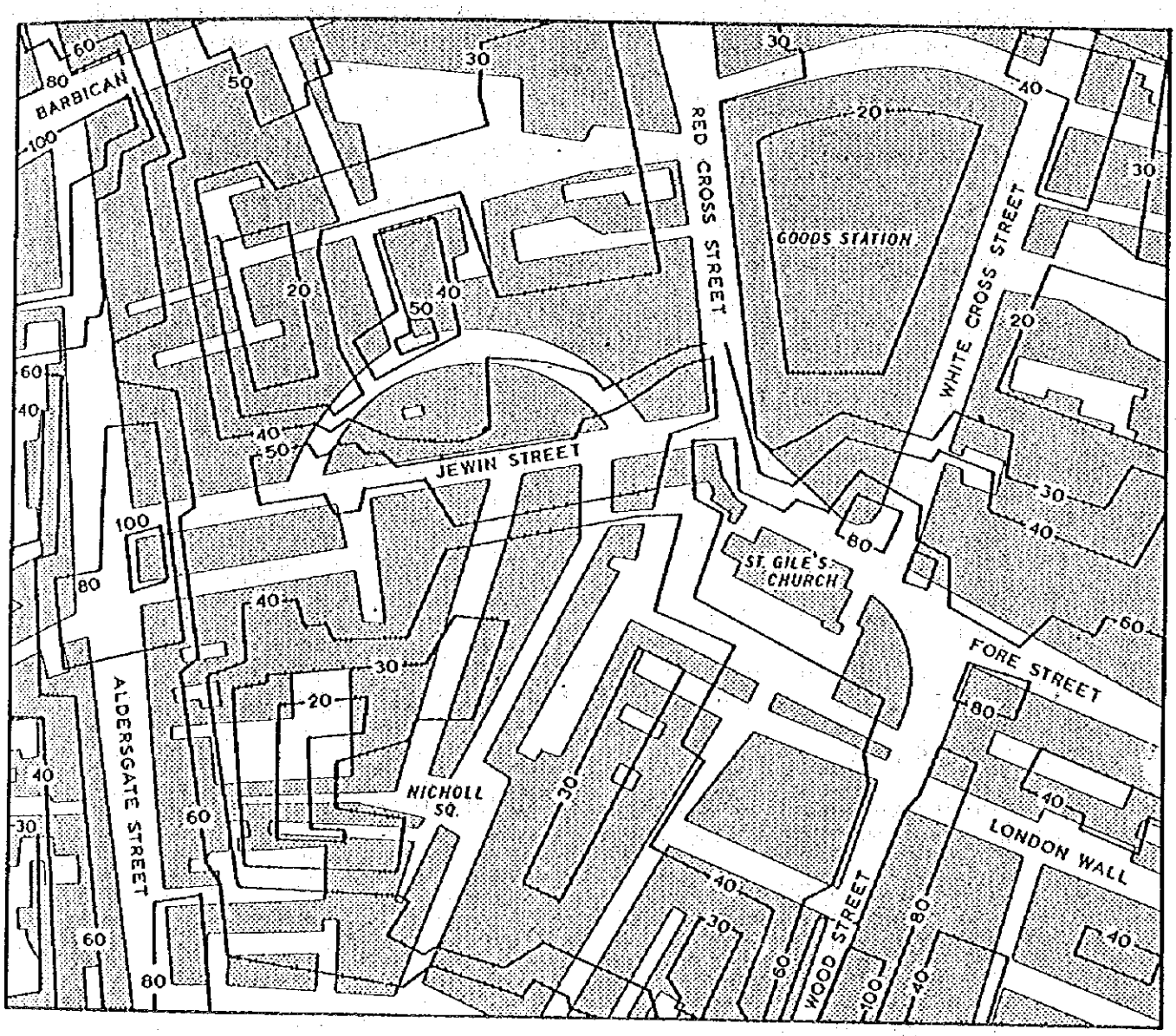


Fig. 1-3.5 ISOPLETHS OF LAND VALUES

This is part of a map which was drawn in 1953 by B. Anotrey (1965) Borbican area of London. This is a sample map of about "isovals", lines joining points of equal value.

1.3.2.10 Land Use Map

The land use map supplies information of the spatial dimension of the different land uses in a given area. It may also reflect planned distribution or allocation of land uses.

There are several types of land use maps based on the type of information and the detailed uses to be reflected. One may prepare an agricultural land use map reflecting agricultural land use distribution among different agricultural products or a forest land use map identifying the type of forest cover.

In the preparation of comprehensive development plans, the main concern is the inter-relationship of the different land uses in a given area. The following land use maps are usually attached to the plan.

a. General Land Use Map

It reflects the distribution of land uses covering the entire municipality. The most common information indicated on the map are:

1) Forest Land Use
2) Agricultural Land Use
3) Open Grassland
4) Built-Up Areas
5) Industrial Areas
6) Parks/Open Spaces
7) Rivers and Swamps

b. General Land Use Plan

It reflects the planned distribution of land uses of the entire municipality. It may also include areas for special uses.

c. Urban Land Use Map

It reflects the detailed distribution of land uses within the identified urban zone. The information supplied are:

1) Residential Areas
2) Commercial Areas
3) Institutional Areas
4) Industrial Areas
5) Parks/Open Spaces
6) Agricultural Areas
7) Rivers/Swamps
8) Special Projects/Uses

d. Urban Land Use Plan

It indicates the planned distribution of urban land uses. Differentiation of land uses based on intensity of uses for residential, commercial, and industrial areas may also be indicated.

e. Zoning Map

It reflects the spatial dimension of the zoning ordinance of the municipality.

f. Map Preparation

The various types of land uses are prepresented and distinguished on the the base map through the use of color coding or hatching land use map should reflect, whenever applicable, built-up areas, agricultural areas, forested areas. Open grasslands, swamps and other areas reserved for special uses.

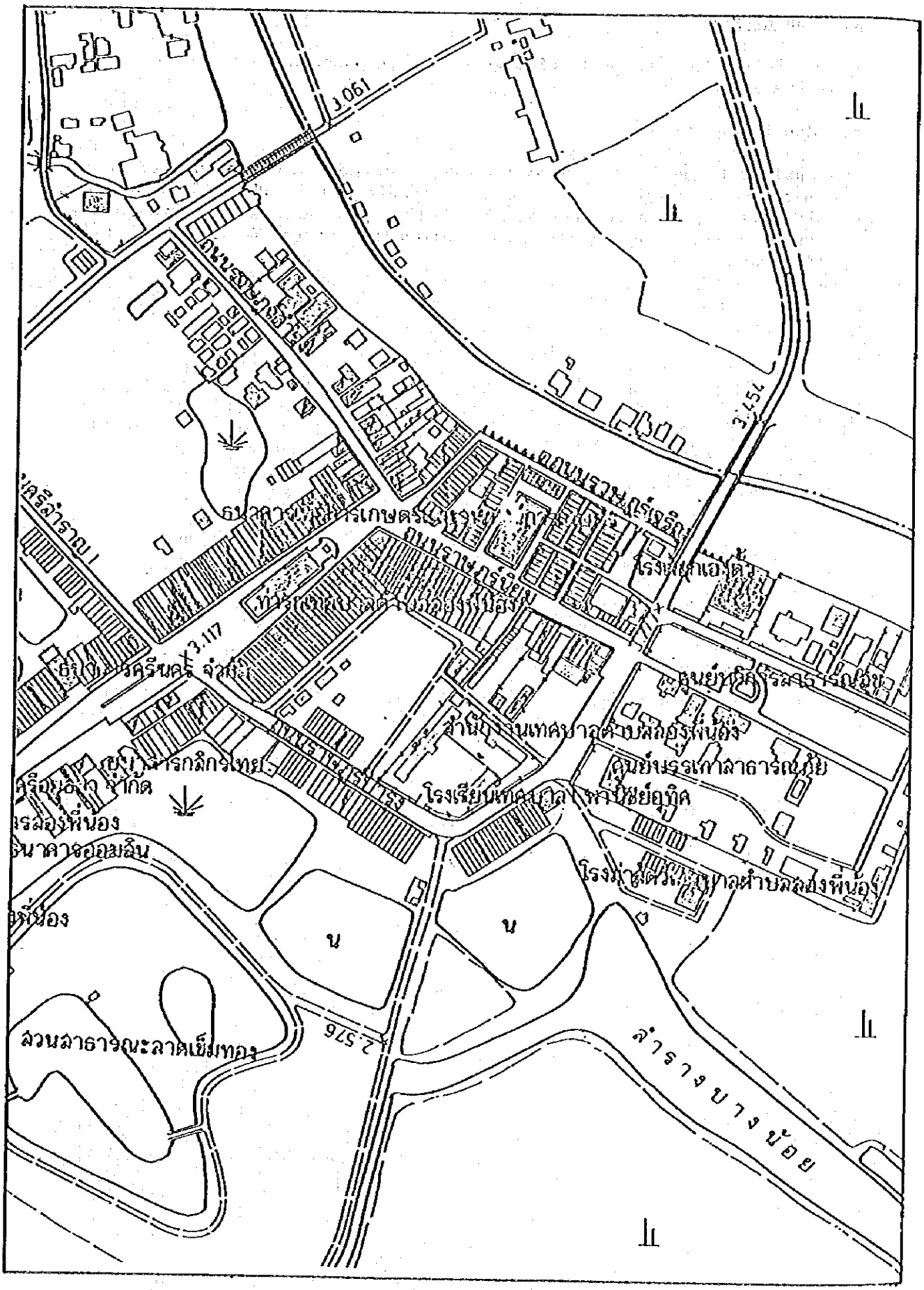
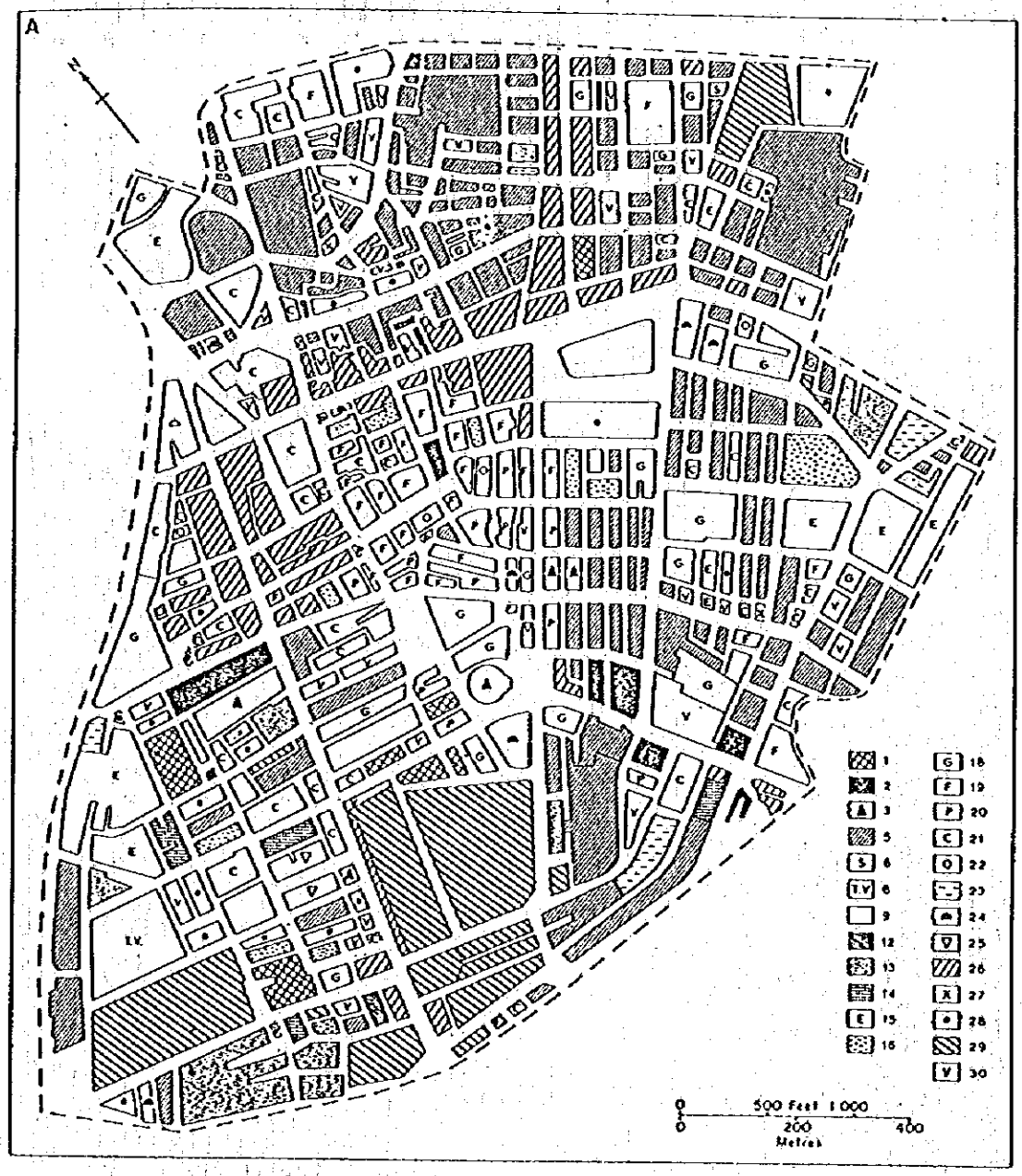


Fig. 1-3.6 LAND USE MAP (1)

Applied Thematic and Analytical Maps

Land Use Map



The key to the shading is as follows:

1:Churches and public places.
2:Entertainment.
3:Cultural including museums and libraries.
4:Indoor games.
5:Wholesaling and covered storage.
6:Open storage including builders' yards.
7:Commercial art studios.
8:Radio, T.V. and film studios.
9:Open land including parks and playing fields.
10:Waste and derelict land.
11:Special industry (mining, smelting or casting).
12:Light industry-those which could be carried out in a residential area without detriment to the amenity.
13:All general industry excluded from 11 and 12.
14:Health.
15:Education.
16:Cleared building sites and buildings under construction.
17:Miscellaneous including abattoirs, kennels and riding stables.
18:Government offices.
19:Financial offices.
20:Professional offices.
21:Commercial offices.
22:Other offices.
23:Public services.
24:Hotels.
25:Residential uses.
26:Retail.
27:Public houses.
28:Car parks.
29:Transport, including filling stations, railway land and airports.
30:Vacant.

Note:all the uses are not represented on the keys since only the relevant have been included. The full list is given here as an indication of the bases of analysis.

Fig. 1-3.7 (DETAILED) LAND USE MAP BY BLOCKS IN GENERAL MANCHESTER

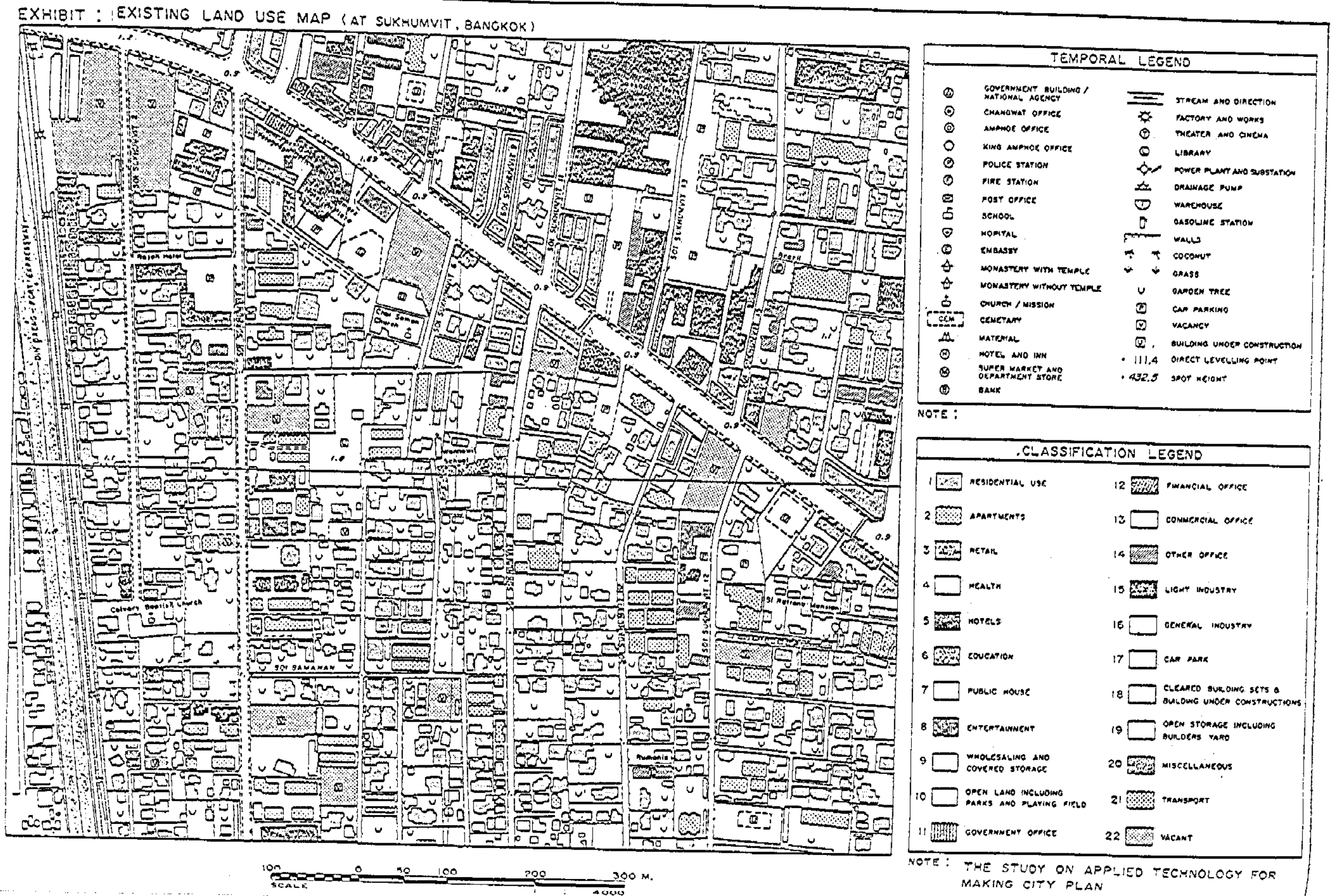


Fig. 1-3.8 LAND USE MAP (2)

Applied Thematic and Analytical Maps

Social Classification Map

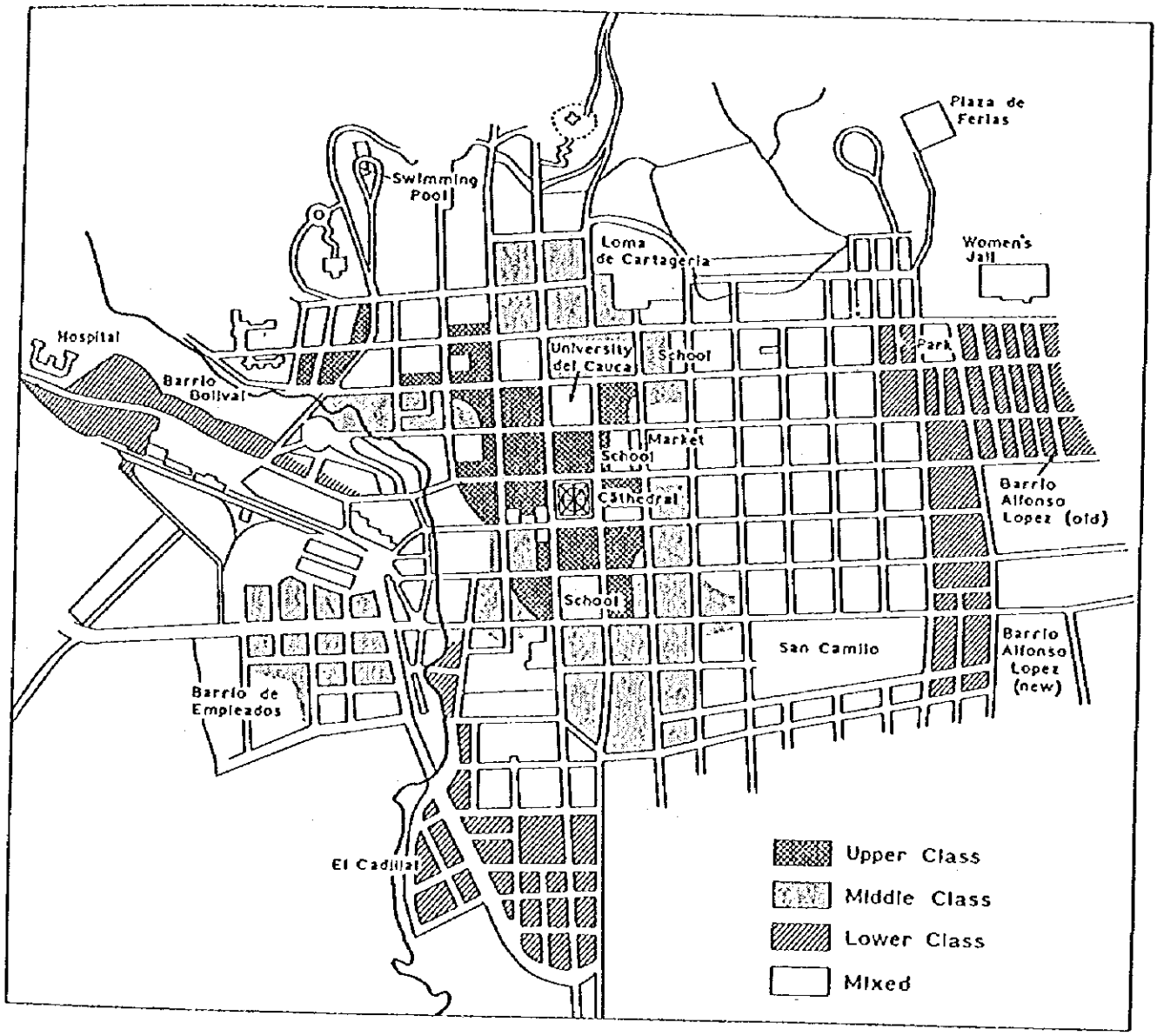


Fig. 1-3.9 SOCIAL CLASSIFICATION MAP

This map clearly depicts the reversal of the concentric zone arrangement of urban land uses in a town or pre-industrial character. The central association of the 'upper class' residential areas with the central institutions emerges clearly. After All. Whiteford (n.d.)

Applied Thematic and Analytical Maps

Urban Growth Map

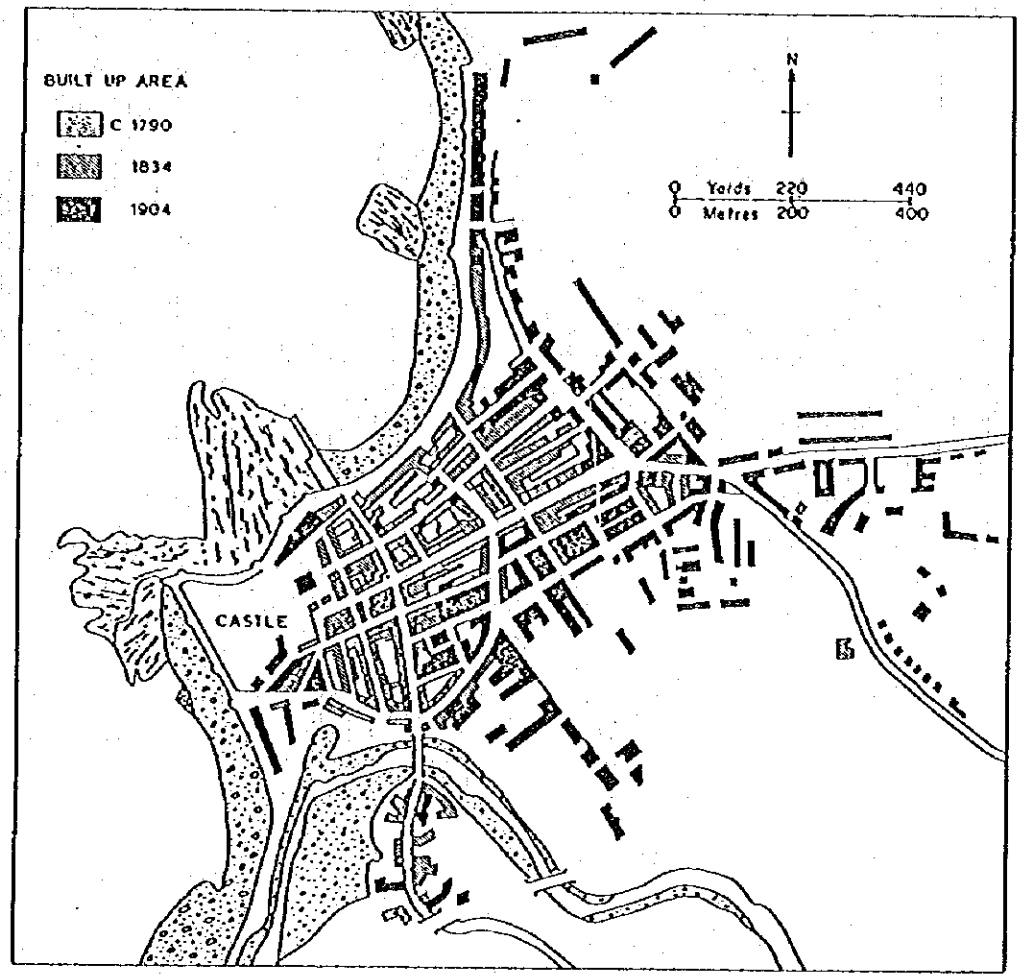


Fig. 1-3.10 URBAN GROWTH MAP

This map indicate the urban growth areas

1.3.2.11 Development Constraints Map

a. Description

A development constraints map illustrates the obstacles to development in the physical sense like subsidence or flooding risks. Such obstacles are best illustrated when a combination of several maps like soil hydrogeologic, topographic maps, is sieved.

b. Use of Development Constraints Map in Land Use Planning

The map is used in identifying areas for development with the least limitations.

c. Map Preparation

A development constraints map is prepared by overlaying the following maps:

1) existing land uses
2) land capability/soil suitability maps
3) special projects maps

When overlaying, consider that the map shall be the basis for delineating areas suitable for urban expansion as well as those for conservation and preservation. Thus, the planner should be able to identify built-up areas, marginal areas for agriculture but suitable for urban use, conservation/preservation areas either for environmental reasons or legislations and major infrastructure and industrial projects.

1.3.2.12 Population Distribution Map

a. Description

Population distribution maps are statistical maps which provide an immediate recognition of the geographic distribution of statistical data which may not be apparent from statistical tables.

Point Symbol Maps

Point Symbol maps are statistical maps applicable to population distribution maps on which dots or circles, representing a certain value, are distributed to show as closely as possible the actual location of the numerical data they represent.

1) Dot Maps

Different sizes of dots are used for different values. Dot maps are never used to show ratios or percentages.

2) Graduated Circles Map

Circles are always graduated to represent smaller and larger values. Graduated symbol maps are occasionally used for

ratios or percentages but only when it is a secondary element of their presentation. In such cases, the size of the circle always represents a numerical value, while related ratios or percentages may be indicated as a shading or color on the symbols. Graduated circles maybe divided into sectors (as in pie charts) with each sector representing an element in the total numerical datum.

b. Uses of Population Distribution Map in Land Use Planning

1) Projection of future needs/demands for services and land areas for such services.

2) Determination of sites and distribution of services and facilities.

3) Formulation policies and strategies on population distribution

c. Preparation of Dot Maps

The preparation of statistical dot map requires an orderly carrying out of several work procedures and making decisions on the design of maps.

1) Number of Dots - The first step is to obtain a list of tables of all the geographic areas to be mapped with their population. Then, calculate the number of dots to be placed in each area. As the number of dots for each area is calculated, is should be entered into the appropriate areas on a copy of the same base map which will be used for preparing the final map. This is called coding the map.

2) Methods of making Dots - Prepare the final drawing by drafting or scribing. If drafting method is used, lay over the dot-coded copy which is a clear film copy of the base map with only the first boundaries on a light table Register it and draw the dots by using a drop bow compass or other dotting pen with ink. If the scribing method is used, prepare the dot-coded copy as a scribe coat and cuth the dots by a dot-scribing instrument. The latter method produces a much better quality of dots, making the maps easier to read.

3) Placement of Dots - The dots represent the statistical data. They should be located as close as possible to the actual distribution of the units.

4) Indicate the appropriate title, legend, and margins of the map.

d. Preparation of Graduated Circle Maps

1) Calculation of circle areas - Area is proportional to the quantity the quantity the circle represents, e.g., the smallest circle should represent the rounded lowest number in the population data.

2) Graduated circles and class intervals - Develop a standardized legend for the sizes according to the data to be mapped.

3) Divided or sectoral circles - when secondary elements (information) are desired, design the division of circles (into sectors), e.g. delineated between rural and urban population age, ranges, sex, etc.

4) Drafting and Scribing - Refer to A Preparation of Dot Maps.

5) Placement of Circles - identify the areas to which the statistical data apply.

6) Indicate the appropriate title, legend and margins of the map.

1.3.2.13 Population Density Map

a. Description

Population density is best represented in choropeth or shaded statistical maps. These maps are shaded in black and white or in color to present several value range by class intervals from high to low, showing concentration of population in relation to land area. The number of classes and the upper and lower limits for each class present major problems in the development of these maps in terms of presenting the data realistically.

b. Uses of Population Density Map

1) It serves as a decision document for distribution of services and facilities.

2) It serves as a basis for the formulation of development policies and implementation of strategies in consonance with the population distribution.

c. Map Preparation

Determination of Class Intervals

For maps, class intervals are always required. It is important to select these carefully, otherwise, the message of the map maybe lost or distorted. If the data are spread over a wide range, the class intervals will be large; if the data range is narrow the class interval will be small. If the data are unevenly distributed, the class intervals will be irregular.

1.3.3 Analytical Maps

1.3.3.1 Erosion Potential Map

a. Description

Erosion potential maps show the degree of susceptibility to erosion of an area. Soil erosion, by definition, is the process by which soil particles are detached and transported primarily by run-off water. The

erosion potential of any are is primarily dependent on the soil type, slope, type of vegetation and the intensity of rainfall. The degree of erosion is dependent on the inter-relationship of the above factors. For example, two areas with similar soil type, slope and vegetation but with extreme difference in the intensity of rainfall would have different degree of erosion. The erosion potential of an area may fall within any of the five categories namely:

1) not susceptible to erosion
2) slightly susceptible
3) moderately susceptible
4) highly susceptible
5) very highly susceptible

b. Uses of Erosion Potential Map in Land Use Planning

An erosion potential map is an important analytical tool in determining land capability and soil suitability for specific crops, identifying suitable areas, for urban development; and determining protective measures for land development and land management.

c. Map Preparation

1) With a tracing paper, make an overlay of the slope map and superimpose the soil map.

2) Examine each soil-slope combination found within the whole municipality to determine and identify susceptibility groups.

3) Outline the boundaries of identified erosion potential areas.

4) Transfer erosion potential data to Municipal base map and use appropriate colors to differentiate each category.

1.3.3.2 Land Capability Classification Map

a. Description

The land capability classification map indicates the suitability of areas for cultivation according to soil conservation management requirements. Factors considered in the identification of land capability classes are soil erosion potential/flooding and soil condition limitations.

Soil condition, on the other hand, includes soil characteristics such as droughtiness, fertility, stoniness, salinity, alkalinity, acidity, depth, presence of toxic substance, etc. The degree of soil limitations ranges from no or slight limitations, moderate, serious or severe, to very serious or very severe.

Table 1-3.4 is a tabulation of the characteristics of land capability.

b. Use of Land Capability Map in Land Use Planning

The land capability map can be used in determining specific areas suitable for uses such as cultivation, forest, pasture, land, etc. The

map can also help in identifying development constraints and proper land management schemes.

c. Map Preparation

1) Make an overlay of soil, erosion, flooding hazard maps on a tracing paper.

2) Examine each soil-erosion potential flooding hazard combination to determine and identify land capabilities.

3) Outline each land capability class and transfer data to municipal base map.

Table 1-3.4 Classification of Land Capability

Class	Character of Land Capability
A	very good land; can be cultivated safety, requiring only simple but good form management practices.
B	good land; can be cultivated safely require easily applicable conservation practices.
C	moderately good land; must be cultivated with caution; requires careful management and complex conservation practices.
D	fairly good land; must be cultivated with extra caution; require careful management and complex conservation practices for safe cultivation; more suitable for pasture or forest.
L	low land; too stony or very wet for cultivation; limited to pasture or forest with careful soil management.
M	sleep land; very severely eroded; shallow; not for cultivation; limited to posture or forest with careful management.
X	very low land; wet most of the time and cannot be economically drained; suited for fish-pond or recreation.
Y	very hilly and mountainous barren; should be reserved for recreation and wildlife or for reforestation.

1.3.3.3 Soil Suitability Map

a. Description

The soil suitability map provides data on the degree of soil suitability for urban development.

Important factors are considerations in identifying suitable sites for urban development such as slope, erosion, soil drainage, depth of underwater table and soil permeability.

The four classes of soil suitability are shown in Table.....

Table 1-3.5 Classification for Soil Suitability

Class	Character of Soil Suitability
I (good)	Area which have properties favorable for the rated use with one to slight limitations which can be easily overcome.
II (moderate)	Areas with moderate limitations mainly due to soil erosion, moderate drainage problems caused by run off and slow permeability.
III (poor)	Area with soils having one or more properties unfavorable for the rated use.
IV (very poor)	Soils under this classification have very severe limitations for urban requirements which are very difficult and costly to overcome Complete replacement or modifications or existing soil conditions may be needed.

b. Uses in Land Use Planning

1) The soil suitability map provides the planner an idea where the urban district could be most suitably situated as well as a guide on how/where the different land uses within the urban zone could be located.

2) The soil suitability map helps determine direction of urban growth and guides the formulation of management controls and measures.

c. Map Preparation

1) Make an overlay of soil, erosion potential, slope and flooding hazard maps on a tracing paper.

2) Examine each combination to determine and identify soil suitability.

3) Outline each soil suitability class and transfer data to municipal base map. Use appropriate color coding to differentiate each category.

1.3.4 Digital Maps

1.3.4.1 General

During the last several years the computer graphic techniques has rapidly advanced throughout the branches of science.

In the field of cartography, photogrammetry and mapping this techniques was adopted, and new field for map production is opening now.

This technique for mapping are started at United State of America, and this techniques were spread over the evropes and asias.

There are several example of the practical and operational utilization of the computer assisted cartographic data processing system for map production.

A few groups started to product a large-scale maps with the help of above system.

Other groups are making a "Map-Information System". The character of this system are maintain the many statistical information with the data of drawing-figure, such as buildings, roads and boundaries.

This system is very useful for the preparation of thematic maps.

An example are indicated in Fig. 1-3.11

This computer assisted cartographic data processing system was introduced by Geographical Survey Institute of Japan (GSI).

The system consists of five work station, which are connected with each other through the local area network at 1986.

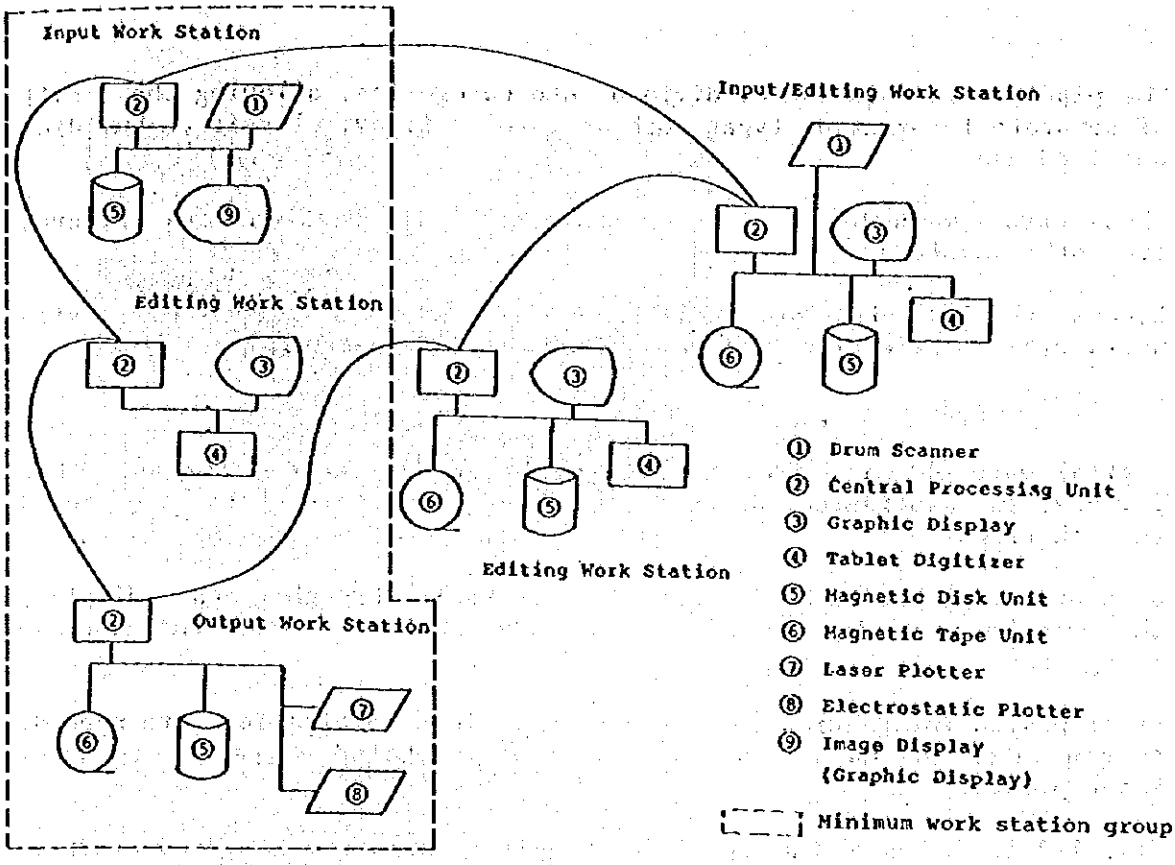


Fig. 1-3.11 THE COMPUTER ASSISTED CARTOGRAPHIC DATA PROCESSING SYSTEM BY GSI

1.3.4.2 Input Data

A typical digital data collection system consists of work station at which operator digitizer map detail with a cursor. These data are stored and can be recalled for graphic display unit, as shown in Fig. 1-3.12.

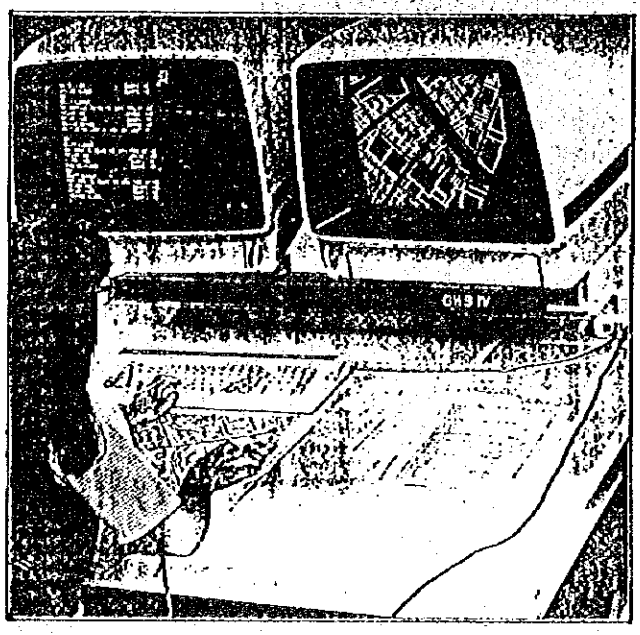


Fig. 1-3.12 GRAPHIC DISPLAY UNIT WITH DIGITIZER

The planimetric data can be divided into categories, allowing the recall of separate information types such as road, railway, classified building and land use.

These data are combined with the statistical information data gathered from other systems.

Because the both data are available on an instant, the systems provide users with an effective tool for information management.

1.3.4.3 Output

Digital data obtained from Maps by means of digitizer units and other devices, and statistical data that gathered from other system are stored in disk files.

Data are available on an instant - access basis through graphic display, the system provide users with an effective tool for information management.

If displayed information on a screen in various combinations are needed. It can makes the hard copy, or it can be outputted on papers by using laser plotter.

Fig. 1-3.13 indicate the examples of some information map, and examples of output map by using automatic plotter are shown in Fig. 1-3.16 ~ 3.18.

[Examples]

(A) House Registered Map

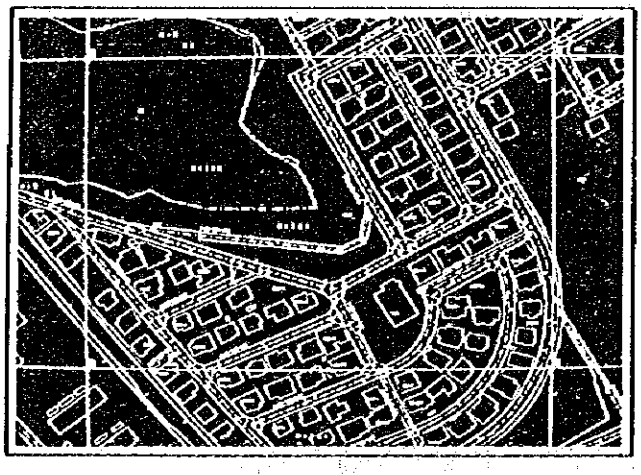
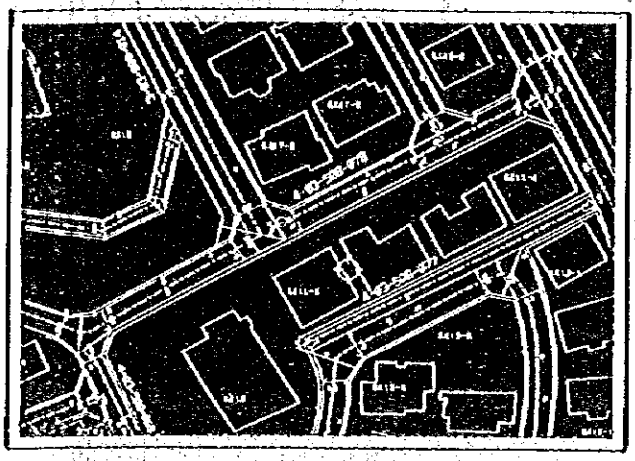


Fig. 1-3.13

(B) Road Information Map



(C) Utility Map

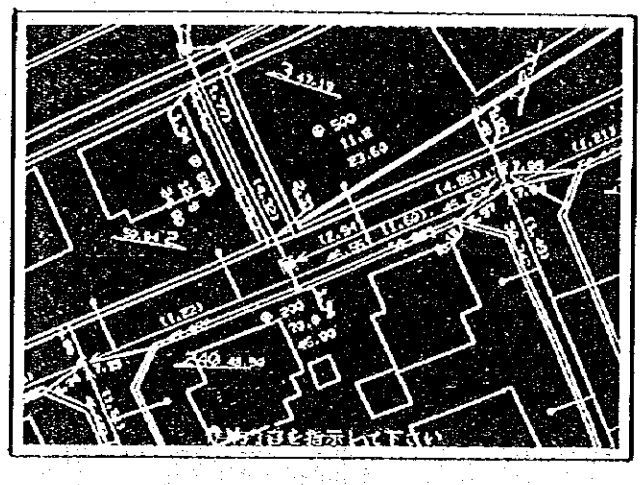
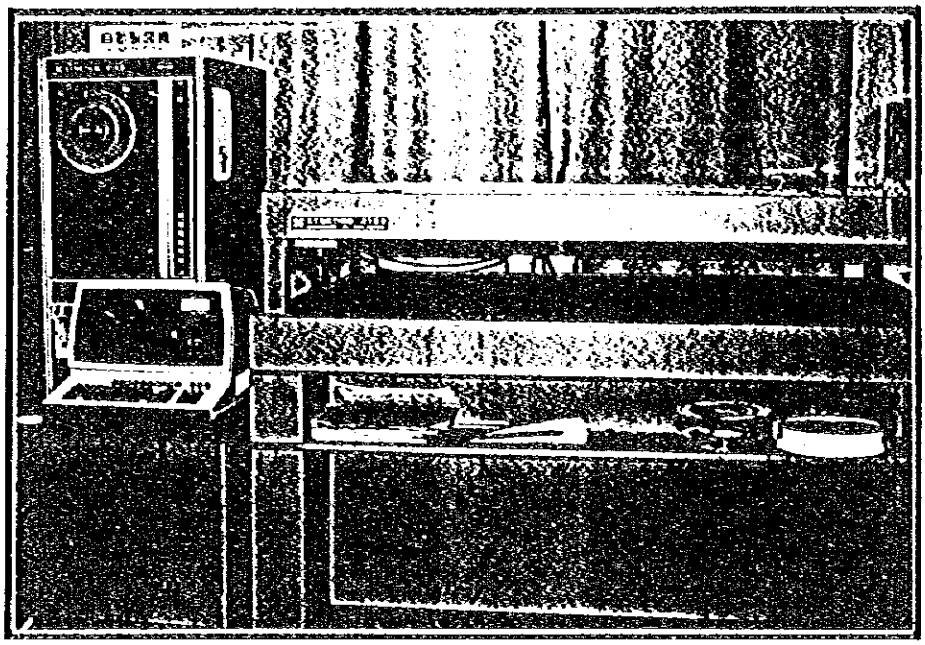
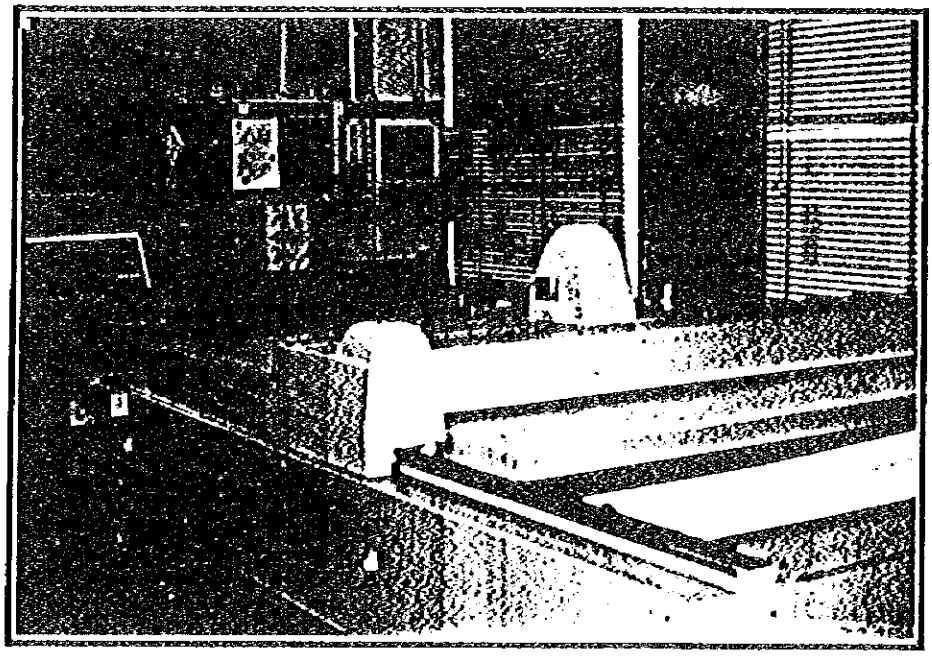


Fig. 1-3.14 SOME EXAMPLES OF DIGITAL MAP ON CRT



(A) Output device (Magnetic Tape Unit) and plotter unit with operation control unit (EXNETICS 1100 SYSTEM by SEIKOSHA, JAPAN)



(B) Large plotter table (110 x 220 cm)
(Mutoo - Industrial co., JAPAN)

Fig. 1-3.15 AUTOMATIC PLOTTER

Fig. 1-3.16 SAMPLE MAP OF REGISTRATION OF HOUSE AND LAND

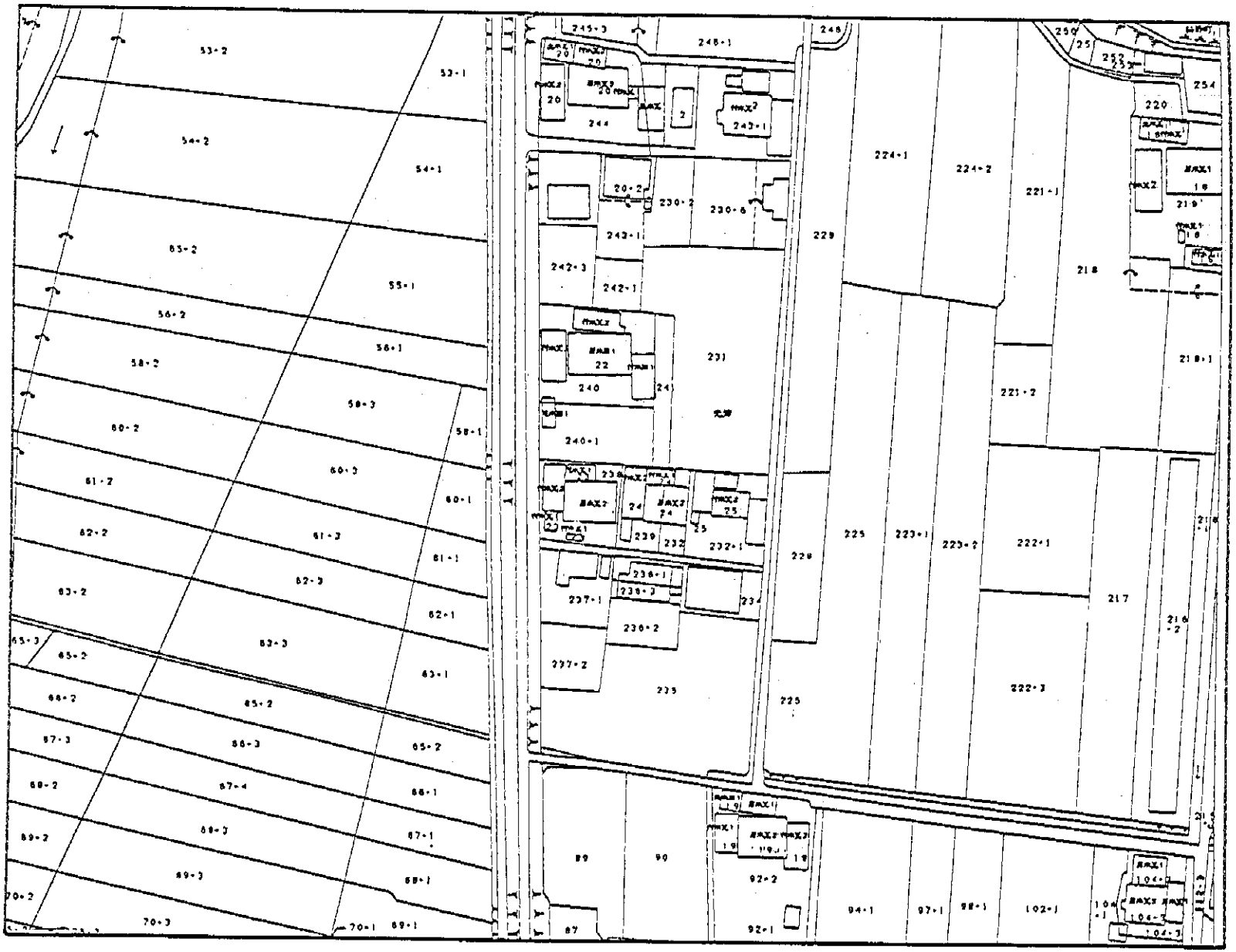
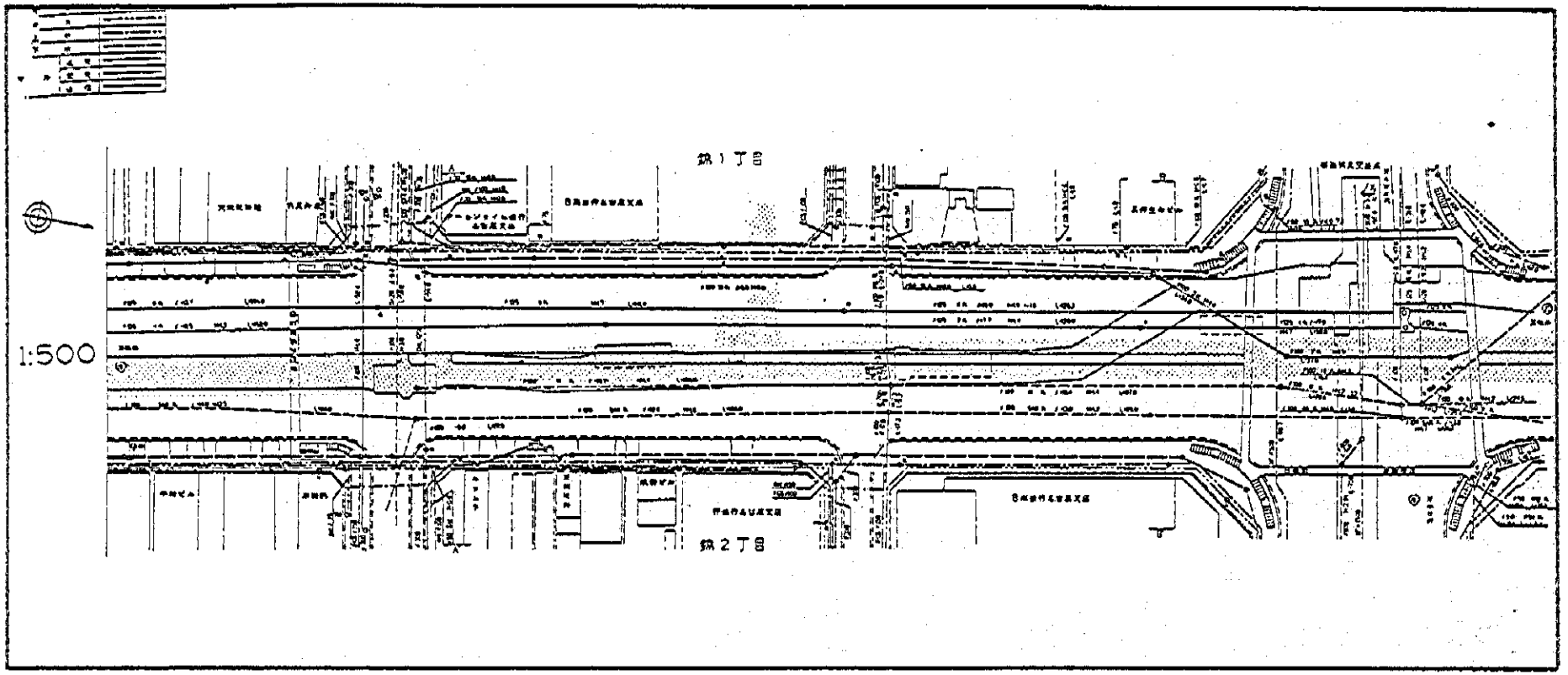


Fig. 1-3.17 SAMPLE MAP OF UTILITY INFORMATION UNDER ROAD



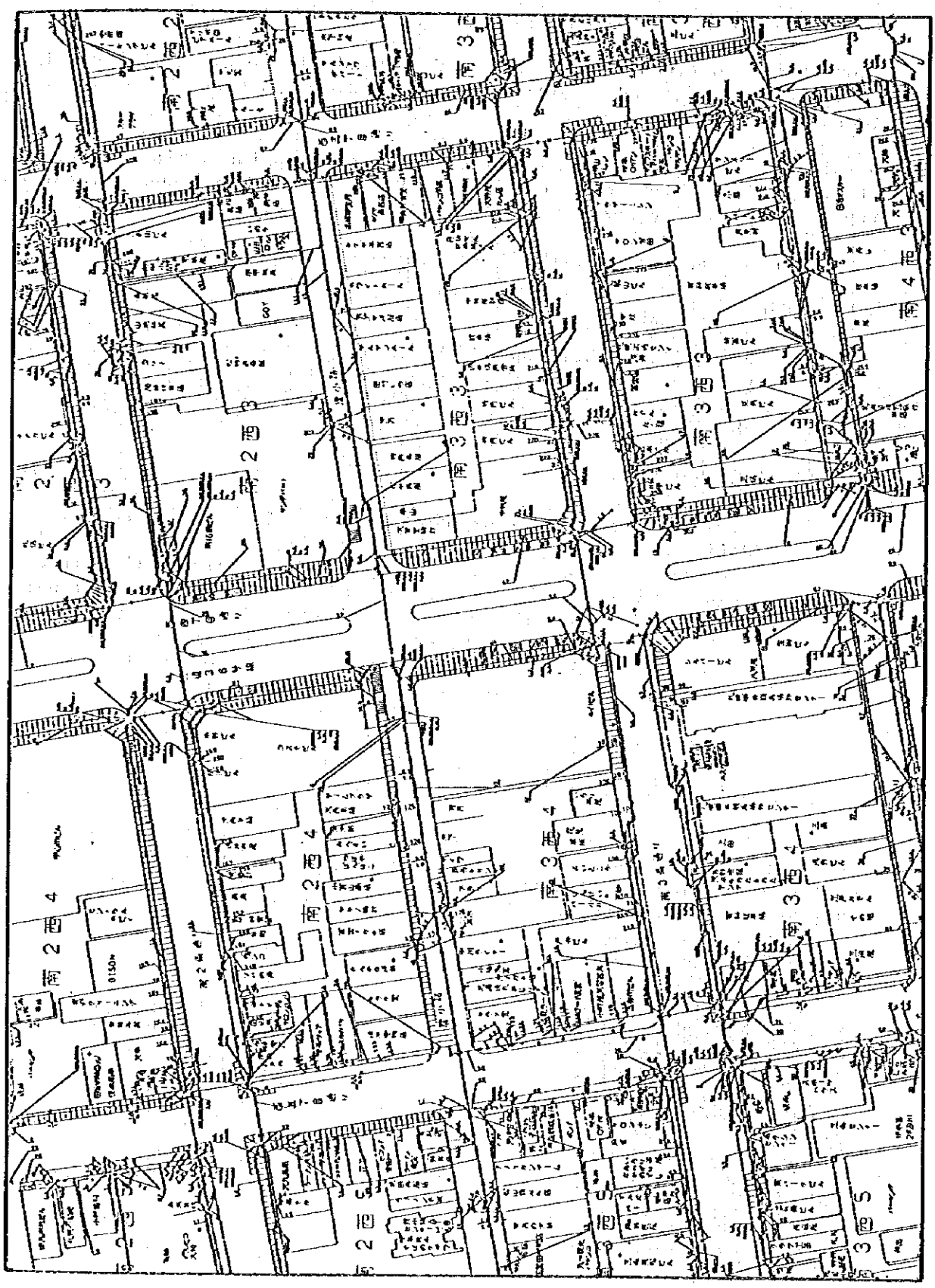


Fig. 1-3.18 SAMPLE GAS UTILITY MAP

1.3.5 Photomap (Photographic Map)

Photomap is defined as the map made by adding marginal information, descriptive data, and a reference system to a photograph or assembly (mosaic) of photographs.

Mosaic is also defined as an assemblage of overlapping aerial photograph or image whose edges have been matched to form a continuous pictorial representation of a portion of the earth's surface.

Usually photomap are classified into three or more types.

. Uncontrolled photomap

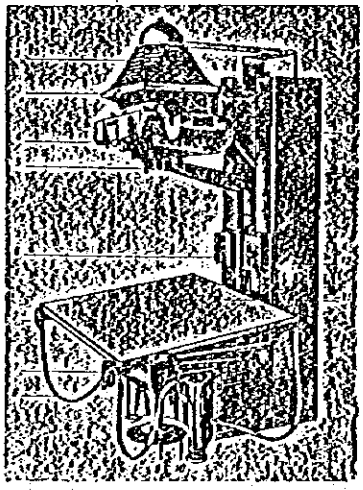
1) Unrectified photomap or photomosaic This photomaps are used for purposes of a general examination or survey of the main features, or certain specific planning than making maps, charts.

. Controlled photomap

2) Rectified photomap or photomosaic The rectification is defined as the process of projecting a tilted or oblique photograph onto a horizontal reference plan, the angular relation between the photograph and the plane being determined by ground reconnaissance. Transformation is the special process of rectifying the oblique image from a multiple - lens camera to equivalent vertical images by projection onto a plane that is perpendicular to the carmera axis.

In this case, the projection is onto a plane determined by the angular relations of the camera axis and not necessarily onto a horizontal plane.

If ground conditions is almost flat, the rectification method using control points is useful for photomap or mosaic. The transformation is carried out with the rectifier device. Fig. 1-3.19a illustrate a device among many types of rectifiers.



1 = lamp cover; 2 = lamp bellows; 3 = condenser frame (Fresnel lenses); 4 = handwheels for displacement of the negative stage; 5 = lens system; 6 = indicator dial for magnification and tilt of the projection table in Y-direction; 7 = control handwheel for tilting the projection table; 8 = discharge hoses; 9 = exposure timer; 10 = magnification control foot disc; 11 = projection table; 12 = indicator dial for aerial camera principal distance (in Fig. 1-12) and tilt in X-direction; 13 = film track
Aerotopo Carl Zeiss, Oberkochen

Fig. 1-3.19a STANDARD SEG V RECTIFIER

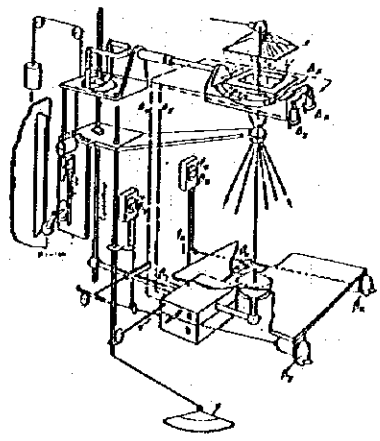
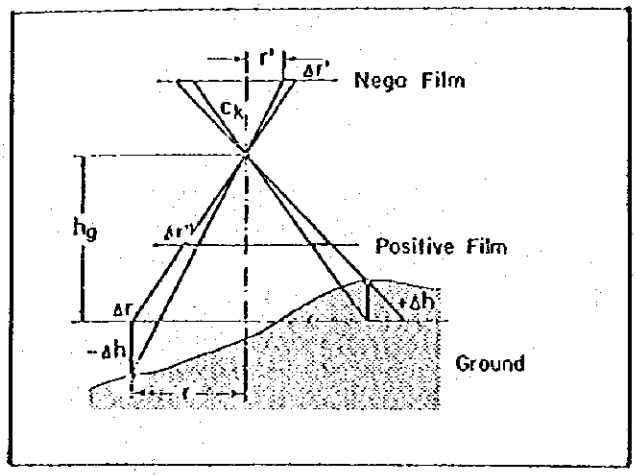


Fig. 1-3.19b DIAGRAM SEG V RECTIFIER

3) Orthophotographic map (Orthophoto Map) If the earth's surface are formed with big undulations, the relief displacements occur onto the photograph as shown in the following Figure. The rectifier cannot remove this displacements and usually need for the differential rectification. These instruments is named "Orthophotograph".



$$\Delta r' = \frac{c_k}{h_g} \Delta r \quad \Delta r = \frac{r'}{c_k} \Delta h$$

$$\Delta r' = \frac{r'}{h_g} \Delta h$$

$$\Delta r'' = \frac{r'}{c_k \, m_k} \Delta h$$

$$\Delta h_{max} = \frac{c_k \, m_k}{r'_{max}} \Delta r''_{max}$$

Fig. 1-3.20 THE RELIEF DISPLACEMENT

Orthophotograph is defined as the photograph having the properties of an orthographic projection. It is derived from a conventional perspective photograph by differential rectification (see below) so that image displacements and scale differences caused by camera tilt and terrain relief are removed.

Principle of differential rectifiers

① Measurement of profile height (height difference)

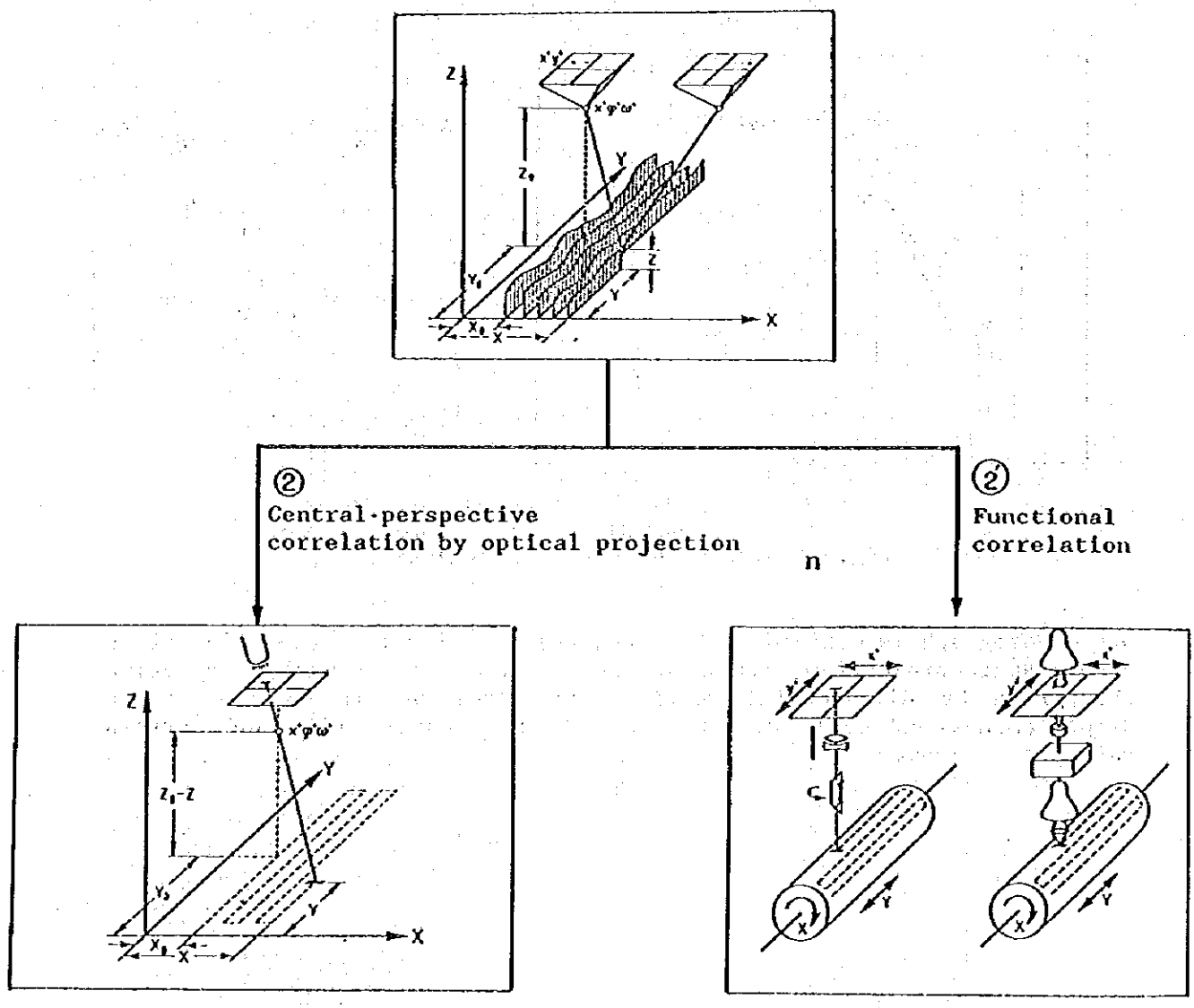


Fig. 1-3.21 PROCEDURE OF MAKING ORTHOPHOTO

Recently the profile heights are calculated from the measured digital terrain models.

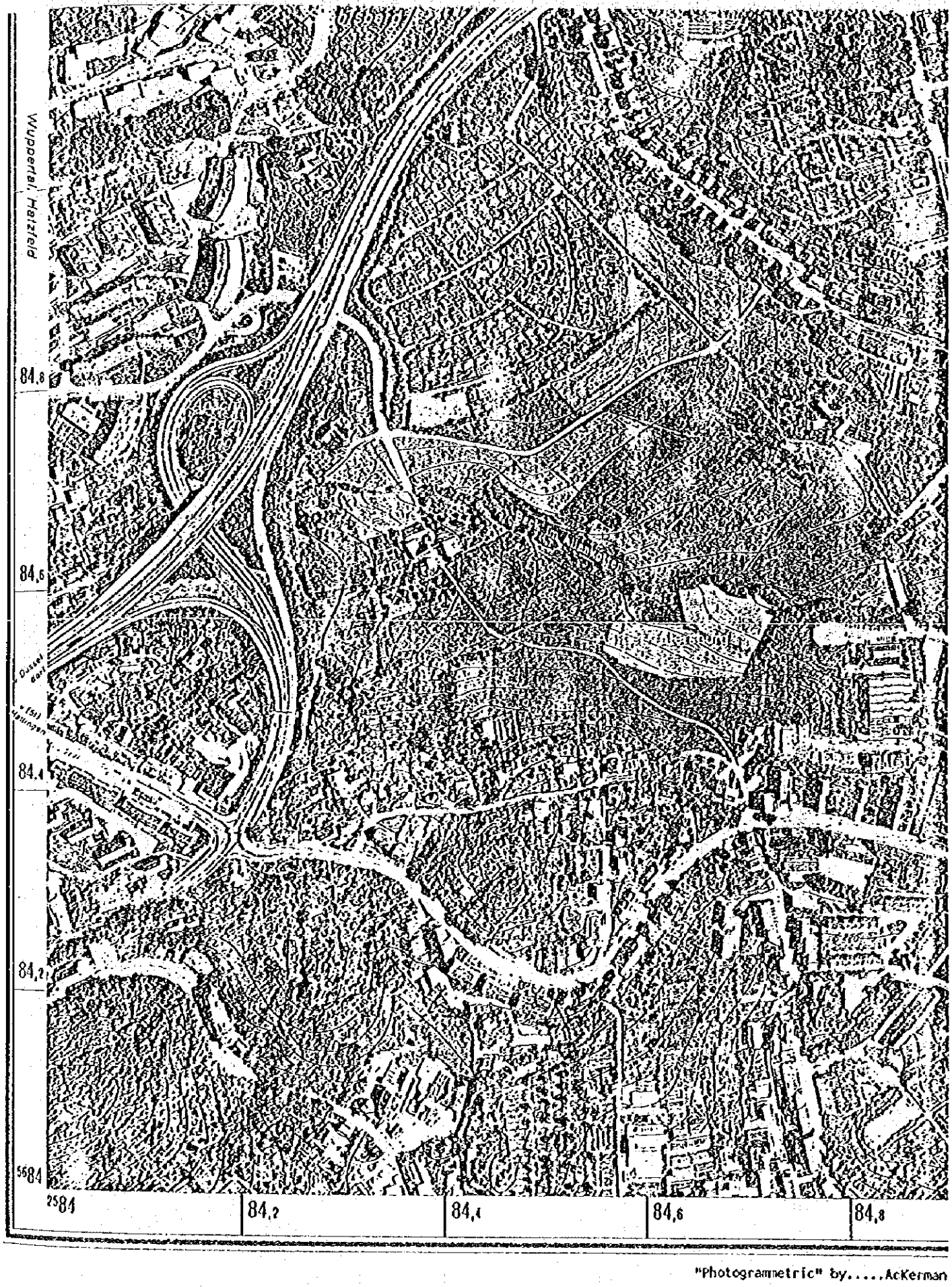


Fig. 1-3.22 ORTHOPHOTO MAP WITH CONTOUR AND INDEX (Standard Style)

CHAPTER 2

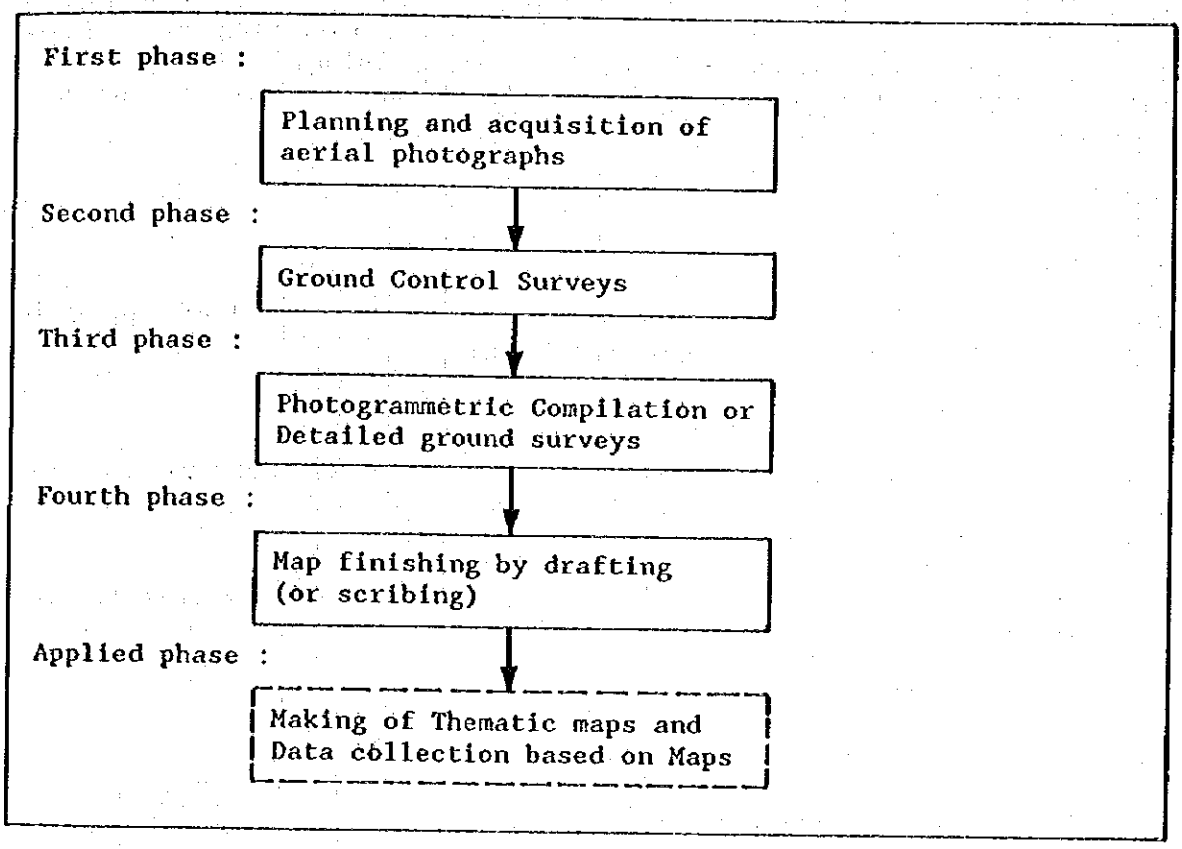
MAPPING

CHAPTER 2

MAPPING

2.1 General

Photogrammetry, the science of making reliable measurements from aerial photographs is the basis for preparing virtually all topographic map today. Maps of small land areas, are still best prepared by ground survey methods; but the efficiency and economy of photogrammetry dictates its use in mapping areas of any appreciable size. The mapping procedure usually consists of four distinct phases and applied phase.



Explanations

First phase : This phase is crucial to the success of a mapping project even though it is usually a small percentage of the total mapping cost. The photographs must be taken with a calibrated precision mapping camera and must meet the specifications for scale, overlap, tilt, time of day and other requirements.

Second phase : To compile an accurate topographic map, the aerial photographs must be related to established horizontal and vertical datums. Ground surveys are performed to establish coordinate positions and elevations for selected ground features clearly visible and identifiable on the aerial photographs. The surveys should start from horizontal and vertical monuments establish by State agencies and should be tied into the national network (RTSD).

Third phase : Ground survey points and additional supplemental control point such as pass-points established by the process of aerial triangulation are plotted on the base map sheets. The pass points are used for controlling individual stereo-models formed from the aerial photographs. This process accurately correlates the aerial photographs to base map.

Fourth phase : Most map sheets today are prepared by scribing or ink drafting procedures. Unless many copies are needed, the final product is a set of black-line positives on polyester sheets which are suitable for making inexpensive paper prints by a diazo process.

Applied phase : This phase is divided into two groups. One is the production of Thematic map designed to provide information on a single topic or group of topics such as land use, geology and population. Other is data collection and data analysis of spatial information based on maps, aerial photographs and related information.

2.1.1 Scope work of surveying

(Purpose)

The purpose of this specification is to define the method of the basic survey for making middle or large-scale maps.

(Range of Surveys)

"Surveys" in this specification means the control surveys and the products of topographic map and photo maps. Thematic maps are out of range.

Control surveys involve triangulation, traverses, and leveling (direct or indirect).

(Standard and Units)

Standards of surveying must adopt the following element.

ellipsoid :	Everest 1830		
parameter :	Semi-major axis	a =	6,377,304.000 m
	Flattening	b =	1/300.8

(Unit to be used)

Unit of length-measure shall be the meter Unit of Angle-measure shall be the degree, minute and second of arc.

Total frame works for surveying are as shown in Fig. 2-1.

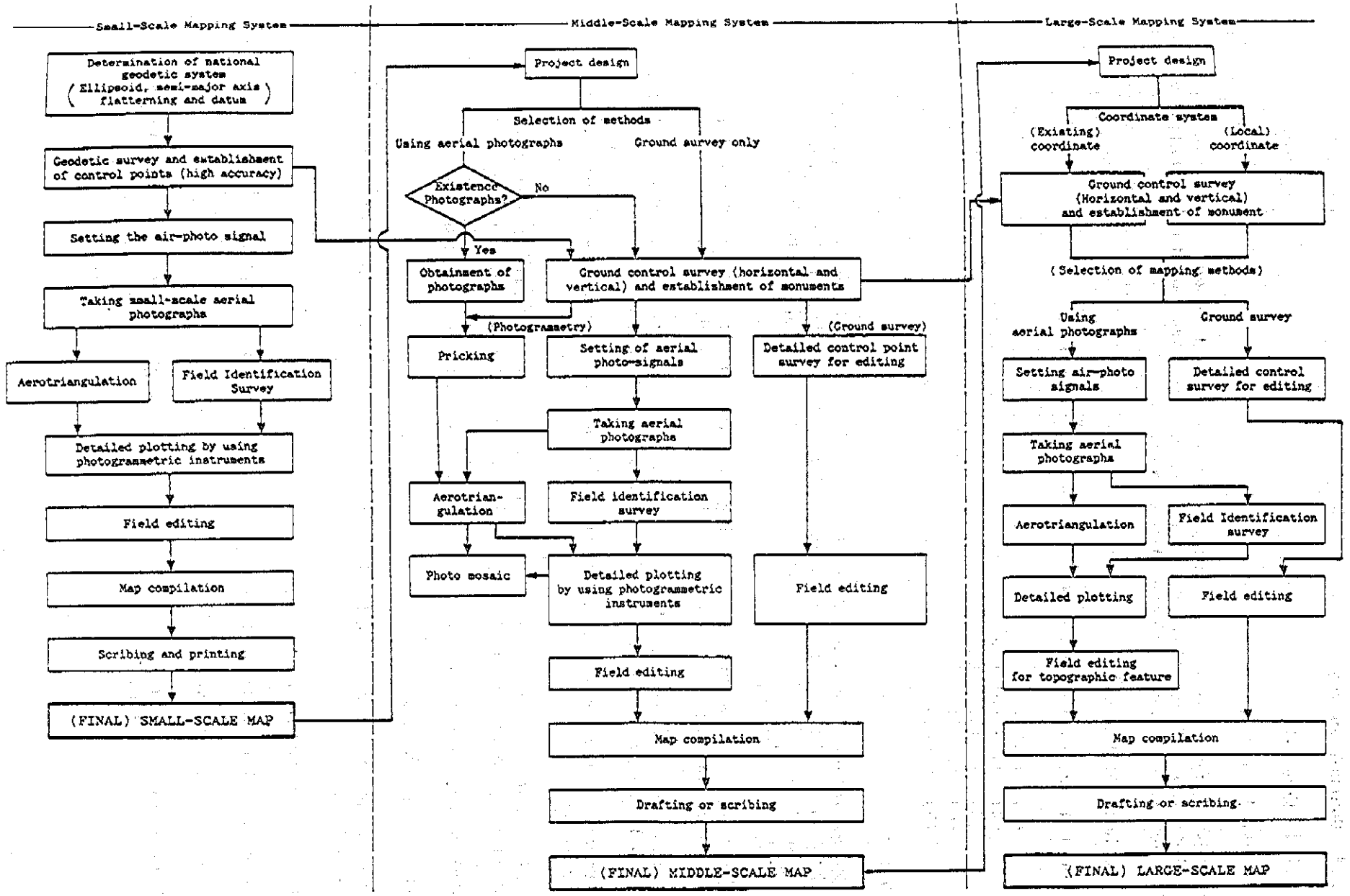


Fig. 2-1.1 PROCEDURE OF MAP-MAKING (BASIC MAP)

2.2 Control Survey

2.2.1 General

(Control Surveys)

"Control Surveys" in this chapter means establishment of new control points for making maps, or establishment of base points for reference survey such as ground depression survey.

(Methods of Survey)

Control survey implies several method as follows:

(1) Traverses
(2) Triangulation
(3) Trilateration
(4) Leveling
(5) Others

Note:

Triangulation: An operation in surveying which consists of extending the survey from a measured base line by measuring the angles in a network of triangles at least one of which includes tghe base line as one of its sides.

Traverse: A method of surveying in which the lenghs and directions of lines connecting a series of stations are measured.

A traverse may be closed or open, according as it does or does not end on a known position or return to the starting point.

Traverses may be of many kinds, such as stadia, compass, or transit traverse.

Trilateration: A method of determing horizontal ground positions by measuring the sides of triangles inlieu of angles.

Generally, electronic instruments are employed for this purpose.

(Permanent Monument)

Permanent Monuments shall be made for newly established points in principle.

(Establishment of Monument)

Monumentation shall be performed according to the standard.

(Selection of Survey Method)

Survey method shall be selected considering the purpose of survey, condition in survey area.