ETL-0354

Terrain analysis procedural guide for built-up areas

APRIL 1984

E T L

S. ARMY CORPS OF ENGINEERS
GINEER TOPOGRAPHIC LABORATORIES
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This procedural guide provides the Army Terrain Analyst with the methods and procedures to generate thematic, or factor, overlays, with supportive tables, for portraying approximately 20 built-up area elements. Retrieval of information from three basic sources (topographic maps, photography, and literature) is considered, and applied techniques for development of factor overlays are documented in a step-by-step sequence.

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PREFACE

This guide for Built-up Areas is one of a series of Analysis and Synthesis Guides being produced. After some modifications, the guides may be published as Department of Army manuals. For this reason, critical comments and suggestions are requested by the author.

Published guides in this series are:

Number	Authors	Title	AD Number
ETL-0178	Jeffrey A. Messmore Theodore C. Vogel Alexander R. Pearson	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR VEGETATION (Report No. 1 in the ETL Series on Guides for Army Terrain Analysts)	AD-A068 715
ETL-0205	Theodore C. Vogel	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR ROADS AND RELATED STRUCTURES (Report No. 2...)	AD-A090 021
ETL-0207	James Tazelaar	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR GEOLOGY (Report No. 3...)	AD-A080 064
ETL-0220	Alexander R. Pearson Janet S. Wright	SYNTHESIS GUIDE FOR CROSS-COUNTRY MOVEMENT (Report No. 4...)	AD-A084 007
ETL-0247	Roland J. Frodigh	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR CLIMATE (Report No. 5...)	AD-A095 158
ETL-0254	Janet S. Wright Theodore C. Vogel Alexander R. Pearson Jeffrey A. Messmore	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR SOIL (Report No. 6...)	AD-A107 048
ETL-0263	James Tazelaar	SYNTHESIS GUIDE FOR LINES OF COMMUNICATION (Report No. 7...)	AD-A104 208
ETL-0285	Jeffrey A. Messmore	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR DRAINAGE AND WATER RESOURCES (Report No. 8...)	AD-A118 318
ETL-0283	Robert A. Falls	SYNTHESIS GUIDE FOR OBSTACLE SITING (Report No. 9...)	AD-A118 347

ETL-0311	James Tazelaar	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR RAILROADS (Report No. 10...)	AD-A123 452
ETL-0344	Jeffrey A. Messmore	SYNTHESIS GUIDE FOR RIVER CROSSING (Report No. 11....)	
ETL-0352	Olin Mintzer Jeffrey A. Messmore	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR SURFACE CONFIGURATION (Report No. 12...)	

This study was conducted under DA Project 4A762707A855, Task C, Work Unit 21, "Military Geographic Analysis Technology."

This study was done under the supervision of A.C. Elser, Chief, MGI Data Processing and Products Division; and K.T. Yoritomo, and Mr. Bruce K. Opitz were directors of Geographic Sciences Laboratory.

COL Edward K. Wintz, CE was the Commander and Director and Mr. Robert P. Macchia, and Mr. Walter E. Boge, were Technical Directors of the Engineer Topographic Laboratories during this period.

CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. Customary Units of Measurement used in this report can be converted to metric (SI) as follows:

Multiply	BY	TO OBTAIN
inches	25.4	millimeter
feet	30.48	centimeter
miles	1.6093	kilometer
acres	0.405	hectare
ounces	28.57	gram
gallons	3.785	liter
Fahrenheit degrees*	5/9	Celsius degrees, Kelvin

*To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula:

$$C = (5/9)(F-32)$$

To obtain Kelvin (K) readings, use formula:

$$K = (5/9)(F=32) + 273.15$$

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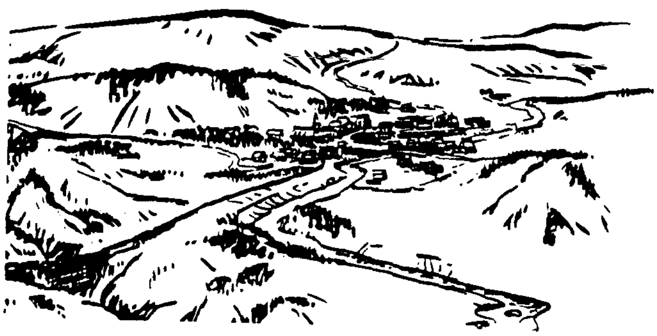
I. INTRODUCTION

"A built-up area is a concentration of structures, facilities, and population which forms the economic and cultural focus for the surrounding area." This definition from FM 90-10 applies to the average city or town. However, there are also built-up complexes that are quite singular in purpose, such as relatively isolated oil refineries, military installations, academic institutions, and large residential developments. From a tactical point of view, the fundamental requirement for built-up area classification is the presence of closely spaced manmade structures. The following graphics represent generalized illustrations of the four major classifications of urban terrain. In the first graphic, a built-up area known as a strip area may be either a string of small, individual settlements or a finger-like extension of a nearby village or city. The remaining three graphics illustrate the more well-known examples of built-up areas; i.e., the village, the small city or town, and the large city.

Strip Area

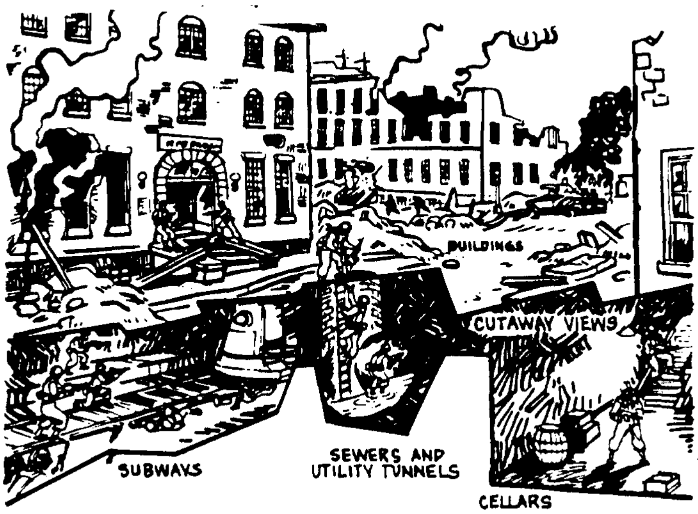
Village



Small City or Town

Large City

In contrast to the natural terrain, the multidimensional characteristic of built-up area features provides capability for vertical and horizontal movement within individual units. Subterranean spaces and corridors also add to the complexity and utility of many built-up areas.



Subterranean Spaces and Corridors

Since World War II, urban growth processes have resulted in a remarkable expansion in both the areal extent and population size of built-up areas; particularly, but not exclusively, in the industrialized nations. In many countries, urban sprawl has led to a coalescing of cities and towns, resulting in continuous urban regions and significantly reducing the amount of land area once categorized as agricultural or natural terrain. Such urbanization frequently lies across strategic avenues of approach. Hence, the desirable practice of bypassing built-up areas during a military conflict can no longer be considered a certain option, and it is therefore necessary to establish methodologies for mapping and tabulating the militarily significant information relating to operations in these potentially critical areas.

A. Purpose. The purpose of this report is to provide terrain analysts with step-by-step procedures for collecting and analyzing built-up-area information and recording the results in the form of factor overlays and data tables. Procedures are provided for using three types of sources: maps, imagery, and literature.

B. Background. The first step in the generation of terrain intelligence and preparation of special-purpose products is to extract data from a variety of source materials and to reduce the data to a uniform format. This first step of extracting data from available sources, then reducing and recording it in the desired form, is the most laborious and time-consuming step in the production cycle. If the process is delayed until a production requirement is imposed, the response time will be increased. However, if the extracting, reducing, and recording is performed in advance and the preformatted results are maintained in a data base, then the time required to respond to a production requirement can be greatly reduced. One practical method of providing this information is the factor overlay concept, which preformats information for the data base.

Figure 1-1 illustrates the factor overlay concept for preformatting data in the form of factor overlays registered to standard topographic maps. Under this concept, data are extracted from various source materials and recorded on factor overlays and supporting data tables. Separate overlays and tables are prepared for each 1:50,000-scale map sheet for each major terrain subject; e.g., surface materials, surface configuration, vegetation, drainage, and roads. Factor overlays and tables are intermediate products intended primarily as tools for the terrain analyst and are not customarily distributed outside of the topographic and intelligence community.

Factor overlays are used in various combinations to generate factor-complex overlays that become, in effect, the manuscripts for special-purpose products such as cross-country movement (CCM), fields of fire, and intelligence preparation of the battlefield (IPB) graphics. The data elements appearing on factor-complex maps become inputs for analytical performance-prediction models. For example, preparation of a cross-country movement map would begin by combining the factor overlays for surface configuration, surface materials, vegetation, and built-up areas into a complex overlay. Those data elements affecting CCM, i.e., slope, stem spacing, stem diameter, soil strength, etc., are recorded for each complex area on the overlay. When processed by analytical models, these elements are transformed into CCM (vehicle-speed) predictions for each complex area.

Built-up area factor overlays with supporting data tables become a part of the data base described above. The source materials used in prepar-

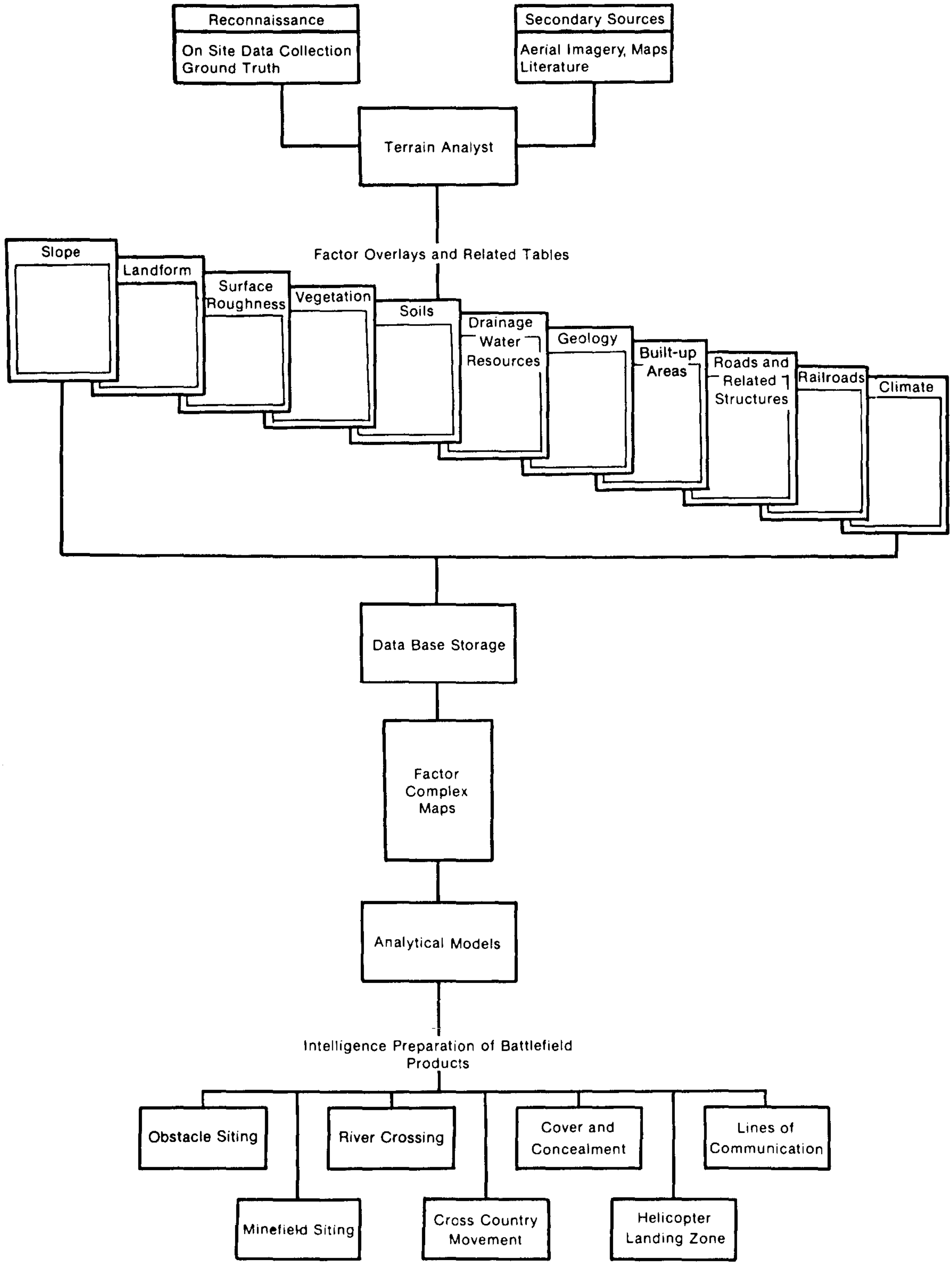


Figure 1-1. Production and Use of Factor Overlays and Data Tables

ation of this factor overlay will include those given in figure 1-1, and these will vary in amount and detail from area to area. Often it will be necessary to use incomplete source information as well as material from foreign sources, which may present problems in translation, definition, etc. As better source material becomes available, first generation overlays will be revised to incorporate the additional information. In some instances there will be built-up areas for which few meager sources are available. In such cases the factor overlay(s) will show little more than that which can be extracted from the best available topographic map.

C. Data Fields. Data fields are specific topographic Military Geographic Information (MGI) terrain categories for which information must be collected and reviewed by the analyst in order to develop factor overlays and data tables. In the case of a built-up areas analysis, they will constitute multiple overlays and supporting data tables, which will become the thematic graphic data base for a selected built-up area. Following is a list of the data fields considered in this procedural guide. Although not exhaustive, the list includes terrain features that are ranked as being particularly significant to military operations in built-up areas.

1. Roads
2. Through Routes
3. Railroads
4. Ports & Harbors
5. Airfields & Heliports
6. Building Heights & Construction Material
7. Vegetation
8. Drainage and Water Resources
9. Electric Power
10. Storm and Sanitary Sewers
11. Water Systems
12. Illuminating Gas - Petroleum Storage and Distribution

D. Suggested Reading. It is recommended that the analyst obtain and become familiar with the following training manuals, field manuals, and texts, as well as the previously published Terrain Analysis Procedural Guides listed in the Preface:

TM S-1, "Specifications for Military Maps," Defense Mapping Agency Hydrographic/Topographic Center, Vol. I and Vol. II, 1973.

TM 5-248, "Foreign Maps," Headquarters, Department of Army, 1963.

TM 30-245, "Image Interpretation Handbook," Vol. I, Department of Army, Navy and Air Force, 1967.

FM 21-26, "Map Reading," Headquarters, Department of Army, 1969.

FM 21-33, "Terrain Analysis," Headquarters, Department of Army, 1978.

FM 30-10, "Military Geographic Intelligence (Terrain)," Headquarters, Department of Army, 1972.

FM 21-31, "Topographic Symbols," Headquarters, Department of Army, 1961.

FM 90-10, "Military Operations on Urbanized Terrain," Headquarters, Department of Army, 1979.

Interpretation of Aerial Photographs, 2nd Edition, T.E. Avery, Burgess Publishing Company, Minneapolis, Minnesota, 1968.

II. SOURCES

In general, three types of information are available for use in the preparation of factor overlays for built-up areas. These sources include large-scale topographic maps, aerial and ground photography, and literature.

A. Maps. A large-scale, 1:12,500, built-up area map is the base map upon which the factor overlays will be developed. Maps at this scale may not be available for many areas, and a suitable base map will have to be prepared by enlarging a selected portion of the best available topographic map to the desired scale. If no topographic map can be found, vertical aerial photo coverage may be used to prepare a photomosaic, which in turn can be reproduced as a photomap base. Other maps published in atlases or in various other publications should be referenced for extraction of thematic detail not shown on standard topographic maps.

B. Aerial and Ground Photography. Aerial photography, vertical and oblique, and ground imagery are excellent sources of information for updating features depicted on topographic maps. They also provide much information not shown on the most detailed line maps. Vertical photography, recorded as stereopairs, will enable the terrain analyst to obtain height measurements of built-up area features (buildings, bridges, towers, storage tanks, etc.). An Analytical Photogrammetric Positioning System (APPS) is being incorporated into the inventory of the Military Geographic Information (MGI) subsystem of the Topographic Support System (TSS). This desktop stereo viewing assembly, interfaced with a calculator, will enable the analyst to extract rapidly and accurately true ground positions and elevations for selected points from a stereophoto pair. Appendix C of this guide is a synopsis of the APPS system, its hardware components, and its application to build-up area analysis.

C. Literature. Literature sources include a wide variety of useful information, among which are administrative reports, departmental reports, planning studies, engineering reports, city plans, guide books, travel literature, and directories.

III. PRELIMINARY ANALYSIS PROCEDURES AND TASK OUTLINE

A. Introduction. This chapter provides the analyst with information and instructions for carrying out the preliminary steps in a terrain analysis for built-up areas. It also includes a general outline of steps involved in conducting the analysis of an MGI Data Field for a built-up area.

B. Built-Up Areas Identification. The approach to built-up areas analysis as presented in this guide uses the 1:50,000-scale topographic map as the primary source for identifying urban terrain. This phase in the built-up areas analysis will be developed as described in the following steps and as illustrated in figure 3-1:

1. Retrieve the 1:50,000-scale topographic maps covering the study area.

2. Working with a single 1:50,000-scale map, register and tape a sheet of translucent overlay material to the map.

3. Place registration ticks at each corner of the neatline, and trace lightly in pencil the 10,000 meter UTM grid lines.

4. Add the map sheet name, number, and the marginal information as listed in appendix A, figures A1 and A2.

5. Locate and outline all built-up areas that cover an area of 10 mm by 10 mm (.39 in by .39 in)* or larger and label each with the appropriate name. Equivalent areas are acceptable providing the narrowest dimension is not less than 6 mm (.24 in).

6. Establish a numerical priority listing (ranking) of built-up areas to be analyzed at a scale of 1:12,500. This sequence should be determined on the basis of the following criteria:

a. Built-up areas on dominant ground

b. Built-up areas on major avenues of approach

c. Built-up areas that are administrative centers (state and national capitals)

Assign a priority number to each built-up area and carry out the analysis accordingly. Where all built-up areas on a 1:50,000-scale map are to be analyzed without concern for priority consideration; number each area, beginning at the top left corner of the identification and overlay and proceed across and down the map.

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*Represents an area of .25 km^2 at 1:50,000 scale.

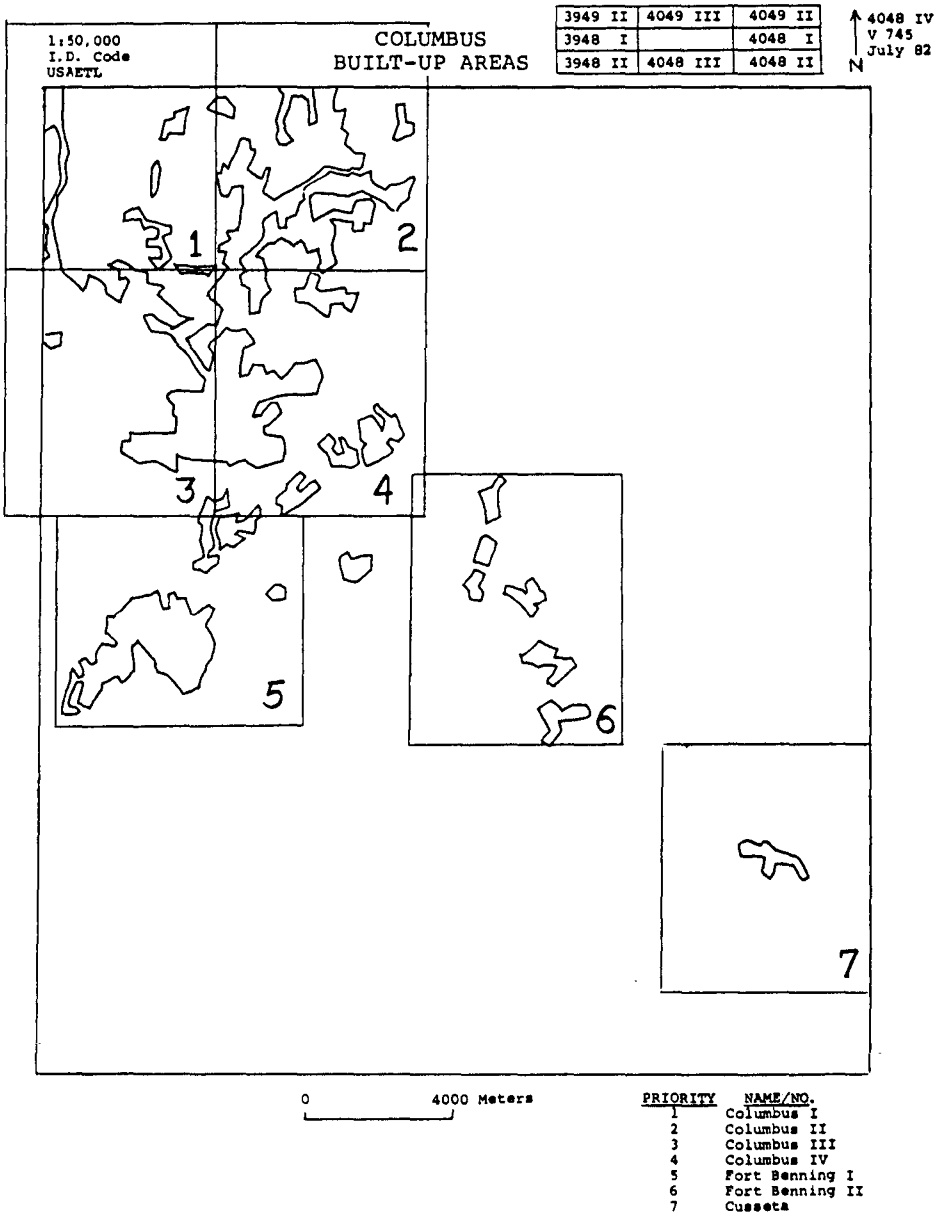


Figure 3-1. Sample 1:50,000 Built-up Areas Factor Overlay

C. 1:12,500-Scale Topographic Map. Retrieve a 1:12,500-scale topographic map of the No. 1 built-up area. If none can be found, outline the desired area on the 1:50,000-scale map (figure 3-2) and enlarge this map segment photographically 400 percent. The format at the 1:50,000 scale will be approximately 12.7 cm by 16.5 cm (5 1/2 by 6 1/2 inches). If a 1:25,000-scale topographic map is available, a comparable area approximately 25.5 cm by 33 cm (10 by 13 inches) may be enlarged 200 percent to the scale of 1:12,500. The enlarged map will become the base map to which all factor overlays will be registered. If no adequate topographic map is available, refer to TM 5-240 and TPCTM S-1 for instructions on how to prepare a photomap as an alternate base.

D. Procedural Outline. For the analyst to extract information for the data fields documented in the following chapters, multiple overlays will be required to map adequately, in an uncluttered manner, the diverse terrain features that make up the urban scene. In this regard, the number of overlays envisioned by this guide is considerably greater than for guides which are concerned with only one data field. Some of the data fields considered in the built-up areas analysis are subjects of earlier reports in the procedural guide series (see preface). These topics include Vegetation, Roads and Related Structures, Drainage and Water Resources, and Railroads and Related Structures. Because of the larger scale of the built-up areas products and the complexities inherent in this unique terrain, some elements are portrayed differently from those depicted on overlays keyed to 1:50,000-scale maps. In this guide each data field is the subject of a separate chapter, and the content of each chapter is governed by whether or not there exists a published procedural guide for the particular data field in question. Where it is considered that a published guide, as in the case of railroads, can be applied to the analysis of built-up areas, the guide is simply referenced in the introduction to the chapter. Where a guide exists, but where changes in procedures are required for adapting the analysis to built-up areas, changes are indicated in this report with the analyst instructed to use the separate guide for instructions that are applicable without modification to built-up area analysis. This method avoids what otherwise would be a need to repeat a great amount of material in this publication. An introductory section in each chapter informs the analyst to what extent supporting material from another procedural guide is required.

The following outline lists the principal steps in a terrain analysis for a built-up area. In the actual work, the analyst will find that the importance of a particular source category (maps, photography, or literature) will vary considerably from one data field to another. For example, topographic maps will be a major source for extracting road information, but such maps will be of little value in gathering building-height data. Therefore no attempt is made in the outline to suggest the relevance of any one source.

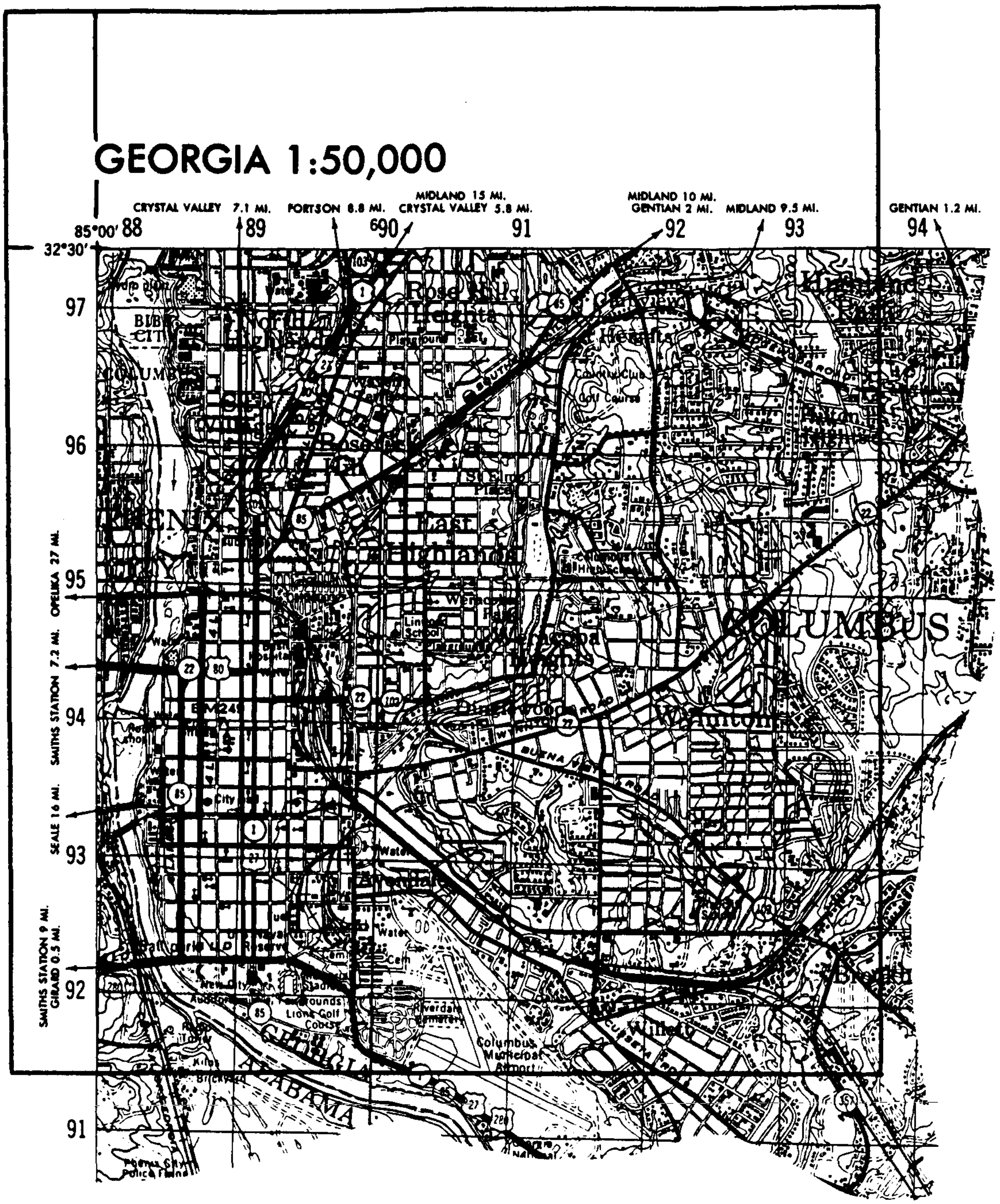
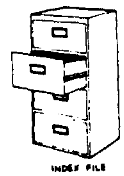
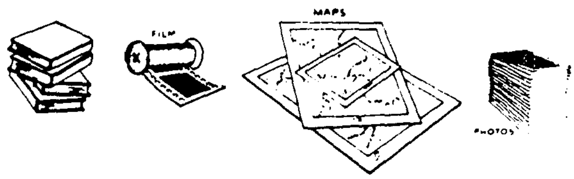


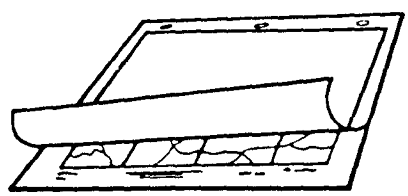
Figure 3-2. Segment of a 1:50,000 Scale Topographic Map to be Enlarged to a Scale of 1:12,500. This segment and portions of three adjacent maps will be mosaiced to encompass the desired area.

1. Data Retrieval: Review the indexes to the data files and withdraw source materials dealing with your area and data fields. These materials should include current topographic maps, vertical and oblique aerial photography, surface photography, literature, overlays, and tables that are the products of other terrain analysis procedural guides. Obtain the published procedural guides that relate to the data fields treated in this study. Review the source material and determine whether they are adequate for the generation of the overlays. If they do not provide sufficient detail or coverage of the area, initiate action to collect additional material, and start your analysis with the material at hand.

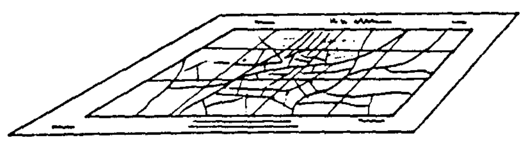




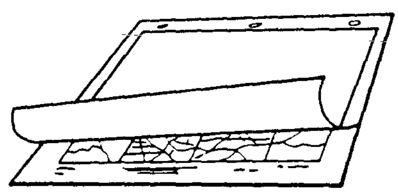
2. Register a translucent (mylar) overlay to the 1:50,000-scale topographic map covering the study area. Outline and label built-up areas as instructed in section B of this chapter.



3. Retrieve or prepare a 1:12,5000-scale topographic map of the built-up area to be analyzed (see section C of this chapter).

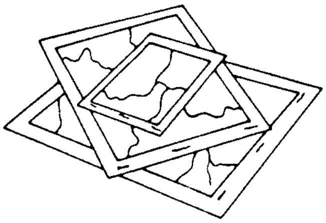


4. Register a sheet of overlay material to the 1:12,500-scale topographic map.

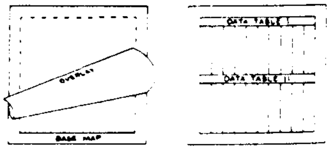


5. Follow the instructions in the chapter dealing with the data field being studied, and pull up specified features from the base map.

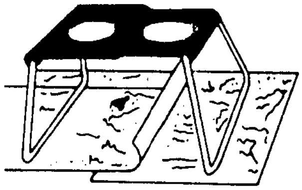
6. Add to or revise the overlay from information derived from other map sources.



7. Prepare required data tables at the same time that the factor overlay is prepared so that data may be entered in the tables as the analysis progresses.

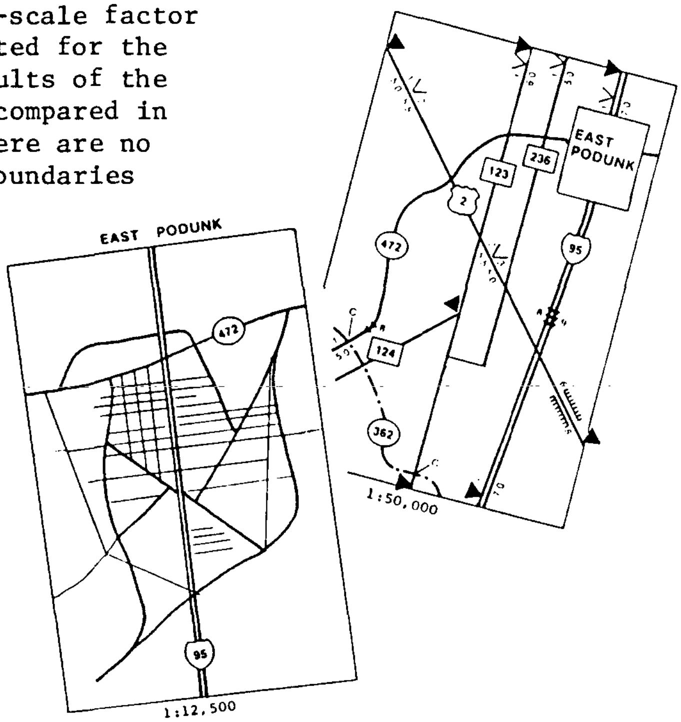


8. Using vertical and oblique aerial photography and surface imagery, check accuracy of map-derived information, and add new material to the overlay and to the data tables.



9. Review all pertinent literature to supplement information extracted from maps and photography.

10. If a 1:50,000-scale factor overlay has been completed for the subject data field, results of the two analyses should be compared in order to insure that there are no inconsistencies where boundaries are contiguous.



IV. ROADS AND RELATED STRUCTURES

A. Introduction. This data field is one of those treated in a published terrain analysis procedural guide for the compilation of factor overlays at 1:50,000 scale.[1] It is essential that the terrain analyst use this guide in the step-by-step development of a built-up areas factor overlay for roads and related structures at the scale of 1:12,500.

Included in this chapter are "Specifications for the Preparation of Roads and Related Structures Factor Overlays," revised to 1:12,500 scale for application to built-up areas analysis. The analyst should follow the detailed step-by-step instructions in Section III of the referenced ETL guide that are applicable to the 1:12,500 scale compilation, checking each one against the revised specifications. In some instances it will be found that steps have been eliminated, and in others that symbology has been changed.

B. Specifications for Preparing Factor Overlays for Roads and Related Structures.

1. Introduction.

a. The purpose of this section is to specify the methods of recording the results of the roads analysis in the form of factor overlays and data tables that are compiled during the analysis of built-up areas.

b. The roads and related structures factor overlays will consist of two parts: (1) an overlay registered to a standard 1:12,500-scale map and (2) data tables describing feature conditions shown on the overlay.

c. The data tables will be prepared on material of the same type and size as the overlay.

d. Normally, not all data required by these specifications will be available during the initial preparation of a factor overlay. However, lack of complete data should not preclude preparation of the overlays. The factor overlay concept envisions the systematic accumulation and recording of data as new source information is acquired through frequent revision and updating.

e. The following sections 2 and 3 provide specifications on the preparation of the 1:12,500-scale factor overlay and on the completion of the associated data tables.

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[1]Theodore C. Vogel, Terrain Analysis Procedural Guide for Roads and Related Structures, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia, ETL-0205, October 1979, AD-A080 021.

2. Roads and Related Structures Factor Overlay.

a. An example of a roads and related structures factor overlay is shown in figure 4-1. Specifications for the format of the overlay are provided in figures A3 and A4 in appendix A. Figure 4-2 illustrates the format of data tables I through IV.

b. Specifications for the symbols to be used on the factor overlays are contained in table 4-1 as a guide only. Precise compliance with the specified dimensions of the symbols is not necessary. Positioning of the symbols, however, should conform with mapping standards. Where the symbols cannot be positioned with mapping accuracy because of deficiencies in the source material, the actual accuracy will be clearly specified in the coverage diagram or reliability statement.

c. Road Category and Identification (Symbols 1, 2, 3, and 4, table 4-1): A road category is defined as that network of roads maintained by a particular level of government, for example, United States 1 (U.S. #1) or Virginia 123. The category will be identified on the overlay by the particular symbol enclosing the identification (ID) number. Category and ID numbers are not shown for tracks or trails.

d. Road Classification and Surface Material (Symbols 8 through 14, table 4-1): The classifications for roads, tracks, and trails, which are specified in TM S-1 and FM 5-36, are summarized below.[2,3]

Type X: All-weather road, hard surface, not susceptible to frost action, with reasonable maintenance passable throughout the year to an unlimited volume of traffic.

Type Y: All-weather road, loose or light surface, locally susceptible to frost action, with reasonable maintenance kept open in all weather, but sometimes only to a limited volume of traffic.

Type Z: Fair weather road, without surface or lightly graveled, becomes quickly impassable in adverse weather, cannot be kept open by maintenance short of reconstruction, limited volume of traffic.

Track: Traveled ways over a natural roadbed with little or no improvement, usually not maintained.

Trail: Natural traveled ways not wide enough to accommodate wheeled or tracked vehicles.

[2]Defense Mapping Agency Hydrographic/Topographic Center, "Specifications for Military Maps," Vol. I, TM S-1.

[3]Defense Mapping Agency Hydrographic/Topographic Center, "MGD - Roads and Road Structures," FM 5-36.

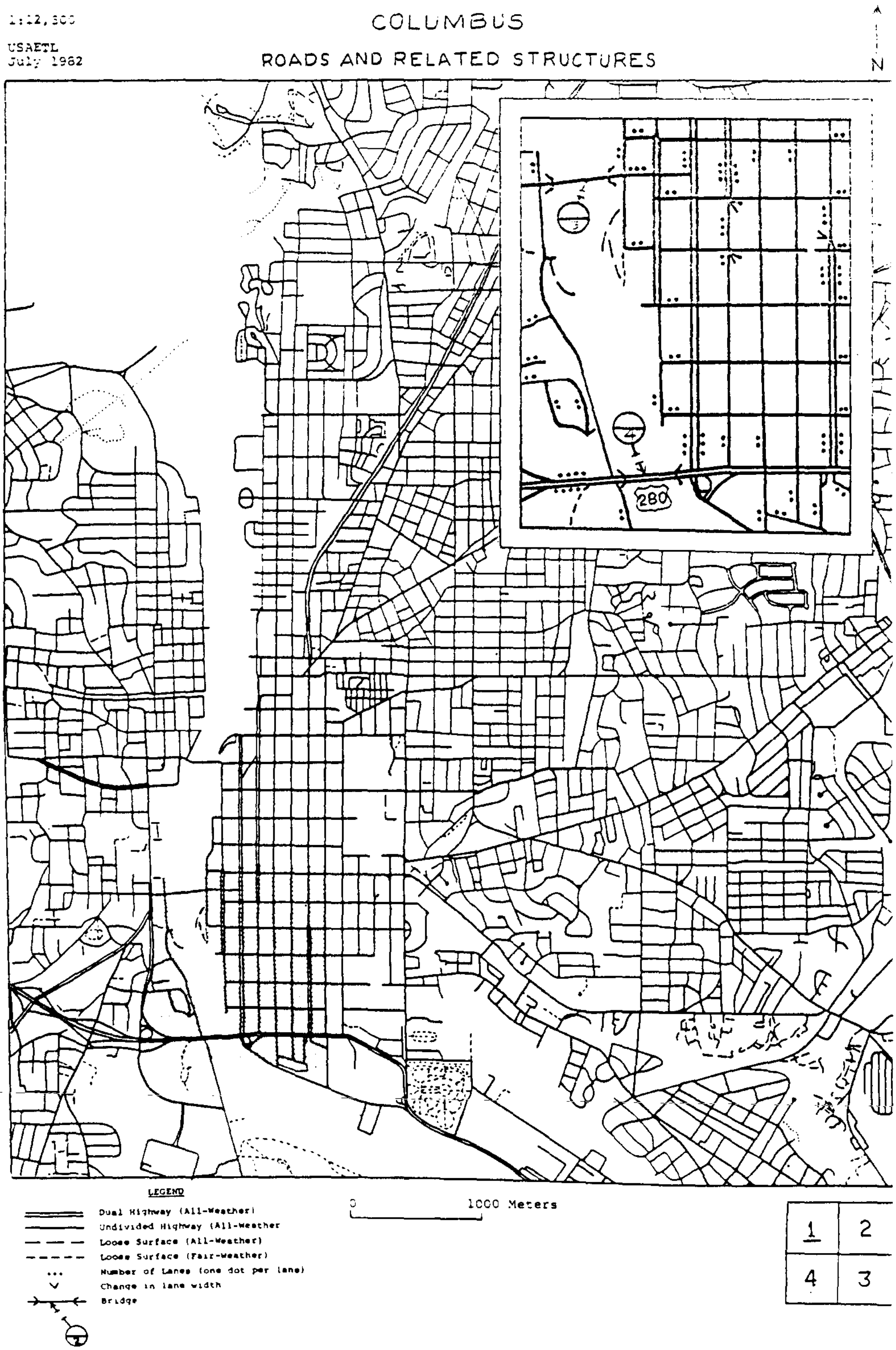
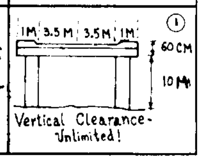
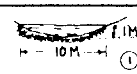


FIGURE 4-1 Roads and Related Structures Factor Overlay

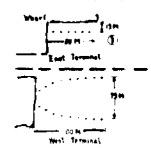
DATA TABLE I-BRIDGES

1	2	3	4				5	6	7					8	9	10
ROAD NO.	BRIDGE NO.	BRIDGE UTM	LOAD CLASS				NO. SPANS	TOTAL LENGTH (m)	SPAN CHARACTERISTICS					FEATURE CROSSED	BYPASS COND.	SKETCH OR COMMENT
			WHEEL		TRACK				CONST MAT'L a	CONST TYPE b	ROAD WIDTH c	O.H. CLEAR d	U. B. CLEAR e			
			→	⇄	→	⇄										
Va State 123	1	532114	105	40	65	25	2	124	MC	Slab	7.0m	unlimited	10m	wind river	?	
	2	131695	85	30	40	20	1	83	CS	Beam	6.5m	unlimited	9.5m	railroad; route 223	difficult (Steep embankment)	

DATA TABLE II-FORDS

1	2	3	4	5	6		7		8	9	10
ROAD NO.	FORD NO.	FORD UTM	crossing LENGTH (m)	WIDTH (m)	DEPTH(m)		VELOCITY(m/sec)		BOTTOM CONDITIONS	APPROACHES	CROSS SECTION AND PROFILE
					PERIOD	DEPTH	PERIOD	VEL.			
Macon Co. 7	1	432194	10	17	AUG MAR	1.0 1.8	AUG Mar	0.9 2.1	CS	difficult (Swampy ground, both banks)	

DATA TABLE III-FERRIES

1	2	3	4	5	6	7	8	9		10	11
ROAD NO.	FERRY NO.	FERRY UTM	TYPE	NO VESSELS	LENGTH (each) (m)	LOAD CLASS (each)	CROSSING LENGTH(m)	APPROACH CONDITIONS		FEATURE CROSSED	TERMINAL LAYOUT
								Left	Right		
N.C. State 34	1	321235	V	1	32	95	3400	Easy	Easy	Herring Bay	

DATA TABLE IV-TUNNELS, GALLERIES, SNOWSHEDS

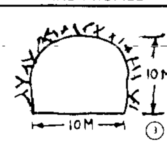
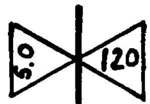
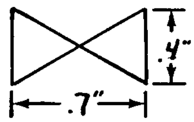
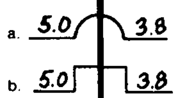
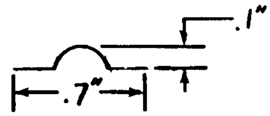
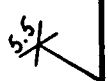
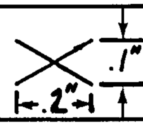
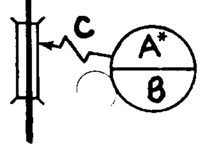
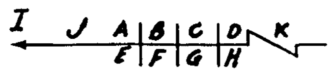
1	2	3	4	5	6	7	8	9	10	11	12
ROAD NO	STRUCT NO.	FUNCTION	PORTAL UTM	LENGTH (m)	OVERBURDEN DEPTH(m)	ROADWAY WIDTH(m)	VERT. CLEAR.	HORIZ. CLEAR.	LINING MAT'L	BYPASS COND.	CROSS SECTION AND PROFILE
W. Va. 304	3	tunnel	134632	600	49	7.0	10.0m	8.0m	Concrete	Impossible (Steep rocky slopes)	

Figure 4-2. Data Tables I, II, III, and IV.

Table 4-1. Symbol Specifications for Roads and Related Structures

No.	Feature	Symbol	Specifications
ROAD CATEGORIES & IDENTIFICATION (1.-4.)			
1.	U.S. Interstate, Federal Routes, Autobahns, or Equivalent		Pickett Template #1168 Symbol 3/8" high
2.	Federal Main Routes, U.S. Routes, or Equivalent		Pickett Template #1168 Symbol 3/8" high
3.	State Route or Equivalent		Pickett Template #1168 Symbol 1/4" x 3/8"
4.	County Route or Equivalent		Pickett Template #1263 Symbol 1/4" x 3/8"
5.	Roadway Width (Each dot = 1 lane)		Dots .05"
6.	Limit of Route Designation		Triangle, solid .2"
7.	Limit of Road Segment (Change in Roadway Characteristics)		"V" .2" on a side
ROAD CLASSIFICATIONS & MATERIALS (8.-14.)			
8.	Type X, Dual Highway, All-Weather, Non-Frost Susceptable		Solid double line .05"
9.	Type X, Route, All-Weather, Hard Surface, Non Frost Susceptible		Single solid line .05"
10.	Type Y, Route, All-Weather, Loose Surface, Locally Frost Susceptible (2 - 3 lanes)		Dashed Line .05" Dash .4" Space .1"
11.	Type Z, Route, Fair-Weather, Loose Surface, Frost Susceptible (1 lane)		Dashed Line .05" Dash .2" Space .1"
12.	Track		Dash .2" x .025", Dot .05" space .1"
13.	Trail		Dotted Line Dots .05" Space .1"
14.	Cul-de-Sac		Dot .10"
15.	Steep Grade (Arrows Point uphill)		Arrowheads .1" triangle

Table 4-1. Symbol Specifications for Roads and Related Structures continued

No.	Feature	Symbol	Specifications
16.	Constriction Left: Horizontal Clearance (meters) Right: Vertical Clearance (meters)		 Numbers .1" high
17.	Covered Passageway/Underpass a) Arch b) Box Left: Horizontal Clearance (meters)		 Right: Vertical Clearance (meters)
18.	Level Crossing, With Height of Electrified Railroad Overhead Power Line (meters)		
19.	Bridge or Overpass A. Load Class - One-Way Wheeled B. Bridge ID Number C. Bypass Condition Easy Difficult Impossible 		Circle diameter .4" Numbers .1" high *Non-Military Load Class Shown
20.	Fords		Numbers .1" high Arrow points to Ford

A. Ford Number
B. Ford Type
   1. A - Vehicular
   2. P - Foot
   3. D - Deepwater, Tank
   4. S - Swimming Vehicles
C. Stream Velocity (Meters Per Second)
D. Seasonal Limitations
   1. X - None
   2. Y - Significant
E. Length (Meters)
F. Width (Meters)
G. Bottom Type
   1. M - Mud
   2. C - Clay
   3. S - Sand
   4. G - Gravel
   5. R - Rock
   6. P - Artificial Pavement
H. Depth (Meters)
I. Arrow Points to Ford Location
J. Approach Conditions, Left Bank
   1. Easy
   2. Difficult
K. Approach Conditions, Right Bank
   1. Easy
   2. Difficult

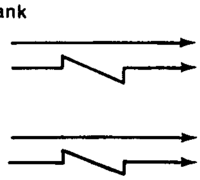
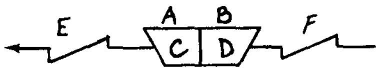
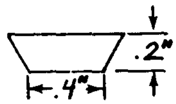
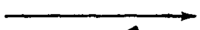
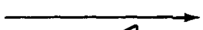
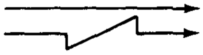
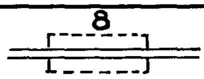
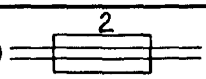
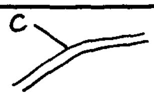
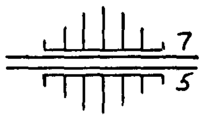
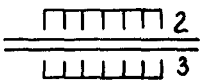


Table 4-1. Symbol Specifications for Roads and Related Structures continued

No.	Feature	Symbol	Specifications
21.	Ferries		
	A. Ferry Number		
	B. Ferry Type		
	1. V - Vehicular		
	2. F - Foot		
	3. M - Military		
	C. Military Load Classification		
	D. Dead Weight Capacity		
	E. Approach Condition, Left Shore		
	1. Easy		
	2. Difficult		
	F. Approach Condition, Right Shore		
	1. Easy		
	2. Difficult		
22.	Tunnel (With ID Number)		Width .2" Length to scale Number .1" high
23.	Gallery or Snowshed (With ID Number)		Width .2", Length to scale Number .1" high
24.	Culverts		Letter .1" High
25.	Cuts and Fills (Height to Nearest Meter)	Fill  Cut 	Numbers 1" High Tick Length to scale

e. Segment End Point (Symbol 7, table 4-1): A segment is defined as a portion of a road characterized by uniform load-bearing capacity, traffic capacity, and width of traveled way. End point of segments are portrayed by nodes along the road at which any of the following conditions occur:

(1) Change in the number of lanes.

(2) Change in surface material.

(3) Point at which road crosses the neatline of the factor overlay.

(4) International boundary crossings in the case of all roads.

(5) State boundary crossings in the case of state and country roads.

(6) County boundary crossings in the case of county roads.

f. Width of Traveled Way (Symbol 5, table 4-1): The width of traveled way indicates the total width of road surface available for use by traffic. This does not include shoulders or medians, which may or may not exist. Accuracy must be to the nearest 0.5 meter. Width is shown for both sides of dual roads.

g. Grade (Symbol 15, table 4-1): The maximum gradient of each segment is symbolized by arrows placed at the bottom and the top of the grade whenever the grade is greater than 7 percent. The arrowheads will be positioned so that the flat end of the first arrowhead marks the bottom of the grade and the pointed end of the second arrowhead marks the top of the grade. The actual grade in percent will be recorded adjacent to the first arrowhead.

h. Constriction (Symbol 16, table 4-1): Constrictions are defined as reductions in the width of the traveled way that are below minimum requirements of 4.0 meters. The figure on the left side of symbol tells the available width of traveled way and the figure on the right side gives the length of the constriction.

i. Bridge or Overpass Identification Number and Load Classification (Symbol 19, table 4-1): ID number applied sequentially within a factor overlay, with the sequence continuous within each route. The load classification shown will be for one-way wheeled vehicles. Other categories of load classifications are recorded in Data Table I (figure 4-2).

j. Bridge or Overpass Bypass Conditions (Symbol 19, table 4-1): Bypasses are local detours along a specified route that enables traffic to avoid an obstruction. Bypasses are classified as easy, difficult, or impossible. Each type of bypass is represented symbolically on the line extending from the bridge symbol to the map location and defined as follows:

(1) Bypass Easy. The obstacle can be crossed within the immediate vicinity of the bridge by a U.S. 2½-ton, 6 x 6, truck (or NATO equivalent) without work to improve the bypass.

(2) Bypass Difficult. The obstacle can be crossed within the immediate vicinity of the bridge, but some work will be necessary to prepare the bypass.

(3) Bypass Impossible. The obstacle can only be crossed by one of the following methods:

(a) Repair of existing bridge.

(b) Construction of a new bridge.

k. Bridge or Overpass Length and Width (Data Table 1): The length and width are recorded on Data Table II and are not placed on the map.

l. Covered Passageways (Symbol 17, table 4-1): Covered passageways are structures that cross above the roadway. They may be road, railroad, or streetcar underpasses, or passageways through or under buildings. Where the structure is a road overpass, symbols 17 and 19 will be used to describe both the overpass and the underpass clearances.

m. Fords (Symbol 20, table 4-1):

(1) A ford is defined as a location in a water barrier where the physical characteristics of water current, streambed, and approaches enable the passage of personnel and/or vehicles and other equipment whose suspension systems remain in contact with the bottom of the stream.

(2) ID numbers are applied sequentially within a factor overlay, starting in the upper left corner and reading to the left and downward.

(3) Approach conditions are symbolized for each bank as easy or difficult.

(a) Approach easy: The approach poses no problem because of slope, surface conditions, or drainage.

(b) Approach difficult: Approach must be used with caution because of steep slope, degraded surface, or poor drainage.

n. Ferries (Symbol 21, table 4-1):

(1) A ferry is defined as a floating vessel that conveys traffic and cargo across a water barrier.

(2) ID numbers are applied sequentially within a factor overlay, starting in the upper left corner.

(3) Approaches are treated in the same manner as for fords.

o. Tunnels, Galleries,* and Snowsheds (Symbols 22 and 23, table 4-1:

(1) This category of feature is defined as any structures other than overpasses that roof the road, regardless of length.

(2) ID numbers will be assigned sequentially within the map sheet. The same tunnel number cannot appear twice within the same map sheet.

(3) Bypass conditions are treated in the same manner as for bridges.

p. Culverts (Symbol 24, table 4-1): Culverts are structures, conduits, or pipes less than 5 meters long that are used to carry water beneath roadways.

q. Cuts and Fills with Heights (Symbol 25, table 4-1): The conventional symbol for cuts and fills will be supplemented by a number indicating the height or depth of the feature in meters. Vertical or near-vertical features, such as retaining walls, will be symbolized by the escarpment symbol supplemented by a metric height number.

r. Level Crossings (Grade Crossings) (Symbol 18, table 4-1): Symbolize all points at which the route crosses a railroad at grade without passing through an underpass or over an overpass. Where the railroad is electrified, the clearance beneath the catenary (in meters) will be recorded above the symbol.

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*Galleries are structures similar to snowsheds, but are designed to protect a road from landslides instead of snowslides.

3. Data Tables.

a. General. A series of four data tables keyed to the overlay features will be used to provide additional, more detailed, information. These data tables are illustrated in figure 4-2. If possible, the four data tables should be placed on one individual sheet, but if too many entries make this difficult, two or more sheets may be used. Metric dimensions are required, and the metric unit of measurement will be stated along with the source of the data, i.e., map, report, title, etc.

SYMBOL	MATERIAL	ROUTE TYPE
k	Concrete	Type (X); generally heavy duty
kb	Bituminous (asphaltic) concrete (bituminous plant mix)	Type (X); generally heavy duty
p	Paving brick or stone	Type (X) or (Y), generally heavy duty
pb	Bituminous surface on paving brick or stone	Type (X) or (Y); generally heavy duty
rb	Bitumen-penetrated macadam, waterbound macadam with superficial asphalt or tar cover	Type (X) or (Y); generally medium duty
r	Waterbound macadam, crushed rock, or stabilized gravel	Type (Y); generally light duty
l	Gravel or lightly metalled surface	Type (Y); generally light duty
nb	Bituminous surface treatment on natural earth, stabilized soil, sand-clay, or other select material	Type (Y) or (Z); generally light duty
b	Used when type of bituminous construction cannot be determined	Type (Y) or (Z); generally light duty
n	Natural earth stabilized soil, sandy-clay, shell, cinders, disintegrated granite, or other select materials	Type (Z); generally light duty

SYMBOL	MATERIAL	ROUTE TYPE
V	Various other types not mentioned above	Classified (X), (Y), or (Z) depending on the type of material used. (indicate length when this symbol is used.)

Source: U.S. Army, "Route Reconnaissance and Classification," FM-5-36, 1970.

b. Data Table I, Bridges:

(1) Column 1; Road Identification Number. Record route number and category of road on which the bridge is located.

(2) Column 2; Bridge Identification Number. Bridge number will be assigned in sequence within the overlay. The sequence of numbers will be continuous along each road.

(3) Column 3; Bridge UTM Coordinates. UTM coordinates (±10m) of the bridge center will be recorded in this column.

(4) Column 4; Bridge Military Load Class. The load classifications, one way and two way, for both wheeled and track vehicles will be posted where known.

(5) Column 5; Number of Bridge Spans. Record the number of spans forming the bridge.

(6) Column 6; Total Length of Bridge. Record in meters the total length of the bridge (between abutments).

(7) Column 7; Bridge Span Characteristics (for each span).

(a) Record the type of bridge construction material.

(b) Record the type of bridge construction.

(c) Record the width of the bridge traveled way (±0.5 meters).

(d) Record the overhead clearance distance (±0.5 meters).

(e) Record the underbridge clearance distance (±0.5 meters).

(8) Column 8; Feature Crossed. Record the name of the obstacle(s) crossed by a bridge as indicated on the best available topographic map.

(9) Column 9; Bypass Condition. Record the bypass condition as indicated on the overlay and describe the distance, direction, type, and condition of the bypass.

(10) Column 10; Sketch of Bridge Cross Section and Profile. A dimensioned profile and cross section of the bridge will be drawn in this space.

c. Data Table II, Fords.

(1) Column 1; Road Identification Number. Record the route number and category.

(2) Column 2; Ford Identification Number. The ford ID numbers will be assigned consecutively within the map sheet, with all fords along a road numbered in sequence.

(3) Column 3; Ford UTM Coordinates. The UTM coordinate ($\pm$10 meters) will be stated for the center of the ford.

(4) Column 4; Ford Length. Record the crossing length of the ford, water line to waterline, in meters.

(5) Column 5; Ford Width. Record the width of the ford in meters.

(6) Column 6; Ford Depth. Record the maximum depth of the water in meters during periods of high and low water; specify the periods.

(7) Column 7; Velocity. Record the maximum and minimum stream velocities in meters per second and the months during which they normally occur.

(8) Column 8; Bottom Characteristics. Determine the bottom characteristics of the ford and record one of the following: M-mud, C-clay, S-sand, G-gravel, R-rock, or P-artificial pavement.

(9) Column 9; Approach Conditions. Record the approach conditions for each bank as indicated on theoverlay. If the approach is difficult, describe the conditions that make it difficult.

(10) Column 10; Cross Section and Profile of Ford. A dimensioned sketch of the ford will be drawn in this column.

d. Data Table III Ferries.

(1) Column 1; Road Identification Number. Record the number and category of the road on which the ferry is located.

(2) Column 2; Ferry Identification Number. An ID number will be assigned to each ferry location. The sequence begins in the upper left corner and progresses to the right and down along each road.

(3) Column 3; UTM Coordinates of Ferry Terminals. UTM coordinates ($\pm$10) will be entered for each terminals

(4) Column 4; Ferry Type. Record the type of ferry: V - Vehicular; F - Foot; M - Military.

(5) Column 5; Number of Vessels. Record the number of vessels in active use.

(6) Column 6; Ferry Length. Record the length of each vessel.

(7) Column 7; Ferry Load Class. Record the capacity-load class of each vessel.

(8) Column 8; Length of Crossing. The length of the normal crossing will be reported to the nearest meter.

(9) Column 9; Approach Conditions. Record the approach conditions for each bank as indicated on the overlay. If either approach is difficult, describe the conditions that make it difficult.

(10) Column 10; Feature Crossed. Record the name of the obstacle crossed by the ferry as indicated on the most recent topographic map.

(11) Column 11; Terminal Layout. Prepare a dimensioned sketch of each ferry terminal.

e. Data Table IV, Tunnels, Galleries, and Snowsheds.

(1) Column 1; Road Identification Number. Record the route number and road category along which the structure occurs.

(2) Column 2; Structure Identification Number. The ID number will be recorded as indicated on the factor overlay.

(3) Column 3; Function of Structure. Record a one-word description of the function of the feature (i.e., tunnel, gallery, or snowshed).

(4) Column 4; UTM Coordinates of Structure Portals. Record the UTM coordinates ($\pm$10m) of both portals of the structure.

(5) Column 5; Structure Length. Record the total length of structure.

(6) Column 6; Depth of Overburden (Tunnels). This entry applies only to tunnels and states the maximum depth of the overburden to the nearest meter.

(7) Column 7; Width of Roadway. Record the width of the roadway within the structure.

(8) Column 8; Vertical Clearance. Record the vertical clearance of the structure.

(9) Column 9; Horizontal Clearance. Record the horizontal clearance of the structure.

(10) Column 10; Construction or Lining Material. A short statement of the construction materials is required in the case of galleries and snowsheds. Tunnels require a lining-material statement.

(11) Column 11; Bypass Condition. Record the bypass condition as indicated on the overlay, the distance and direction to the bypass, the type of bypass, and the conditions that make its use difficult.

(12) Column 12; Cross Section and Profile Sketch. A dimensioned cross section will be sketched in this column.

V. THROUGH ROUTES AND RELATED STRUCTURES

A. Introduction.

Through routes are those roadways that have the capacity for providing a continuous flow of military traffic through built-up areas. Although as part of urban road system they are included on the factor overlay for Roads and Related Structures (section IV of this report), they are also treated separately for the purpose of more clearly illustrating routes that are vital to rapid vehicular movement through built-up areas.

There is no procedural guide describing the analysis of through routes; however, the Procedural Guide for Roads and Related Structures (ETL-0205)[4], contains much instructional material that will be applied to through-route analysis. As in the case of the preceeding chapter on Roads and Related Structures, the following pages on the analysis of through routes and related structures is designed to be used with the procedural guide (ETL-0205). As the analyst follows the procedural steps in this section, the guide (ETL-0205) should be referenced for supplemental information.

B. Map Analysis.

1. Road Category and Identification: The category and the identification of roads on most topographic maps are indicated by symbols placed astride or adjacent to the road symbol. The identification numbers (or letters) appear inside the symbol, with the category from the map legend, and select the proper symbol from table 5-1.

Determine the correct category from the map legend, and select the proper symbol from table 5-1.

Draw the symbol astride the road on the overlay, and enter the identification number inside the symbol.

Follow the road throughout its length on the map, and look for points at which either the category or the ID number changes. Generally, a built-up area map will encompass an area totally within a country, state, or province; however, such a map might include portions of a metropolitan complex that could reflect changes in road designations when passing from one political jurisdiction to another.

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[4]Theodore C. Vogel, Terrain Analysis Procedural Guide for Roads and Related Structures, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia, ETL-0205, October 1979, AD-A080 021.

Table 5-1. Symbol Specifications for Through Routes and Related Structures

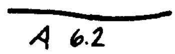
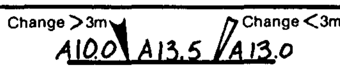
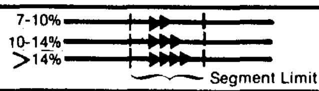
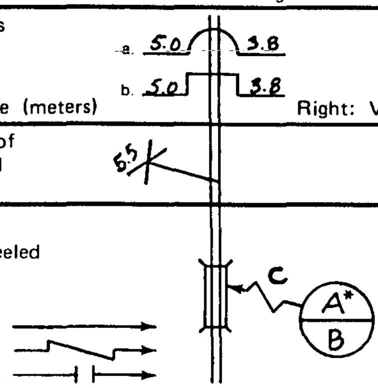
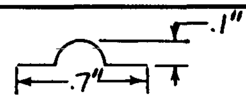
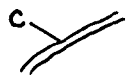
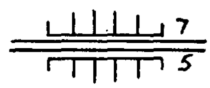
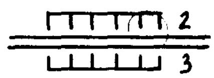
No.	Feature	Symbol	Specifications
	ROAD CATEGORIES & IDENTIFICATION (1.-4.)		
1.	U.S. Interstate, Federal Routes, Autobahns, or Equivalent	495	Pickett Template #1168 Symbol 3/8" high
2.	Federal Main Routes, U.S. Routes, or Equivalent	66	Pickett Template #1168 Symbol 3/8" high
3.	State Route or Equivalent	239	Pickett Template #1168 Symbol 1/4" x 3/8"
4.	County Route or Equivalent	123	Pickett Template #1263 Symbol 1/4" x 3/8"
5.	Parking Lots, Rest Areas, and Parks with Length of Feature (meters)	P(165)	Letter .2", numbers .1"
6.	Emergency Drive-Off		Arrow .2" long.
7.	Roadway Width (meters) & Surface Material (C - Concrete, A - Asphalt)		Numbers and Letters .15" high
8.	Limit of Route Designation		Triangle, solid .2"
9.	Limit of Road Segment (Change in Width)		Pickett Template #1043 Symbol .1" x .4"
10.	Dual Highway, All Weather Non Frost Susceptible		Solid double line .05"
11.	Undivided Highway, All Weather Non Frost Susceptible		Single solid line .05"
12.	Steep Grade (Arrows Point up hill)		Arrowheads .1" triangle
13.	Covered Passageway/Underpass ~~a) Arch~~ b) Box Left: Horizontal Clearance (meters)		Right: Vertical Clearance (meters)
14.	Level Crossing, With Height of Electrified Railroad Overhead Power Line (meters)		
15.	Bridge or Overpass A. Load Class - One Way Wheeled B. Bridge ID Number C. Bypass Condition Easy Difficult Impossible		Circle diameter .4" Numbers .1" high *Non-Military Load Class Shown

Table 5-1. Symbol Specifications for Through Routes and Related Structures continued

No.	Feature	Symbol	Specifications
16.	Tunnel (With ID number)		Width .2" Length to scale Number .1" high
17.	Culverts		Letter .1" high
18.	Cuts and Fills (Height to Nearest Meter)	Fill  Cut 	Numbers .1" high Tick Length to scale

Consider the following comments as you follow the road (these comments are based on U.S. conditions, but comparable conditions exist in foreign areas):

a. Interstate and federal routes are not changed when state or county boundaries are crossed.

b. State roads change both category and ID numbers when state boundaries are crossed; i.e., Virginia 216 may become Maryland 33 when the state line is crossed.

c. County roads either terminate or change category when county or state boundaries are crossed.

2. Through Route Classification (Type) and Surface Materials: Study the map legend carefully and compare with road requirements tables. Determine which factor overlay symbol is to be used for each map symbol.

Trace the alinement of each through route, using the symbol selected. Break the tracing at the category symbol, and change the symbol whenever the classification changes.

Check the points at which through routes cross international, state, or county boundaries: road types often change at these points.

Estimate the material of the road surface as best you can from the map legend, and record lightly alongside the road.

3. Width of Traveled Way: The accuracy with which the width of the traveled way can be determined will vary with the topographic map available for use. The Federal Republic or Germany (FRG), U.S.S.R., and some other European maps indicate the width in meters. The U.S. maps, however, indicate the width by the number of lanes or a range of widths. The following information indicates the lane widths as currently shown on U.S. military maps.

	METERS	FEET
One Lane	At least 2.5 but less than 5.5	At least 8 but less than 18
Two Lanes	At least 5.5 but less than 8.2	At least 18 but less than 27
More than Two Lanes	At least 8.2	At least 27

Follow each route and determine the number of lanes and widths. Convert the lane width to meters and lightly record this value on the overlay alongside the road.

In the case of dual routes, indicate the width of each route. If the source map gives only the overall width, assume half the width on each side.

Note every point at which a change in width occurs, placing a symbol at these points.

4. Culverts: Culverts are infrequently symbolized on topographic maps. If the map being used does symbolize these structures, they may be taken directly from the map and symbolized in accordance with table 5-1.

If the culverts are not symbolized on the map, search the routes for points at which the road crosses single-line intermittent or perennial streams. If there is no symbol to indicate a bridge, ford, or ferry, it may be assumed that there is a culvert at that point. Go back along the route and look for points where the adjacent contours indicate that the road crosses a draw or gulley; these are points at which there probably are culverts.

5. Road Gradient: Using the contour lines as indicators, locate all road gradients on hills that appear to be near or greater than 7 percent. A hill with a 7-percent gradient or slope will have a 7-meter vertical increase or difference (VD) for every 100 meters of horizontal distance.

At the location of each gradient, determine the elevation of the top (E_1) and bottom (E_2) of the slope. Subtract the lower elevation from the higher elevation. $E_1 - E_2 = VD$

Determine the horizontal distance (HD) between the top and bottom of the slope, points E_1 and E_2 respectively, and divide this number into VD. The resulting number multiplied by 100 will equal the gradient expressed as a percent. Percent gradient = $\frac{VD}{HD} \times 100$

If your answer is 7 percent or greater, use the appropriate symbol from table 5-1 to indicate the slope on the route.

6. Height of Road Cuts and Fills: Locate and determine the elevation of the contour line that is immediately adjacent to the top of either the cut or fill map symbol. If the top of the cut or fill symbol falls between two contour lines, estimate the elevation and add this number to the contour line that is the lower elevation.

Locate and determine the elevation of the contour line that is immediately adjacent to the bottom of either the cut or fill symbol. This elevation should be estimated, as above, if the bottom of the symbol is located between two contour lines.

Subtract the number (elevation) you determined for the bottom of the map symbol from the number (elevation) you determined for the top of either the cut or fill symbol. This elevation is an estimate of the height of either the road cut or fill.

Record this number to the nearest meter on the overlay adjacent to the cut or fill symbol.

7. Emergency Drive-Offs: These emergency areas are usually characterized by flat areas adjacent to the road and easily accessible from the road. In flat, open country it is unnecessary to show all such areas. In urban areas and heavily forested areas the emergency drive-offs should be shown.

Care must be taken not to show areas where there are obstacles between the road and the potential drive-off areas. Areas with fences, cuts, fills, or deep ditches should not be shown.

Look for roads and tracks leading from the roads to adjacent fields or open areas such as athletic fields or parking areas.

8. Level Crossings: Level crossings (grade crossings) may or may not be symbolized on the topographic map. If the map legend gives a symbol for such crossings, use symbol 14 from table 5-1 at this point.

Where such crossings are not specifically symbolized on the map, look for points where road and railroad symbols cross. If there is no map symbol indicating a bridge or overpass, it may be assumed that a grade crossing exists.

The clearance beneath the catenary is required only if the railroad is electrified and uses overhead wires. Electrified railroads are usually labeled, but the catenary clearance is seldom given. If the railroad is electrified, but no clearance is given on the topographic map, check the railroad factor overlay. If the clearance cannot be determined, place a question mark above the crossing symbol on the overlay to indicate that there are overhead wires, but the clearance is unknown.

9. Turn-Out, Rest, and Park Areas: These features can be determined only if they are symbolized on the map. Where they are symbolized, it is usually possible to measure the length of the area.

Select only areas with 100 meters of the road and with an access from the road.

Look for highway rest stops, shopping center parking lots, stadium and athletic field parking lots, parks, factory and business parking lots, and municipal airfields.

10. <u>UTM Coordinates</u>: Refer Analysis Procedure #10 in Terrain Analysis Procedural Guide for Roads and Related Structures (ETL-0205) for detailed instructions for determining UTM coordinates.

11. <u>Structure Length Determination:</u> Refer to ETL-0205 Analysis procedure #11 for detailed instructions on structure length determination. Record structure lengths where required in the proper data tables.

12. <u>Structure Width Determination</u>: The width of all structures (one or more lanes) can be estimated directly from the map by using the road symbol. For tunnels use only one-half the width indicated by the road symbol unless other information sources indicate differently. This width reduction is necessary because some structures are built with only one lane to reduce cost of construction.

13. <u>Determination of Bypass Conditions</u>: Bypasses are local detours along a specified route that enable traffic to avoid an obstruction. Bypasses are classified as easy, difficult, or impossible. Each type of bypass is represented symbolically on the line extending from the bridge symbol to the map location, (table 5-1, symbol 15) and defined as follows:

a. Bypass Easy. The obstacle can be crossed within the immediate vicinity of the bridge by a U.S. 2-1/2-ton, 6 x 6 truck (or NATO equivalent) without work to improve the bypass.

b. Bypass Difficult. The obstacle can be crossed within the immediate vicinity of the bridge, but some work will be necessary to prepare the bypass.

c. Bypass Impossible. The obstacle can only be crossed by one of the following methods:

(1) Repair of existing bridge.

(2) Construction of a new bridge.

Bypass conditions can be determined from a detailed study of the area directly adjacent to the obstruction.

The following factors should be considered when evaluating bypass conditions:

Steepness of bank slopes
Depth of water
Denseness of vegetation
Roughness of surface
Presence of boulders
Presence of approaches
Wet, soft ground

14. Depth of Tunnel Overburden: The maximum depth of the material (soil, rock, etc.) lying directly over a tunnel can be estimated by using the contour lines found on a topographic map.

a. Determine the elevation of the road surface where it intersects the symbol for each tunnel portal. Select the portal with the lowest elevation.

b. Locate the highest contour line that passes directly over the tunnel symbol and determine its elevation.

c. Subtract the elevation determined in step (a) from the elevation determined in step (b). This number is an estimate of the depth of the tunnel overburden. Record this number in column 5, Data Table II, as an estimate.

C. Photo Analysis.

1. Introduction: "Section III, Photo Analysis" in ETL-0205, contains detailed instructions relating to basic photo interpretation methods. The analyst should become familiar with this information before proceeding with the following steps. The numbers in parentheses identify the corresponding features in the Map Analysis section, part B. This will aid the analyst in referencing both map and photo procedures.

2. Road Classification (Type) and Surface Material (2): Check aerial photography against map derived information. Up-date all through routes on the factor overlay (symbols 10 and 11), correcting symbology where required.

3. Width of Traveled Way (3): Using a tube magnifier, measure road widths, comparing the results against the factor overlay. Use symbol No. 9 to identify the length of the road segments having constant widths. Refer to the conversion table under feature No. 3 in the Map Analysis section to establish the number of lanes in the segments, placing beside the road symbol a numerical value signifying the number of lanes.

4. Culverts (4): These features may be identifiable on aerial photography, or they may be inferred from drainage patterns (element No. 4, Map Analysis Section). Oblique photography can provide information on the location and construction of culverts. Use symbol No. 17 to identify these features on the factor overlay.

5. Road Gradient (5): Apply photo interpretation methods for slope analysis in order to identify and label through-route gradients of 7 percent or greater. Contour lines on the base map should be used for locating road segments that may require photo analysis. Use symbol No. 12 where necessary.

6. Road Cuts and Fills (6): Follow through routes on aerial photography, locating areas with cuts and fills. Apply vertical measuring techniques in determining depth of cuts and heights of fills, recording the information on the factor overlay, using symbol No. 18.

7. Emergency Drive-Offs (7): Detailed information inherent in large scale aerial photography will indicate the accessibility and general condition of existing and potential drive-off areas. Identify these locations on the factor overlay with symbol No. 6.

8. Level Crossings (8): Level crossings (grade crossings) are readily identifable on aerial photography. The presence of overhead wires (catenary) may also be detected. Use symbol No. 14 to locate each level crossing on the factor overlay.

9. Turnout, Rest, and Park Areas (9): Identify these areas on the photography, symbolizing them on the factor overlay, using symbol No. 5.

10. Bridges (12): Detailed analysis of aerial photography is a requisite for identification of the data elements listed in the bridge data table. The procedures for making these determinations through imagery interpretation methods are thoroughly documented in ETL-0205.7. Bridge information will be shown on the factor overlay, using symbols No. 13 and No. 15.

11. Surface Materials (2): Indicate surface material (concrete or asphalt) along each through route by letter designation preceeding the lane width numeral (symbol No. 7). On all types of aerial imagery concrete surfaces will appear light-toned and asphalt surfaces will appear dark-toned. Road margins will be more clearly apparent on concrete roads.

12. Tunnels (11, 12): Locate tunnels on vertical and oblique aerial photography. Check locations against any tunnels shown on the factor overlay (symbol No. 16), and make adjustments as required. Establish data requirements for documenting tunnel information in Data Table No. II.

D. Specification for Preparing Factor Overlays for Through Routes and Related Structures.

1. Introduction:

a. The purpose of this section is to specify the methods for recording the results of the through routes analysis in the form of factor overlays and data tables.

b. Through routes and related structures factor overlays will consist of two parts: (1) an overlay registered to a 1:12,500 scale topographic map and (2) data tables describing feature conditions shown on the overlay.

c. The data tables will be prepared on material the same type and size as the overlay.

d. Normally, not all data required by these specifications will be available during the initial preparation of a factor overlay. However, lack of complete data should not preclude preparation of the overlays. The factor overlay concept envisions systematic recording of data as it is acquired and accumulating data through frequent revision and update.

2. Through Routes and Related Structures Factor Overlay:

a. An example of a factor overlay is shown in figure 5-1. Specifications for the format of the overlay are provided in figures A1 and A2 of appendix A. Figures 5-2 and 5-3 illustrate the format for Data Tables I and II.

b. Specifications for symbols to be used on the factor overlays are contained in table 5-1 as a guide only. Precise compliance with the specified dimensions of the symbols is not necessary. Positioning of the symbols, however, should conform with mapping standards. Where the symbols cannot be positioned with mapping accuracy because of deficiencies in the source material, the actual accuracy will be clearly specified in the coverage diagram or reliability statement.

c. Road Category and Identificatios (Symbols 1, 2, 3, and 4, table 5-1): A road category is defined as that network of roads maintained by a particular level of government. The category will be identifield on the overlay by the particular symbol enclosing the identification (ID) number.

d. Road Classifications (Symbols 10 and 11), table 5-1): The following classifications are used to identify through routes:

(1) All-weather, divided highway, hard surface, not susceptible to frost action, with reasonable maintenance passable throughout the year to an unlimited volume of traffic.

(2) All-weather, undivided highway, hard surface, not susceptible to frost action, with reasonable maintenance passable throughout the year to an unlimited volume of traffic.

e. Segment Identification (Symbol 9, table 5-1): A segment is defined as that portion of a through route characterized by uniform width. End points of segments are portrayed by nodes along the route at

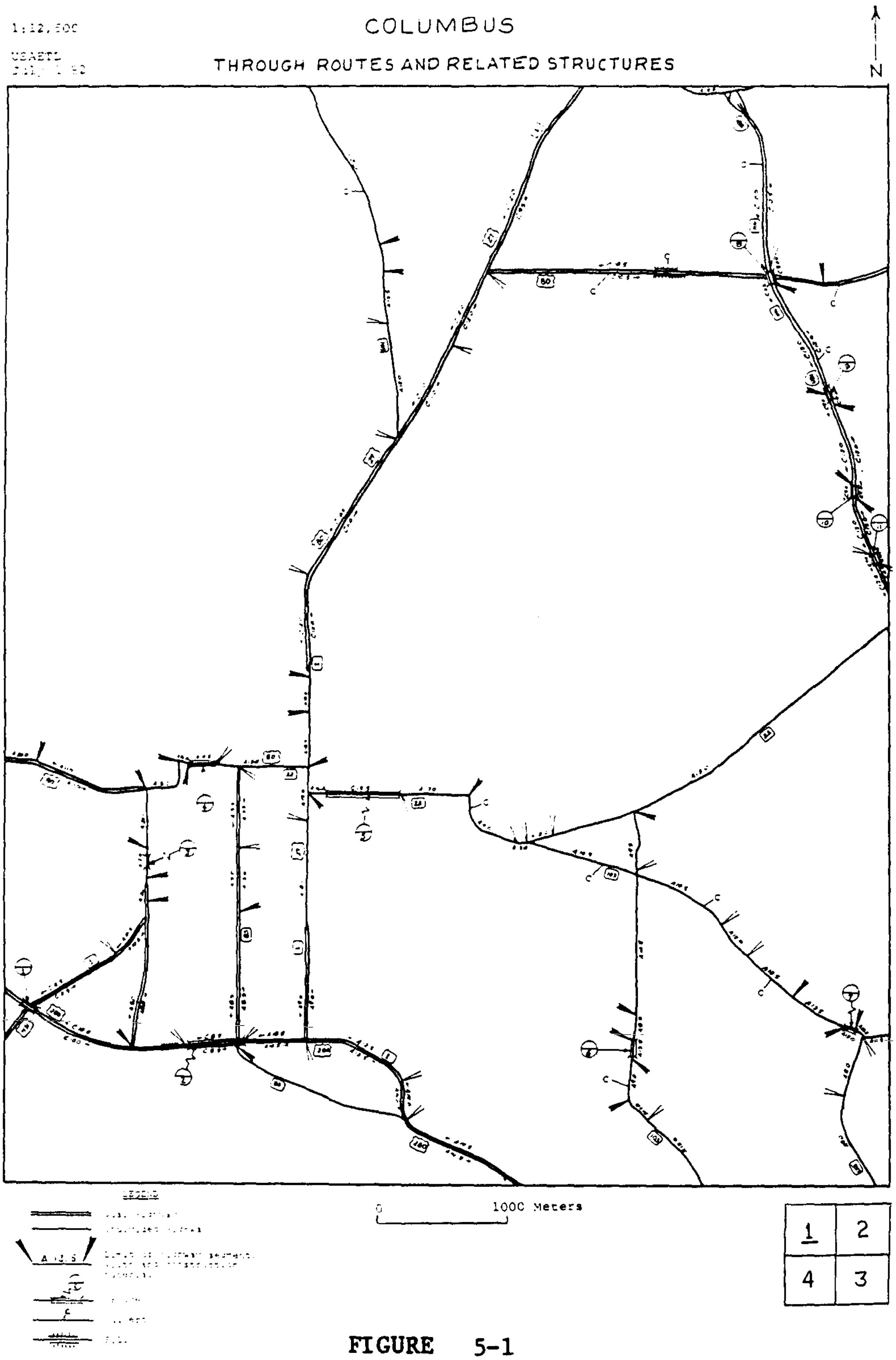


FIGURE 5-1
Through Routes and Related Structures Factor Overlay

which changes in width occur.

f. Width of Traveled Way (Symbol 7, table 5-1): The width of traveled way indicates the total width of road surface available for use by traffic. This does not include shoulders or medians, which may not exist. Accuracy must be to the nearest 0.5 meter. Width is shown for both sides of dual roads.

g. Grade (Symbol 12, table 5-1): Grades 7 percent or greater are shown using arrowheads in multiples of 2, 3, and 4, symbolizing grades of 7 - 10 percent 10 - 14 percent and greater than 14 percent. The grade symbol will be placed directly on the route with the tips of the arrowheads pointed upslope. Short lines drawn across the roadway, above and below the symbol will indicate the upper and lower ends (limits) of the designated grade.

h. Turnout, Rest, and Park Areas (Symbol 5, table 5-1): These are defined as prepared areas adjacent to the roadway that can be used by vehicles as stopping points so as not to block the roadway itself.

i. Emergency Drive-Off Areas (Symbol 6, table 5-1): These are defined as unprepared areas adjacent to the roadway where vehicles can drive off from the road in an emergency. Such areas are characteristically flat without steep banks, fences, or other obstacles that would hinder departure from the road.

j. Bridge or Overpass Identification Number and Load Classification (Symbol 15, table 5-1): The ID numbers are applied sequentially within a factor overlay, with the sequence continued within each route. The load classification shown will be for one-way wheeled vehicles. Other categories of load classifications are recorded in Data Table I (figure 5-2).

k. Bridge or Overpass Bypass Conditions (Symbol 15, table 5-1): Bypasses are local detours along a specified route that enables traffic to avoid an obstruction. Bypasses are classified as easy, difficult, or impossible. Each type of bypass is represented symbolically on the line extending from the bridge symbol to the map location and defined as follows:

(1) Bypass Easy. The obstacle can be crossed within the immediate vicinity or the bridge by a U.S. 2 1/2-ton, 6 x 6 truck (or NATO equivalent) without work to improve the bypass.

(2) Bypass Difficult. The obstacle can be crossed within the immediate vicinity of the bridge, but some work will be necessary to prepare the bypass.

(3) Bypass Impossible. The obstacle can only be crossed

by one of the following methods:

(a) Repair of existing bridge.

(b) Construction of a new bridge.

l. Bridge or Overpass Length and Width (Data Table I): The length and width are recorded on Data Table I and are not placed on the map.

m. Covered Passageways (Symbol 13, table 5-1): Covered passageways are structures that cross above the roadway. They may be road, railroad, or streetcar underpasses, or passageways through or under buildings. Where the structure is a road overpass, both symbols 13 and 15 will be used so as to describe both the overpass and the underpass clearances.

n. Tunnels (Symbol 16, table 5-1): This feature is defined as any structure, other than overpasses, that roofs the road, regardless of length. Identification numbers will be assigned sequentially within the map sheet. Bypass conditions are treated in the same manner as for bridges.

o. Culverts (Symbol 18, table 5-1): Culverts are structures, conduits, or pipes that are used to carry water beneath roadways.

3. Data Tables:

a. General. Two data tables keyed to the overlay features will be used to provide additional, more detailed information. These data tables are illustrated in figures 5-2 and 5-3. The two data tables should be placed on one individual sheet, but if too many entries make this difficult, two or more sheets may be used.

b. Data Table I, Bridges.

(1) Column 1: Road Identification Number: Record route number and category of route on which the bridge is located.

(2) Column 2: Bridge Identification Number: Bridge number will be assigned in sequence within the overlay. The sequence of numbers will be continuous along each route.

(3) Column 3: Bridge UTM Coordinates: The UTM coordinates (±10m) of the bridge center will be recorded in this column.

(4) Column 4: Bridge Military Load Class: The load classifications, one-way and two-way, for both wheeled and tracked vehicles will be posted.

(5) Column 5: Number of Bridge Spans: Record the number of spans forming the bridge.

(6) Column 6: Total Length of Bridge: Record in meters the total length of the bridge (between abutments).

(7) Column 7: Bridge Span Characteristics (for each span):

(a) Record the type of bridge construction material.

(b) Record the type of bridge construction.

(c) Record the width of the bridge traveled way.

(d) Record the overhead clearance distance.

(e) Record the underbridge clearance distance.

(8) Column 8: Feature Crossed: Record the name of the obstacle(s) crossed by a bridge as indicated on the best available topographic map.

(9) Column 9: Bypass Condition: Record the bypass condition as indicated on the overlay and describe the distance, direction, type, and condition of the bypass.

(10) Column 10: Sketch of Bridge Cross Section and Profile: A dimensioned profile and crossed section of the bridge will be drawn in this space.

DATA TABLE I-BRIDGES

1	2	3	4				5	6	7					8	9	10
ROAD NO OR NAME	BRIDGE NO.	BRIDGE UTM	LOAD CLASS				NO. SPANS	TOTAL LENGTH (m)	SPAN CHARACTERISTICS					FEATURE CROSSED	BYPASS COND.	SKETCH OR COMMENT
			WHEEL		TRACK				CONST MAT'L a	CONST TYPE b	ROAD WIDTH c	O H CLEAR d	U B CLEAR e			
			→	→/←	→	→/←										
Va State 123	1	552114	105	40	65	25	2	124	MC	Slab	7.0m	unlimited	10m	wind river	? difficult (Steep embankment)	①  1M 3.5M 3.5M 1M; 60 CM; 10M; Vertical Clearance-Unlimited!

Figure 5-2. Data Table I — Bridges.

c. Data Table II, Tunnels:

(1) Column 1: Road Identification Number: Record the road or route number and route category along which the tunnel occurs.

(2) Column 2: Tunnel Identification Number: The ID number will be recorded as indicated on the factor overlay.

(3) Column 3: UTM Coordinates of the Portals: Record the UTM coordinates (±10m) of both portals of the tunnel.

(4) Column 4: Tunnel Length: Record the total length of the tunnel.

(5) Column 5: Depth of Overburden: This entry applies to the maximum depth of the overburden to the nearest meter.

(6) Column 6: Width of Roadway: Record the width of the roadway within the tunnel.

(7) Column 7: Vertical Clearance: Record the vertical clearance of the tunnel.

(8) Column 8: Horizontal Clearance: Record the horizontal clearance of the tunnel.

(9) Column 9: Lining Material: A short statement on the lining material is required in this column.

(10) Column 10: Bypass Condition: Record the bypass condition as indicated on the overlay, the distance and direction to the bypass, the type of bypass, and the conditions that make its use difficult.

(11) Column 11: Cross Section and Profile Sketch: A dimensioned cross section will be sketched in this space.

DATA TABLE II-TUNNELS

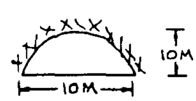
1	2	3	4	5	6	7	8	9	10	11
ROAD NO OR NAME	TUNNEL NO.	PORTAL UTM	LENGTH M.	OVERBURDEN DEPTH (M)	ROADWAY WIDTH (M)	VERT CLEAR	HORIZ. CLEAR	LINING MATL	BYPASS CONDITIONS	CROSS SECTION AND PROFILE
VA State 304	3	134632	600	49	7.0	10.0M	7.0M	Concrete	Impossible (Steep Rocky Slopes)	

Figure 5-3. Data Table II — Tunnels.

VI. RAILROADS AND RELATED STRUCTURES

A. Introduction.

In preparing a railroads factor overlay for a built-up area, the analyst should obtain the Terrain Analysis Procedural Guide for Railroads and Related Structures (in preparation). This guide, designed for analysis at a scale of 1:50,000, is equally applicable at the 1:12,500 scale. The following specifications are reprinted from the ETL guide on railroads, and are intended only to describe the symbology to be used on the factor overlay, and the content of the data tables. ETL-0311 provides detailed instructions necessary for completion of the required analysis.

B. Specifications for Preparing Factor Overlays for Railroads.

1. Introduction:

a. This section specifies the methods of recording the results of the railroad analysis in the form of factor overlays and data tables.

b. The railroad factor overlays will consist of two parts: (1) an overlay registered to a standard 1:50,000-scale map and (2) data tables describing feature conditions shown on the overlay.

c. In congested areas, the basic 1:50,000-scale overlay may be supplemented by overlays registered to larger scale maps. Where the larger scale supplements are used, the area covered by the supplement will be outlined and identified on the basic overlay.

d. Where a standard 1:50,000-scale map is not available as a base for the overlay, a base map at another scale may be used. If it exceeds 26 by 34 inches, the base map will be subdivided and two or more overlays prepared.

e. The data tables will be prepared on material of the same type and size as the overlay.

f. Normally, not all data required by these specifications will be available during the initial preparation of a factor overlay. However, lack of complete data should not preclude preparation of the overlays. The factor overlay concept envisions the systematic recording of data as it is acquired and the accumulating of data through frequent revision and update.

2. Railroad Factor Overlay:

a. An example of a factor overlay is shown in figure 6-1. Specifications for the format of the overlay are provided in figures A1,

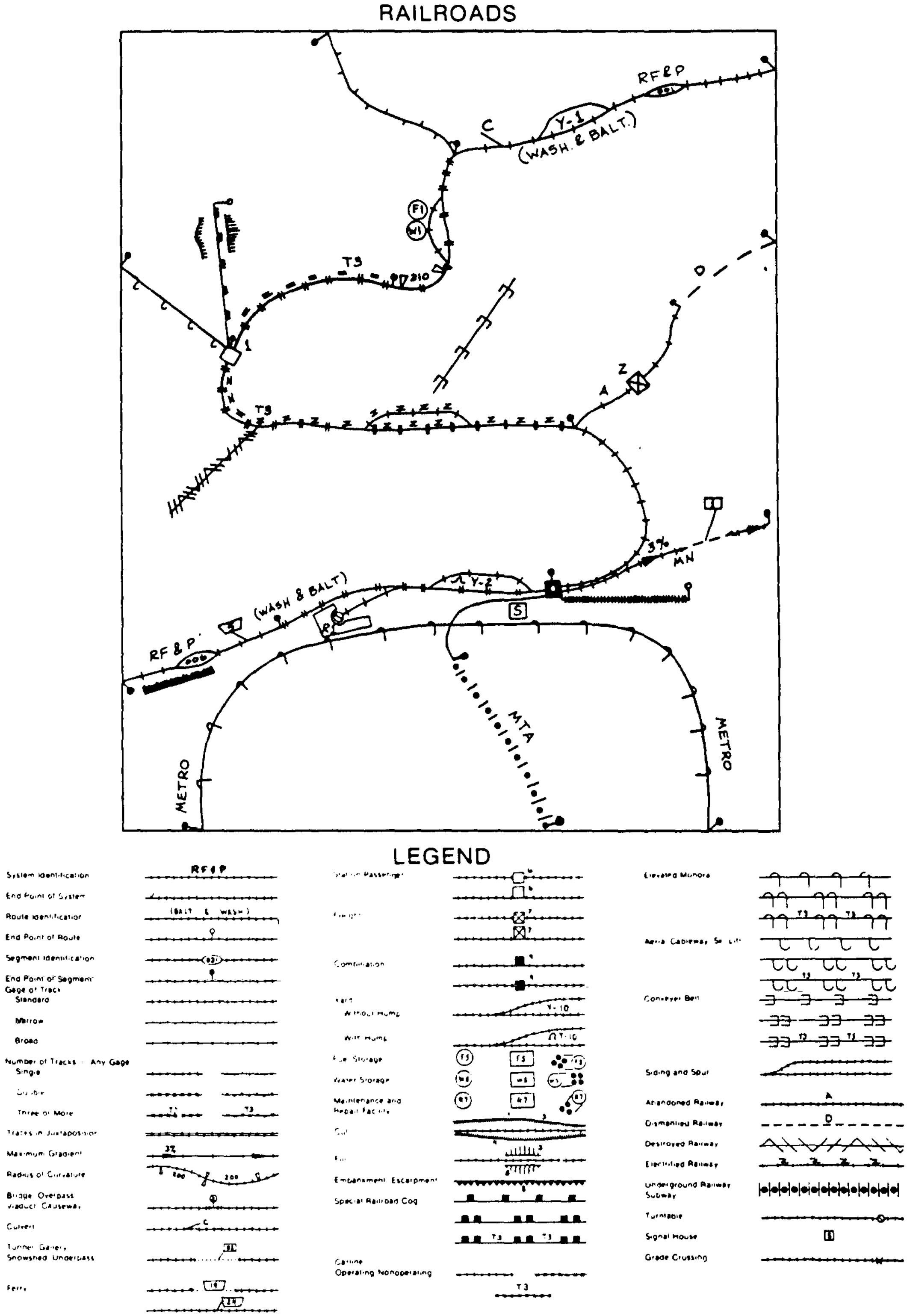


FIGURE 6-1 Sample Factor Overlay - Railroads

A2, and A3 of Appendix A. Figure 6-2 illustrates the format of data tables I through IV.

b. The symbols to be used on the railroad factor overlays are contained in table 6-1. Positioning of the symbols should conform with mapping standards. Where the symbols cannot be positioned with mapping accuracy because of deficiencies in the source material, the actual accuracy will be clearly specified in the coverage diagram or reliability statement.

c. System ID and End Points (Symbols 1 & 2):

(1) A railroad system is defined as that network of rialroads operated by a single management entity, governmental or corporate. Examples; Richmond, Fredericksburg and Potomac (RF&P), and Pennsylvania Central (PC). The system will be identified on the factor overlay by initials that will be placed alongside the component routes on the factor overlay to clearly identify the system to which each route belongs.

(2) System and points are those points at which a RR system begins, ends, or changes identification. There may be system end points within many map sheets. System end points will always coincide with route and segment end points.

d. Route ID and End Points (Symbols 3 & 4):

(1) A route is defined as that portion of a system providing through lines between selected points. Routes are usually specified by the system management, but it may often be convenient or appropriate for the analyst to select others. The route will be identified on the factor overlay by abbreviations of the two end points placed in parenthesis, i.e., (Wash-Balt.).

(2) Route end points are the terminal points selected. There may be no route end points within the area of 1:50,000-scale factor overlay. Route end points always coincide with segment and points and may coincide with system end points. Kilometer distances are always measured from route end points.

e. Segment ID and End Points (Symbols 5 & 6):

A segment is defined as that portion of a route characterized by uniform load bearing, traffic capacity, and operating characteristics. End points of segments are defined by nodes that are along the route, at which any one of the following conditions occur:

(1) A change in the number of tracks (points at which passing tracks or sidings start or end do not constitute nodes).

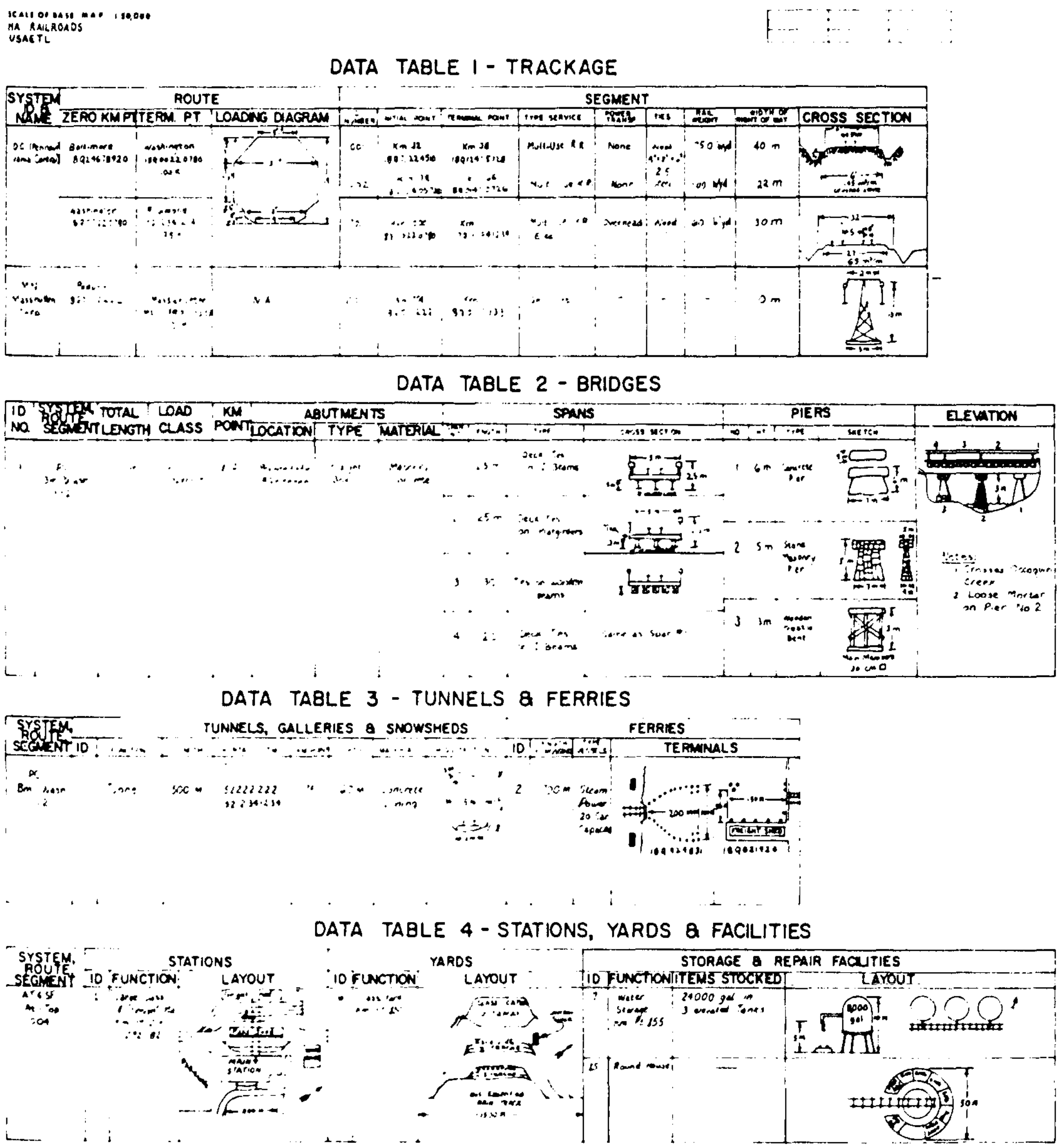


Figure6-2 Sample Data Tables.

Table 6-1. Symbols Specified for Railroads.

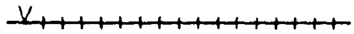
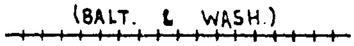
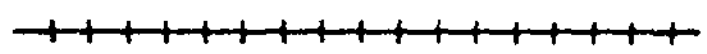
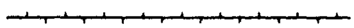
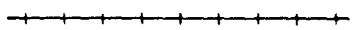
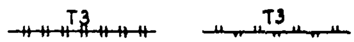
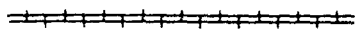
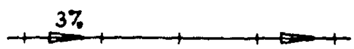
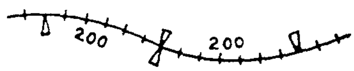
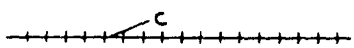
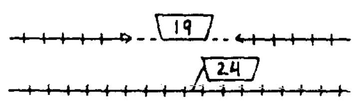
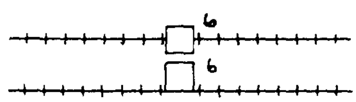
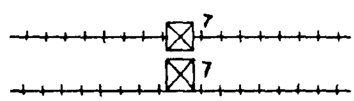
No.	Feature	Symbol
1.	System Identification	
2.	End Point of System	
3.	Route Identification	
4.	End Point of Route	
5.	Segment Identification	
6.	End Point of Segment	
	Gage of Track	
7.	Standard	
8.	Narrow	
9.	Broad	
10.	Number of Tracks — Any Gage Single	
11.	Double	
12.	Three or More	
13.	Tracks in Juxtaposition	
14.	Maximum Gradient	
15.	Radius of Curvature	
16.	Bridge, Overpass, Viaduct, Causeway	
17.	Culvert	
18.	Tunnel, Gallery, Snowshed, Underpass	
19.	Ferry	
	Station	
20.	Passenger	
21.	Freight	

Table 6-1. Symbols Specified for Railroads (Cont.).

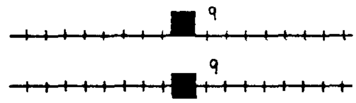
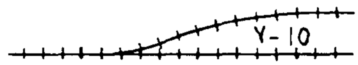
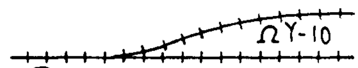
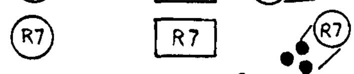
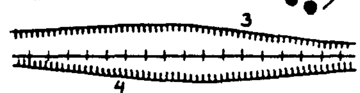
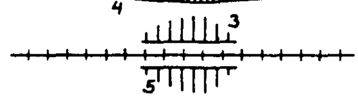
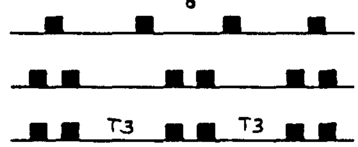
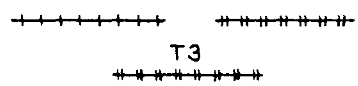
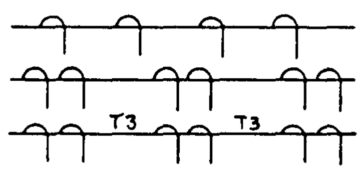
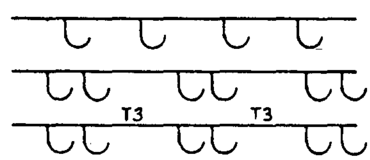
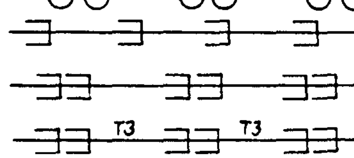
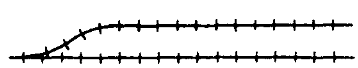
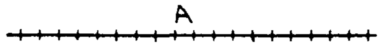
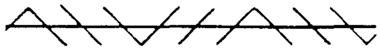
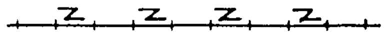
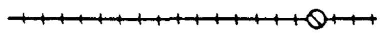
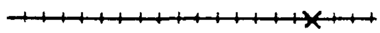
No.	Feature	Symbol
22.	Combination	
23.	Yard Without Hump	
24.	With Hump	
25.	Fuel Storage	
26.	Water Storage	
27.	Maintenance and Repair Facility	
28.	Cut	
29.	Fill	
30.	Embankment, Escarpment	
31.	Special Railroad Cog	
32.	Carline Operating/Nonoperating	
33.	Elevated Monorail	
34.	Aerial Cableway, Ski Lift	
35.	Conveyer Belt	
36.	Siding and Spur	

Table 6–1. Symbols Specified for Railroads (Cont.).

No.	Feature	Symbol
37.	Abandoned Railway	
38.	Dismantled Railway	
39.	Destroyed Railway	
40.	Electrified Railway	
41.	Underground Railway, Subway	
42.	Turntable	
43.	Signal House	
44.	Grade Crossing	

(2) A change in the gage of the track

(3) A route terminal

(4) A system terminal

(5) Point at which the route crosses the neatline of the factor overlay

(6) A terminal or junction at which traffic may be diverted onto another route

(7) A change in type of construction such that the load-bearing capacity, speed, or traffic capacity is altered

(8) A point at which electrification starts, ends, or changes method of power transfer

(9) A point at which a change in method of traffic control occurs

(10) International boundary crossings

Segments will be numbered sequentially along a route within a map sheet; start at that segment nearest the zero kilometer point.

f. Gage of tracks (Symbols 7, 8, 9):

The terms normal gage, narrow gage, broad gage, and metric gage have different dimensional meanings in different areas. The terms must be defined to the nearest .01 meters on both the overlay and the data tables.

g. Number of tracks (Symbols 11, 12, 13, 14):

(1) The number of tracks for single-and double-track lines is indicated by the number of ticks used with the gage symbol. Routes with three or more tracks are symbolized by the double track symbol supplemented by a "T" followed by a number indicating the actual number of tracks.

(2) Lines operated by different systems that closely parallel each other or share a common right-of-way are considered in juxtaposition and are indicated by separate symbols. Symbols for such lines will be displaced from the centerline sufficiently to make it clear that there are two distinct lines.

h. Maximum Gradient (Symbol 15):

The maximum gradient of each segment is symbolized by arrows placed at the bottom and at the top of the grade whenever the grade is greater than 2 percent. The arrowheads will be positioned so that the flat end of the first arrowhead marks the bottom of the grade and the pointed end of the second arrowhead marks the top of the grade. The actual grade in percent will be recorded adjacent to the first arrowhead.

i. Radius of Curvature (Symbol 16):

The radius of curvature will be shown for all curves with radii of 300 meters or less. The symbol will be placed at both ends of each curve, or section of a curve in the case of compound curves. The symbol will be placed in contact with the track symbol on the inside of the curve. The radius in meters will be recorded adjacent to one of the symbols on the side towards the other end of the curve.

j. Bridge, Overpass, Viaduct, Causeway (Symbol 17):

(1) Bridges, overpasses, viaducts, and causeways are defined as those structures longer than 10 meters that carry a line over an obstacle. Structures less than 10 meters long are symbolized as culverts. In exceptional cases overpasses less than 10 meters long may be treated by the symbol if they are considered sufficiently important.

(2) Identification numbers will be assigned sequentially <u>within the map sheet</u>. The same bridge number cannot appear twice within the same map sheet.

k. Tunnels, Galleries, Snowsheds, and Underpasses (Symbol 19):

(1) This category of feature is defined as any structure which roofs the tracks <u>regardless of length</u>.

(2) Identification numbers will be assigned sequentially within the map sheet. The same tunnel number cannot appear twice within the same map sheet.

l. Ferries (Symbol 20):

The ferry symbol may be positioned either within the waterway crossed, as in symbol 20a, or to the side, with a lead line to the location, as in symbol 20b.

m. Stations (Symbols 21, 22, 23):

(1) Station symbols will be positioned to indicate whether the station is between or astride the tracks or to one side.

n. Yards (Symbols 24, 25):

(1) Yards of all types will be indicated by outlining the area with the single track symbol and placing the code letter Y within the outline followed by the identification number. Where the yard is a gravity or hump yard the code letter will be preceded by the hump symbol.

(2) Identification numbers will be assigned sequentially within each map sheet.

o. Maintenance and Repair Facilities and Fuel and Water Storage Facilities (Symbols 26, 27, 28):

Symbolization for fuel and water facilities will be varied according to the type of facility. Small facilities will be symbolized by the specified circle or rectangle. Structures large enough to be symbolized at scale will be outlined and the code letter and identification number placed within the outline. Clusters of small facilities will be symbolized by the circle or rectangle with lead lines indicating the included facilities.

p. Cuts and Fills (Symbols 29, 30, 31):

The conventional symbols for cuts and fills will be supplemented by a number indicating the height or depth of the feature in meters. Vertical or near-vertical features such as retaining walls will be symbolized by the escarpment symbol supplemented by a metric height figure.

q. Special Railroads (Symbols 32, 33, 34, 35, 36):

Special railroads will be treated the same as other except that the system identifiers and terminal points need not be shown. Kilometer distances will be measured from the route terminal points.

Explanations are not deemed necessary for symbols 37-45.

3. <u>Data Tables.</u>

a. General:

A series of four data tables keyed to features on the overlay will be used to provide additional detailed information. These data tables are illustrated in figure 6-2. Data tables will use the same format as the overlay and will carry the same identification. Where practical, all four tables may be placed on a single overlay-sized page as illustrated. Where there are too many entries to enter on a single page, two or more pages may be used. Metric dimensions are preferred in all cases, but the unit of measurement will always be given.

b. Data Table I, Trackage:

(1) Column 1; System ID number and Name: The system ID initial as used on the overlay will be entered, followed by the full identification spelled out.

(2) Column 2; Route Zero Kilometer Point: The name and UTM coordinates (± 10m) of the point of origin will be recorded in this column, with the name placed above the coordinates.

(3) Column 3; Route Terminal Point: The name, UTM coordinates, and kilometer distance from the zero kilometer point will be listed in sequence within this column.

(4) Column 4; Route Loading Diagram: A dimensioned loading diagram for the route will be drawn in this column.

(5) Column 5; Segments Identification Number: The three digit ID number for the segment will be shown in this column.

(6) Column 6 & 7; Segment Initial Point and Terminal Point: The kilometer point and UTM coordinates for the start and end point of the segment will be entered in these columns. The initial point will always be on the end nearest the Route Zero Kilometer Point.

(7) Column 8; Type of Service: A brief statement of the type of service provide by the segment will be placed in this column. Examples: Electrified multiuse RR, Ski Lift, Cog RR, Passenger Subway.

(8) Column 9; Power Transfer: This column is used only for electrified routes. Method by which the power is transferred to the engine will be identified as overhead, third rail, or underground. "None" is entered for non-electrified routes.

(9) Column 10; Ties: The type material, dimensions, and spacing of the track ties will be listed vertically in this column.

(10) Column 11; Rail Weight: The weight of the tracks will be recorded in this column as weight per unit length.

(11) Column 12; Width of Right-of-Way: The total width of the right-of-way will be entered.

(12) Column 13; Cross Section: A dimensioned, Representative cross section of the segment right-of-way will be drawn in this column. In many cases a single cross section may be used for several segments.

c. Data Table II, Bridges:

(1) Column 1; Identification number: This number will be assigned on an overlay basis. The sequence will begin in the upper left corner and progress to the right and down in a normal reading manner.

(2) Column 2; System, Route, Segment ID: The system ID initial, route identification abbreviation, and segment ID number will be entered in this column. Stack them vertically in that sequence.

(3) Column 3; Total Length: Show the total length of the bridge stated to the nearest meter.

(4) Column 4; Load Classification: Load class of each feature will be recorded in this column, expressed in Coopers E categories.

(5) Column 5; Kilometer Point: The distance in kilometers from the Zero Kilometer Point to the nearest end of the bridge is to be entered.

(6) Colums 6, 7, & 8; Abutment Location, Type, and Construction Material: The UTM coordinates, type of construction, and construction material will be listed in this order in these columns.

(7) Column 9; Span Number: Span number(s) beginning at the end nearest the Route Zero Kilometer Point are to be recorded.

(8) Column 10; Span Length: Give the length of individual spans stated to the nearest meter.

(9) Column 11; Span Type: Construction type of that particular span will be entered in this column. Normally an entire multispan bridge is of one type.

(10) Column 12; Cross Section: A dimensioned sketch of each span's cross section will be drawn in this space. Normally the same cross section will be used for each span.

(11) Column 13; Pier Number: Pier number(s) from the Route Zero Kilometer Point will be recorded here. The total number of piers depends on the length and construction type of bridge.

(12) Columns 14, 15, and 16; Pier Height, Type, and Sketch: The height from base of construction to top of pier, construction material, and a sketch of each pier respectively will be posted in these columns. Dimensions should be accurate to the nearest meter.

(13) Column 17; Elevation: An elevation drawing of the entire bridge with each span and pier numbered will be placed in this column. Space is adequate for extra descriptive notes as well as

for dimensions.

d. Data Table III, Tunnels and Ferries:

(1) Column 1; System, Route, and Segment: The system initial, route abbreviation, and segment number will be entered in this column, stacked vertically in that sequence.

(2) Column 2; Tunnel, Gallery, and Snowshed ID: The sheet ID number is assigned to the feature. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading fashion.

(3) Column 3; Function: The function performed by this feature, ie., tunnel, gallery, or snowshed, will be recorded in this column.

(4) Column 4; Length: Total length of feature, portal to portal, will be inserted in this column, stated to the nearest meter.

(5) Column 5; Portals (UTM): The UTM coordinates of each entrance portal will be listed in this column. They will be stacked vertically with the upper set being that of the portal nearest the Route Zero Kilometer Point.

(6) Column 6; Kilometer Point: The distance in kilometers from the Zero Kilometer Point to the nearest portal of the feature to be entered will be placed in this column.

(7) Column 7; Depth: Show the maximum depth below ground level of any portion of the tunnel stated to nearest five meters.

(8) Column 8; Material: The construction material of the feature is to be posted in this column. In the case of tunnels, the lining material will be stated.

(9) Column 9; Cross Section: A dimensioned cross section sketch will be drawn in this space. Several may be necessary to accommodate junctions with other tracks within the feature, especially in the case of subways.

(10) Column 10; Ferries ID: The sheet ID number is assigned to the feature. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading manner.

(11) Column 11; Length of Crossing: The length to the nearest meter of the normal crossing by a fully laden vessel will be entered in this column.

(12) Column 12; Type of Vessel: The vessel type, capacity, and power source will be listed in this column.

(13) Column 13; Terminals: A plan view of each terminal area will be drawn in this space. The plan shown on the left will be the drawn in this space. The plan shown on the left will be the one nearest the Route Zero Kilometer Point. Each will include the UTM coordinates.

e. Data Table IV, Stations, Yards, and Facilities:

(1) Column 1; System, Route and Segment: The system initial, route abbreviation, and segment number will be entered in this column, stacked vertically in that sequence.

(2) Column 2; Station ID: The sheet ID number is assigned to the feature. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading manner.

(3) Column 3; Function: A short description of the station function with kilometer point and UTM coordinates for location purposes will be recorded in this column.

(4) Column 4; Layout: A plan view of the station area will be drawn in this space.

(5) Column 5; Yard ID: The sheet ID is assigned to the feature. Each individual yard type will have a number even though it may be physically adjacent to another yard type. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading manner.

(6) Column 6; Function: A brief statement as to yard type and kilometer point will be entered in this space.

(7) Column 7; Layout: A plan view of the yard area will be drawn in this space. Adjacent yard types should be included in the same sketch to best portray their physical relationships.

(8) Column 8; Storage and Repair Facilities ID: The sheet ID number is assigned to each storage and repair facilities. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading manner.

(9) Column 9; Function: The function filled by the facility will be entered in this column.

(10) Column 10; Items Stocked: This column applies to storage facilities only and will give items stored and in what amounts.

(11) Column 11; Layout: A plan and elevation sketch of each separate facility will be drawn in this space.

VII. PORTS AND HARBORS

A. Introduction.

There is as yet no separate terrain analysis procedural guide for Ports and Harbors. This chapter, therefore, contains the complete procedures for collecting and recording information on Ports and Harbors as one of the data fields for built-up areas analysis.

By definition a harbor is a body of water where ships are relatively protected from adverse wave or current action. Harbors are classified according to location: coastal, bay and estuary, and rivers. A port is that portion of a harbor that has facilities for transacting business between ship and shore.

Harbor works are the structures designed to provide shelter, to control water flow, and to regulate erosion for the improvement of the navigability of a harbor. The principal categories and types of structures are breakwaters, jetties, groins, sea walls, bulkheads, dikes, locks, and moles. Harbor works do not include port facilities that are designed specifically for the transfer of cargo and the servicing of ships.

B. Map Analysis.

1. Retrieve the largest scale topographic and hydrographic maps available for the built-up area being analyzed. Register the factor overlay to the 1:12,500-scale built-up area base map in preparation for adding information for Ports and Harbors. As the map analysis progresses, extracted information should be entered in the four data tables. However, some of the required data can be retrieved only from literature or aerial imagery and therefore can be completed only partially at this point in the overall analysis sequence.

2. Harbor Works: Outline all harbor works. These include structures designed to control water flow, and to regulate erosion for the improvement of the navigability of the harbor. Among them are:

a. Breakwaters
b. Jetties
c. Groins
d. Sea walls
e. Bulkheads
f. Dikes
g. Locks
h. Moles

Harbor works do not include port facilities that are designed for the transfer of cargo and the servicing or construction of ships.

3. Wharves: Outline all wharves. These will vary in symbology from single-line representations for narrow structures to broad wharves with extensive storage and materials-handling facilities. In this guide

the term wharf will include any permanent structure designed to facilitate ship-to-shore exchange of personnel or material. Other designations included in this category are dock, pier, jetty, or quay. Wharves may parallel the shore or may extend into the harbor at any angle from the shore.

4. Storage Facilities: Locate and identify all storage structures and open storage areas that appear to be part of the port complex. This category includes buildings or storage areas that, although not located directly on wharves, are apparently related to port activities. Label each identified storage facility, using numbers with a letter "S" prefix (S1, S2, S3, etc.). Enter the designation in Data Table III and, where possible, complete the entries listed in the table.

5. Shipbuilding/Repair Facilities: Identify shipbuilding and repair facilities, labeling each by number on the factor overlay. These port activities may be recognized by the existence of marine railways or drydocks, or both. Label each facility numerically with an "S/R" prefix (S/R1, S/R2, S/R3, etc.), and enter the same designation in Data Table IV. Complete the entries in the table, extracting the required information from the source maps if possible. However, it may be necessary to refer to aerial photography for this data.

6. Fairways (Navigable Approaches): Trace the main channel(s) that mark the shipping lane(s) from the harbor entrance to the port facilities. Use the symbol from table 7-1.

7. Aids to Navigation: Using symbols from table 7-1, plot the locations of lighthouses, beacons, and channel markers.

8. Depth Soundings: Add depth data to the factor overlay, transferring soundings from the topographic maps or hydrographic charts. Convert values to meters and enter in Data Table 1 (figure 7-1).

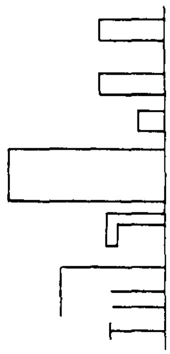
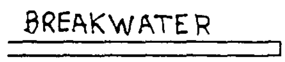
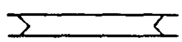
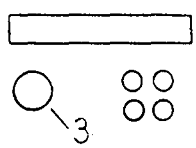
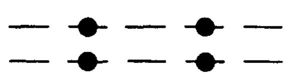
C. Photo Analysis.

1. Harbor Works: Refer to current aerial photography to check the accuracy of map-derived information, and update the factor overlay as necessary. In general, photography will provide greater detail than maps in revealing such features as bulkheads, locks, and tide gates.

2. Wharves: Use recent vertical aerial photography to locate wharves not shown on topographic or hydrographic maps. Add new wharves to the factor overlay and modify the overlay to depict alterations in older structures.

Check photo-based information against map-derived data entered in Data Table II (figure 7-2). Fill in missing entries that can be determined from photography. Establish the kind of material used for

Table 7-1. Symbol Specifications for Ports and Harbors.

No.	Feature	Symbol	Specifications
1.	Wharf		Draw to scale. Where dimensional and construction data are available, identify individual wharves by number ① referencing the wharf in Data Table II.
2.	Breakwater (concrete)		Draw to scale. Label BREAKWATER or with the abbreviation BW.
3.	Breakwater (riprap)		Draw to scale. Label BREAKWATER or with the abbreviation BW.
4.	Lighthouse		Triangle .1" x .4" Circle .1" dia.
5.	Beacon		Triangle .1" x .4" Circle .1" dia.
6.	Tidal Gate (lock)		V-shaped symbols in waterway
7.	Depth (sounding)	10	Numbers .15" (depth in meters)
8.	Structures		Draw to scale. Where dimensional and construction data are available, identify individual structures by number, referencing the structures in Data Table III.
9.	Channel		Width of channel to scale. Dash .2" Space .1"
10.	Channel Marker		Dot .1"

Data Table I — Harbors

1	2	3			4			5		6		7	8
Area (ha)	Controlling Depth (m)	Entrance			Approach			Clearance		Icing		Mean Tidal Range (m)	Maximum Current (Knots)
		Length (m)	Width (m)	Depth (m)	Length (m)	Width (m)	Depth (m)	Vert (m)	Horiz (m)	Period With Ice Dates	Period Closed By Ice		

Figure 7-1. Data Table I — Harbors.

Data Table II — Wharves

1	2	3	4	5		6	7	8
Map ID	UTM Grid Coord	Control	Use	Construction		Length	Width	Depth Alongside
				Substructure	Superstructure			

Figure 7-2. Data Table II — Wharves.

constructing each wharf and enter this information in Data Table II. Oblique aerial and surface photography will aid in identifying categories of wharf construction.

Types of Wharf Construction

Substructures	Superstructures
1. Wood Piling	1. Wood Planking (with or without asphalt paving)
2. Wood Bulkheaded (Backed by Solid Fill)	2. Concrete
3. Concrete Pilings	3. Steel Planking (with or without Paving)
4. Solid Concrete Bulkhead with Solid Fill	
5. Steel Pilings	
6. Steel Sheet Pilings (Interlocking)	
7. Stone or Concrete Block	

3. Storage Facilities: Analysis of aerial photography can reveal much information about storage facilities. The shapes of structures are often keys to the identification of stored materials. This is particularly true of cylindrical tanks normally used for petroleum products, spherical tanks for natural gas, and the tall, rectangular shape that is characteristic of grain elevators. Materials in open storage can be relatively easy to identify. Among these are coal, ore, building materials (lumber, steel, brick and stone), and scrap materials. Oblique aerial photos can be invaluable in establishing the identify of storage facilities.

Using photography sources, continue the analysis begun with topographic and hyrographic maps, label storage facilities by number on the factor map, and enter data as specified in Data Table III (figure 7-3).

4. Shipbuilding/Repair Facilities: Aerial photography can provide definitive information for identifying shipyards. Among features that represent identification aids are

a. Large Cranes
b. Ship Ways
c. Drydocks
d. Marine Railways

Data Table III — Storage Facilities

1	2	3	4	5	6	7	8
Map I.D.	UTM Grid Coord.	Commodity Stored	Type Storage	Length	Width	Height	Construction Material

Figure 7-3. Data Table III — Storage Facilities.

Data Table IV — Shipbuilding/Repair Facilities

1	2	3	4
Map I.D.	UTM Grid	Drydock Type	Vessel Size (Tons)

Figure 7-4. Data Table IV — Shipbuilding/Repair Facilities.

e. Ships on Ways
f. Ships in Drydocks

Label each shipyard numerically (1, 2, etc.) and enter the assigned number(s) in Data Table IV, with the information specified.

5. Fairways (Navigable Approaches): If hydrographic charts are not available, fairways may be identified on aerial photography by locating channel markers. Show the fairway on the factor overlay using the appropriate symbol from table 7-1.

6. Aids to Navigation: Locate aids to navigation on aerial photography and plot their locations on the factor overlay, using symbols from table 7-1. Included in this category are lighthouses, beacons, and channel markers.

D. Specifications for Preparing Factor Overlays for Ports and Harbors.

1. Introduction:

a. The purpose of this section is to specify the methods for recording the results of the Ports and Harbors analysis in the form of a factor overlay and four data tables.

b. The factor overlay will be registered to a 1:12,500-scale built-up area topographic map and will be one of three data fields depicted on the overlay. Other sharing the same overlay are Railroads and Related Structures and Airfields and Heliports.

c. Normally, not all data required by these specifications will be available during the initial preparation of a factor overlay; however, lack of complete data should not preclude preparation of the overlays. The factor overlay concept envisions the systematic recording of data as it is acquired and the accumulating of data through frequent revision and update.

2. Ports and Harbors Factor Overlay:

a. Specifications for the format of a factor overlay are provided in Figures A1 and A2 of Appendix A. Figures 7-1 through 7-4 illustrate the format for Data Tables I through IV.

b. Specifications for the symbols to be used on the factor overlays are contained in table 7-1 as a guide only. Precise compliance with the specified dimensions of the symbols is not necessary. Positioning of the symbols, however, should conform with mapping standards. Where the symbols cannot be positioned with mapping accuracy because of deficiencies in the source material, the actual accuracy will be clearly specified in the coverage diagram or reliability statement.

3. Feature Descriptions.

a. Wharves: Wharves are manmade structures, generally extending at an angle from the short or waterfront to accomodate vessels loading or unloading. Symbolize by drawing wharves to scale on the factor overlay. If information concerning wharf construction is available, the wharf should be numbered (see sample overlay), with detailed construction data entered in Data TableII.

b. Breakwater (concrete): A solid, elongated feature, constructed to intercept wave action and create a protected refuge for vessels at anchor or moored at wharves. Straight lines will be used to show the outline of this type of breakwater on the overlay, and the word BREADWATER, or the abbreviation BW, will be printed parallel to the symbol on the factor overlay.

c. Breakwater (riprap): Same as b, above, except that the feature will be outlined on the overlay by wavy lines to simulate the irregular material used in the construction of the breakwater.

d. Lighthouse: A rotating light designed as an aid to navigation, usually located to warn mariners of dangerous obstacles.

e. Beacon: A nonrotating light, sometimes fixed to channel markers, placed as an aid to navigation.

f. Tidal Gates: Movable (hinged) barriers, designed to impound waters at high tide in order to maintain high water levels within enclosed basins during periods of low water.

g. Depth Soundings: Numerical values (meters) indicating water depths at mean low water.

h. Structures: Port facilities (buildings) located on or close to the waterfront. Includes storage facilities, structures relating to shipbuilding and repair, ferry terminals, port administration and police facilities, etc. Where identification of structures is possible, number them consecutively and provide detailed information for each numbered structure in Data Table III.

i. Channels: Navigable fairways identified by channel markers and leading to port facilities (wharves or anchorages). Position as shown on hydrographic charts.

j. Channel Markers: A variety of fixed or floating devices identifying the lateral limits of a channel. Position as shown on hydrographic charts or aerial photographs.

4. Data Tables.

This section instructs the analyst on procedures for making entries in the four data tables (figures 7-1 through 7-4) that will supplement the Ports and Harbors Factor Overlay.

a. Data Table I - Harbors

(1) Column 1; Area: Enter the harbor area in hectares.

(2) Column 2; Controlling Depth: Record the minimum depth (meters) between the harbor entrance and the port facilities.

(3) Column 3; Entrance: Enter the harbor entrance length, width, and depth in meters.

(4) Column 4; Approach: Enter the length, width, and depth of the fairway from the entrance to the port facilities.

(5) Column 5; Clearance: Enter the minimum clearance below any fixed bridge(s) on the fairway.

(6) Column 6; Icing: Enter the period (average dates) that the harbor has an ice cover. If the port is closed during the winter season by ice, indicate this period (average dates).

(7) Column 7; Mean Tidal Range: Record the average range between high and low tides in meters.

(8) Column 8; Maximum Current: Enter the maximum tidal current in knots. If the port is on a river not affected by tidal fluctuations, indicate the average stream flow in knots.

b. Data Table II - Wharves

(1) Column 1; Map ID: Enter the number used to identify the wharf on the factor overlay.

(2) Column 2; UTM Grid Coordinates: Record the UTM Grid Coordinates of the midpoint of the wharf.

(3) Column 3; Control: Enter the controlling authority (commercial, military, police, etc.)

(4) Column 4; Use: Indicate the primary use (petroleum export, coal export, grain import, recreation, ferry service, etc.).

(5) Column 5, Construction: Record the type of substructure and superstructure.

Types of Wharf Construction

Substructures	Superstructures
(a) Wood Piling	(a) Wood Planking (with or without Asphalt Paving)
(b) Wood Bulkhead (Backed by Solid Fill)	(b) Concrete
(c) Concrete Piling	(c) Steel Planking (with or without Paving)
(d) Solid Concrete Bulkhead with Solid Fill	
(e) Steel Pilings	
(f) Steel Sheet Pilings (interlocking)	
(g) Stone or Concrete Block	

(6) Column 6; Length: Enter the wharf length in meters.

(7) Column 7; Width: Enter the wharf width in meters.

(8) Column 8; Depth Alongside: Enter the water depth adjacent to the wharf in meters.

c. Data Table III - Storage Facilities.

(1) Column 1; Map ID: Record the number used to identify the storage facility on the factor overlay.

(2) Column 2; UTM Grid Coordinates: Identify the UTM grid coordinates of the storage facility and enter in this column.

(3) Column 3; Commodity Stored: Enter the commodity designation (coal, lumber, wheat, oil, etc.) in this column.

(4) Column 4; Type Storage: If the commodity is stored in a structure, enter the word "closed." If the stored material is unprotected, the word "open" will be used.

(5) Column 5; Length: Enter structure length in meters. If the structure is cylindrical, indicate the diameter in meters (Dia. 5 m).

(6) Column 6; Width: Enter structure width in meters.

(7) Column 7; Height: Enger the maximum height of the storage facility.

(8) Column 8; Construction Material: Information entered in this column relates to material used in the construction of storage structures. Categories include reinforced concrete, concrete block, stone, brick, steel frame with sheet metal cladding, wood frame with wood or composition siding, welded or riveted steel (tanks), etc.

d. Data Table IV - Shipbuilding/Repair Facilities:

(1) Column 1; Map ID: Enter here the number used to identify the facility on the factor overlay.

(2) Column 2; UTM Grid Coordinates: Locate the facility within the1000 meter square (6 digits) and enter in this column.

(3) Column 3; Type Facility: Record the type of accommodation for ship building or repair. This includes graving docks, floating dry docks, and marine railways.

(4) Column 4; Vessel Size: Enter the maximum capacity (tonnage) of the facility.

GLOSSARY FOR SECTION VII

ANCHORAGE -- see holding basin/anchorage.

APPROACH -- The portion of a waterway that leads to the entrance of a port or harbor.

BERTH -- The water area at the edge of a wharf, a dock or a pier reserved for a vessel to load or unload its cargo or passengers.

BOARDING POINT -- A designated point or area outside of the harbor entrance where incoming vessels wait to pick up the harbor pilot.

BOLLARD -- A wooden or metal post set on a wharf to provide a mooring point.

BREAKWATER -- A structure of native or manmade materials erected in a direction to protect or shield a harbor from the forces created by wave action.

BUNKERING RATE (OFF-LOAD FACTORS) -- The rate at which supplies such as coal or oil can be placed into a ship's bunker.

BUOYS -- Floating objects anchored to the harbor bottom to identify a channel, a range, or a bottom condition such as a shoal or a reef.

CHANNEL MARKERS -- A series of buoys, poles, or other marks that are visible above high water and define the safe channel.

CHARACTER OF BOTTOM -- A description of the terrain condition at the bottom of the harbor (rock, mud, sand, or silt, and if firm, medium, or poor.).

COMMUNICATION/DISPATCHING -- An operational function in busy harbors to maintain an efficient flow of traffic in and out of the harbor/port facilities; includes pilotage, anchorage, and inspection.

CONSPICUOUS OBJECTS FOR ORIENTATION (ENTRANCE) -- The natural or manmade features that are prominently visible or form a recognizable pattern from seaward to aid in alining the craft approaching the harbor entrance.

CONTROLLING DIMENSIONS (ENTRANCE) -- The depth and the width of the water passage at specific tide, wind, or water conditions that determine the maximum draught of ship that can pass safely through the entrance.

DIRECTION/QUADRANT (APPROACH) -- The channel alinement or area of open water that affords a safe, unobstructed course for a craft to use to approach the entrance. Marked by channel markers or by range markings with a specified limit of the safe bearings.

DOCK -- The water area between parallel piers; also called a slip.

DOLPHINS -- A cluster of pilings set in the water offshore to provide a mooring point, or close to a structure to protect the structure and the vessels that may have to pass close by.

DRAUGHT -- The distance below the water's surface to which a ship's bottom will reach under various loadings considering the water's buoyance, which is a function of the salinity and temperature.

DRYDOCK (SHIPBUILDING AND REPAIR) -- A structure which can receive a floating vessel and then remove the water surrounding the hull to expose it for repair.

ENTRANCE -- The junction of the open sea or waterway and the channel leading into the harbor; usually marked or designated by a range description or by conspicuous objects for orientation.

FAIRWAYS -- The channel that must be left unobstructed for free navigation in a harbor; described by width, depth, and overhead clearance.

FIXED MOORINGS -- A structural configuration (buoys, dolphins or other) singly or in multiple units set away from the shore or permanent wharves to which vessels can be secured; may be an area where fore and aft anchors are to be used to prevent vessel rotation; may also be next to a ponton wharf or floating dock to permit unloading.

FLOATING DRYDOCK -- A buoyant, vessel-like structure that can be submerged to accept a vessel and then raised by draining to bring the vessel out of the water for hull repair.

GRAVING DOCK -- see drydock.

GROIN -- A jetty-like structure extending from a beach at an angle to the shoreline to arrest lateral currents and to prevent beach erosion; also erected in rivers and tidal channels at an angle to the direction of water flow to increase velocity and to control silting.

HARBOR -- An area of water affording a natural or artificial haven for vessels.

HARBOR DATA -- The physical dimensions of the water area used as a harbor, from its approach to its terminal berth, or haven, position.

HARBOR DIVISIONS -- Areas within a harbor that are defined by certain conditions such as depth, shelter, prevailing winds, and holding ground, and dictate the type and size of vessel that can use the harbor.

HARBORWIDE CARGO HANDLING EQUIPMENT -- The movable equipment either as part of the mechanical wharfside facilities or as separate pieces that can be used for cargo handling.

HEADING BASIS (OFF-SHORE PIPELINE) -- The direction that a vessel must approach and moor at the pipehead wharf.

HEADING FROM TARGET (ENTRANCE) -- The established direction that must be taken to stay within the channel limits of the entrance.

HOLDING BASIN/ANCHORAGE -- An area of the harbor where vessels may lie anchored without obstructing traffic movement; classified by the depth and minimum rotational diameter around the anchor point. (Diameter is equal to two times the ship's length, plus the horizontal projection of the anchor chain's length).

Class	Minimum diameter m.	Depth m.
1	800	15
11	500	9
111	300	6

HOLDING GROUND -- The bottom ground of the different harbor areas identified by class as to the quality of the holding power of that ground:

Class 1 - excellent
2 - good
3 - fair
4 - poor

JETTY -- A breakwater-like structure at the mouth of a river, harbor or elsewhere to control water flow or currents, generally for the purpose of maintaining channel depths; usually alined parallel with the prevailing direction of water flow. Used by the British as a general term for wharf and in certain Far Eastern ports refers to ponton wharf.

LANDSIDE ACCESS/EXIT -- The position of the docking facility in relation to the adjoining terrain and the manner in which cargo is moved to and from the dock.

LIFT CAPACITY (MOVEMENT CAPABILITY) -- The amount of cargo that can be lifted at one time by a particular piece of equipment.

LIGHTERAGE -- The transhipment of commodities or passengers between ship and wharf through use of floating equipment.

LOADING RATE (OFF-LOAD FACTORS) -- The rate of loading/unloading possible at the off-shore pipeline mooring.

LOCALE (TYPE OF HARBOR) -- A distinction between those on coastal waters and those that must be reached by traversing an inland waterway.

MARINE RAILWAY (DRYDOCK TYPE) -- A railed structure where the vessel is blocked and then towed out of the water for drydock work.

MECHANICAL WHARFSIDE FACILITIES -- Movable barges, floats, cranes, or cars that may be on rails, whells, or vessels, thus reaching the incoming vessel from either the land or water side.

MOLE -- A massive wharf structure with broad surface that may serve more than the basic purpose of a berthing place for vessels.

MOVEMENT CAPABILITY (MECHANICAL WHARFSIDE FACILITIES) -- The area (as a radius) that the facility can reach, the height to which cargo can be lifted, and the cycling time to pick up, swing over, deposit, and return for another load.

NAVIGATION AIDS -- The specific manmade or man-placed structures that aid in the movement of traffic in and out of the port or harbor.

OPERATING DATA -- The amount of traffic, the amount of the different commodities, and the purpose of stop (initial, terminal, in-transit, transshipment).

PIER -- A wharf running at an angle with the shoreline of the body of water, providing a landing place to discharge cargo, passengers, stores, or fuel.

PILOTAGE (NAVIGATION AIDS) -- A maritime service provided by harbor officials where people familiar with the harbor channels and obstructions "pilot" the vessel between the harbor entrance and a safe berth.

PONTON WHARF -- A wharf built up on a series of pontons (pontoons) where more permanent structures are impractical or undesirable; see jetty.

PONTOON (DRYDOCK TYPE) -- A drydock constructed of pontoons to float the vessel. It then can be drained for hull work.

PORT -- A harbor with terminal facilities for cargo manipulation or other ship-to-shore business. Term may apply to the entire harbor in which business is transacted or only to the terminal facilities within the harbor.

PORT AUTHORITY -- A designation of the type of administration and its extent in operating the port, with the type of port maintenance provided.

PREVAILING WINDS -- Description of the wind direction that affects a harbor area, to identify method of anchoring.

QUADRANT (APPROACH) -- see direction/quadrant (approach).

QUAY -- A solid-wall structure built against and parallel to the shore so that vessels can berth alongside its face.

RANGE (NAVIGATION AID)
RANGE (TARGET, APPROACH) -- Two or more objects alined on a designated bearing to define a safe direction of approach. The safe approach may follow the range direction or be to either side of the range in which case a second range must be established to define the other limit of safe travel.

RESTRICTED APPROACH -- Inland waterway or open water conditions that can prevent a craft from heading to an entrance along that specific bearing. For example, high water may hide rocks; low water may decrease available channel depths; wind from a certain direction can drive the craft on shore, and so forth.

VIII. AIRFIELDS, HELIPORTS, AND RELATED STRUCTURES

A. Introduction. This section describes procedures for preparation of factor overlays for Airfields and Heliports. Also included are instructions for entering map-derived information in data tables. Although the factor overlay will be registered to a built-up area, 1:12,500-scale topographic map, and basic information will be "pulled up" from that map, it is the responsibility of the analyst to review other large-scale maps for needed information. In the event that only one or few airfields are located in the built-up area being defined, the airfield information may be combined with one of the other required factor overlays.

1. Airfields. An airfield, for the purposes of this guide, is an area used for the landing and takeoff of fixed wing aircrafts, with associated structures for traffic control, passenger accomodations, and aircraft maintenance (figure 8-1).

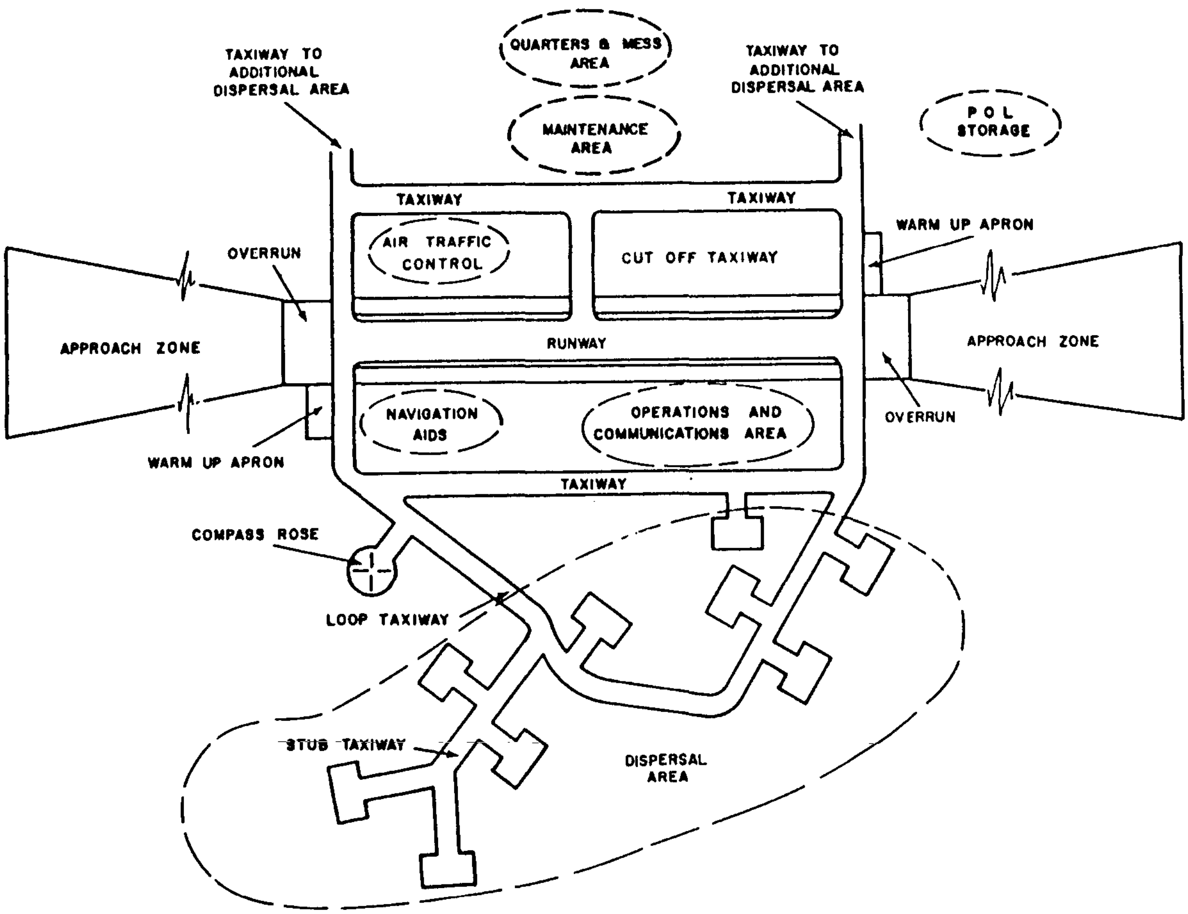


FIGURE 8-1. Airfield Layout

Portions of airfields may be set aside for helicopter (rotary wing) operations, and it can be assumed that airfields designed for fixed wing aircraft have the capability of serving as heliports as well.

An airfield may be a natural surface area, a military landing strip with revetments, a simple advance landing strip, or a multirunway air terminal with operating areas and installation facilities. An airfield is composed of the operating area (flightstrips, taxiways, aprons, and hardstands) and the installation facilities (hangers, administrative and operational buildings, personnel accomodations, and maintenance and storage facilities). The most important part of the operating area is the flightstrip, including runway, overrun, shoulders, cleared areas, and lateral safety zone. The flightstrip and the approach zones at both ends of the flightstrip comprise the flightway (figure 8-2).

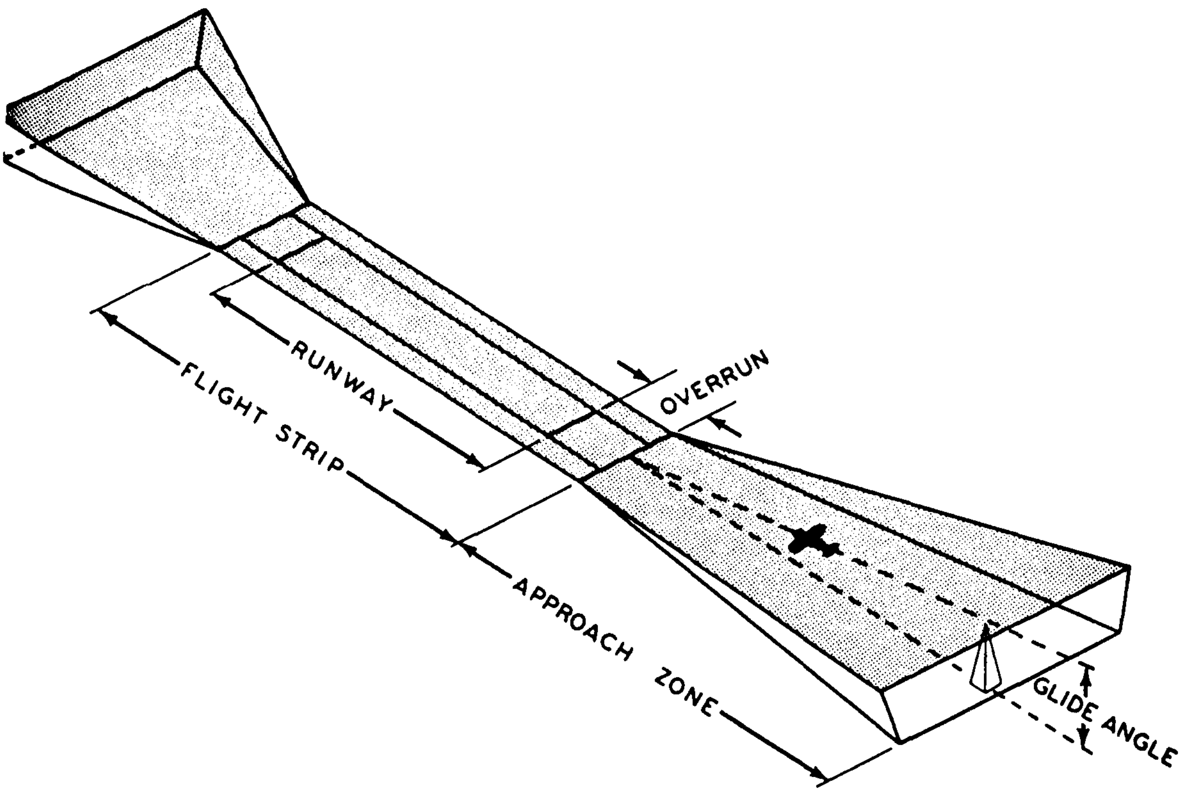


FIGURE 8-2. Diagram of a Flightway

The length of a runway is determined by the ground run required by the type of aircraft the runway is designed to accommodate. In general, the width of a runway ranges from 100 feet to 250 feet, and immediately adjacent to the shoulders on each side of a runway is a cleared area and lateral safety zone. A clear zone, equal in width to the flightstrip and in length to the overrun, is provided at each end of a runway, minimizing the hazard of overshooting or undershooting a runway. That portion of a clear zone that is an extension of a runway and its shoulders is called an overrun. The capacities of runways are usually listed in pounds and refer either to the gross takeoff weight or single wheel-load of an aircraft. Capacity of a runway can be approximated by observing the largest type aircraft using it.

2. Heliports: Heliports, like airfields, vary in size and significance, and like airfields may contain maintenance and service facilities, hangars, administration or operations offices, control tower, communications facilities, and fuel storage. Heliports may exist as individual entities (figure 8-3), or they may be part of an airfield complex (figures 8-4 and 8-5).

B. Map Analysis - Airfield

1. Runways, Taxiways, Aprons, and Hardstands: With the overlay registered to the 1:12,500-scale topographic map, outline all airfield runways, taxiways, aprons, and hardstands.

2. Airfield Perimeter: Trace the outer limits of the airfield boundaries on the factor overlay. The perimeter may be identified by a clear break in vegetation symbology, or there may be a fence symbol outlining the limits of the airfield.

3. Structures: Outline all airfield related structures (control tower, hangars, service and administration buildings, fuel tanks, etc.). Number each structure and enter the numbers in the Structures data table along with any of the specified information that can be determined from map sources.

4. Airfield Name/Elevation: Indicate the name of the airfield on the overlay, just outside the perimeter boundary line, follow by the field elevation in meters.

5. Runway Azimuths: At the end of each runway indicate its azimuth, rounded off to the nearest 10 degrees. Drop the zero from the numerical value, using a one or two-digit number. For example: 273^{o} would be recorded as 27, and 090^{o} would be 9.

6. Runway Length and Width: Indicate these dimensions within the runway outline. If the runways are not sufficiently wide to permit

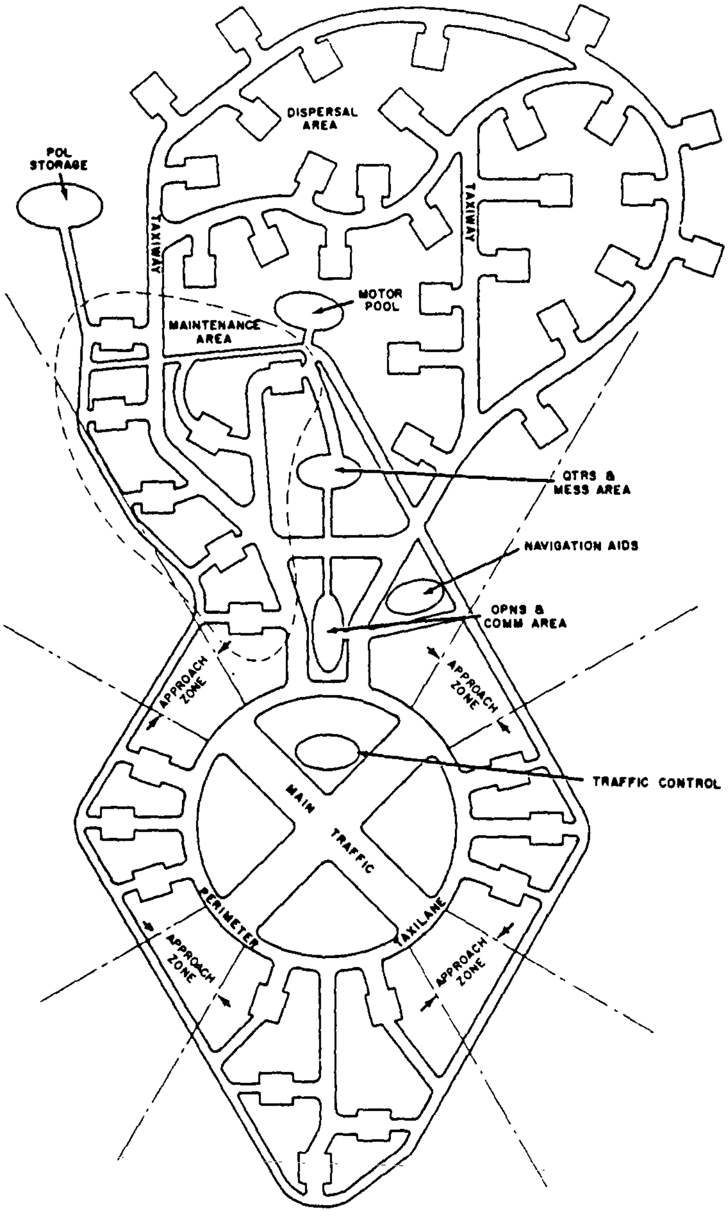
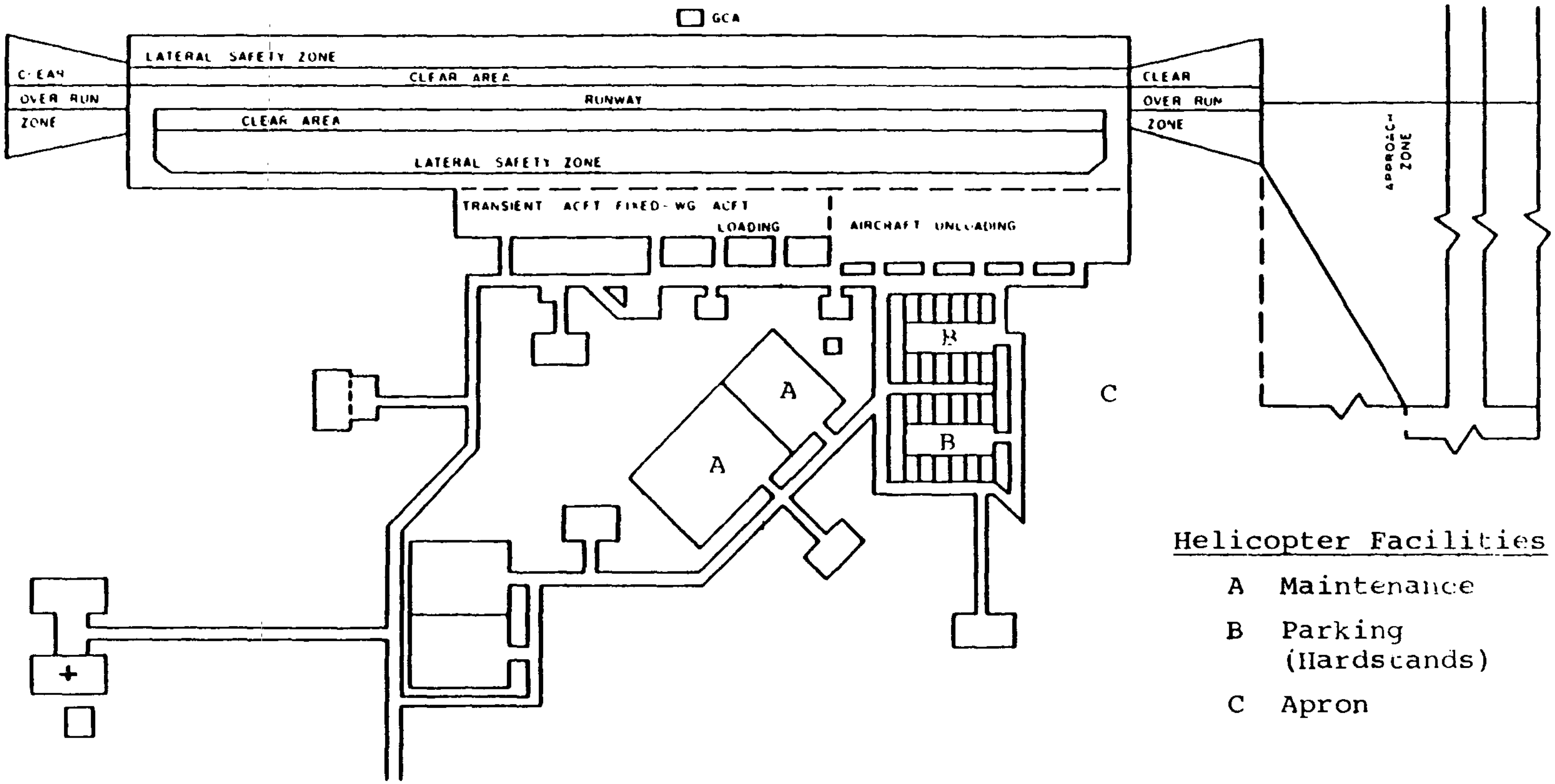


FIGURE 8-3. Heliport Layout



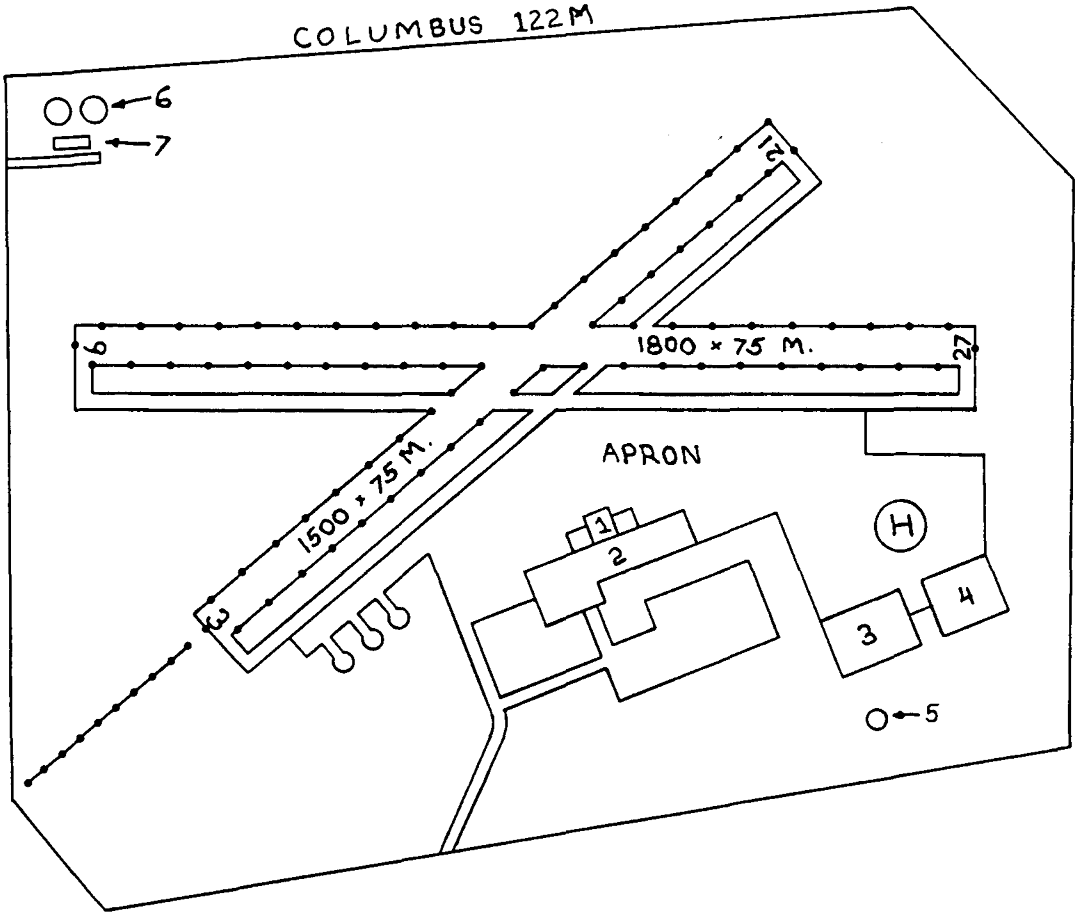
Helicopter Facilities

A Maintenance

B Parking (Hardstands)

C Apron

FIGURE 8-4. Airfield with Helicopter Facilities



Structures

1. Control Tower
2. Administration Building (Passenger Terminal)
3. Fixed Wing Aircraft Hangar (With Maintenance Facilities)
4. Helicopter Hangar (With Maintenance Facilities)
5. Water Tower
6. Fuel Storage
7. Fuel Distribution Building

Figure 8-5. Schematic Layout Showing Collocation of Airfield and Heliport Facilities this procedure, the numerals may be placed immediately adjacent to the runway. The runway length measurement should exclude the overrun area.

7. Runway Lights: Runway lights are white lights used to indicate the location of the runway and assist aircraft in landing and taking off. They are placed along the length of the runway between the threshold lights in two straight lines at the edge of the runway equidistant from the runway centerline. Flush white centerline lights may be found at some large modern airports. Generally topographic maps will not show this information. Refer to aeronautical charts for location of runway lights, and use the dot symbol in table 8-1 for depicting them on the factor overlay.

8. Approach Lights: A system of lights dispersed symmetrically about and along the extended center line of the runway. The system has its origin at the threshold of the usable landing area and, for a primary instrument approach, extends outward for 900 meters. For approaches other than a primary instrument approach, the system will extend only 460 meters. At some locations, terrain conditions prevent the installation of the entire length of either the 900-meter or 460-meter system. Where such is the case, the maximum possible length will be installed. For this information refer to aeronautical charts or other specialized maps for operational aids. Use a dot symbol superimposed on a line extending out from the end of the runway to show the presence of approach lights.

C. Map Analysis - Heliports

1. Runways, Helipads, Taxiways, Aprons, and Hardstands: As in thecase of Airfields, outline all of these features on the factor overlay. Facilities for landing and takeoff at a heliport will vary from helipads to runways. Helipads accommodate rotary wing aircraft that do not require a takeoff ground run to become airborne. Conversely, heliports with runways offer evidence that they are designed for heavier wheeled cargo or passenger helicopters.

2. Heliport Perimeter: Outline the boundaries of the heliport on the factor overlay.

3. Structures: Locate and outline all heliport-related structures (control tower, hangars, service and administration buildings, fuel storage tanks, etc.). Label each structure by number, and enter the number, with supporting information, in the Data Table.

4. Heliport Name (Number)/Elevation: Label the heliport by name or number. If there is more than one heliport on the factor overlay, identify them sequentially: H-1, H-2, etc. A helipad, with no supporting facilities, will be identified by the letter H placed within a circle. This symbol will also be used to locate a helipad at an airfield. Place

Table 8-1. Symbol Specifications for Airfields and Heliports.

A. Airfields:

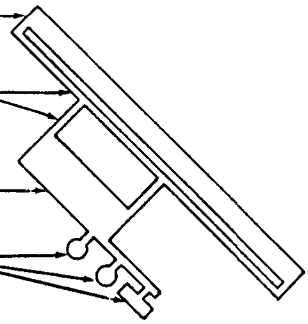
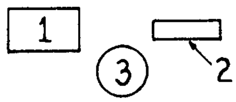
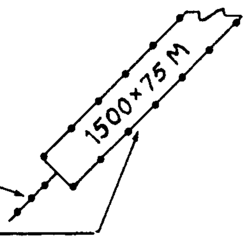
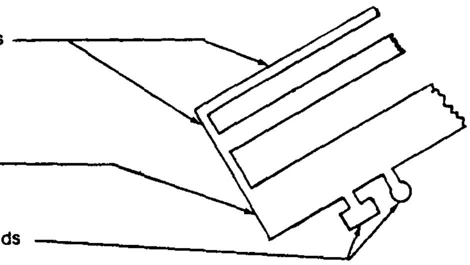
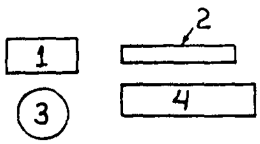
No.	Feature	Symbol	Specifications
1.	Runways		Outline runways to scale.
2.	Taxiways		Outline taxiways connecting runways, aprons, and hardstands to scale.
3.	Aprons		Outline aprons to scale.
4.	Hardstands		Outline hardstands to scale.
5.	Airfield Perimeter		Draw a boundary line representing the airfield perimeter.
6.	Structures		Outline all structures. Number each, and list in the Data Table.
7.	Airfield Name-Elevation	COLUMBUS - 200 M	Place name and elevation just outside the perimeter symbol.
8.	Runway Azimuth		Place the runway azimuth at the end of the runway outline (within or just outside).
9.	Runway length and width		Place length and width designations inside, or just outside runway outline.
10.	Approach Lighting		Show locations along line drawn to scale (length).
11.	Runways Lights		Show locations by dot symbols along the lateral boundary of the runway.

Table 8-1. Symbol Specifications for Airfield and Heliports (Cont.) .

B. Heliports:

No.	Feature	Symbol	Specifications
1.	Landing area — Runways		Draw outline of the landing area or runway to scale.
2.	Taxiways		Outline taxiways connecting runways/ landing areas, aprons, and hardstands to scale.
3.	Aprons		Outline aprons to scale.
4.	Hardstands		Outline hardstands to scale.
5.	Heliport perimeter		Draw a boundary line representing the heliport perimeter.
6.	Structures		Outline all structures. Number each, and list in Data Table.
7.	Heliport Name/(No.), elevation	COLUMBUS - 200M H-1	Place name (No.) and elevation just outside the perimeter symbol.
8.	Helipad (without facilities)		Circle .4" Dia. Letter .3" High

the heliport name or number and the elevation in a position on the factor overlay just outside the perimeter line symbol.

5. Runway Azimuth: Where heliports have distinctive runway orientation, label azimuths as instructed under Map Analysis for Airfields (step 5).

6. Runway Length and Width: Record these dimensions in accordance with instructions under Map Analysis for Airfield (step 6).

7. Runway/Helipad Lights: Lights outlining helicopter runways will be symbolized by dots along the perimeter of the landing surface (table 8-1). Lines of biderectional lights are located on each side of the runway. These lines of lights extend past the end of the runway to intersect lines of lights placed not less than 20 nor more than 25 feet from the surfaced end of the runway. Helipad lighting consists of omnidirectional lights spaced around the perimeter of the landing surface.

D. Photo Analysis - Airfields

1. Runways, Taxiways, Aprons, and Hardstands: Locate these airfield features on the aerial photography and check the factor overlay information to determine what changes or additions should be made to airfield features derived from maps. Modify the factor overlay accordingly.

2. Airfield Perimeter: Compare the airfield boundaries traced or transferred from map sources and update as required.

3. Structures: Add to the overlay structures not shown on maps. Include them in the numerical listing begun during the map analysis, and enter new and revised information in the Airfield data table.

4. Runway Azimuths: At most major airfields the magnetic alinement of runways is painted in large numerals at the ends of the paved surfaces. These azimuths, contrasting with the runway coloration, may be legible on aerial photography. The terrain analyst should transfer these values to the ends of runways shown on the factor overlay. If the numerical designations of runway azimuths do not appear, or are illegible on the photography, measure the magnetic orientation of each runway and enter the values at the ends of the runways.

5. Runway Length and Width: Use standard photogrammetric methods for determining the length and width of runways. Record the measurements (meters) on the factor overlay within the runway boundary lines, or beside the runway.

6. Runway Lights and Approach Lights: These navigation aids described under Map Analysis - Airfields, may be visible on aerial photography. Use the dot symbol (table 8-1) to indicate their locations on the

factor overlay.

E. Photo Analysis - Heliports

1. Runways, Helipads, Taxiways, Aprons, and Hardstands: Identify these features on the aerial photography and revise or update the factor overlay coverage determined from maps.

2. Heliport Perimeter: Study aerial photography and check the accuracy of heliport perimeters shown on the factor overlay. Add the boundaries of heliports and helipads not appearing on map sources.

3. Structures: Update information retrieved from maps. Add new structures and include them in the numerical listing already started. Enter revised and new information in the data table. Aerial photography will be particularly useful for determining structure height and building material.

4. Runway Aximuths: Where runways can be identified on aerial photos, their azimuths will be indicated on the factor overlay as described under Map Analysis - Airfields (step 5).

5. Runway Length and Width: Using standard photogrammetric procedures, determine runway lengths and widths and record these dimensions within the runway boundary lines or immediately adjacent to the runway lateral limits.

6. Runway/Helipad Lights: Using dot symbols (table 8-1), indicate the location of runway/helipad lighting on the factor overlay. Refer to Map Analysis - Heliports (step 7) for description of lighting systems for helicopter operations.

F. Element Descriptions - Airfields.

1. Runways (Symbol 1): An airfield runway is a flat landing surface, normally oriented to take advantage of prevailing winds. The number of runways may vary from one to several, and some airfields will have parallel runways, i.e., two runways with the same headings - not to be confused with a parallel taxiway.

2. Taxiways (Symbol 2): Taxiways are access paths to parking aprons, hangar aprons, and hardstands. A parallel taxiway parallels the runway but is usually narrower. Link taxiways connect the runways with other taxiways, parking and hangar aprons, or hardstands. A perimeter taxiway usually starts at one end of the runway and ends attheother, and is normally oval in shape. Loop taxiways are usually located at one or both ends of the runway, forming a loop.

3. Aprons (Symbol 3): Aprons are generally found near the administration buildings and the passenger and freight terminals. They are used for aircraft loading, parking, servicing, and warm-up, and are usually paved.

4. Hardstands (Symbol 4): Hardstands, aircraft parking sites, are usually dispersed around the perimeter of the airfield and linked by takiways.

5. Airfield Perimeter (Symbol 5): Boundary of the total area (developed and undeveloped), often delineated by fencing.

6. Structures (Symbol 6): Included in this category are hangers, maintenance and repair shops, administrative offices, communication and traffic control facilities, fire and emergency aid stations, and storage structures.

7. Runway Azimuths (Symbol 8): Numerical designation (magnetic direction) of a runway, to the nearest 10 degree increment. The last zero is dropped from the number, which is usually painted on the ends of the runways. Examples: 9 = 090°, 12 = 120°, 27 = 267° (ie 270°).

8. Runway Length and Width (Symbol 9): Measurement of runway dimensions (meters), excluding shoulders.

9. Approach Lights (Symbol 10): A system of lights dispersed symmetrically about and along the extended center line of the runway. The system has its origin at the threshold of the usable landing area, and for a primary instrument approach, extends outward for 900 meters. For approaches other than a primary instrument approach, the system will extend only 460 meters. At some locations, terrain conditions prevent the installation of the entire length of either the 900-meter or 460-meter system. Where such is the case, the maximum possible length will be installed.

10. Runway Lights (Symbol 11): Runway lights are white lights used to indicate the location of the runway and to assist aircraft in landing and takeoff. They are placed along the length of the runway between the threshold lights in two straight lines at the edge of the runway equidistant from the runway centerline. Flush white centerline lights may be found at some large modern airports.

G. Element Descriptions - Heliports.

1. Runways/Landing Areas (Symbol 1): A specially prepared surface designed for rotary wing aircraft takeoff and landing operations. It includes the paved surface (runway or landing pad) and the areas immediately adjacent that have been cleared of all aboveground obstructions.

2. Taxiways (Symbol 2): Traffic lane through, or on the edges of, parking, maintenance, and access aprons to permit ground movement of helicopters.

3. Aprons (Symbol 3): Aprons are generally found near the administration buildings and the passenger and fright terminals. They are used for helicopter loading, parking, servicing, and warm-up, and are usually paved.

4. Hardstands (Symbol 4): Hardstands, helicopter parking sites, are usually dispersed around the perimeter of the heliport and linked by taxiways.

5. Heliport Perimeter (Symbol 5): Boundary of the total area (developed and undeveloped), often delineated by fencing.

6. Structures (Symbol 6): Included in this category are hangers maintenance and repair shops, administrative offices, communication and traffic control facilities, fire and emergency aid stations, and storage structures.

7. Helipad (Symbol 8): Although a heliport may include helipads or runways, or a combination of both, symbol 8 will be used to identify established takeoff and landing sites that do not have the maintenance and service facilities associated with heliports.

H. Data Tables.

1. Airfield Data Table - Structures (figure 8-6):

a. Column 1; Structure Identification No.: Enter the number that is used to identify the structure on the factor overlay.

b. Column 2; UTM Grid Coordinates: Record the UTM grid coordinates ($\pm$10) for each structure.

c. Column 3; Classification: Indicate the use category of the structure i.e., control tower, hangar, repair facility, fuel storage, administration, etc.

d. Column 4; Dimensions: Enter the structure length, width, and height (meters).

e. Column 5; Construction Material: Record the material used in the construction.

2. Heliport Data Table - Structure (figure 8-7):

a. Column 1; Structure Identification No.: Enter the number that is used to identify the structure on the factor overlay.

Airfield Data Table — Structures

1	2	3	4			5
No.	UTM Grid Coord.	Classification	Dimensions			Construction Material
			Length	Width	Height	

Figure 8-6. Airfield Data Table.

Heliport Data Table — Structures

1	2	3	4			5
No.	UTM Grid Coord.	Classification	Dimensions			Construction Material
			Length	Width	Height	

Figure 8-7. Heliport Data Table.

b. Column 2; UTM Grid Coordinates: Record the UTM grid coordinates (±10) for each structure.

c. Column 3; Classification: Indicate the use category of each structure, i.e., control tower, hangar repair facility, fuel storage, administration, etc.

d. Column 4; Dimensions: Enter the structure length, width, and height (meters) for each structure.

e. Column 5; Construction Material: Record the material used in the construction.

GLOSSARY FOR SECTION 8

ADMINISTRATION AND TERMINAL BUILDINGS -- Buildings used for offices and services for passengers and cargo.

AIRFIELD -- An area used for the landing and takeoff of aircraft, together with any associated areas and structures serving air traffic or the airfield installations.

AIRPORT -- An airfield that has buildings and equipment for servicing, operating, and maintaining aircraft, and for accommodating civilian passengers and freight.

AIR TERMINAL -- An installation provided with the facilities for loading and unloading aircraft and for the intransit handling of traffic (passengers, cargo, and mail) that is moved by aircraft.

APPROACH ZONE -- The lower limits of approach to a flightstrip, as determined by adjacent obstructions and represented by a plane surface extending upward and outward from the end of the flightstrip.

APRON -- A prepared area used for parking aircraft while loading or unloading, or for servicing or repairing aircraft, or in the case of a warmup apron, for assembling or warming up aircraft near the end of a runway.

AZIMUTH -- As used in relation to Air Terminals, designates runway orientation. Each runway is designated (and on most fields marked) with a number that indicates the magnetic azimuth (clockwise from the north) of the runway in the direction of landing. The marking is usually given to the nearest 10 degrees with the last zero omitted. Thus the east end of an east-west runway (assuming the magnetic declination is zero) would be marked 27, and the west end 9.

BASE COURSE -- Sometimes referred to as "base material." Placed directly beneath the surface material of a runway, taxiway, hardstand, or apron, it may consist of untreated or treated crushed stone or granular materials mixed with various types of binders. In some cases, a subbase may be employed if traffic consists of heavy wheel loads and the supporting capacity of the subgrade is low.

BITUMINOUS SURFACE -- A paved surface composed of crushed rock or gravel bound by a bituminous material.

CLEARED AREA -- A rectangular area located adjacent to and outside of the runway shoulders, in which tree stumps are removed and the surface is graded to minimize hazards.

CLEAR ZONE -- A cleared area located at each end of the runway. Width is equal to runway, runway shoulders, and runway clear areas, and length is normally equal to the overrun.

COMMUNICATION FACILITIES -- Includes number of lines of circuits, points served, network connections, reliability of service provided, and possibilities for expansions of telephone, telegraph, teletype, cable, radio, and other facilities.

CONTROL TOWER -- A raised, covered, enclosed platform used for the direction and control of traffic.

CRASH STRIP -- A graded marked surface usually located parallel to the existing runways, to be used for emergency landings.

DISPERSED PARKING AREA -- An area selected for the dispersed parking of aircraft in order to reduce the chance of observation or damage by enemy action.

DRAINAGE -- Adequate drainage provides for the interception and diversion of surface and ground water flow originating from adjacent land and the effective removal of both surface runoff and subsurface flow from an air landing area. Only in very few cases will the natural drainage be sufficient by itself; consequently, artificial drainage must be installed.

ELECTRIC POWER -- Includes information as to whether electric power is generated locally or obtained from a transmission network; also includes distribution voltage, phase, and cycles. Alternate sources available in event of power failure should also be included.

FLIGHTSTRIP -- Includes area of the runway, shoulders, cleared area, overruns, and clear zones.

FLIGHTWAY -- Includes flightstrip area together with the two approach zones.

FOOD FACILITIES -- Installations such as cafeterias and restaurants equipped to provide mass feeding. Also included are catering facilities for providing in-flight food services for aircraft.

FUEL DISPENSING METHOD -- Means by which aircraft are fueled, usually by (1) fuel trucks (2) fueling pits (with self-contained meters, filters, hoses, and reels), or (3) hydrants (these require separate hose, reels, etc. in mobile units).

GLIDE ANGLE -- A small vertical angle measured outward and upward from the endof the flightstrip or airdrop zone, above which no obstruction should extend within the area of the approach zone. It also indicates the safe descent angle for various types of aircraft and is expressed as a ratio such as 35:1.

GLIDE PATH -- The flight path of an aircraft as it glides downwards, the line of which forms an angle with the longitudinal axis of the aircraft; or the line to be followed by an aircraft as it descents from horizontal flight to land upon the surface. Also called glide slope.

HANGAR -- A covered, usually enclosed area for the housing, maintenance, and repair of aircraft.

HARDSTAND -- A stabilized or surfaced area provided to support standing aircraft. Hardstands are normally dispersed at intervals along each side of a taxiway.

HELICOPTER LANDING PAD (HELIPAD) -- A prepared area on the ground designated and used only to accommodate takeoff and landing of helicopters.

HELIPORT -- A group of facilities designed for takeoff, landing, servicing, fueling, and parking of rotary-wing aircraft.

HELIPORT CLEAR ZONE -- The areas immediately adjacent to the ends of a runway that have been cleared of all above-ground obstructions and graded to prevent damage to aircraft that land short or overrun the runway.

HELIPORT LANDING AREA -- A specially prepared surface designed for rotary-wing aircraft takeoff and landing operations. It includes the paved surface (runway or landing pad) and the areas immediately adjacent that have been cleared of all above-ground obstructions.

HOVER -- The action of a helicopter while maintaining an altitude of 4 to 10 feet above the ground and holding a constant heading (1) over a selected point without forward motion or (2) taxiing (airborne) from one point to another.

HOVERLANE -- A defined aerial traffic lane for direct movement of hovering helicopters between an approach-departure area and the servicing and parking areas of an airfield.

LANDING FIELD -- A very general term designating an area of land prepared for the takeoff and landing or aircraft.

LANDING ROLL -- The necessary ground-contact distance, from touchdown to stop, traveled by an aircraft when landing.

LATERAL SAFETY ZONE -- A rectangular area adjacent to the clear area, that is outside of the runway shoulders. Essentially, an extension of the clear area to prvide greater protection in the event of erratic performance by aircraft that runs off the runway.

LIGHTING -- Significant among the lighting facilities at air landing areas designed to provide visual aids for pilots landing in darkness or bad weather are

Approach lighting - An arrangement of high-intensity lights beginning approximately 3,000 feet out from the end of the runway that guides the pilot to the runway. Arrangement is in a variety of configurations.

Threshold lighting - Special lighting identifying the end of the approach lighting and the beginning of the runway.

Runway lighting - Lights along the runway to assist thepilot in touchdown, roll, and taxi of the airplane.

Taxiway lighting - Lights along the taxiways to assist the pilot in maneuvering to the terminal or hangar areas.

LOAD CAPACITY IN EQUIVALENT SINGLE WHEEL LOADING (ESWL) -- Used as yardstick for runway bearing capacity, ESWL represents an attempt to reduce many variable elements to a single figure. Among the items considered are spacing of wheels, tire pressures, depth of paving, and subgrade reaction. Calculation is made through the use of tables derived for the purpose. Among other methods of expressing runway weight-bearing capacity are AUW (all up weight), SWL (single wheel loading), and gross aircraft weight.

MAINTENANCE FACILITIES -- Includes those facilities available for the servicing, maintenance, and repair of aircraft. Services rendered may range from turnaround to major overhaul, and may include inspection, minor maintenance, specialized maintenance, or extensive repairs.

NAVIGATION AIDS -- These cover a variety of devices and systems to assist in air navigation. Among the more widely available are

VOR - Very high frequency Omni-directional Range

TACAN - Tactical Air Navigation

VORTAX - A combination of VOR and TACAN

GCA - Ground Control Approach System

ILS - Instrument Landing System

ASR - Airport Surveillance Radar

(Also see lighting.)

OBSTACLES -- Natural or manmade objects near or within the air landing area, drop zone, or helicopter landing zone that are hazardous to landings, takeoffs, or air drops; e.g., transmission lines, tall chimneys, or high hills and mountains. Notation should be made if obstacles are lighted or unlighted.

OPERATING AREAS -- All areas of an airfield that require stable surfaces to accommodate aircraft.

OVERRUN -- A graded and compacted portion of the clear zone, located at the extension of each end of the runway, to minimize risk of accident to aircraft due to overrun on takeoff or undershooting on landing. Its length is normally equal to that of the clear zone, and its width is equal to that of the runway and shoulders.

PARKING AREA -- A prepared area used in place of hardstands for the parking of aircraft. It is also referred to as a conventional apron or parking apron.

POL (PETROLEUM, OILS, AND LUBRICANTS) -- A collective term to cover fuels, oils, and associated products. Specifications are given in a variety of ways, e.g., USAF designation, NATO code, DoD Flight Information Publication (Flip) Code, American Society for Testing Materials (ASTM) specifications, octane rating, etc.

PREFABRICATED SURFACES -- An expedient or temporary runway surfacing material consisting of transportable units that can be laid in place for immediate use; the principal types are

PSP - Pierced Steel Plank, with interlocking edges.

PAP - Pierced Aluminum Plank, with interlocking edges.

PBS - Prefabricated Bituminous Surface - an asphalt impregnated and coated fabric, normally burlap or hessian cloth.

REFERENCE POINT -- A structure or feature of the airfield, usually the control tower, selected as the arbitrary location by which to reference the locations of other features.

ROAD, ACCESS -- A road, normally improved, connecting an airfield with an existing road net.

ROAD, SERVICE -- A road interconnecting airfield facilities and linking them with the access road.

RUNWAY -- A stabilized or surfaced rectangular area located along the centerline of the flightstrip on which aircraft normally land and take off.

SANITATION AND SEWAGE DISPOSAL -- Means by which sewage and other wastes are removed from an area. Includes piped sewer systems, septic tanks, trash and garbage-collection methods, vector eradication programs, and disease-preventive measures.

SHOULDER -- A graded and compacted area on each side of the runway to minimize the risk of accident to aircraft running off or landing off the runway.

SPECIAL EQUIPMENT AVAILABLE -- Includes specialized vehicles such as foam trucks, snowplows, mobile lounges, and specialized devices for cargo handling, runway clearance, and ammunition handling.

STORAGE FACILITIES -- Areas and buildings set aside for the temporary holding of supplies and cargo for later shipment or use. Particular attention should be paid to ammunition and explosive storage areas and fuel storage areas.

SUBGRADE -- Subgrade applies to the natural soil in place or to fill material upon which a base or pavement is to be constructed.

SURFACE MATERIAL -- Sometimes referred to as "surface course" this is the top layer of pavement of a runway, taxiway, hardstane, etc. It may be rigid (cement concrete) or flexible (bituminous aggregate). Depth will vary depending on material used and expected traffic and weight load.

TAKEOFF RUN -- The distance traveled by an aircraft along the runway before becoming airborne.

TAXIWAY -- A prepared strip for the passage of aircraft on the ground to and from the runway and parking areas. The width of the taxiway includes a stabilized, surfaced, or paved central strip.

TOUCHDOWN AREA -- That portion of the beginning of the runway normally used by aircraft for primary contact of wheels on landing.

IX. BUILDING HEIGHTS AND CONSTRUCTION MATERIAL

A. Introduction: Clusters of manmade structures are the principal "terrain" features of the built-up area. They are the distinctive elements that stand as unique and complex anomalies over, and under, the natural terrain. As one segment in the comprehensive built-up areas terrain analysis guide, this chapter introduces the analyst to principles of urban construction and describes the methodology for preparing factor overlays. The information describing principles of urban construction has been extracted and abridged from Urban Terrain Analysis Aids.[8] This study, as well as others, reveals that certain generalizations can be made concerning the physical characteristics of the worldwide urban environments.

In order to complete overlays as described in this chapter, the analyst would need to have access to large scale topographic maps, vertical and oblique aerial photography, and literature containing descriptive data relative to urban construction. Obviously the analyst will be confronted with built-up areas where much of the desired information will be unavailable. As in the analysis of other data fields, the analyst is instructed to develop the overlays to the maximum extent possible with the material at hand. As the data base is expanded with new material, the factor overlays will be updated.

B. Principals of Urban Construction: There have always been, throughout the world, two major solutions to the problem of how to design a structure successfully to withstand loads (figure 9-1). These two solutions, which provide the basis for classifying buildings into broad types, and (1) the construction of walls of sufficient thickness and number to withstand all forces; and (2) the construction of a frame, composed of columns and beams, upon which the forces of load can be placed. The first solution, that dependent on walls, is referred to as mass construction because of the dependence on bulk (mass) of the wall (figure 9-2). The second solution, dependent on columns and beams, employs the principle that all loads can be directed along beams and columns, and thus vertically downward, through the columns to the earth itself. Because of locked interdependency of columns and beams, this broad class is framed construction (figure 9-14).

Each of the two major types of construction is divisible into several subtypes. Some of these, because of universality of building are found widely throughout the world. Others, because they are positively related to some local condition--a shortage or abundance of

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[8] Richard Ellefson et al., Urban Terrain Analysis Training Aids, Technical Memorandum 14-81, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, Maryland.

material, a shortage or excess of labor, or some cultural reason--are narrower in distribution either temporally or spatially. For instance, concrete tilt-up buildings are the products of the modern age and are found in such places as California where cost-efficient means are sought to offset high labor rates. By contrast, old half-timbered buildings are found where labor was abundant and construction timber was plentiful.

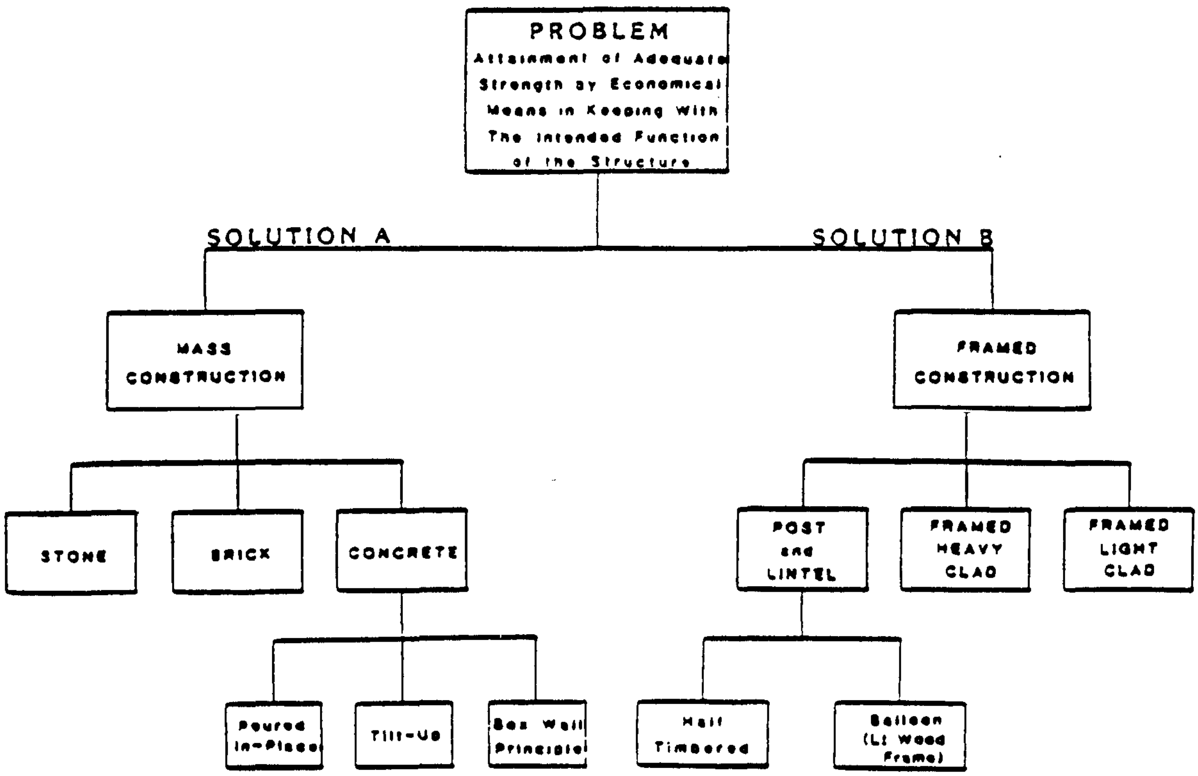


Figure 9-1. Building Type Priciples

1. <u>Mass Construction</u>

In this section, Solution A (figure 9-1) is discussed. Detailed information is provided for identifying structures by configuration (style), and architectural design is related to building use (figure 9-3). Methods of mass construction are also shown (figure 9-4).

Exterior Walls Bear Load of:

a. Structure

b. Roof

c. Building Contents

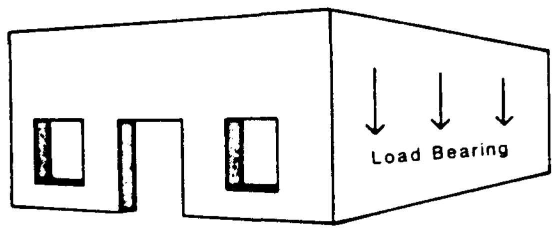


Figure 9-2. Principles of Mass Construction.

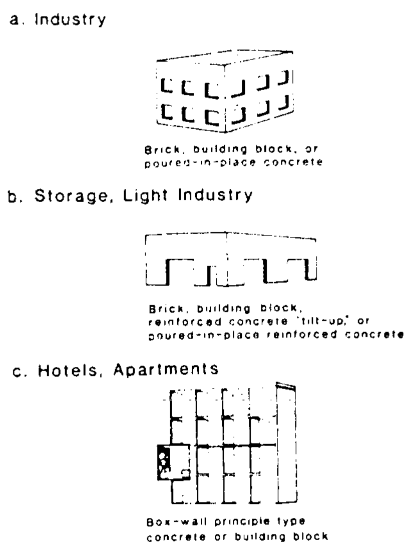


Figure 9-3. Common Uses of Mass Construction.

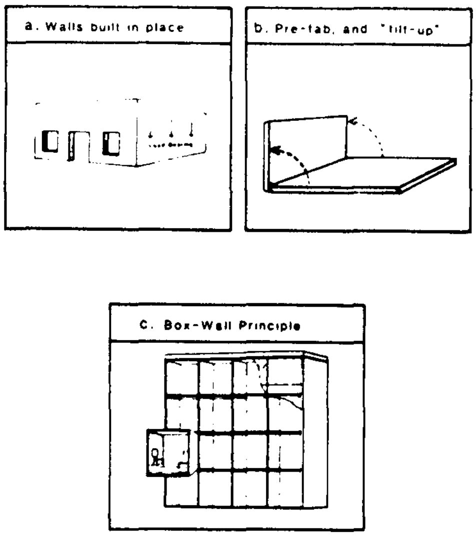


Figure 9-6. Methods of Mass Construction.

a. Mass, Stone: Construction with stone, a building material of classical architecture, employs the principle of mass in the walls to support the load of roof and floors. Its high level of compressive strength makes it a good (although prohibitively costly today) material for the construction of walls. Because of its low tensile strength, joists for ceilings and roofs are made of some other material, usually wood. To gain sufficient mass to support weights associated with institutional buildings (which are often constructed of stone), walls must be thick. Further, they can allow relatively few windows and doors, as any such openings reduce the integrity of the wall and its ability to hold up loads.

A common use of stone, however, is in the foundations of brick buildings. In these instances, the cost of providing stone is justified because of its conveying the appearance of strength and because of the solid foundation that it provides because of its high compressive strength.

b. Mass, Brick: Brick, as a manmade substitute for stone, provides a solution to the problem of a load-bearing through the employment of mass in walls. As modules, bricks are set in such a way (through bonding) to provide sufficient support for the weight of the walls themselves plus all the transmitted weight of floors, roof, and live load.

The very nature of bricks as building modules and the way in which they are assembled cause brick buildings to have a distinctive set of characteristics. Identification of these characteristics is a learnable skill one which enables the observer to establish, first, that brick (masonry) construction has been employed, and them to infer the building's related characteristics such as wall thickness. Evaluation for military application then follows.

The principles that state that the loads of mass buildings are borne by their walls rather than by frames is exhibited in many ways in brick buildings. One dominating characteristic is the high proportion of wall space relative to openings for windows and doors. An excessive number of openings in the wall would reduce the weight-bearing integrity of the wall to too great a degree. Placement of windows and doors is also vital. They must be alined vertically, leaving expanses of unbroken wall between them to support the vertical loads. A further example of wall strength is the massive nature of the corners of the buildings. Meeting at right angles provides both mass and bracing. Corner windows are thus precluded.

Brick buildings (figure 9-5) have a distinctive set of characteristics. These aid in their identification.

I.D. Key Number 1: Because of the dependence on the exterior wall for structural strength, it is not possible for windows and doors to exceed more than one-third of that wall unless special measures are taken (as seen in figure 9-6). This characteristic is readily seen in the field and enables the observer to determine construction type from a considerable distance away.

I.D. Key Number 2: Wall integrity can be maintained only if windows are alined vertically. The amount of wall between the windows provides the required load-bearing strength.

I.D. Key Number 3: The walls of a brick building are load-bearing and must be sufficiently thick to withstand loads. However, because there is more aggregate load on the lower stories than on the upper stories, the lower part of the wall must be thicker. The wall on the top story is thin (approximately 12 inches). In this example (figure 6) note that the wall of the ground floor is six bricks thick (approximately 24 inches). Second and third stories are five bricks thick, the fourth floor is four bricks thick, and the top floor is three bricks thick.

I.D. Key Number 4: Differences in wall thickness may be seen and measured in wall openings. An identification problem can occur where the glazing (glass) is placed either flush with the wall's exterior or at the same distance from the face of the wall on each floor. In such instances, however, identification can be made by looking through the glass at the window's sills (bottom, side, or top).

I.D. Key Number 5: Brick arches or stone lintels above windows and doors are usually present. These help to replace wall integrity lost when openings are made for windows and doors (see details in figure 9-7).

I.D. Key Number 6: Floor joists must be anchored in the side walls by some device (see details in figure 9-8). Plates or wedges are used for this purpose and are often decorated.

Bricks are sometimes covered with a stone veneer. Because of the high expense involved, this stone veneer is placed only on the side facing the street. The true character of the building can always be seen from the rear. Also, brick buildings are often covered with plaster to protect them from the weather. Close observation usually reveals that in some places the plaster has eroded away, exposing the bricks underneath.

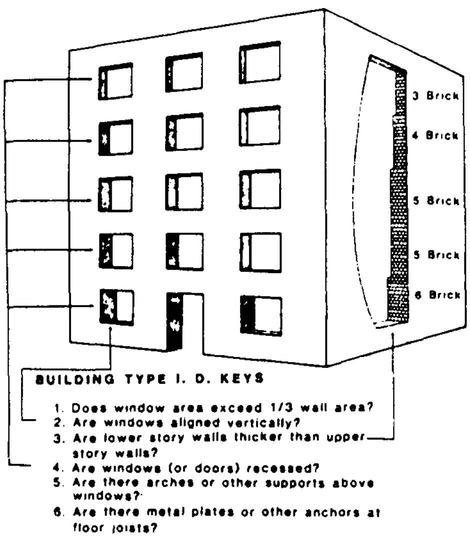


Figure 9-5. Mass Construction — Brick.

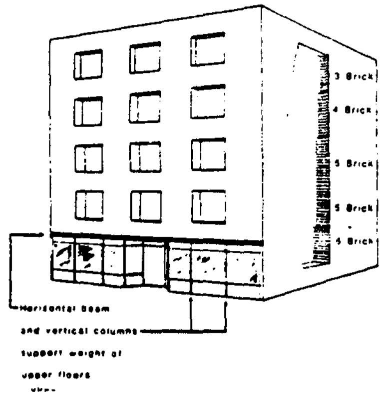


Figure 9-6. Mass Construction — Storefront Variation.

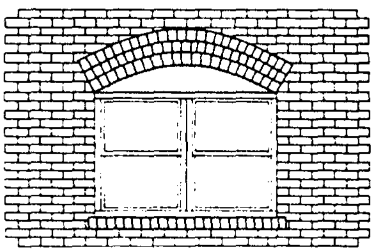


Figure 9-7. Mass Construction — Architectural Details (Arch above windows provides strength).

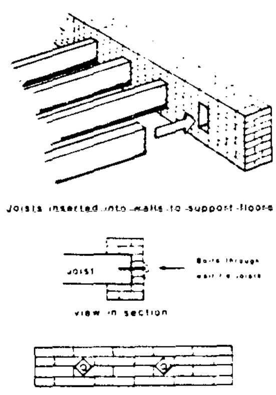


Figure 9-8. Mass Construction — Architectural Details.

c. Mass, Concrete: Because of its plastic conditions during the process, concrete has been well adapted to handling by machinery, thus reducing the hand labor required in the placement of either stone or brick. It is also a strong material, for in addition to its inherent load-bearing compressive strength it has high tensile strength through the addition of steel reinforcement. Concrete thus has the capability of being used as a horizontal building member; that is for floors, ceiling, roofs, and beams (in framed buildings).

Despite its versatility and the expectations given it, the use of concrete in mass construction buildings has settled into just three basic physical forms serving relatively few functions (figure 9-9).

The simplest of these forms is the type of building in which the concreteis "poured-in-place" (on the building site) into forms. The outer walls are thus constructed; interior support of ceiling and roof joists may be accomplished--as with brick buildings--either by load-bearing interior walls or by posts. Although there were some early experiments (around the turn of the century) with construction tall buildings entirely of poured concrete, the use of the method has been restricted mostly to low structures (one to three stories). Common uses are for storage buildings, industrial buildings, and such public gathering places as auditoriums and gymnasiums.

A variation on this method is the "tilt-up" form of construction in which concrete walls are laid in slabs on the ground (usually on the concrete slab floor of the building under construction) and then lifted ("tilted") into place. This method is particularly favored where high levels of technology exists, where labor is expensive, and where the desired building height is only one or two stories.

The following characteristics and functions will aid in identifying these two variations of concrete building construction:

I.D. Key Number 1: Buildings of this type are frequently used for storage or light industry and thus have little requirements for natural light. Or, large area structures of the type used for industry will provide light to the entire floor area through the employment of "sawtooth skylights" placed in rows. As with any mass construction building, window and door openings in the walls detract from structural integrity.

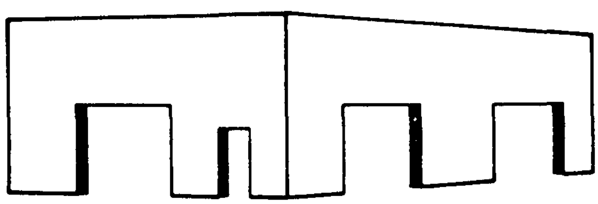
I.D. Key Number 2: Also, in accordance with construction principles, the walls must be strong enough (therefore, thick enough) to support loads. In addition, these walls may have reinforcement bars within them, but the presence and amount vary regionally with building codes, and these, in turn, reflect allowance for local conditions; e.g., earthquakes or general levels of the economies of regions and countries.

I.D. Key Number 3: These buildings are usually simple in design and are normally boxlike. Excessive indentations and corners are not present because there is no need to add "wings" to provide natural light to all rooms. Also, the simpler the design, the lower the construction cost, an important factor in buildings designed for mundane functions.

I.D. Key Number 4: There is no need to give these buildings high-pitched roofs. The usual device is to support the roof with a low arch or a truss, they may have a "sawtooth skylight" roof.

I.D. Key Number 5: Most of these structures consist of a single story. Because of the functions they serve, however, they are often fairly tall (up to 20 feet).

A recent advanced variation is to place a second floor in these structures, to be used for office space. Interior load-bearing support is then employed.



BUILDING TYPE I. D. KEYS

1. Is there a large area of unvented wall?
2. Are the walls thick (8" - 10")?
3. Does the building have an angular shape?
4. Does the building have a low roof profile?
5. Does the height exceed 1 - 2 stories?

Figure 9-9. Mass Construction — Reinforced Concrete "Tilt-Up"/ Poured-in-Place Reinforced Concrete.

The third common use of concrete is in "box-wall" construction. In such buildings the mass walls and combined floor/ceilings are used to brace one another, as in a framed building. The form of construction is a combination of mass and framed construction methods. These box-wall buildings employ the principle of using a series of weight-bearing, reinforced-concrete walls (although brick is substituted in some instances) across which slab floor/ceilings are placed. Loads of the floor/ceilings are thus transmitted to the vertical walls which, in turn, transmit them to the ground. The weight-bearing walls thus form three sides of a cell (which may be a single room or may be subdivided into smaller rooms). The floor/ceiling slabs form two more sides of the "box" while the sixth side is enclosed only by some nonweight-bearing, curtain-wall material or glass. A common use is for hotels and apartments that consist of room modules whose function is fixed. Identification keys are as follows:

Box-wall-principle buildings (figures 9-10 through 9-13) have several distinctive features that aid in their identification. Also, not only is their form of construction very simple, but being a recent development, they follow the mode of modern planning in that they frequently are placed well back on their lots. They are thus readily visible from all sides. Identification keys are as follows:

I.D. Key Number 1: The most obvious key to identification is that commonly all the cells of which the building is composed are the same size. The outer edges of all four sides of these cells (floor, ceiling, and walls) can usually be seen. Each cell contains but a single room (e.g., a hotel); small ("studio") apartments may have internal nonload-bearing partitions. Each cell is often fully vented on the side of the cell facing the outside, as this is the only place to gain natural light.

I.D. Key Number 2: Because of the need for mass to support the structure, the structural members (both walls and floor/ceilings) must be fairly thick (usually 6 to 8 inches); walls are ordinarily a little thicker than floor/ceilings.

I.D. Key Number 3: The use of floor/ceilings as part of the structural support means that, unlike brick buildings, the walls have the same thickness throughout the whole height of the building. This feature is most obviously seen in the end walls.

I.D. Key Number 4: To keep their structural integrity, all the walls, both external and end walls and internal walls, have few if any openings for doors and windows. Often, end walls have small windows vertically alined in the center, where they provide natural light to stairway landings on each floor.

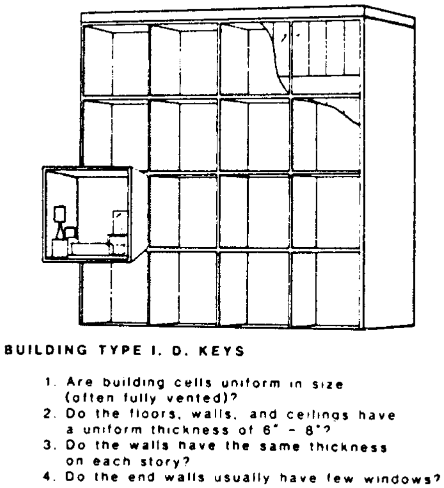


Figure 9-10. Mass Construction — Box-Wall Type.

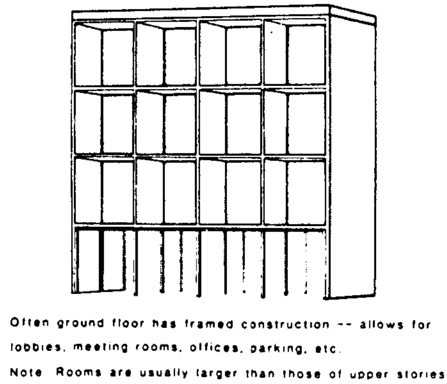


Figure 9-11. Mass Construction — Box-Wall Type (Ground floor variation, Hotels and Apartments).

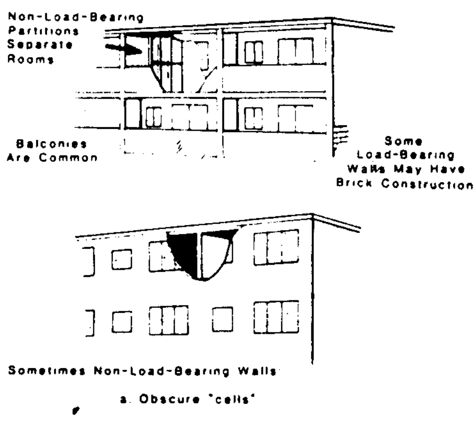


Figure 9-12. Mass Construction — Box-Wall Type, Apartment House.

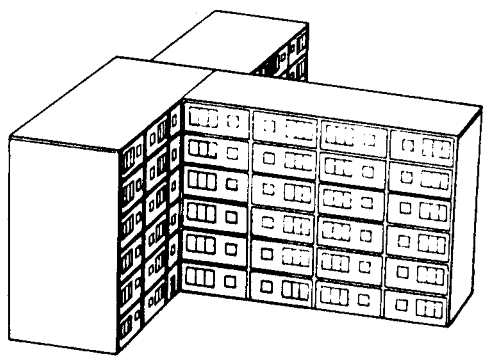


Figure 9-13. Mass Construction — Box-Wall Type, Multiple Module Variation.

2. Framed Construction

Framed buildings in an urban setting are generally represented by a conglomeration of different heights and cladding styles. The basic framed construction (figure 9-14) may be masked by the material applied to the structure. The identification keys, the illustrations (figure 9-18 through 9-26), and the supporting text will help the analyst identify framed buildings for the purpose of showing their distribution on factor overlays.

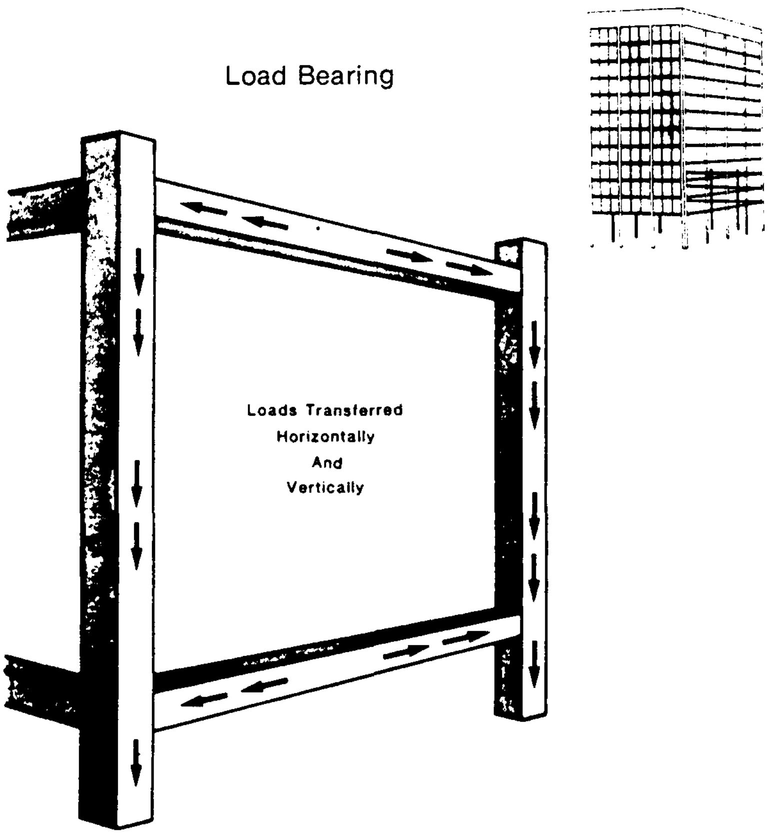


Figure 9-14. Principals of Framed Construction.

a. Framed, Post and Beam (figure 9-15): The principle of post-and-lintel construction is exhibited in the post-and-beam wooden structures built widely in northwest Europe from the 12th centruy through the mid-19th century. The term "beam" is more specific than "lintel" and refers to a wooden member with given bending strength that is thus capable of spanning fairly long distances (20 feet, for example). Accordingly, larger ranges are possible. These structures employed heavy fire-resistant timbers of great strength for posts and beams. They were joined into box-like frames that resisted load forces. Interiors were divisible into rooms that served what was frequently a mixed function of retail, hand crafting of goods and a residence within the same building. Posts were joined to beams by using the method of fitting a pinion into a mortise and anchoring it with dowels. Because of the use of a frame, the walls and partitions were not load-bearing. Accordingly, they were made of lighter material such as boards, panels, light screens (in the Orient), bricks, or mud and straw. These nonload-bearing walls perform the same function for these post and beam construction buildings as do the curtain walls (glass and other light materials) of modern framed skyscrapers.

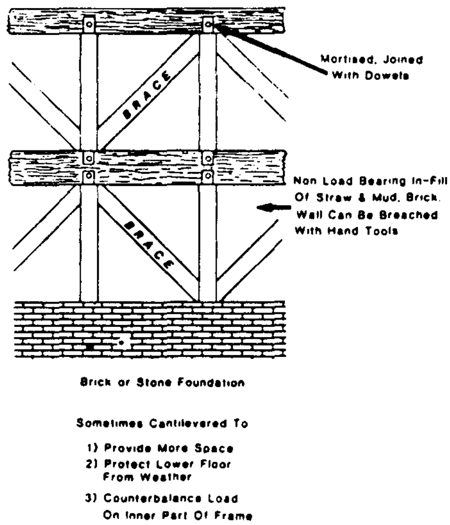


Figure 9-15. Framed Construction — General Wood Post and Beam.

A familiar variety of post-and-beam construction is the half-timbered building, common to Germany and other parts of northwestern Europe (figures 9-16 and 9-17). The distinguishing feature of these buildings is the exposed wooden structural members, i.e., theposts, the beams, and, usually, an extensive number of short wooden braces. These exposed members are often highly decorative, and their use (even if artificial) is frequently incorporated into modern construction to impart a "classical" appearance. The nonload-bearing curtain walls of these buildings are no thicker than the depth of the wooden posts and beams (usually about 6 to 8 inches).

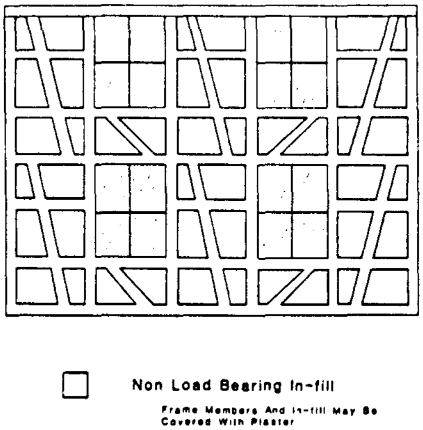


Figure 9-16. Framed Construction — Sub Type: Half Timber.

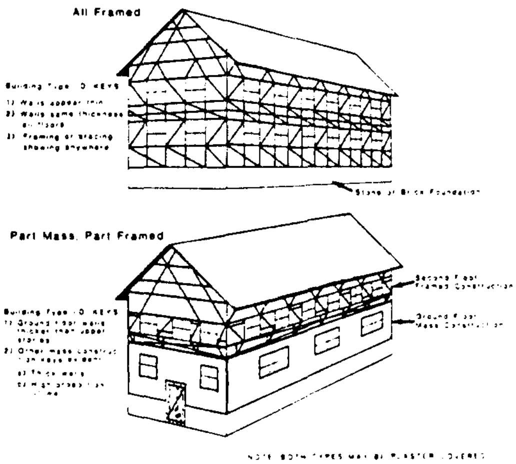


Figure 9-17. Framed Construction — Half Timbered and Partly Half-Timbered Houses.

A common feature of these buildings is an overhang of about a foot or so of an upper floor over a lower one. These are used, in part, to protect the lower area from weathering. They also have a structural function in that the cantilevered overhang serves to counterbalance the forces bearing upon the interior parts of the frame.

Light wood-framed construction (ballon type, a variant of the post and beam method) employs studs, rather than massive posts. They are nailed to equally light weight sills and joists. The lightness of the construction requires the use of sheathing of the exterior and interior walls to add rigidity. The frame is not structurally independent, as in a post and beam building.

b. Framed, Heavy Clad. The introduction of skeletal frames for large buildings (in the 1890's) ushered in the era of the skyscraper. To overcome the general public belief that framed buildings were not as strong as mass construction buildings, the designers obscured the frame with a masonry-like heavy cladding made of brick and/or stone veneer (figure 9-18). Note the insets of wall maerials. The ground floor often has a stone veneer cladding and the upper floors commonly have brick cladding. Accordingly, the identification of such buildings must depend on the observation of a series of other identification keys.

I.D. Key Number 1: The first step in identification is to note the height of the building. The observer should suspect that most buildings taller than six stories are framed.

I.D. Key Number 2: Being framed, these buildings have a high proportion of windows because the frame, rather than the walls, bears the loads of the buildings. This is especially true of office buildings; hotels, however, usually have fewer windows (commonly only one window per guest room).

I.D. Key Number 3: The exterior walls have the same thickness throughout the entire height of the building.

I.D. Key Number 4: The uniform thinness of the walls is also apparent by the fact that the windows are not recessed. The observer must look into the windows to note the thickness of the wall into which they are set.

I.D. Key Number 5: Frame members (the columns) are commonly visible at some point, usually on the ground floor. They are also evenly spaced (20 to 25 feet apart). The eye should be allowed to follow observed columns at ground level upward in the structure. Windows are always set between the columns.

I.D. Key Number 6: The style of framed, heavy-clad buildings often follow classical lines. To make the building appear more massive, the ground floor forms a heavy-looking base called the pediment. It usually has large windows, heavy-appearing columns, and often a mezzanine (partial second floor). The main part of the building is the shaft and is uniform in appearance with the same type of cladding throughout. The top floor(s) (the capital) is a lesser version of the pediment and may have large windows and decorative columns.

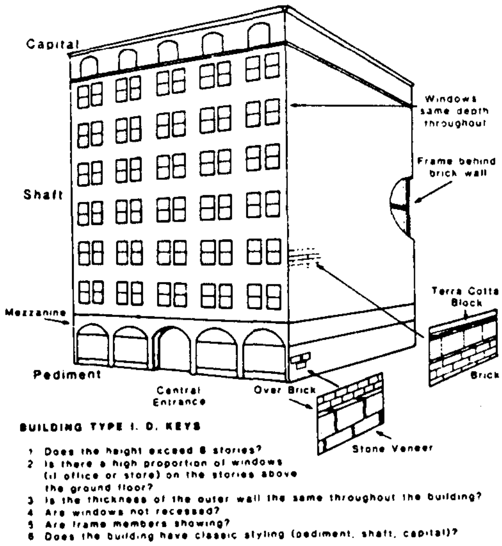


Figure 9-18. Framed Construction — Heavy Clad.

c. Framed, Heavy Clad - Modern Style Variation

Architects experimented with framed high-rise buildings during the 1920's and 1930's in an attempt to get away from the stereotyped forms that had developed. Their efforts produced these first modern-appearing heavy-clad framed buildings (figure 9-19). Several features serve to identify these buildings.

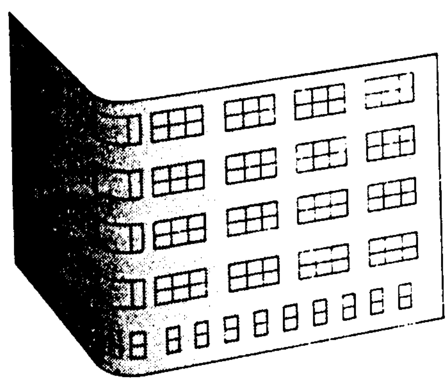
I.D. Key Number 1: Recognizing that the proportion of venting in framed buildings could be quite high, the architects opted to fill all the wall space between columns with windows.

I.D. Key Number 2: The intentionally large area of windows gives these structures an appearance closer to that of the more recent light-clad structures that were built following World War II.

I.D. Key Number 3: A further refinement, one adding to the modern appearance, was the use of curved windows. Opaque glass bricks were sometimes employed.

I.D. Key Number 4: A modified structural appearance was also achieved by placing curved windows at the corner of the structure. This bold architectural statement demonstrated that the strength of framed buildings (unlike those of mass construction buildings) was not dependent on massive corners.

I. D. Key Number 5: The break with tradition was completed with the elimination of the classical forms of pediment, shaft, and capital. All the lines of the building were smooth and modern and were of a type possible only with the use of framed construction. The departure, seen in light-clad buildings, of giving the structure only a curtain wall "skin" awaited the introduction of post-World War II designs.



BUILDING TYPE I. D. KEYS

1. Is there a high proportion of windows?
2. Is the window pattern similar to those found in framed light-clad buildings?
3. Are there curved windows?
4. Does the building have a curved corner?
5. Are classical features (pediment, shaft, capital) absent?

Figure 9-19. Framed Construction — Heavy Clad (Modern style variation).

d. Framed, Heavy Clad - Factory, Storage, or Garage Variation

Framed, heavy-clad structures have proven to be the ideal solution to the problem of providing space for conducting the functions of manufacturing, warehousing, and vehicle parking (figure 9-20). Of particular importance are the lack of interior load-bearing walls and the possibility of receiving the maximum amount of natural light through large windows. Accordingly, these buildings have very distinctive features and are easy to recognize in the field through application of the identification keys.

I. D. Key Number 1: Commonly, these buildings will have a maximum proportion of their exterior walls devoted to windows to provide maximum light as deeply inside these large structures as possible. The cladding between the windows simply covers columns and beams.

I. D. Key Number 2: With the large area devoted to windows, it is usually possible to see the columns inside the building. Because of their role in supporting the balance of the frame of the building and not just the floor above, columns are either steel I-beams or fairly thick reinforced concrete; buildings with a similar function but having mass construction (and thus thick exterior walls) would have thin iron columns.

I. D. Key Number 3: The big advantage of framed construction, here, is the provision of large open-bay interior space, especially for manufacturing, storage, and vehicle parking. This character is usually readily seen through the large windows.

I. D. Key Number 4: Note the presence of loading docks and large doors on the ground floor as another positive identification key.

I. D. Key Number 5: The top of the roof of such structures will usually have ventilation devices as required by the functions and the usual broad dimensions of such buildings.

e. Framed, Light Clad - Skyscrapers (High Rise)

Framed, light-clad skyscrapers (figure 9-21), the symbol of the downtowns of modern cities, have been built in great numbers since the early 1950's in cities throughout the world. They are important to urban terrain analysis because of their large numbers in the valuable core areas of cities and because of both the opportunities and constraints they present for military operations. They present an ideal solution to the problem of increasing the use of expensive land space severalfold, as they can be built to great heights at relatively low cost and provide large interior areas for office space.

I. D. Key Number 1: The style is almost always quite simple and without ornament; classical forms such as pediment, shaft, and capital are lacking.

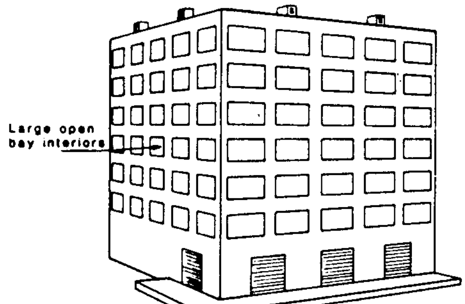


Figure 9-20. Framed Construction — Heavy Clad, Factory, Storage, or Parking Garage Variation.

I. D. Key Number 2: The exterior walls of the building are kept intentionally thin (where there are no windows), walls are but a few inches thick; although (occasionally) there may be several inches of air space between inner and outer elements of the wall, causing the walls to appear thick. This thinness is readi' perceived by the observer, particularly in contrast to heavy clad an mass construction buildings.

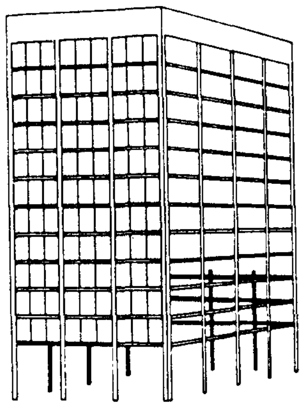
I. D. Key Number 3: Columns and beams can ordinarily be observed somewhere in the structure. The most likely place to look is on the ground floor, where columns may be exposed either in large rooms or in arcades open to the outside. Columns are also usually visible through the large windows.

I. D. Key Number 4: These structures normally have a high proportion of windows and are classified as venting types (figure 9-22 through 9-26).

I. D. Key Number 5: To aid identification, the analyst should study the illustrations depicting venting types.

I. D. Key Number 6: This form of construction is used especially for tall buildings (exceeding at least four stories).

I. D. Key Number 7: In many instances, these buildings have been placed in newly built or in redeveloped areas where modern planning practices call for considerable air space between structures. There are many instances in older cities where framed structures have replaced older individual buildings and have been built to fill the lot completely, thus exposing only the front and rear of the structure.



BUILDING TYPE I. D. KEYS

1. Does the building have a simple, modern style?
2. Does the outer "skin" appear thin?
3. Is the frame visible? On the ground floor? Through the windows? At the sides, rear?
4. Is there a high proportion of windows?
5. Is the window pattern one of the major classes for framed, light-clad buildings?
6. Does the height exceed 4 stories?
7. Is the building physically separated from others?

Figure 9-21. Framed Construction — Light Clad.

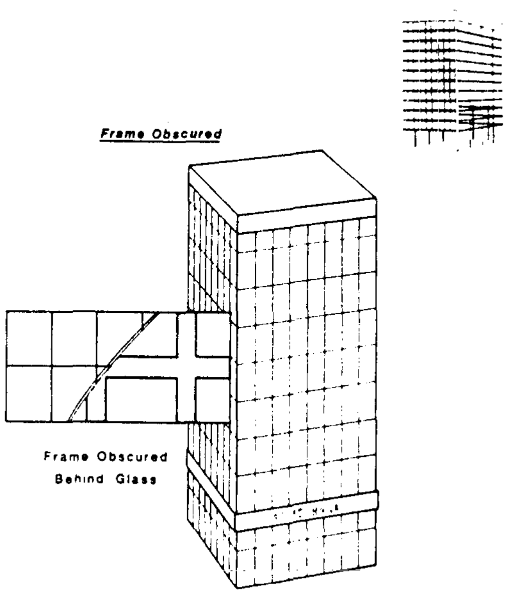


Figure 9-22. Framed Construction — Light Clad, Venting Type.

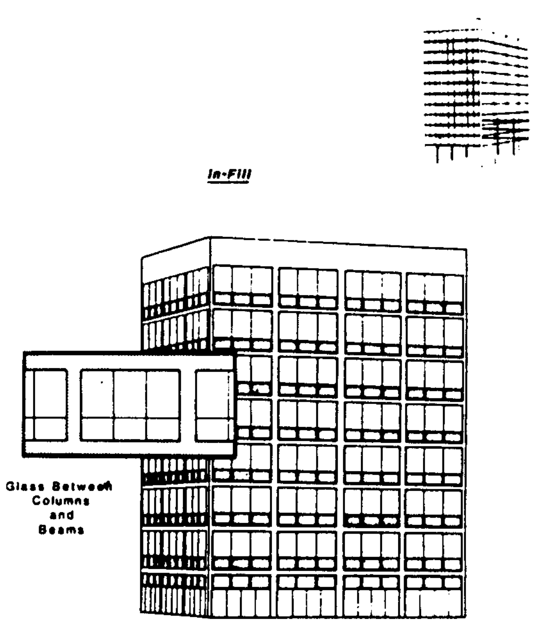


Figure 9-23. Framed Construction — Light Clad, Venting Type.

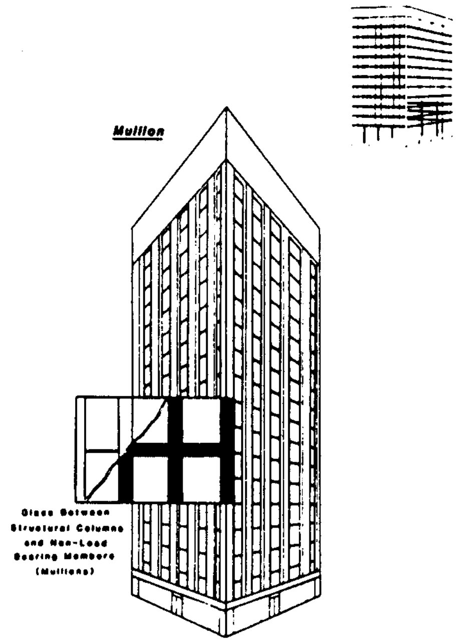


Figure 9-24. Framed Construction — Light Clad, Venting Type.

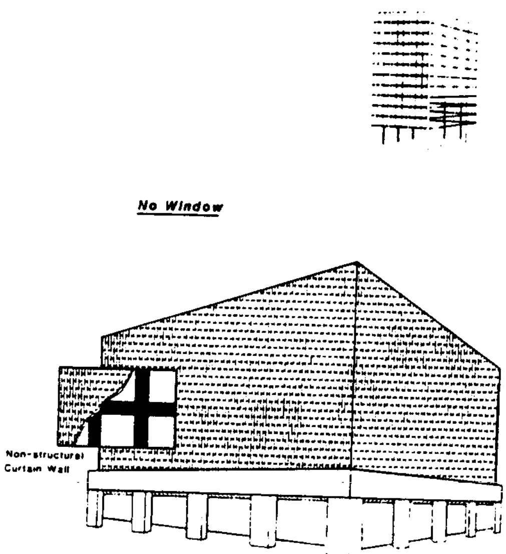


Figure 9-25. Framed Construction — Light Clad, Venting Type.

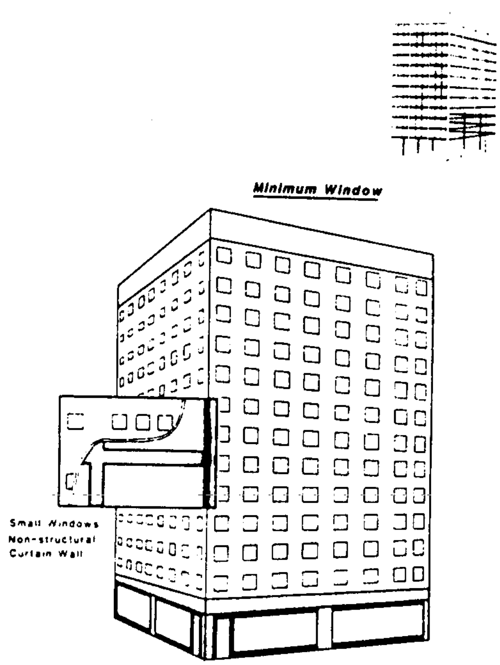


Figure 9-26. Framed Construction — Light Clad, Venting Type.

3. Residential Construction

a. High Density Form. This form epitomizes the city itself. General characteristics are full use of the building lot and a squarish appearance. Maximum use is thereby gained of the expensive land of cities, a natural product of high concentration of the activities found in the city. (Figures 9-27 and 9-28).

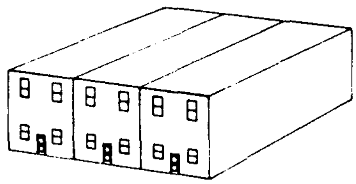
The residential examples seen here demonstrate these characteristics. (1) The angular shape of the entire block is carried through to the flat roof; some exceptions exist, as in the German style referred to previously. (2) To gain full use of valuable land, buildings are placed flush to the sidewalk. This lack of setback has the further effect of narrowing the width of the whole street area (considering building front to building front) and thus reduces the line of sight. (3) To gain maximal use of the lot, the walls of adjoining buildings are either butted one against another -- if the structures were built independently -- or they may have common walls ("party walls") if all the units were built at the same time. (4) The necessity to provide each unit with access to the street results in very narrow frontage; giving every unit adequate floor space requires that each be long and narrow. (5) As a result of this narrowness, buildings are often only a single room wide.

Because of adherence to the stated principles, high density form buildings are found throughout the cities of the world where land values are high, as in core areas and along arterial streets.

European hof-style construction (figure 9-28) offers an excellent solution to the problem of providing open space for apartment dwellers where the demands of the city require the use of high density form. Intensive use of the land is obtained to a high degree, but some privacy and utility space result from the use of an inner court (hof).

Each characteristic illustrates the point: (1) There is no setback from the sidewalk. Filling an entire block is not uncommon (although the effect may be achieved through use of several independently built units that together form a perimeter around a court). (2) The court (hof) normally serves such functions of the apartments as storage of fuel, clothes drying, automobile parking, and a protected place for children to play. Entry is normally provided by one or more tunnels. The opportunities for use of the concealment provided by these hofs is significant. (3) In order to gain a maximum amount of natural light, each apartment unit has windows facing both outward to the street and inward to the court. Entry to the units is ordinarily within the tunnel of the hof rather than directly to the street. This fact should be recognized during the planning of clearing maneuvers. (4) Because most of these structures were built prior to the widespread modern use of framed construction, they are mostly built of bricks; tall buildings, therefore, have very thick walls on the lower stories.

Hof-style apartments are particularly common in central and northern Europe. Some cities, such as Prague and Helsinki, have large areas of them.



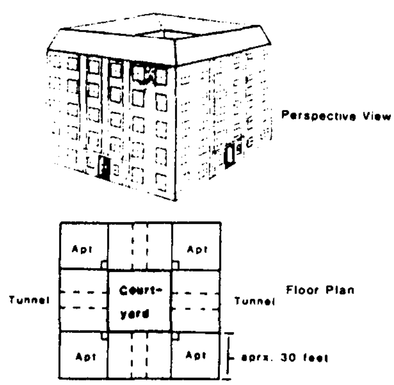
CHARACTERISTICS

1. Angular form, flat roofs
2. Little, or no, setback from sidewalk
3. Adjoining walls (often "party" walls)
4. Narrow, set end-wise to street
5. Floor plans: often only one room wide

Location:

High land value areas of cities

Figure 9-27. Residential — High Density Form.



CHARACTERISTICS:

1. No set back, occupies full block
2. Has inner courtyard (hof): provides concealment and cover
3. Apartment units face both courtyard and street
4. Construction: usually brick

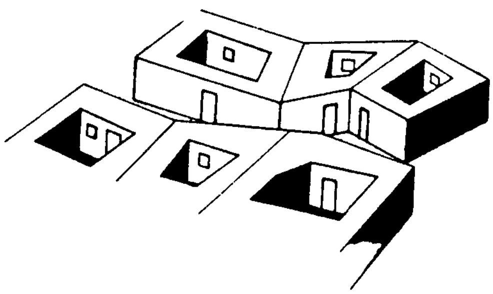
Area found:

Central and Northern Europe

Figure 9-28. Residential — High Density Form, Hof Style Apartment Building (Central and Northern Europe).

An architectural variation on the high density form, again with an enclosed courtyard, exists in the Middle East and in the countries around the Mediterranean Sea in both Europe and North Africa. Variations are seen in Latin America, where it was introduced by Spanish colonists.

A distinctive set of characteristics (figure 9-29) is to be observed: (1) Typical high density is obtained in the lack of setbacks from the street. Buildings are set on extremely narrow streets. The high density form is further carried out by the flat roofs; houses situated in dry climates do not require pitched roofs. (3) Buildings are generally low-rise, one and two stories, though they may reach three and four stories in areas of high land value. (4) Following the customary desire for privacy in these areas, there are no windows on the street side of the house. (5) Outdoor living space is provided in the enclosed courtyards; access to the rooms of the house is through the courtyard as well. (6) Street patterns are normally quite irregular; horizontal lines of sight are extraordinarily short. Accordingly, cover and concealment opportunities are high both on the street and within the houses.



CHARACTERISTICS:

1. No set backs
2. Flat roofs
3. One to two stories tall
4. Windowless outer walls, inner courtyards
5. Floor plan: all rooms open on to courtyard

Location:
on narrow, curving streets with short horizontal lines-of-sight

Area found:
Middle East, North Africa, and Mediterranean (with variations in Latin America)

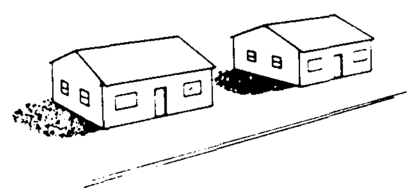
Figure 9-29. Residential — High Density Form, Enclosed Courtyard Style (Middle East and Mediterranean).

b. <u>Low Density Form</u>. The other primary design, low density form, occurs broadly throughout the world. It consists of detached structures and is found wherever the pressure of high land-cost (or a cultural need for protection or privacy) is not found. The form is common for residential structures (as indicated in figure 9-30) but does occur for commercial buildings in areas away from the center of the city.

The characteristics stand in contrast to those of the high density form and constitute a distinctive list: (1) Buildings are detached from one another. (2) Accordingly, they are set back from the street, thus increasing its effective width (when viewed as being from one house front across to another). (3) Except in areas of dry climates where tradition calls for flat roofs, the roofs are generally pitched. (4) While high density form structures are placed endwise to the street to gain maximal access, low density dwellings are usually set widthwise to the street, giving a broad appearance and providing abundant possibilities for the house to have natural light in rooms facing outward in all directions. (5) The wide variety of locales in which they are found opens countless possibilities to floor plans.

The form is common in Europe, North America, and throughout the world where European colonists took their approach to building with them. Within given cities, low density form solution is usually found in a broad zone surrounding high density structures of the core.

General Characteristics:



CHARACTERISTICS:

1. Detached buildings -- open space between
2. Set back from street
3. Pitched roofs
4. Broad appearance -- set width-wise to street
5. Floor plans: varies with style, age

Area found:
NW Europe, North America - in suburban areas of large cities and often throughout small towns

Figure 9-30. Residential — Low Density Form, (Northwest Europe, North America).

Germany has a large number of detached, low density form houses located away from the core areas of cities. They are seen especially in new housing tracts both at the edge of large cities and in newly built areas where small towns and villages are expanding. Just as in American suburbia, there is a manifested desire of people to have a detached private dwelling. In some instances, bowing to high-cost requirements, the structures contain two dwelling units.

Two construction forms are illustrated in the drawing (figure 9-31). In the upper one, building blocks are used in a traditional mass construction way. In the lower, modern technology is employed to erect buildings from factory-built pre-cast modules. While both house types are substantial, the latter provides more cover to defenders.

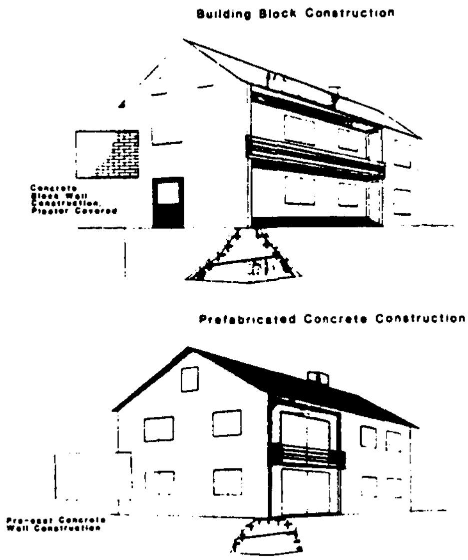


Figure 9-31. Residential — Low Density Form, (German Type).

c. Map Analysis.

1. Retrieve the largest scale topographic maps available for the built-up area being analyzed.

2. Register a sheet of translucent overlay material to the 1:12,500 scale topographic map that has been selected as the base map for the analysis.

3. Trace the neatline on the factor overlay and add the required marginal information as shown in figures A2 and A3, appendix A.

4. Outline all buildings and structures (this category includes all manmade buildings, towers, walls, fences, and stadiums). Some topographic maps show only landmark buildings, with the primary built-up area portrayed by a screened tint. Where this is the case and analysis of aerial photos and literature provides no structure detail, delimit the built-up area by outlining the screened (tinted) area on the factor overlay. Where heights of towers or other structures are indicated on the topographic map, transfer these values, in meters, to the factor overlay adjacent to the feature symbol. In general, structure heights are not shown on topographic maps. Height determination is treated in the following section.

d. Photo Analysis.

1. In order to identify structures on the basis of height, construction material, and roof description, the analyst should extract from the data base large scale vertical and oblique aerial photography. Surface photography as well as pictorial material from literature sources should also be retrieved for this purpose.

2. Working with the retrieved material, add unmapped structures to the factor overlay.

3. At this point, having outlined all structures, make a translucent copy of the overlay. This duplicate copy will be used to develop Factor Overlay No. 2, a classification of buildings according to construction type (step 7). Lay this sheet aside temporarily and continue preparation of Factor Overlay No. 1 (steps 4 through 6).

4. Applying photogrammetric methods, analyze stereo pairs to determine building heights. Detailed instructions for this procedure are included in the "Terrain Analysis Procedural Guide for Roads and Related Structures" (ETL-0205).[9] Training Manual 30-245, Image Interpretation Handbook, Vol. 1, also provides instructions for extracting vertical measurements from aerial photography.

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[9] Op. Cit.

5. As measurements are made of structure heights, refer to the following table 9-1, selecting the appropriate letter designation for the height/roof construction. Print the letter symbol within each structure outline.

TABLE 9-1. SYMBOLOGY FOR FACTOR OVERLAY NO. 1

Meters	Approx. No. of Stories	Flat Unobstructed	Flat Obstructed	Other
0-10	1-3.5	A	D	G
10-25	3.5-8.5	B	E	H
Greater than 25	Greater than 8.5	C	F	J

Where there are large sections with the same building type, as in many single-family residential areas, the section may be outlined and labeled on the overlay by a single identifier. Individual buildings may be omitted from such outlined areas (figure 9-33).

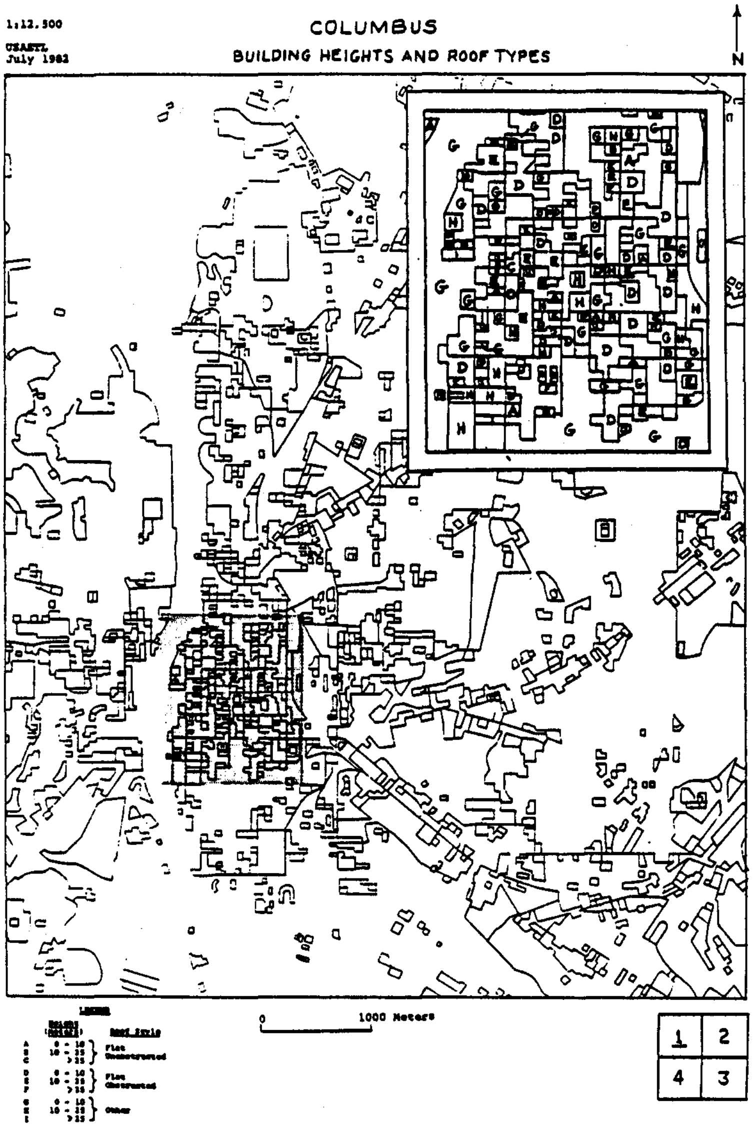
6. When all structures have been labeled, add legend material as portrayed in Sample Factor Overlay No. 1 (figure 9-32).

7. If building construction types can be identified from oblique aerial photography, surface photography, and/or other supporting information, prepare Factor Overlay No. 2 (figure 9-33), placing a number on each building (structure) according to the numerical designations in table 9-2.

TABLE 9-2. SYMBOLOGY FOR FACTOR OVERLAY NO. 2

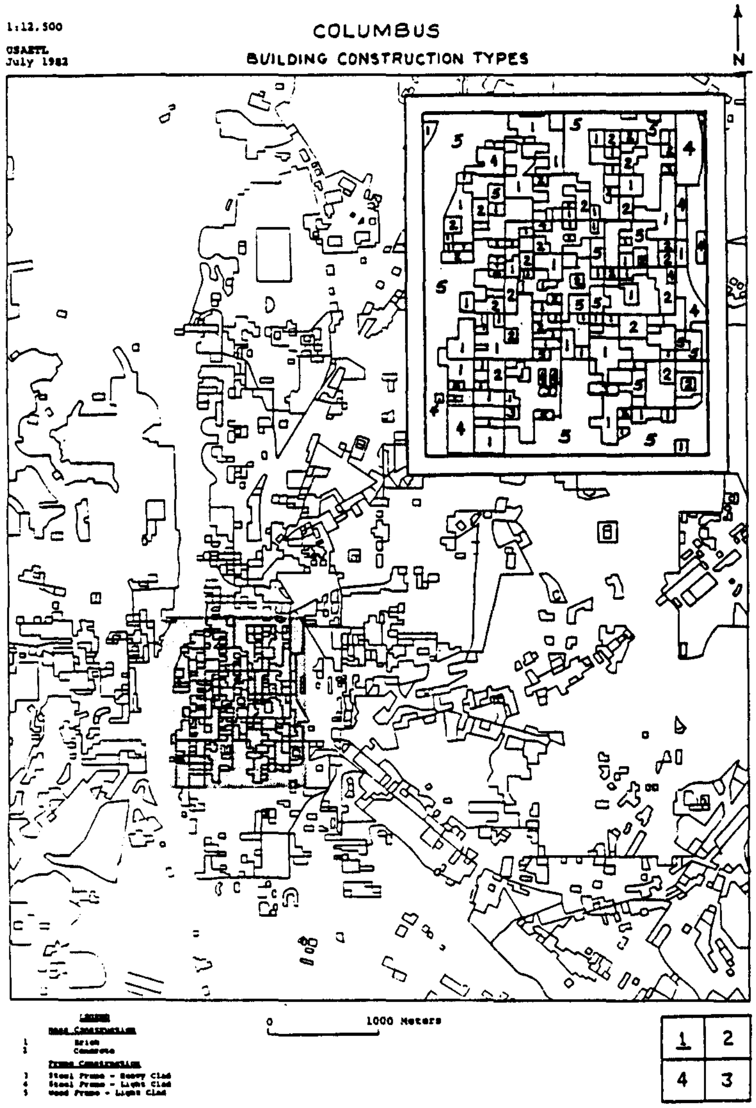
Mass Construction		
Brick	1	
Concrete	2	
Frame Construction		
Heavy Clad	3	Steel Frame
Light Clad	4	Steel Frame
Light Clad	5	Wood Frame

8. Add legend information as illustrated in figure 9-34.



Note: The scale of this overlay has been greatly reduced for publication in this guide. For clarity, only the shaded portion of the built-up-area has been annotated in detail in the enlarged inset.

Figure 9-32. Sample Factor Overlay No. 1 - Building Heights and Roof Types



Note: The scale of this overlay has been greatly reduced for publication in this guide. For clarity, only the shaded portion of the built-up-area has been annotated in detail in the enlarged inset.

Figure 9-33. Sample Factor Overlay No. 2 - Building Construction Types

e. Literature Analysis.

Literature sources will be particularly useful in determining building construction types (Factor Overlay No. 2). These fall into a wide range of technical and nontechnical categories, among which are engineering reports, urban planning studies, travel brochures, city atlases, pictorial handbooks, etc. Literature analysis should be carried out concurrently with photo analysis.

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GLOSSARY

Section IX

Architectural

ARCHITECT - literally, one who builds arches

CAPITAL - the crown, or upper part of a building of classical style (Construction type is brick in some cases but is especially associated with framed, heavy-clad structures.)

CLADDING - the outer cover of a framed building. It protects from the weather and adds bracing.

CURTAIN WALL - lightweight material covering a building's frame

ELEVATION - a scale drawing of the front, rear, or side of a structure

ELEVATOR HOUSING - the small structure on the roof of a building containing the elevator's lifting mechanism

FIRE DOOR - a metal-sheathed, fire-resistant door which seals off one portion of a building from another

FRAME-OBSCURED - having a type of curtain wall, usually glass and other lightweight material, that obscures the frame (of a framed building)

FUSIBLE LINK - weak link in chain holding a fire door open, melts at certain temperature

HEAVY CLADDING - brick (often backed with terra cotta brick) curtain wall covering a framed building

HOF-STYLE - buildings constructed around the perimeter of a block, thus forming an interior courtyard

IN-FILL - a type of window pattern in which glass fills space between columns and beams in a framed building

LIGHT CLADDING - lightweight materials (including glass) forming a curtain wall covering a framed building

LIGHT WELL - an opening in the middle of a building to allow rooms facing the light well to receive natural light

MEZZANINE - a floor between ground floor and an upper floor, or a partial floor above the main floor

MULLION - nonload-bearing member between windows

OPEN BAY - a large open area in a light-clad framed building, often an office

PARAPET - a low wall around the perimeter of a flat-roofed building

PARTITIONS - a partial or full (floor to ceiling) interior wall

PARTY WALL - an adjoining wall of two units of a mass construction building that shares the load from both units

PEDIMENT - the lower floor of a classically designed building, often having classic Greek columns or other decoration

PLAN VIEW - the view from overhead, the planimetric view, of a building or city street pattern

RURAL FORM - term used to describe buildings that do not fully occupy their lots; they are detached from one another and are set back from the street

SHAFT - the central part of a classically designed building

SPANDREL - the space from the top of a window sill on one floor to the bottom of the window on the floor above

URBAN FORM - term used to describe buildings that fully occupy their lots (no setbacks, adjoining side walls); they are usually angular in shape, often with flat rooftops

VENTING - windows and doors of a building

WALLS - exterior walls (as opposed to partitions within a building)

WINGS - extensions of a building to allow natural light to penetrate

Building Materials

BRICK - in U. S. 4" x 8" x 2", usually somewhat larger in Europe and elsewhere

BUILDING BLOCKS - molded, aggregate material, often a mix of concrete and other materials. Size varies with use: outer walls are often 8" thick, inner walls are thinner

HEADER - the end or width of a brick

LIGHTWEIGHT CONCRETE AGGREGATE - concrete for curtain walls of framed buildings made of foamed concrete. Non-weight-bearing

MASONRY - term applying to both stone and brick construction

RE-BAR - steel reinforcement bar used to strengthen concrete

STRETCHER - the length of a brick

TERRA COTTA - clayware made into hollow bricks to serve as the inner part of the curtain wall of framed buildings; also molded into decorative exterior items

VENEER - a thin coating of material, often stone placed over other structural material

Building Types

BOX-WALL PRINCIPLE - a mass construction building in which there is mutual support of loads from the combination of walls and floor/ceilings

BRICK BUILDING - a mass construction building in which the loads are carried by walls of brick (usually thicker in the lower floors, getting thinner as building height increases)

FRAMED CONSTRUCTION, HEAVY CLADDING - a framed building with a curtain wall made of brick, stone, terra cotta, or a combination

FRAMED CONSTRUCTION, LIGHT CLADDING - a framed building with a curtain wall made of glass, plastic, lightweight concrete aggregate, or other material

POURED-IN-PLACE CONCRETE - a building constructed by first erecting forms and then filling these with concrete

STONE - a mass construction building in which walls made of stone support the loads

TILT-UP - mass construction building whose walls are made of concrete poured in horizontally lying forms and lifted ("tilted") into place

Structural

BALLOON (light wood-frame) - a form of framed construction where building support comes from large numbers of narrow, closely spaced members nailed together instead of from heavy timbers joined by mortises and tenons

BEAMS - horizontal frame members in a framed building

CENTRAL PYLON - a reinforced concrete module in the center of a framed light-clad building, serving as the inner support anchor for floor joists

COLUMNS - vertical frame members in a framed building

DOWEL - a pin (wooden, used with post and beam construction)

FRAMED CONSTRUCTION - building in which the load is carried by a frame

HALF-TIMBERED - a building having the frame made of short timbers; in-filled walls are made of some light material and are not load bearing

MASS CONSTRUCTION - the method of construction where loads are carried by thick walls rather than by a frame

MORTISE - a rectangular cavity in a wooden beam or post for receiving a corresponding projection (tenon) from a beam or a post. Used in post-and-beam construction.

POST AND LINTEL - structural members of a framed building in which posts are the vertical members and lintels the horizontal supporting members above doors and windows

POURED-IN-PLACE CONCRETE - refers to a concrete building built from concrete poured into frames on site

PREFAB - refers to concrete (and other buildings) where principle members are made off-site and transported to building under construction

TENON - a rectangular projection in a wooden beam or post placed into a mortise to form a joint

X. VEGETATION

The extent and type of vegetation will be found to vary greatly from built-up area to built-up area. This will be particularly evident when different climatic regimes are compared. Although built-up areas are generally considered more devoid of vegetation than sparsely populated regions, there are many urban areas where vegetation has as much military significance as it does in the adjacent suburban terrain, if not more.

The following specifications have been extracted from the "Terrain Analysis Procedural Guide for Vegetation" (ETL-0178).[10] Although originally prepared for analysis of 1:50,000-scale topographic maps, they will also serve for the development of vegetation factor overlays at the scale of 1:12,500. For built-up-areas analysis, additional symbology has been added to provide for mapping linear vegetation growth in highway medians and along roadways. Specifications presented here are intended to introduce the terrain analyst to the requirements for preparing vegetation factor overlays and related tables for built-up-areas. The analyst should use the "Procedural Guide for Vegetation" (ETL-0178) in developing the required documentation.

A. Introduction

1. This section prescribes the format and symbols to be used to prepare factor overlays for the vegetation data field.

2. It is not anticipated that all data required by these specifications will be available during the initial preparation of a factor map. Lack of complete data, however, should not preclude preparation of the factor overlay. The factor overlay concept envisions the systematic recording of data as it is acquired, periodic revision of the overlays, and the accumulation of data over a period of time.

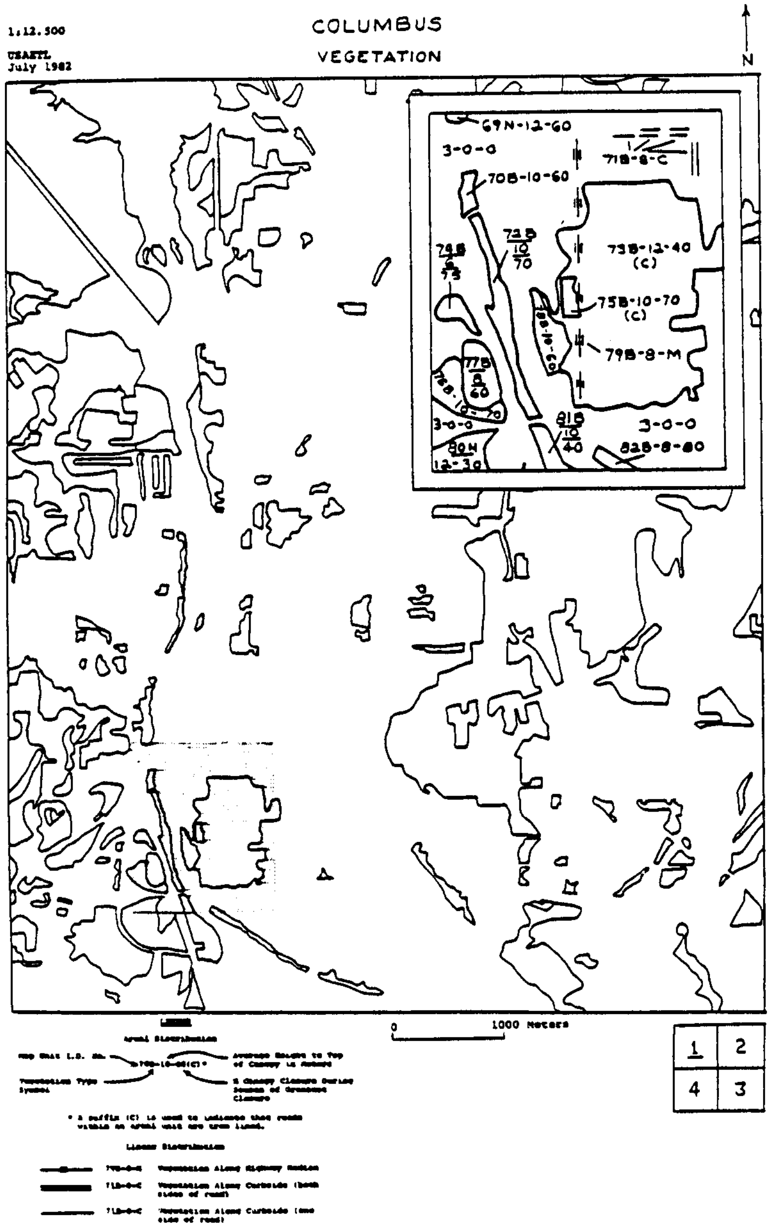
B. General Description. The vegetation factor overlays will consist of two parts as follows:

1. An overlay registered to a 1:12,500-scale map with areas of uniform vegetation conditions outlined and identified (figure 10-1). The vegetation type, maximum canopy closure, and mean height to the top of the canopy will be provided for each area.

2. A series of accompanying data tables describing the vegetation conditions within each area (figures 10-2 and 10-3).

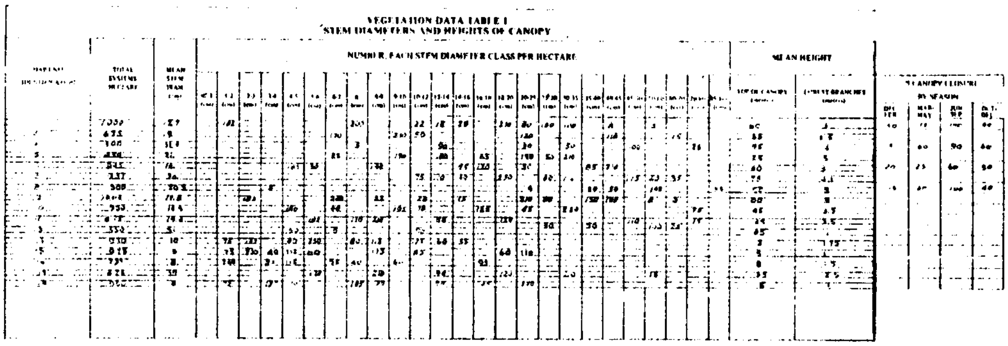
C. Data Elements. The following data elements will be presented by

[10] Jeffrey A. Messmore, et al., Terrain Analysis Procedural Guide for Vegetation, U. S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia, ETL-0178, March 1979, AD-A068 715.



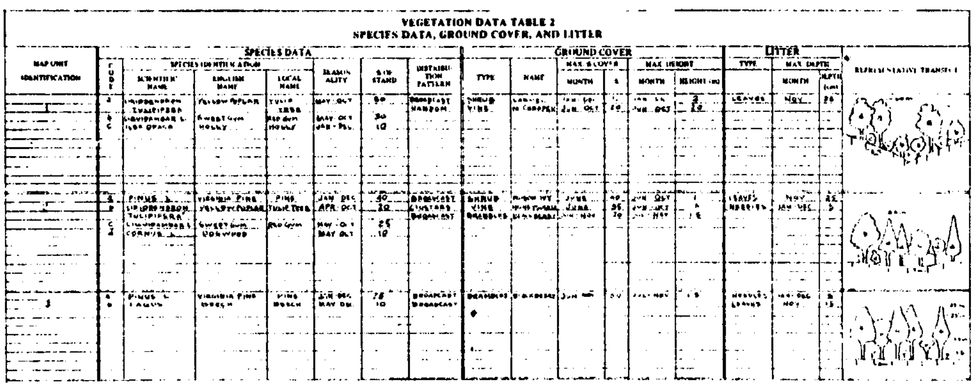
Note: The scale of this overlay has been greatly reduced for publication in this guide. For clarity, only the shaded portion of the built-up-area has been annotated in detail in the enlarged inset.

Figure 10-1. Sample Vegetation Factor Overlay



VEGETATION DATA TABLE 1
STEM DIAMETERS AND HEIGHTS OF CANOPY

Figure 10-2. Vegetation Data Table 1



VEGETATION DATA TABLE 2
SPECIES DATA, GROUND COVER, AND LITTER

Figure 10-3. Vegetation Data Table 2

the factor overlay and accompanying tables:

1. Map unit identification/vegetation boundaries.
2. Mean height to top of canopy.
3. Percent canopy closure.
4. Number of stems per hectare.
5. Tree crown diameter.
6. Mean stem diameter.
7. Number of trees in each stem diameter class per hectare.
8. Stem spacing.
9. Species identification, seasonality, and distribution.
10. Ground cover type, percent of cover, and height.
11. Litter type and depth.
12. Mean height to lowest branches.
13. A representative transect.

D. Format

1. Factor Overlay (figure 10-1)

a. The general format for the factor overlay will be as prescribed in appendix A.

b. Source(s) used in the preparation of the factor overlay tables will be entered in the marginal area B (figures A3 and A4) to the left of the coverage diagram when they are not adequately described in the coverage diagram. Where a single source is used or all sources apply to the entire sheet, the coverage diagram may be replaced by the source listing.

c. The legend material on the following page will be used as appropriate (figure 10-1).

LEGEND

Areal Distribution

Map Unit I.D. No. → 70B-10-80(C)* ← Average Height to Top of Canopy in Meters

Vegetation Type Symbol → 70B ... ← % Canopy Closure During Season of Greatest Closure

Alternate Treatments:

70B / 10 / 80	70B / 10-80	70B / 10 / 80

*A suffix (C) may be used to indicate that roads within an areal unit are tree lined.

Linear Distribution

79B-8-M	Vegetation Along Highway Median
71B-8-C	Vegetation Along Curbside (both sides of road)
71B-8-C	Vegetation Along Curbside (one side of road)

2. Data Tables I and II

a. The general format of the data tables will be as prescribed in figures 10-2 and 10-3.

b. Where the number of map units will permit, Data Tables I and II will be placed on a single overlay. When the number of map units is too great to permit placing all tables on a single overlay, a separate overlay will be prepared for each table.

E. Symbolization

1. Factor Overlay (figure 10-1)

a. Each area of uniform vegetation conditions will be outlined in a solid line 0.2 mm wide and assigned an identification number. Identification numbers will be assigned sequentially from left to right starting in the upper left corner.

b. The map unit identification number, vegetation type identification symbol, percent canopy closure during the season of greatest closure, and the mean height to the top of canopy in meters will be entered in each map unit area in black letters at least 3.2 mm high.

Where applicable, a letter (C) in parentheses may be added to indicate that roads in the map unit are tree lined. Alternatively, linear symbols may be used in forested areas as they are used where no areal distribution exists (figure 10-1).

c. Where the area being described has no plants 2 meters or greater in height, the canopy closure and plant height will be symbolized by zeros.

2. Data Tables

a. Vegetation Data Table I

(1) Data appearing in this table applies only to plants 2 meters or greater in height. Information on plants less than 2 meters high will be treated in Data Table II under "Ground Cover."

(2) Map Unit Identification: Identification numbers will be listed in numerical sequence in the first column of the table.

(3) Number of Stems/Hectare: The total number of stems per representative hectare will be recorded in column two.

(4) Mean Stem Diameter: The mean stem diameter of each map unit will be recorded in the appropriate column.

(5) Stem Spacing: The mean distance in meters between adjacent trees will be recorded in the appropriate column.

(6) Number of Trees in Each Stem Diameter Class per Hectare: The number of trees in each stem diameter class within a representative hectare will be recorded in the appropriate diameter class columns. Diameters will be determined at breast height (1.4 meters).

(7) Mean Height: The mean height to the top of canopy and the lowest branches of the foliage mass will be recorded in the last two columns. The mean height to the top of the canopy must be the same as that recorded on the factor map.

(8) Percent Canopy Closure by Season:

(a) The seasons affecting plant growth will be determined and indicated at the top of the columns by recording the abbreviations for the first and last month of each season.

(b) The prevailing canopy closure of the primary canopy will be recorded in the appropriate column in percent.

b. Vegetation Data Table II

(1) Map Unit Identification: Identification numbers will be listed in numerical sequence in the first column.

(2) Species Data

(a) Species Code: A single letter alphabetic code will be assigned each species occurring in the primary canopy (2 meters or higher) and recorded in the second column.

(b) Species Identification: It is not essential that each species' scientific, English, and local names be recorded. However, two types of names should be recorded, where possible, to minimize ambiguity.

(c) Seasonality (Duration of Foliage): The starting and ending months of the period during which the species is in foliage will be recorded in this column. In the case of plants perenially in foliage, January and December will be recorded.

(d) Percent of Stand: The percentage of each species occurring in the map unit will be recorded in this column. The percentage will be based on the number of plants. Percentages may not always total 100 percent because of an inability to identify all species.

(e) Distribution Pattern: Distribution of each species within the map unit area will be classified according to one of the following categories and recorded in this column:

Vegetation Distribution Pattern	Definition
RANDOM	Irregularly spaced individual and small groups of plants.
BROADCAST	Irregularly spaced individual plants.
CLUSTERS	Plants in groups, but mechanically independent; plant shape not affected by association.

CLUMPS	Plants in close association, stems independent; plant shape affected by association.
GRIDS	All plants approximately equally distant from nearest neighbor.
HILLS	Plants grouped in mounds of earth with groups spaced regularly.
ROWS	Plants closely spaced in one direction much more widely spaced in another.
STRIPS	Elongated patches of vegetation, vegetation along highway medians, and along the curbside of roads.

(3) Ground Cover

(a) Type: The types of ground cover (plants less than 2 meters high) will be identified by general terms such as shrubs, grasses, vines, and brambles. Scientific terms should be avoided.

(b) Name: The names of the ground cover plants should be either the English or local names, whichever are known.

(c) Maximum Percent Cover: The time period during which the ground cover plants will give the greatest coverage of the ground will be indicated by recording the abbreviations of the first and last months of the period. Estimations of the percent of ground covered will be made to the nearest 10 percent. Because of overlapping by different species, the total percent of cover can exceed 100 percent.

(d) Maximum Height: The time period during which the plants reach their maximum height will be indicated by recording the abbreviations of the first and last months of the period. Estimates of maximum height will be made to the nearest 0.5 meter.

(4) Litter:

(a) The types of ground litter will be indicated by general terms such as leaves, twigs, needles, branches, etc.

(b) Maximum Depth: The period during which the ground litter reaches its greatest depth will be indicated by recording the abbreviations for the first and last months of the period and the maximum depth in centimeters.

(5) Representative Transect

(a) The representative transect will be a carefully prepared, realistic sketch of a cross section of the vegetation within the area. Particular care will be taken to depict the shapes of the crowns and the relative heights accurately.

(b) The treatment of a nonhomogeneous area, such as shown in the transect for map unit 101 (figure 10-3), will be done only when the area is too small or too narrow to be depicted on the factor map. Normally, this type of area would be treated as three or more map units.

(c) Plants shown in the transect will be identified by placing the species code from column 2 within the crown area (figure 10-3) or in a special legend located in marginal area B (figures A3 and A4).

XI. DRAINAGE AND WATER RESOURCES

The following specifications have been adapted from the "Terrain Analysis Procedural Guide for Drainage and Water Resources " (ETL-0285)[11] for use in preparing factor overlays for built-up areas. These specifications fully document the steps to be taken and the symbology to be used in developing factor overlays and data tables. However, the analyst should become familiar with the complete procedural guide on this data field in order to understand all phases involved in the development effort.

Drainage-related elements not being treated in the built-up area analysis are

1. Bridges

2. Tunnels

3. Drainage Basins

4. Groundwater

Bridges and tunnels will be shown on the Roads and/or the Railroads factor overlays.

Drainage basin demarcation has little military significance at scales larger than 1:50,000.

Ground water as a natural element is not considered relevant to military operations in built-up areas. Where ground water sources are tapped for distribution in an urban area, pumping stations and pipe lines will be shown on the Water Systems factor overlay.

1. Watercourses and Water Bodies

A. Introduction

1. This section prescribes the format and symbols to be used to prepare factor overlays for the data field watercourses and water bodies.

2. It is not anticipated that all data required by these specifications will be available during the initial preparation of a factor overlay. Lack of complete data, however, should not preclude

[11] Jeffrey A. Messmore, Theodore G. Vogel, and Roland J. Frodigh, Terrain Ananlysis Procedural Guide for Drainage and Water Resources, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia, ETL-0285, AD-A118318.

preparation of the factor overlay. The factor overlay concept envisions the systematic recording of data as it is acquired, periodic revision of the overlays, and the accumulation of data over a period of time.

B. General Description. The watercourses and water bodies factor overlay will consist of two parts as follows:

1. An overlay registered to a 1:12,500-scale map (figure 11-1).

2. A series of accompanying data tables describing those features assigned ID numbers on the overlay as well as other related information (figures 11-2, 11-3, and 11-4).

C. Data Elements. The following data elements will be presented by the factor overlay and accompanying tables:

1. Factor Overlay

a. Alinement of all watercourses.

b. Shore alinement of all water bodies.

c. Terminal points and identification of watercourses with dry gap widths 3 m or greater.

d. Terminal points and identification of watercourse segments with dry gap widths 3 m or greater.

e. Dry gap widths, by classes, of water courses with gap width 3 m or greater.

f. Average maximum depth during seasonal high and low water periods.

g. Bank heights and min/max slopes above mean water for watercourses with gap widths greater than 50m and for water bodies.

h. Delineation of wet areas.

i. Structures and special features/areas.

j. Point and area obstacles.

k. Areas subject to flooding.

l. Location of watercourse cross sections.

m. Navigation channels.

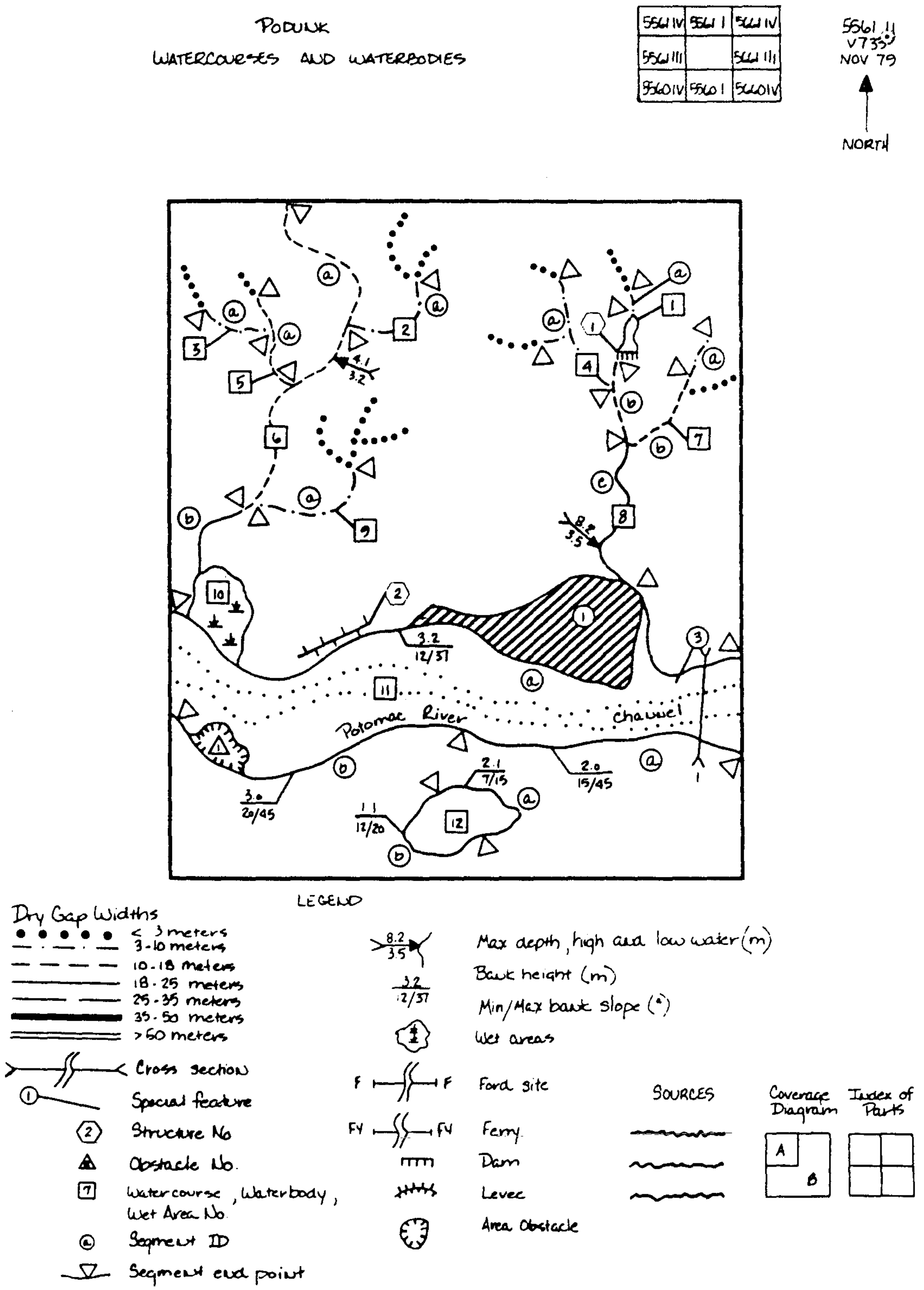


Figure 11-1. Format for Watercourse and Water Body Factor Overlay.

DATA TABLE I - WATERCOURSES AND WATERBODIES

SCALE OF BASE MAP 1:50,000

SHEET

5561 IV	5561 I	5661 IV
5561 III		5561 III
5560 IV	5560 I	5660 IV

5561 II
V733
NOV 79

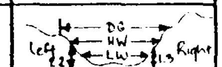
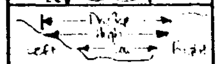
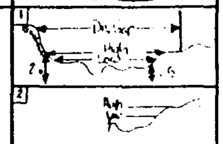
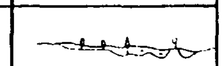
HYDROGRAPHIC FEATURE				DRY GAP WIDTH IN METERS	SEASONAL DEPTH WIDTH AND VELOCITY INFORMATION										BANK INFORMATION						MAX DISCHARGE cu m/s	CROSS SECTION SKETCH
					HIGH WATER CONDITIONS					LOW WATER CONDITIONS					RIGHT BANK			LEFT BANK				
ID NO.	LOCAL NAME	CLASS	SEG. LETTER		MONTHS	DEPTH (m) MIN	MAX	WATER WIDTH IN METERS	VEL mps	MONTHS	DEPTH (m) MIN	MAX	WATER WIDTH IN METERS	VEL mps	HEIGHT IN METERS	SLOPE IN DEGREES MIN/MAX	MATERIAL	HEIGHT IN METERS	SLOPE IN DEGREES MIN/MAX	MATERIAL		
1	[illegible] Creek	Stream	a	8.1	Mar	2.2	2.1	6.2	2.1	Aug	1.7	2.3	3.1	0.5	2.0	15/31	GC-GM	1.5	10/32	GW.GP	740	
			b	12.4	Mar	3.0	4.1	6.5	2.3	Aug	2.0	3.1	3.3	0.5	3.0	13/19	CM Stone	2.0	5/20	SMCL	740	
2	[illegible] River	River	a	2500.0	Jan, Feb	20	22	2200	20	Oct	25	17	2100	1.0	4.0	25/60	Rock	—	—	—	1500	
			a	2500.0	Jan, Feb	18		2400	2.0	Oct	20		2200	1.0	—	—	—	2.0	15/45	SC	1500	
			b	2600.0	Jan, Feb	25	29	2400	2.0	Oct	20	24	2250	1.0	---	--	—	3.0	20/45	SC	1500	
3	Great Swamp	Swamp	—	--	Apr	1.0	1.2	--	—	Sept	0.5	Dry	—	—	—	—	—	—	—	—	—	
4	(Walden) Pond	Pond	a	20.0	Apr	2.0	2.8	15	<1	Sept	1.0	1.5	12	<1	1.0	15/40	CM	—	—	—	—	

Figure 11-2. Format for Data Table 1 – Watercourses and Water Bodies.

DATA TABLE II - WATERCOURSES AND WATERBODIES

HYDROGRAPHIC FEATURE				BOTTOM CONDITIONS		TIDAL INFLUENCE			WATER QUALITY					ICE CONDITIONS													OBSTACLES	
											ANALYSIS			NO. OF ICE DAYS PER MONTH												MAX ICE THICKNESS (CM)		
ID NO	LOCAL NAME	CLASS	SEG NO	MATERIAL	SLOPE IN DEGREES	MAX MO'S	MIN MO'S	DAILY RANGE IN METERS	ID NO	SAMPLE DATE	CHEM	PPM (MG/L)	GEN CLASS	1	2	3	4	5	6	7	8	9	10	11	12		ID NO	DESCRIPTION/SKETCH
1	Pohick Creek	Stream	a	CL Some Boulders	30	3,8	6,12	0.2	1	10-71	CA Mg Na NaC CL F	44 12 65 17 70 15	Brackish Polluted	6	8	5	-	-	-	-	-	-	-	2	2	30	1	Wind Fall Trees
			b	CM Some Boulders	30	3,8	6,12	0.3	2	1-72	Na Cl	60 110	Brackish Polluted	6	8	5	-	-	-	-	-	-	-	2	2	20		
2	Potomac River	River	a	CL over SC	2	3,8	6,12	0.5	3	10-70	CA F Cl	60 10 50	Brackish	5	6	-	-	-	-	-	-	-	-	1	1	20	3	Sunken Barge 4x10x5 Meters at 1345 5126
			a																									
			b	CL over Rock	2	3,8	6,12	0.5	—	—	—	—	Brackish	5	6	-	-	-	-	-	-	-	-	-	-	20	4	Submerged Rocks
3	Great Swamp	Swamp	—	OH PT Over CL	<1	3,8	6,12	0.2	5	1-72	—	—	High Californ Coast	7	7	6	-	-	-	-	-	-	-	-	-	30	-	NONE
4	Walden Pond	Pond	a	CM	<1	—	—	—	4	12-72	NaCl CaCl Cl	16 110 200 20	Fresh	7	7	6	-	-	-	-	-	-	-	-	-	30	–	Reeds near shore

Figure 11-3. Format for Data Table 2 – Watercourses and Water Bodies.

DATA TABLE III - WATERCOURSES AND WATERBODIES

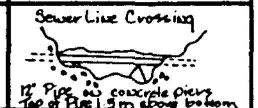
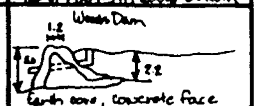
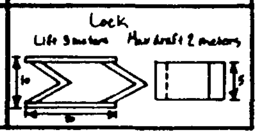
HYDROGRAPHIC FEATURE				NAVIGATION INFORMATION											AREAS SUBJECT TO FLOODING					STRUCTURES & SPECIAL FEATURES	
				NAVIGATION SEASON			CLEARANCES														
							MIN VERTICAL IN METERS			MIN HORIZONTAL IN METERS			MAX DRAFT IN METERS								
ID NO	LOCAL NAME	CLASS	SEG NO	OPEN DATE MO/DAY	CLOSE DATE MO/DAY	CAUSE	UTM COORD	LOW W	HIGH W	UTM COORD	LOW W	HIGH W	LOW W	HIGH W	ID NO	LAST DATE	MEAN DEPTH (m)	DURATION (DAYS)	CAUSE	ID NO	DESCRIPTION/SKETCH
	Pohick Creek	Stream	a	—	—	—	—	—	—	—	—	—	—	—	1	6/72	2.0	3	Heavy Rains	1	 Sewer Line Crossing; 12" Pipe on concrete piers; Top of Pipe 1.5m above bottom
			b	2/15	12/20	Ice	32214018	410	210	[illegible]	5.0	5.0	0.5	1.5			None	on segment		2	 Weir Dam; 1.2; 2.2; Earth core, concrete face
2	Potomac River	River	a,b, c,d,e	2/1	12/20	Low Water	92263049	5.0	3.1	[illegible]	1000	1000	5.0	7.0	2	6/72	3.0	6	Ice Jam	4	Numerous Small Boat Docks
																				6	 Lock; Lift 3 meters; Max draft 2 meters; 10; 5

Figure 11-4. Format for Data Table 3 – Watercourses and Water Bodies.

n. Location of fords and ferries.

2. Data Tables

a. Classification of watercourses, water bodies, and wet areas.

b. Wet and dry gap widths.

c. High and low water conditions.

d. Water velocity and maximum discharge.

e. Bank and bottom information.

f. Representative watercourse cross sections.

g. Tidal influence.

h. Water quality information.

i. Ice conditions.

j. Description/sketch of points and area obstacles.

k. Navigation information.

l. Description of areas subject to flooding.

m. Description/sketch of hydrologic structures and special features/areas.

D. Format

1. Factor Overlay (Figure 11-1)

a. The general format for the factor overlay will be as described in appendix A, figures A3 and A4.

b. Source(s) used in the preparation of the factor overlay and tables will be entered in area B of the factor overlay and to the left of the coverage diagram when they are not adequately described in the coverage diagram. Where a single source is used, or all sources apply to the entire sheet, the coverage diagram may be replaced by the source listing.

2. Data Tables

a. The general format of the data tables will be as prescribed in figures 11-2, 11-3, and 11-4. Where the number of entries permit, the watercourse, and water body data tables will be placed on a single overlay. When the amount of information is too great to permit placing all tables on a single overlay, a separate overlay will be prepared for each table.

E. Symbolization. The following symbology will be used on the factor overlay:

1. Terminal points for watercourses

Terminals points are defined as:

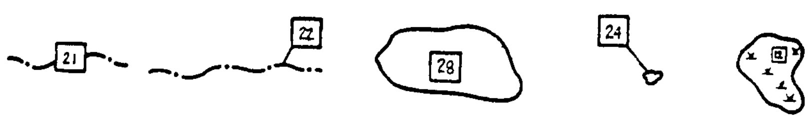
a. The points where the watercourse crosses the map neatline.

b. The point at which the dry gap width becomes 3m or greater.

c. The point at which the watercourse loses its identity by entering a water body or larger watercourse or where the watercourse regains its identity be emerging below a dam.

d. The symbol is not used for watercourses with dry gap widths less than 3 meters or for water bodies.

2. Watercourse/Water Body/Wet Area Identification



a. Watercourse identifications will be shown only for watercourses with gaps 3 meters or more in widths.

b. Wet areas include swamps, marshes, bogs, paddy/wet crops, etc.

c. Watercourses, water bodies, and wet areas will be numbered sequentially within each map sheet.

d. Where space will permit, the symbol will be placed within the open water or wet area. For small watercourses, the symbol will be placed astride or adjacent to the watercourse. Lead lines will be used for small water bodies or short watercourses. The size of the box may be adjusted to accommodate the number of digits in the identifier.

e. The watercourse name, where shown on the base map, may be placed parallel to the watercourse in approximately the same size lettering as used on the base map. Names will not be used on the overlay where they would clutter the overlay or obscure other data.

3. Start/End Points of Watercourse and Water Body Segments.

a. In the case of watercourses with dry gap widths of 50 meters or less, segments are selected primarily on the basis of the watercourse width class. However, extreme changes in bank, depth, bottom, or velocity conditions may also be reasons for establishing a segment.

b. Segments for water bodies and watercourses greater than 50 meters wide will be selected on the basis of bank heights.

c. A separate series of segments will be established for each side of watercourses with gap widths greater than 50 meters.

4. Segment Identification

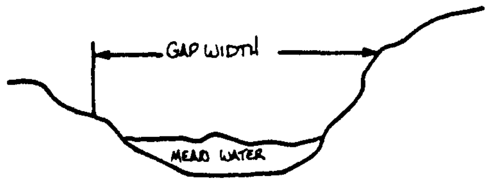
a. Segments will be assigned lower case alphabetical identifiers, starting with the first upstream segment.

b. Segments for watercourses with gap widths of 50 meters or less will include both banks.

c. Separate segments will be required for each bank for water bodies and watercourses with gap widths greater than 50 meters; i.e., there will be a separate series of segments for each bank.

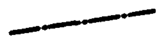
5. Watercourse Widths

Gap width width is defined as the horizontal distance, bank to bank, measured at the first slope break above mean water level (see following illustration).



a. Watercourses with gap widths less than 3 meters.

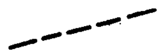
b. Watercourses with gap widths 3-10 meters.



c. Watercourses with gap widths 10-18 meters.

d. Watercourses with gap widths 18-25 meters.

e. Watercourses with gap widths 25-35 meters.



f. Watercourses with gap widths 35-50 meters.

g. Watercourses with gap widths greater than 50 meters and all water body shorelines to scale.

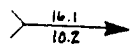
6. <u>Bank conditions</u>

a. Bank conditions are shown for each bank segment of watercourses 50m or greater in width and water bodies where sufficient space is available for recording this information.

b. Numerator indicates bank height above mean water to the nearest tenth of a meter.

c. Denominator indicates min/max bank slope in degrees.

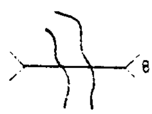
7. Maximum Water Depth



a. Numerator indicates average maximum depth in meters during seasonal high water periods.

b. Denominator indicates average maximum depth in meters during seasonal low water periods.

8. Location of Watercourse Cross Section

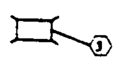


a. Cross sections will be used wherever required to illustrate the watercourse conditions.

b. Identifying number will be used as cross reference to Data Table 1.

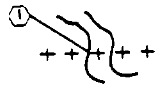
9. Structures and Special Features

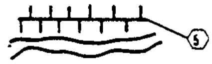
Identifying number is used as a cross reference to data tables.

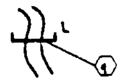
a. Bridges 

b. Tunnels 

c. Dams 

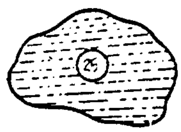
d. Cable crossings 

e. Levees 

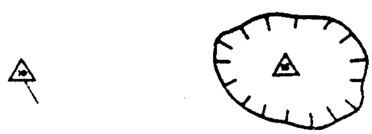
f. Locks or lifts 

g. Special feature described in data tables, e.g., navigation aids, location of gaging stations, etc.

h. Special area described in data tables, e.g., sewage disposal and filtration beds, fishponds and hatcheries, glaciers, etc.



10. Obstacles



a. Number identifies the obstacle and serves as cross reference to data tables.

b. Where the watercourse or water body is large enough, obstacles may be symbolized or noted within the water area. Symbols will be sketch versions of those appearing in the Army technical manual.[12]

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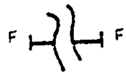
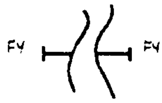
[12]AMS TM S-1, chap. 6, sec. VIII, Specifications for Military Maps, 1974.

11. <u>Crossing Sites</u>

a. Fords



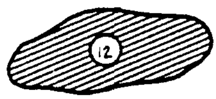
b. Ferries



12. <u>Navigation Channels</u>

Channels will be shown only for those watercourses large enough to permit symbolization by a double line.

13. <u>Areas Subject to Flooding</u>



a. Area boundary indicates maximum extent of flooding.

b. Number identifies area within the map sheet and serves as reference to data tables.

14. <u>Water Quality Sample Sites</u>

Point at which water sample taken.

F. Data Table I. Data appearing in this table will be referenced to watercourses, water bodies, and wet areas identified on the overlay.

a. The watercourse, water body, and wet area identification numbers will ~~be assigned sequentially within the map sheet. These~~ numbers will be assigned starting in the upper left hand corner of the overlay and progressing across and down the overlay.

b. The feature names will be taken from the map to which the overlay is registered.

c. Hydrographic features will be classified into one of the following categories:

(1) River

(2) Stream

(3) Inland Waterway

(4) Aqueduct, Penstock, Pipeline, Flume

(5) Canal (navigable, abandoned, under construction)

(6) Irrigation canal/ditch

(7) Drainage canal/ditch

(8) Lake

(9) Pone

(10) Inland Sea

(11) Marsh

(12) Swamp

(13) Paddy/Wet Crops

(14) Salt Pan

(15) Reservoir

(16) Lagoon

d. Segments will be assigned identifying lower case letters starting at the first upstream segment. Where there are more than 26 segments, two letters, e.g., aa, bb, will be used for segments 27 and above.

e. The dry gap width will be recorded to the nearest tenth of a meter. Widths will be measured horizontally between the first slope breaks above mean water.

f. The months during which high water conditions are most likely to occur will be indicated by entering the abbreviations for the months, e.g., Mar for March, Jun for June, etc.

g. Maximum and minimum water depth during average high water conditions will be recorded to the nearest tenth of a meter for each segment. If the watercourse is completely dry during a part of the season, it will be noted.

h. Width of the water gap during high water conditions will be recorded to the nearest tenth of a meter.

i. Water velocity during high water conditions will be recorded in meters per second.

j. Low water conditions will be recorded in the same fashion as for high water.

k. Bank heights will be recorded to the nearest tenth of a meter measured between mean water and the first slope break.

l. Bank slopes will be recorded in degrees.

m. Bank material will be indicated by recording either the unified soil classification or a work description such as riprap, masonry, rock bituminous, etc.

n. The maximum flow in cubic meters per second ($^{cu\ m}/s$) for period of record will be recorded whenever the information is known or can be estimated.

o. The segment cross section may be either a representative sketch or an actual cross section. Where actual cross sections are used, the location will be indicated on the overlay.

2. Data Table II

a. The feature number and name and the segment identification letter will be recorded in the same manner as in Data Table I.

b. Bottom conditions are indicated by recording the bottom material in unified soil classification system symbols or by a word description and slope of the watercourse in degrees.

c. Tidal influences, if any, are indicated by entering number codes for the months during which the maximum influence occurs, e.g., 1 for Jan., 2 for Feb., etc.

d. The mean daily tidal range within a segment will be recorded to the nearest tenth of a meter.

e. The water quality sample number will appear on the overlay and in the data table. The date the sample was taken if known, will be recorded in the table.

f. The water analysis will indicate the type of contaminants and the parts per million (ppm) or milligrams per litter ($^{mg}/l$) for each.

g. Each sample will be assigned a general classification as follows:

(1) Fresh - less than 500 ppm dissolved solids

(2) Brackish - 500-15,000 ppm dissolved solids

(3) Salt - more than 15,000 ppm dissolved solids

(4) Polluted - Polluted by sewage, agricultural wastes or industrial wastes.

h. The mean number of days of icing during each month will be indicated by recording a number in the column beneath the appropriate month. The month during which the heaviest icing occurs will be circled.

i. The maximum ice thickness occurring during the year will be recorded in centimenters.

j. Obstacles will be described by recording the obstacle number from the overlay and providing a sketch or brief narrative description.

3. Data Table III.

a. Feature number and name and the segment identification letter will be recorded in the same manner as in Data Table I.

b. Open and closing dates for navigation will be recorded for those hydrographic features known to be frequently used for navigation.

c. The reason for closing a segment to navigation will be recorded in the form of a brief statement, i.e., ice, flood, maintenance, etc.

d. The location of minimum vertical and horizontal clearances will be recorded in UTM coordinates to the nearest 10 meters.

e. The minimum vertical and horizontal clearances will be given to the nearest meter.

f. The maximum draft of vessels that can navigate the channel during mean water will be given to the nearest 0.5 meter.

g. The identification number of areas subject to flooding will be taken from the overlay.

h. If known, the date of the most recent flood will be recorded.

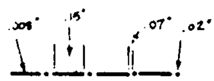
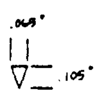
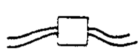
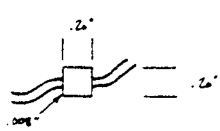
i. The mean depth within the flooded area will be recorded to the nearest tenth of a meter.

j. The past duration of the flood will be recorded in days.

k. The cause of flooding will be recorded, i.e., heavy rain, ice jams, broken dam, etc.

l. Structures and special features will be described by recording the identification number and providing a sketch or narrative description or both. Structures and features to be treated here include dams, tunnels, locks, lifts, levees, inclined planes, etc.

SYMBOLIZATION

WATERCOURSES	SYMBOL	DIMENSIONS
Dry Gap Width		
< 3 meters		
3 - 10 meters		
10 - 18 meters		
18 - 25 meters		
25 - 35 meters		
35 - 50 meters		
> 50 meters		
Watercourse start and end points		
Watercourse identification number		

Watercourse segment start
and end points

Watercourse segment
identification

Elevated aqueduct,
penstock, pipeline,
or flume

Underground aqueduct

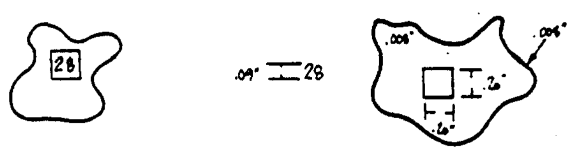
Location of cross
section

Bank height in meters
Min/Max bank slope in
degrees

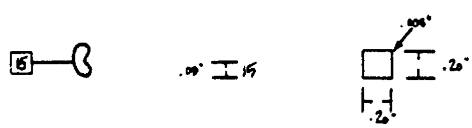
Maximum water depth.
Numerator, depth at high
water to nearest tenth
meter; denominator, depth
at low water to nearest
tenth meter.

WATER BODIES

Identification No.
Large Bodies

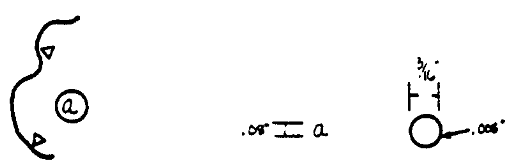


Identification No.
Small Bodies



Bank segment start/
end points

Bank segment
identification



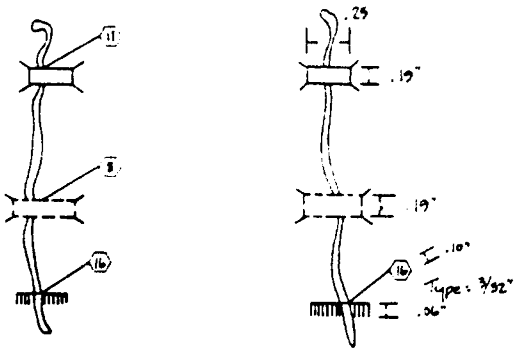
Wet Areas

STRUCTURES & SPECIAL FEATURES

Bridges

Tunnels

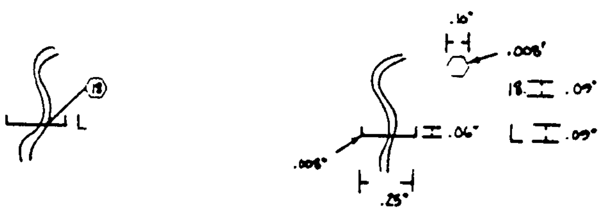
Dams



Cable crossing

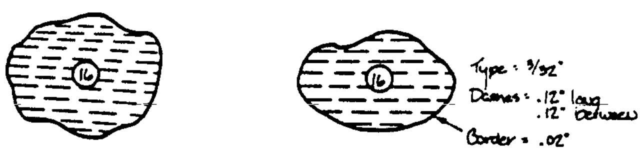
Levees and other
flood control
structures

Locks, lifts and
other hydraulic
structures



Special feature

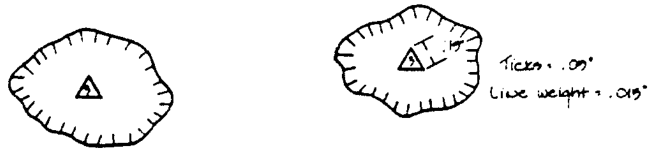
Special area



OBSTACLES

Point Obstacle

Area Obstacle

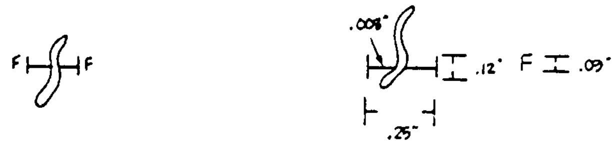


Rapids

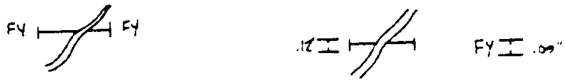
Falls

CROSSING SITES

Fords

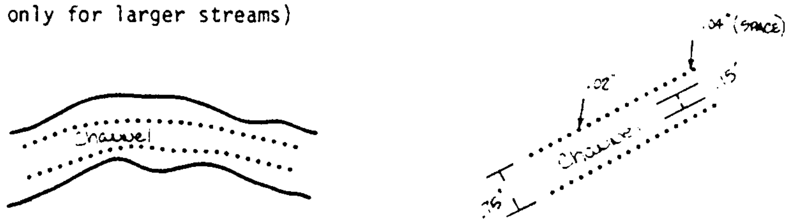


Ferries

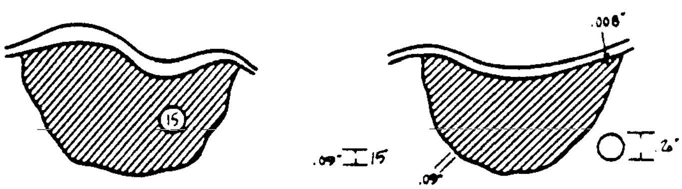


NAVIGATION CHANNELS

(Shown only for larger streams)



AREAS SUBJECT TO FLOODING



WATER QUALITY SAMPLE SITES

Point at which water sample taken

XII. ELECTRIC POWER*

"Electricity in most urban areas is obtained from themoelectric plants within a city, and/or by transmission lines from a regional power supply system drawing from hydro and/or thermal sources.

"Thermal Powerplants, Conventional Stream

"Most steam powerplants have certain basic elements that are fairly easy to recognize: large fuel storage areas, usually containing huge mounds of coal; mechanical fuel handling devices, generally some type of conveyor; cooling towers or cooling ponds (if not located next to a natural body of water); tall smoke stacks; and an adjacent transformer and switching yard.

"a. Boilers. Boilers in most steam powerplants are installed in a building that usually is several stories high; however, in some modern powerplants where climatic conditions are favorable, boilers are installed in open air frameworks. Most boilers are of the water-tube type; hot gases resulting from the burning of fuel, circulate around water filled tubes in which steam is generated.

"b. Cooling Facilities. Immediately after steam leaves the turbine it is condensed into water. The cooling water used to speed the condensing process in many powerplants comes from a stream or lake and is returned to its original source. Where water is in short supply, however, the cooling water must be reused. Cooling towers and cooling ponds are the most common types of facilities used to reduce the temperature of the water that has been used in the condensing process so it can be reused for condensing. A cooling tower is a large wooden or sheet-metal structure open at the top and bottom.

"Thermal Powerplants, Internal Combustion

"Powerplants that have internal combustion engines are different from other types of thermal powerplants. In addition to the adjacent substation, the principal recognition feature is an exhaust stack, one of which is provided for each engine. Most of these powerplants have capacities of less than 10,000 kilowatts.

"Hydro Powerplants

"Hydro power is dependent upon the pressure exerted by a column of water, or head, directed against the rotor buckets, vanes, or blades of a hydro turbine, which, in turn, activate the rotor of an electric generator.

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*This section (excepting Analysis Procedures) was taken from FM 30-10, Military Geographic Intelligence (Terrain), March 1972.

Three principal types of facilities are foot-of-dam, separated dam, and powerhouse (diversion).

"Classification of Powerplants

"Powerplants are classified according to the amount of service they are expected to provide as base load, peak load, and standby. A base load powerplant usually operates 24 hours a day. A peak load powerplant operates daily during the times when consumption needs exceed the maximum capacity of the base load plant. A standby powerplant operates only during emergencies. Powerplants are further classified according to the consumers they serve: public utility, industrial, or combination. A public utility, industrial, or combination. A public utility powerplant serves all kinds of consumers - residential, commercial, transportation, and industrial; an industrial powerplant serves an industrial installation or area and is not connected to the public power network; and a combination plant primarily serves an industrial installation or area, but it also serves some other consumers and usually is connected to the public power network.

"Transmission of Power

"Transmission systems are designed and constructed to transfer electrical energy from powerplants to consumers. To transmit large quantities of power for considerable distances, high voltage power lines are required. Generally, high voltage is considered to be 45,000 volts (45 Kv) or more. Nearly all high-voltage transmission is of 3-phase current, using one conductor per phase. A high-voltage powerline therefore usually has three heavy "wires" supported by large insulators for each "circuit." Powerlines often comprise two circuits (six "wires") on the same poles, which also carry above the main conductors one or two smaller wires, attached without insulators, to protect main circuits from lightning. The voltage is reduced at various substations in the transmission system until it reaches the level that can be used by the consumer. The level for most domestic consumption in the world is from 110 to 120 volts and from 220 to 380 volts.

"Substations

"Substations are located at key points in the transmission system, and their functions depend on the type of equipment installed. This equipment is used for switching (transferring electrical energy from one circuit to another of the same voltage), transforming (changing the voltage received to a higher or lower voltage), converting (changing alternating current to direct current), or inverting (changing direct current to alternating current). Switching, converting, and inverting equipment is almost always located inside a building; however, transformers, most of which resemble large metal boxes into which slots have been cut and are capped by three or more Christmas tree shaped groups of insulators, generally are out in the open and relatively easy to recognize."

ANALYSIS PROCEDURES

A. Map Analysis

1. Register a sheet of overlay material to the 1:12,500 scale topographic map.

2. Trace the neatline on the factor overlay, and add marginal information as shown in figures A3 and A4, appendix A.

3. Locate the outline powerplants. These may be identified by the presence of tall chimneys, railroad sidings, cooling towers or ponds, and powerlines extending outward from the powerplant complex.

4. Draw lightly in pencil all transmission lines and associated towers (supports) shown on the map. A completed factor overlay is shown in figure 12-1. Further identification will be discussed under photo and literature analysis.

B. Photo Analysis

1. Aerial and ground photographs are excellent sources of information for identifying features in an electrical power system. Add powerplants, transmission lines, and electrical substations not shown on topographic maps.

2. Using stereo pairs, measure heights of smokestacks and transmission towers, and label the height of these features on the factor overlay.

C. Literature Analysis

1. Literature on urban electrical power systems generally will include statistical yearbooks, construction plans, brochures, and other technical publications. Use these sources to check information already plotted on the factor overlay.

2. Referencing literature sources, extract material necessary to complete the factor overlay, using symbology listed in table 12-1.

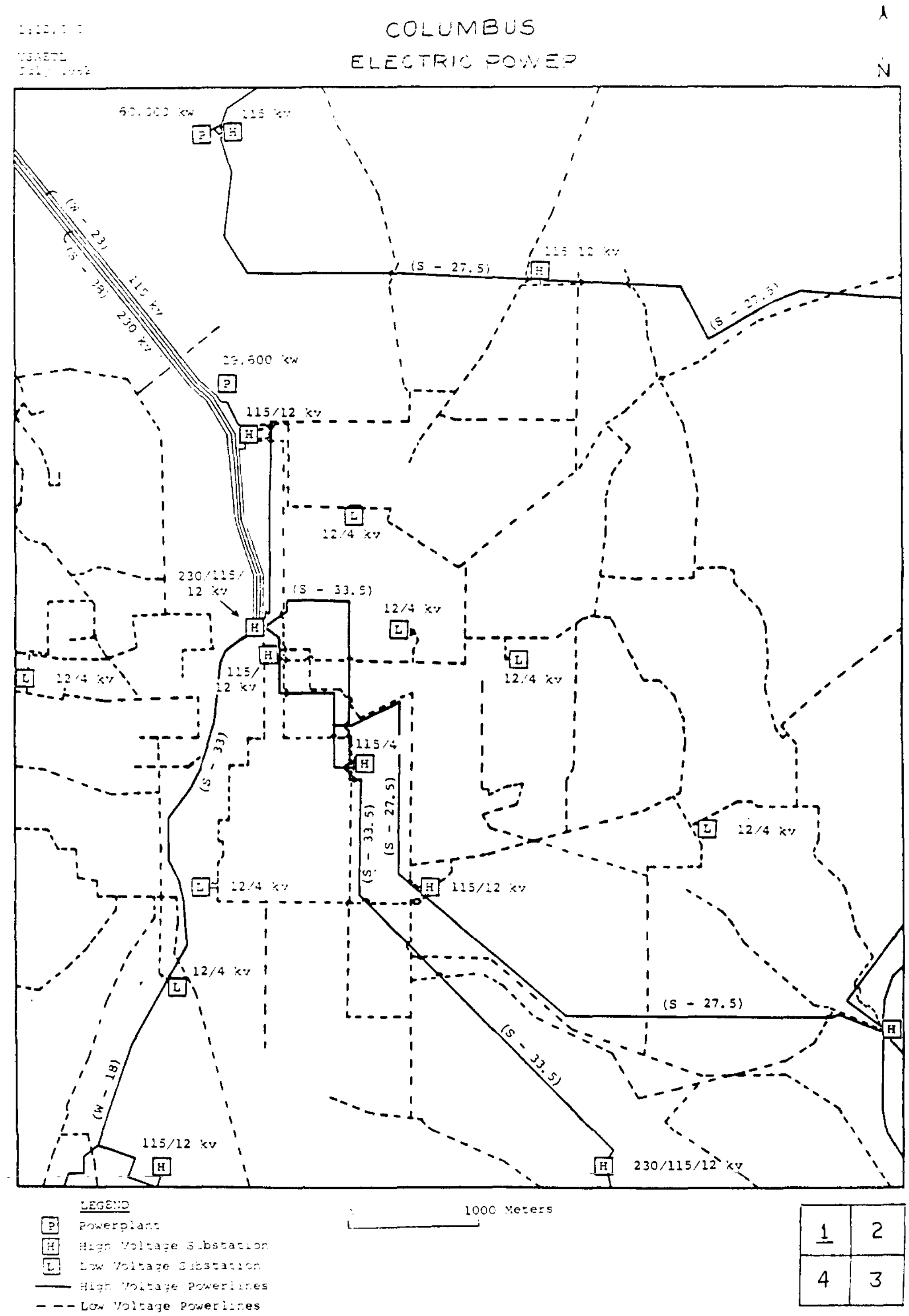
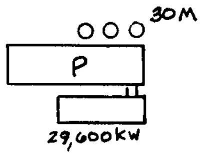
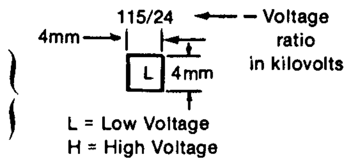
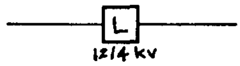
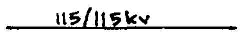
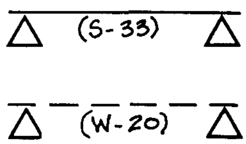
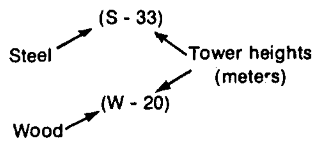


Figure 12-1. Sample Electric Power Factor Overlay

Table 12-1. Symbol Specifications for Electric Power.

Feature	Symbol	Specifications
Powerplant		Outline to scale. Label with letter "P". Indicate output in kilowatts, chimney heights in meters.
Substations A. High Voltage Transformer >45kv		
B. Low Voltage Transformer <45kv		
Powerlines A. High Voltage >45kv		Solid line - 1mm
B. Low Voltage <45kv		Dashed line - 1mm
Powerline Towers (heights and construction material)		 Triangles (4mm/slide indicates ends of powerline segments with designated heights.

XIII. STORM AND SANITARY SEWERS*

"Sewerage

"Sewerage is a process of urban waste removal using water as a carrying medium. A sewerage system includes all the facilities for collection, transportation, treatment, and disposal of sewage. Domestic sewage includes bathroom, laundry, and kitchen wastes. Industrial sewage includes wastes from manufacturing processes and food preparation, as well as water used for cooling. Street wastes include refuse, debris, greases, and oils which wash off buildings and street surfaces during rains, and also include storm water runoff.

"a. Sewage Collection. The use of water as an agent for disposal of sewage is relatively new. Although it is used in the western world, waterborne sewage systems elsewhere are rudimentary, limited in extent, or nonexistent.

"(1) Sewer mains form a network of lines paralleling the water distribution system. Where street wastes and storm waters, and domestic and industrial sewage are carried in the same drains or sewers, the system is called a combined system. Where they are carried in separate sewers, the terms "dual" or "separated" systems are used. The pattern of mains may be dendritic, grid, or belt, as with the water supply system, but with several important differences. Water flowing under pressure supplied by a high head or by pumping from a central point can overcome minor differences in relief and can more readily follow the road pattern. Sewage collector lines must more closely follow drainage lines to various sub-central collecting stations where pumps maintain the flow of sewage to the treatment plant. These stations are critical features in the water supply system. Because the quantity of sewage flow approximates the flow of water supply, any disruption in the sewerage system would require an immediate curtailment of water to prevent sewage backup or bursting of sewage and water mains.

"(2) Waterborne sewerage is but one means of waste collection. In many parts of the world, collection of domestic wastes is made from individual houses or from interior courtyard bins by carts or trucks. In many cities, waterborne sewerage is limited to commercial and wealthy residential areas. The sewerage may empty into community cesspools, which are pumped out periodically for final disposal.

"b. Treatment and Disposal. The purification of sewage is essentially an oxidation process in which organic matter is reduced by bacterial action into its basic mineral constituents. When the sewage flow is

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*This section (excepting Analysis Procedures) was taken from FM 30-10, Military Geographic Intelligence (Terrain), March 1972.

heavy, natural purification by stream water must be assisted by prior treatment of sewage. Municipal treatment facilities may provide limited or full treatment, depending on the capacity of the stream for self-purification, the type of sewage discharged, and the degree of civic interest in sanitation.

"(1) Natural purification. In the simplest form, sewage discharged into a stream is separated into solid and liquid components by sedimentation. A stream can act as a purifying plant provided the balance of aerobic and anaerobic bacteria is sufficient to decompose the volume of sewage entering the stream.

"(2) Purification by treatment. For small towns or small military camps, direct dumping of sewage is feasible, but for cities of any appreciable size, sewage must have some treatment to prevent stream pollution. Mechanical, chemical, and biological means are employed to reduce the unstable organic content of sewage water prior to discharge, by removing solids, by speeding the bacterial action, and by chemically neutralizing contaminants.

"c. Treatment Methods. Two stages of sewage treatment are employed. Primary treatment is designed to reduce the discharge of contaminants to a point where the stream can continue self-purification. Primary treatment consists of separating the suspended solids from the liquid sewage by stabilizing the solids or sludge. Secondary treatment consists of disposal or treatment of sewage liquids or effluent by processes similar to water purification.

"(1) Primary treatment. Screens are used to withdraw debris and grease, which are gathered in sedimentation tanks. Sedimentation basins aid the settling of sewage solids. The separated solids are termed sludge. Sludge is withdrawn for further settling and digestion through the use of septic and Imhoff tanks. After digestion, sludge may be further dried for disposal as earthy material. Sludge drying beds may be open or, in moist climates, under glass and are distinctive features of sewage plants. Gas produced in sludge digestion is sometimes collected for use as a fuel. In large cities, sufficient gas may be collected for the operation of small electric power plants.

"(2) Secondary treatment. Raw effluent may be disposed of by discharging it into streams or by irrigation. Effluent also may be treated by oxidation, filtration, and chlorination processes similar to water treatment. When disposed of by irrigation, effluent is distributed over porous ground and allowed to evaporate and to percolate into the soil. Grasses are usually planted in these areas to speed the disposal. This method is used primarily in semiarid climates where there are large areas of wasteland away from populated places. An oxidation pond is a relatively large, shallow, artificial or natural pond into which settled sewage is discharged for purification by sunlight and air. Trickling filters are beds of crushed stone, slag, or gravel over which effluent is sprayed. As the sewage trickles down through the bed, the organic matter remains and is stabilized by bacterial action."

ANALYSIS PROCEDURES

A. Map Analysis

1. Tape a sheet of translucent material to the 1:12,500 scale topographic map.

2. Trace the neatline on the overlay, and refer to figures A3 and A4, appendix A, for instructions for annotating the required marginal information.

3. Outline sewage treatment facilities, including structures, sedimentation basins, and filter beds.

4. Topographic maps do not show the underground network of sewer mains. See section C, Literature Analysis, for source material that, if available, will provide information on the planimetric distribution of sewer lines.

B. Photo Analysis

1. Use aerial photography to locate sewage treatment facilities. When located along a stream course these urban structures often can be identified by the sharp tonal contrast between the sewage outfall and the receiving waters. Also, they will be located downstream from water-supply processing plants.

2. In the absence of information on subsurface sewer lines, aerial photography (vertical and oblique) may reveal locations where storm drains empty into larger drainage channels. These points should be identified on the factor overlay.

C. Literature Analysis

1. As in the case of water supply networks, adequate information on storm and sanitary sewer lines will be limited to municipal reports, urban-planning studies, and engineering documents. If such material can be retrieved, develop the factor overlay, (figure 13-1) using the symbology listed in table 13-1.

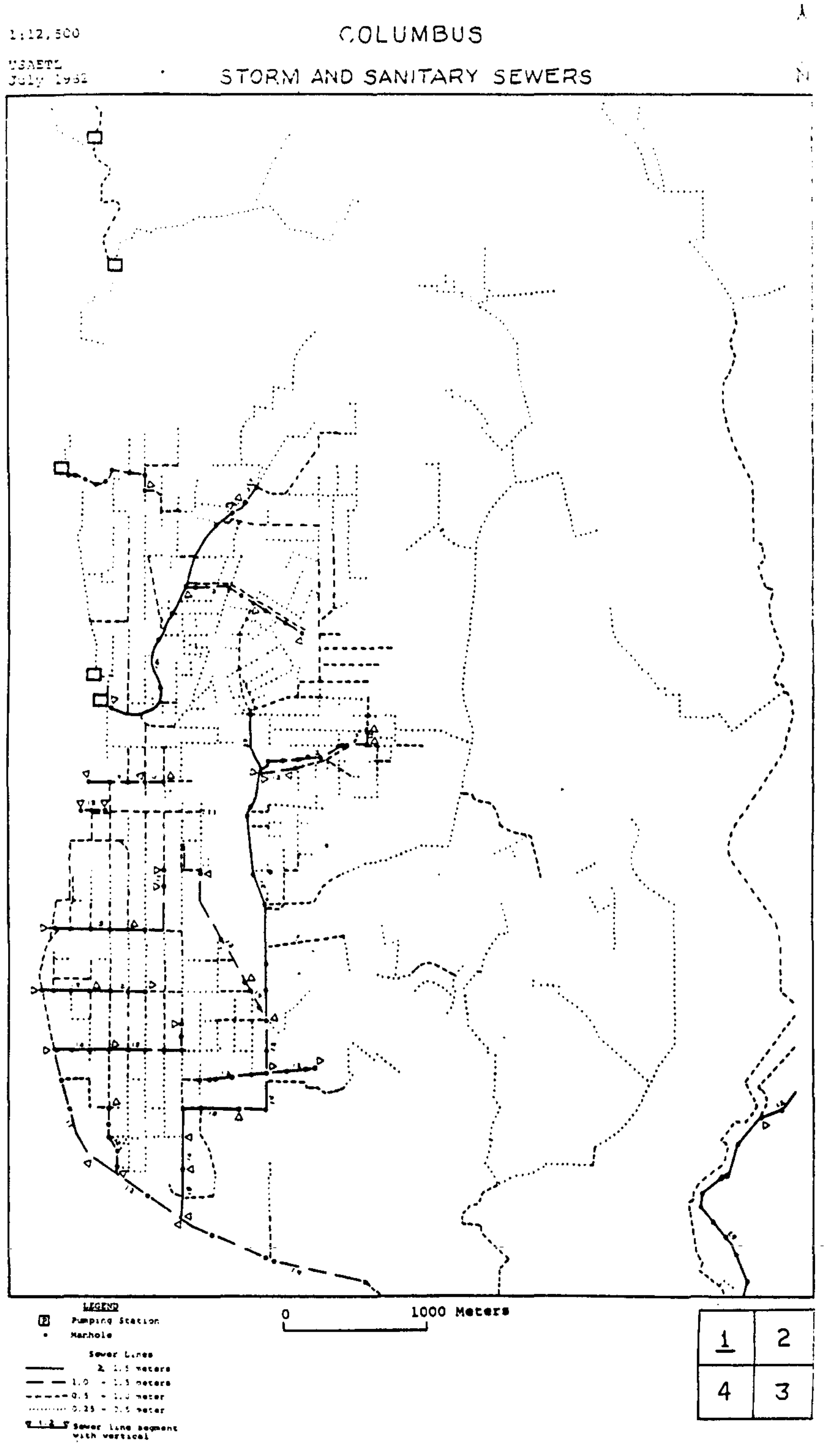
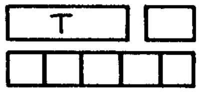
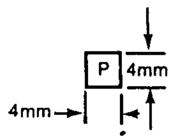
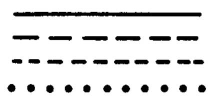
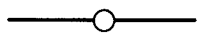
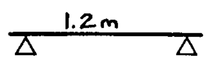


Figure 13-1. Sample Storm and Sanitary Sewers Factor Overlay

Table 13-1. Symbol Specifications for Storm and Sanitary Sewers.

Feature	Symbol	Specifications
Sewage Treatment Facility		Outline to scale, Label with letter "T"
Pumping Station		
Sewer Lines — Vertical Dimensions		
1.5 meters or greater 1 to 1.5 meters 0.5 to 1 meter 0.25 to 0.5 meter		Solid line 1mm Long dash 5-6mm Short dash 2-3mm Dot 1.5mm
Manhole Locations on sewer lines with vertical dimensions 1 meter or greater.		Circle 3mm dia.
Actual vertical dimension of sewer line segments between triangle symbols (shown only on lines with 1 meter or more vertical dimension).		Triangles 3mm/side

XIV. WATER SUPPLY SYSTEMS*

"Urban water supplies are obtained from surface and ground water sources. Surface sources may be relatively pure sources, such as river headwaters and upland lakes that require only limited treatment, or relatively polluted and turbid sources, such as the lower and middle reaches of rivers that require considerable treatment. In areas of low, uncertain, or seasonal rainfall, impounding reservoirs are constructed to contain surface runoff. Ground sources are used by tapping natural springs and by drilling wells.

"a. Collection. There are different facilities for collection of surface and ground water. Collection of surface water from rivers, lakes, and reservoirs is generally done by means of intakes, which withdraw water from levels with the least turbidity, odor, algae, floating debris, or ice. For small water supply systems, the intake may be a simple pipe with a coarse screen extending into the water, or it may be a submerged crib of concrete or timber. Larger water systems make use of intake towers, vertical concrete or steel tubes having gates at different levels which are opened according to the depth from which water is to be withdrawn. A reservoir is normally equipped with intake towers either in the center of the water or as part of the dam. Where the source is a swift-flowing stream, a canal may be constructed to a reservoir or to a pool in which the intake is situated. Instead of intakes, infiltration galleries are sometimes laid under the body of water or on-shore below the ground water level to collect seepage from the river. Infiltration galleries usually consist of a series of perforated pipes surrounded by gravel and sand. The number of wells that can be sunk depends upon the extent of area that each well can effectively tap. The yield of a well is dependent on the porosity of the water-bearing formation and the rate of underground flow. From each well, a pipe connects with some central collecting point.

"b. Storage. Extensive storage facilities are an integral part of most water supply systems. The storage facilities are designed to maintain raw water adequate to cover prolonged periods of drought, and reserve supplies of treated water to offset interruptions in flow in various parts of the distribution system. Systems based on headwater sources almost invariably have extensive facilities to contain surface runoff from the watershed or catchment basin. The catchment basin includes the runoff or drainage area and the impounding reservoir area. For protection of the water supply, natural vegetative cover is carefully maintained over the entire watershed area. Impounding reservoirs may be enlarged natural lakes or ponds, or lakes artificially created by damming stream valleys. Such storage areas are generally of very large size and may contain more than a year's normal water requirement. Middle and lower stream courses

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*This section (excepting Analysis Procedures) was taken from FM 30-10, Military Geographic Intelligence (Terrain), March 1972.

provide a more certain water supply, but because of great seasonal fluctuations in stream flow, impounding reservoirs are frequently used.

"c. Treatment. The treating of water from its raw state to a finished potable product involves a sequence of processes. Mechanical cleaning comprises the use of coarse and fine screens in series to strain the water and remove debris, ice, vegetation, fish, and algae, and of desedimentation basins to allow suspended solids to settle to the bottom. Chemical purification comprises the removal or neutralization of bacteria and other fine organic particles, and the use of flocculents to remove colloids. Objectionable dissolved chemicals are removed by precipitation to reduce water hardness, corrosiveness, and discoloration. In the final treatment stage, minute quantities of several chemicals may be introduced to improve the quality of water. This includes protection of water in transit after treatment and reduction of excessive alkalinity or corrosiveness.

"(1) Facilities (fig. 14-1). The facilities provided at a water treatment plant depend on the water source. Water from polluted middle or lower courses of rivers generally requires all treatment processes, whereas upland water sources require less treatment to remove bacteria. A large city could conceivably utilize all the various sources of water supply, but most cities usually have only one or two main sources.

"(2) Filtration. Filtration is the heart of the water treatment process. Filtration processes differ in the use of slow and rapid sand filter systems.

"(a) The slow sand filter consists of a series of rectangular basins about 1.8 to 3 meters (6 to 10 feet) deep, in which water is passed over beds of sand and then seeps through to collector basins below, leaving impurities in the sand. This system is commonly used in Asia and in many parts of Eastern Europe where published data on capacity is not available or difficult to obtain. Direct observation is usually needed to determine capacity. Capacity may be estimated with reasonable accuracy if the size of the filter beds and the nature of the water can be determined. Filter beds are most frequently of quarter-acre size, about 62 meters by 15 meters (205 feet by 50 feet). Turbid river water without preliminary settlement filters at a rate of about 3 million gallons per acre of filter bed per day. Clear river water filters at about 4 to 6 million gallons per acre of filter bed per day. Lake and reservoir water filters at about 8 million gallons per acre of filter bed per day. Water after sedimentation and chemical treatment filters at about 10 million gallons daily per acre of filter bed.

"(b) Rapid sand filtering systems are used in large modern water treating plants in the United States and in large cities of Western Europe. There are two types of rapid sand filters: gravity or pressure. Gravity rapid sand filtration consists of a series of rectangular basins containing sand and coagulant chemicals through which water is passed. The rate of filtration is over 100 million gallons per acre per day. In some cases,

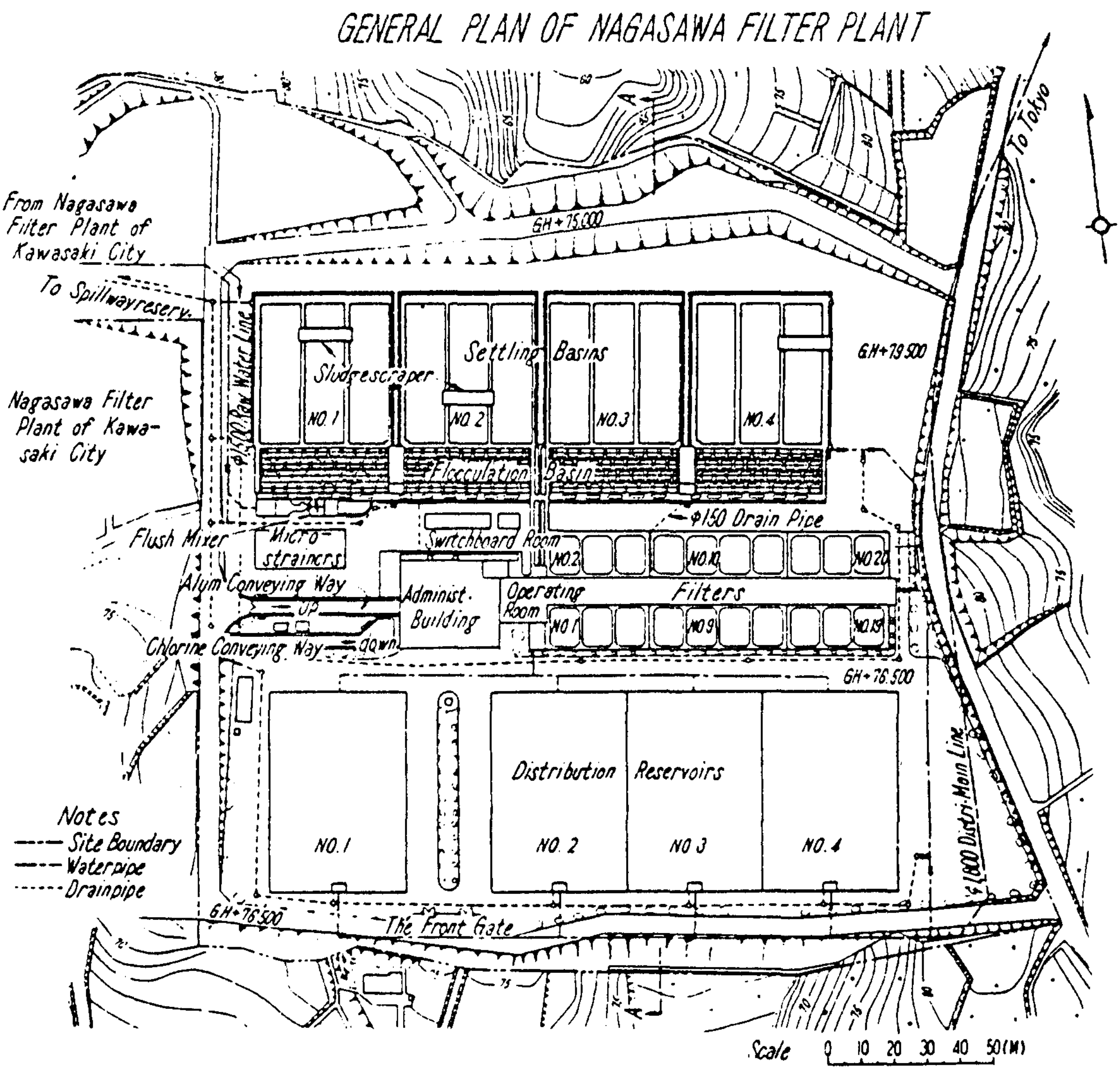


Figure 14-1. Plan of Water Treatment Facilitity in Japan

the rate is as much as 250 million gallons per acre of filter bed or higher. The speed is obtained because of concurent use of chemicals with sand filtration, and because cleaning of beds is done rapidly by back flowing filtered water. Pressure sand filters are enclosed horizontal or vertical tanks, through which water is forced under pressure; special sands and chemicals help to increase the rate of filtration. Pressure filters are of small size in comparison with rapid or slow gravity filter beds. A pressure filter tank of 2.5 x 4 meters (8 x 14 feet) has a capacity of about 250 million gallons daily. With rapid filtration will be found sedimentation or clarification basins which pretreat water before filtration.

"d. Transportation. Pipelines, tunnels, and canals used for transportation of water are called aqueducts. These convey water from intake to treatment plant, and from treatment plant to storage and distribution points. Aqueducts may be open channels, closed pipelines, or tunnels. There are two systems of aqueduct water flow, gravity flow and pump-forced flow.

"e. Distribution. Water distribution facilities include the distribution reservoirs; arterial, feeder, and street mains; booster pumps; standpipes and elevated tanks; valves, street hydrants, meters; and service connections to buildings. The system is constructed to meet simultaneously the fluctuating domestic demand and a variety of public and industrial needs, as well as emergency supplies for firefighting.

"(1) Service areas. The distribution system is divided into service areas, each of which has its own reservoirs, elevated tanks, and booster stations designed to provide the particular service required for each area.

"(2) Distribution reservoirs. Distribution reservoirs related to each service area form a secondary storage system within the city, which enables mains to be shut off for maintenance or repair, and which provides emergency supplies for other parts of the city. Distribution reservoirs comprise surface reservoirs, standpipes, and elevated tanks.

"(3) Distribution lines. Water lines are usually laid under the streets of a city for easy maintenance; depths usually range from two feet in warm climates to over seven feet in cold climates. The layout of lines is determined by the street pattern, but the system of flow is through a graduation of lines in a dendritic, grid, or belt pattern. In a dendritic flow pattern, arterial mains are generally laid along main roads where land is relatively flat; where the terrain is irregular, mains may be laid along ridge lines. Feeder lines extend along all branch roads to divide, in turn, into street mains from which service connections lead to buildings. In the grid flow pattern, there is an intercrossing and interconnecting pattern of arterial, feeder, and street mains through which water is distributed by circulation. By opening and closing valves, the pattern of flow can be altered for maintenance or repair without serious interruption in service. This system is normally used in central areas of cities. One use of the grid system is to send water to the scene of fires over several routes to increase hydrant pressure. The belt system forms a ring around the city to combine the advantages of the grid pattern for central areas, and the dendritic pattern for outlying areas. The ring arterial mains and some feeder mains form a ciruclating system, but the rest are only distributary and are dead ended at the last service connection.

"(4) Mains. The sizes of arterial, feeder, and street mains differ according to the volume of water to be delivered, but a general range may be noted. Arterial mains commonly have a diameter of 1.2, 1.5 or 1.8 meters (48, 60 or 72 inches). Feeder mains generally are 0.6 to 0.8 meter (24 to 30 inches) in diameter and may be of concrete, cast iron, or steel pipe construction. Street mains generally are 0.3 to 0.6 meter (12 to 24 inches) in diameter and are mostly of cast iron and steel construction.

"(5) Valves, hydrants, and service connections. Valves are located at each interconnection and change in diamter of pipe. There are normally thousands of valves in each distribution system; to open and close lines, and to eliminate vacuums which could interfere with the free flow of water. Service connections consist of the piping from street mains to the consumer plumbing system.

"f. Measurement and Computation. Although it is common for water consumption to be stated in terms of thousands of gallons per day, month, or year, the rate of flow (volume passing in a unit of time), or its total volume, is often expressed in predetermined units for specific purposes. The following units and equivalents usually are used:

Cubic feet per second (cfs), used to measure rate of flow (1 cfs = 448.83 gpm =646,315 gpd).

Gallons per minute (gpm) and gallons per day (gpd), used to express pump output, pipe flows, and fixture requirements.

Millions of gallons per day (mgd), used to express total daily flow or rate of flow.

Cubic feet, used in measuring storage volume
(1 cu. ft = 7.48 gallons).

Acre feet, used in measuring storage volumes
(1 acre ft = 43,560 gals)."

ANALYSIS PROCEDURES

A. Map Analysis

1. Register overlay material to the 1:12,500 scale built-up area topographic map.

2. Trace the neatline on the factor overlay, and add marginal information as indicated in figures A3 and A4, appendix A.

3. Trace outline of water system related structures: reservoirs, water towers, standpipes, and pipelines that appear on the topographic maps. Label each feature (Treatment Plant, Storage Reservoir, Aqueduct, Intake Tower, Settling Basin, etc.)

4. If municipal maps showing distribution of underground waterlines are available, use symbols in table 14-1 to portray the network of water mains on the factor overlay (figure 14-2).

B. Photo Analysis

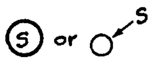
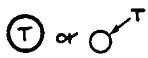
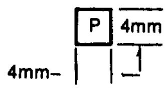
1. Apply photo interpretation methods to identify all above-surface water system features, checking against information derived from maps.

2. Determine the heights of water towers and standpipes, and indicate these measurements on the factor overlay. If a Building Heights and Construction Material overlay (chapter 9) has been completed, the required height information may be extracted from this overlay.

C. Literature Analysis

1. Municipal reports and engineering plans and studies will represent the primary sources of information on underground pipelines. Use such documents for developing the overlay in accordance with the following specifications (table 14-1).

TABLE 14-1. SYMBOL SPECIFICATIONS FOR WATER SYSTEMS

Feature	Symbol	Specifications
Water Treatment Plant		Outline structures to scale. Label with letter "P".
Standpipe		Outline to scale. Label with letter "S". Indicate height in meters.
Water Tower		Outline to scale. Label with letter "T". Indicate height in meters.
Pumping Station		
Pipelines		
76 cm (30") or greater		Solid line 1mm
51 - 76cm (20 - 30")		Long dash 5 - 6mm long
25 - 51cm (10 - 20")		Short dash 2 - 3mm long

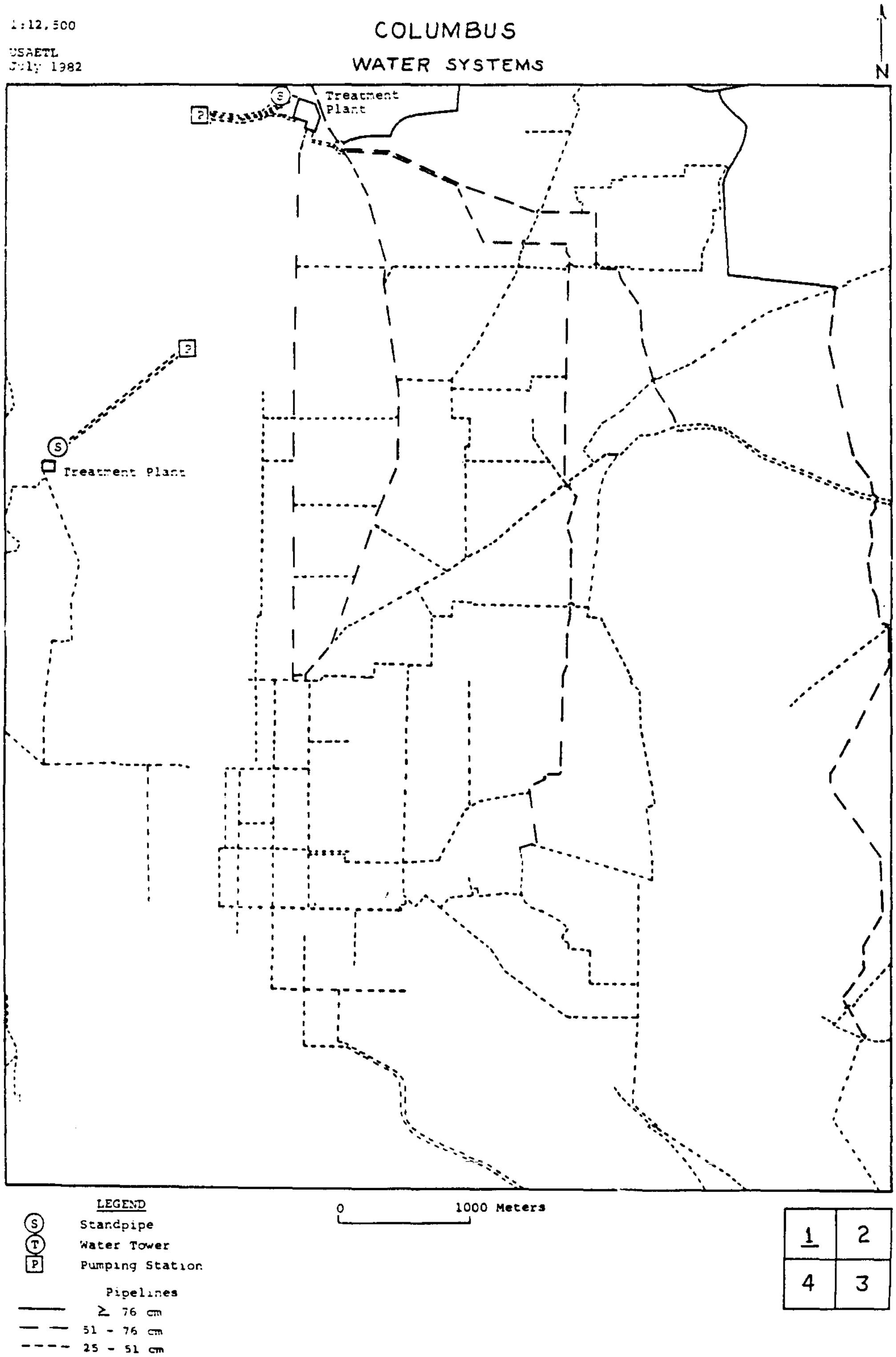


Figure 14-2. Sample Water Systems Factor Overlay

XV. GAS SYSTEMS*

"In many cities of the world, industries, as well as the bulk of the population, are dependent on a gas supply system. Huge gas works form prominent features on the urban skyline and are key elements in the urban economy. Natural gas is supplied to cities from gas fields, or petroleum refineries. Manufactured gas is produced from coal, petroleum, and oil shale, with coal being by far the most important source. Coal gas is produced by heating coal in closed containers which separates the more volatile gaseous and liquid hydrocarbons from the solid residue known as coke. Various processes of separation and blending with oil, water, and air produce a number of gases with different properties and different industrial uses. Manufactured gas is stored in huge telescoping low pressure tanks, which rise or fall depending on volume stored to maintain a constant pressure, and in high pressure tanks which store great quantities of gas in comparatively small containers. Natural gas is ordinarily stored in underground reservoirs, usually away from cities. In urban areas, spherical tanks are generally used for the storage of gas under high pressure. The distribution of gas is primarily by pipeline, similar to water supply distribution. The key point in this system is the dispatching office, where control of flow and pressure throughout the system is maintained. In suburban areas of cities, gas is sometimes distributed in small tanks, and is commonly termed "bottled" gas."

ANALYSIS PROCEDURES

A. Map Analysis

1. Tape a sheet of overlay material to the 1:12,500 scale topographic map selected for the built-up area analysis.

2. Trace the neatline on the factor overlay, and add marginal information described in figures A3 and A4, appendix A.

3. Outline structures, including storage tanks, that make up the gas dispatching center.

4. Municipal utilities maps and/or gas company maps may provide information on the underground gas line network. Use such maps to plot the gas distribution system on the factor overlay, applying the symbology from table 15-1.

B. Photo Analysis

1. Photography, aerial and surface, will provide the analyst with

*This section (excepting Analysis Procedures) was taken from FM 30-10, Military Geographic Intelligence (Terrain). March 1972.

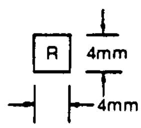
material to verify and update map-derived information.

2. Use stereo pairs to determine heights of gas storage tanks. Print measurements in meters adjacent to the feature on the factor overlay.

C. Literature Analysis

1. Literature sources will represent the best, and possibly the only, information available for preparation of a gas systems factor overlay (figure 15-1). In this category are city engineering plans, gas company maps, and statistical reports. Use such documents to map the gas distribution system, applying the symbology from the following table.

TABLE 15-1. SYMBOL SPECIFICATIONS FOR GAS SYSTEMS

Feature	Symbol	Specifications
Gas Works (Dispatching office)		Outline structures to scale. Indicate height of storage tanks in meters. Label complex with the letters "GW".
Regulator Station		
Pipelines		
High Pressure		Solid line 1mm
Low Pressure		Dashed line 5-6mm

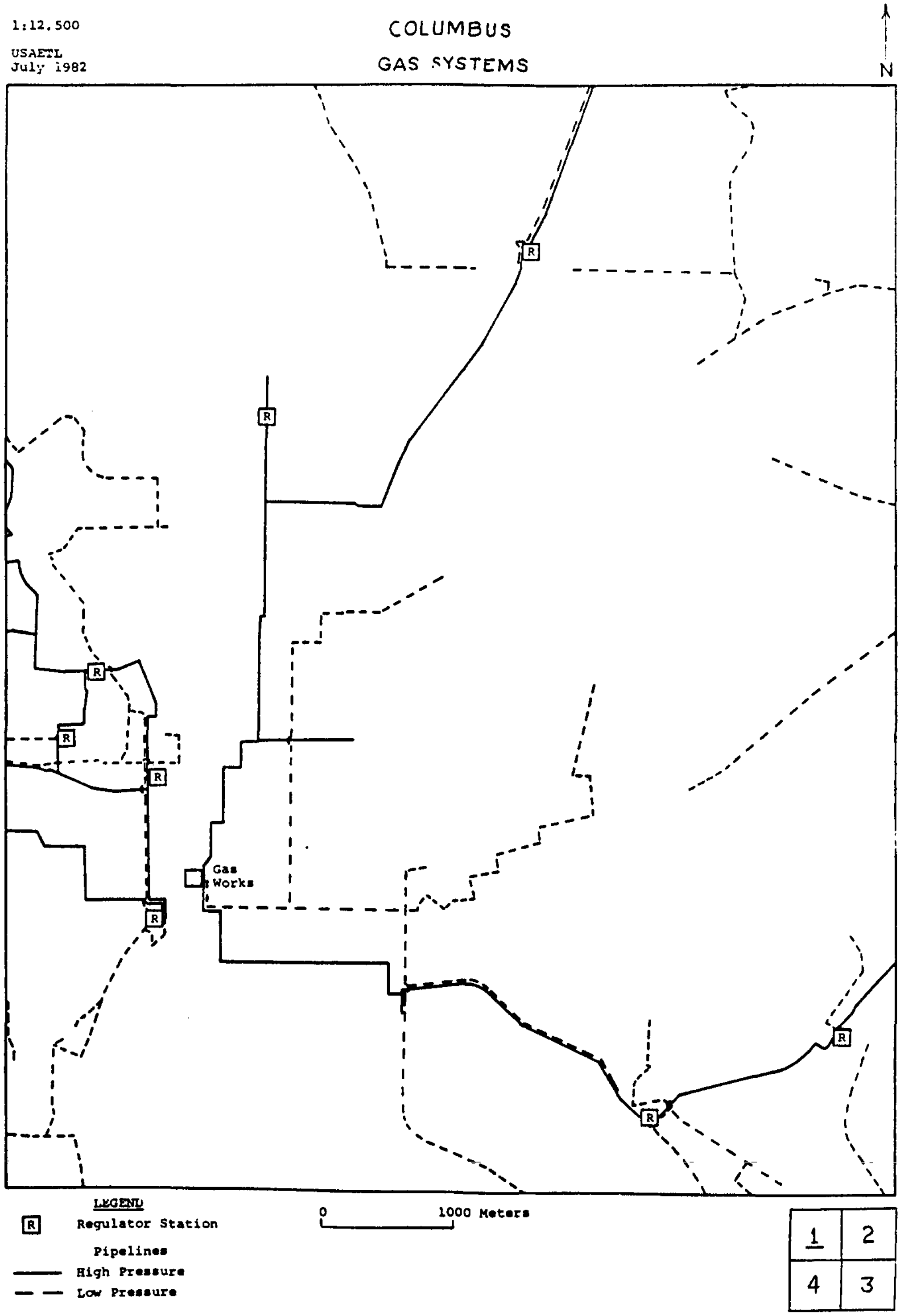


Figure 15-1. Sample Gas Systems Factor Overlay

APPENDIX A. SPECIFICATIONS FOR THE PREPARATION OF FACTOR OVERLAYS

Objectives and Design Elements Common to All Factor Overlays

A. Objectives

The objectives of this section are to establish the operational concepts for the production of factor overlays and to prescribe the design and formats for those elements and components common to all factor overlays.

B. Operational Concepts

1. Factor overlays are intended primarily for use within the mapping and intelligence community as quick reaction terrain products for distribution to the user.

2. Factor overlays provide formatted geographic data that can be retrieved and used in various combinations for terrain analysis and for production of special terrain products.

3. Factor overlays will be prepared in the form of stable base overlays that will accept photographic reduction to 70 by 105 mm and retain their legibility when enlarged back.

4. Normally each data field will require several factor overlays for each area. Data elements to be portrayed on each factor overlay, the symbology to be employed, and unique formats are specified separately for each data field.

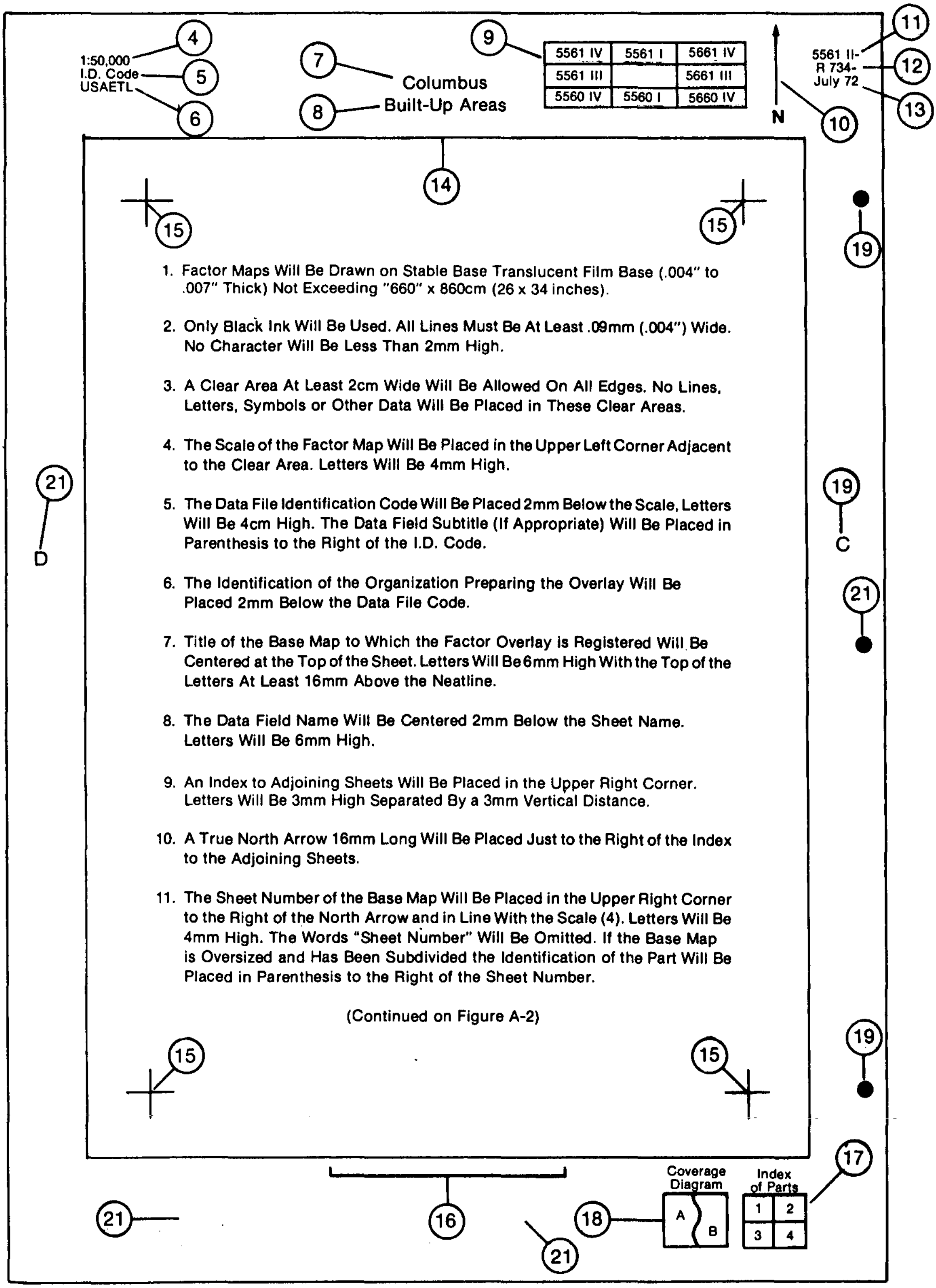
5. These specifications do not treat methods of collecting or reducing data. Their purpose is to specify the manner of graphically recording collected and reduced data.

C. Format

1. General format specifications are indicated in figures A1 through A4.

2. No single factor overlay will exceed 660 by 860 mm (26 by 34 inches), including titles, legends, and other marginal data. Where use of a base map exceeding these dimensions is desired, the base will be subdivided and separate factor overlays prepared for each part. When an oversized base is subdivided, each subdivision will be assigned identification and an index of parts prepared as per figures A1 through A4.

3. Whenever possible, factor overlays will be registered to a standard scale U.S. military map. Base maps other than U.S. military maps will be clearly identified in the upper right corner of the factor overlay.



1. Factor Maps Will Be Drawn on Stable Base Translucent Film Base (.004" to .007" Thick) Not Exceeding "660" x 860cm (26 x 34 inches).

2. Only Black Ink Will Be Used. All Lines Must Be At Least .09mm (.004") Wide. No Character Will Be Less Than 2mm High.

3. A Clear Area At Least 2cm Wide Will Be Allowed On All Edges. No Lines, Letters, Symbols or Other Data Will Be Placed in These Clear Areas.

4. The Scale of the Factor Map Will Be Placed in the Upper Left Corner Adjacent to the Clear Area. Letters Will Be 4mm High.

5. The Data File Identification Code Will Be Placed 2mm Below the Scale, Letters Will Be 4cm High. The Data Field Subtitle (If Appropriate) Will Be Placed in Parenthesis to the Right of the I.D. Code.

6. The Identification of the Organization Preparing the Overlay Will Be Placed 2mm Below the Data File Code.

7. Title of the Base Map to Which the Factor Overlay is Registered Will Be Centered at the Top of the Sheet. Letters Will Be 6mm High With the Top of the Letters At Least 16mm Above the Neatline.

8. The Data Field Name Will Be Centered 2mm Below the Sheet Name. Letters Will Be 6mm High.

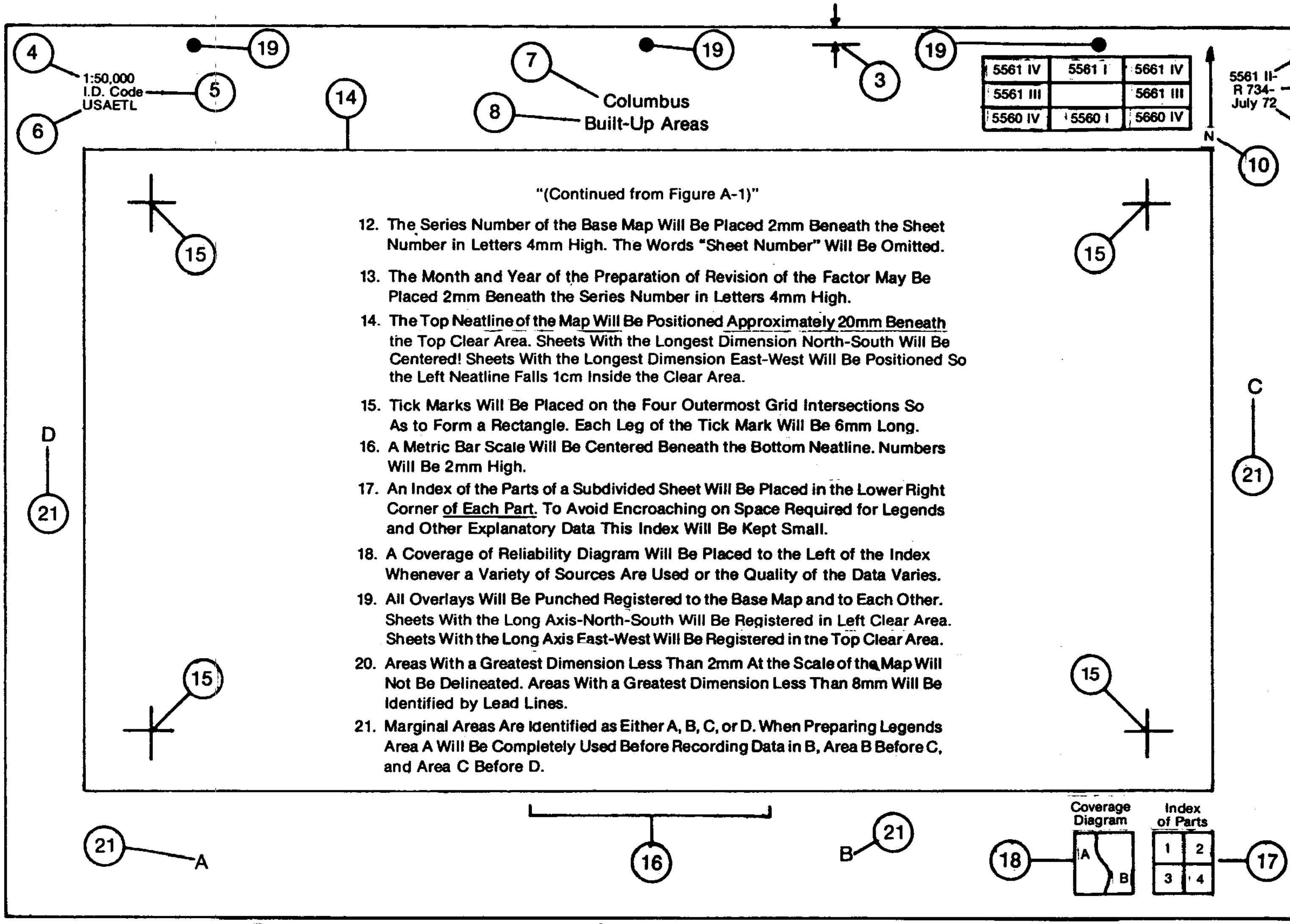
9. An Index to Adjoining Sheets Will Be Placed in the Upper Right Corner. Letters Will Be 3mm High Separated By a 3mm Vertical Distance.

10. A True North Arrow 16mm Long Will Be Placed Just to the Right of the Index to the Adjoining Sheets.

11. The Sheet Number of the Base Map Will Be Placed in the Upper Right Corner to the Right of the North Arrow and in Line With the Scale (4). Letters Will Be 4mm High. The Words "Sheet Number" Will Be Omitted. If the Base Map is Oversized and Has Been Subdivided the Identification of the Part Will Be Placed in Parenthesis to the Right of the Sheet Number.

(Continued on Figure A-2)

Figure A 1. Format for 1:50,000 Scale Factor Overlays With Long Axis N-S.



"(Continued from Figure A-1)"

12. The Series Number of the Base Map Will Be Placed 2mm Beneath the Sheet Number in Letters 4mm High. The Words "Sheet Number" Will Be Omitted.
13. The Month and Year of the Preparation of Revision of the Factor May Be Placed 2mm Beneath the Series Number in Letters 4mm High.
14. The Top Neatline of the Map Will Be Positioned Approximately 20mm Beneath the Top Clear Area. Sheets With the Longest Dimension North-South Will Be Centered! Sheets With the Longest Dimension East-West Will Be Positioned So the Left Neatline Falls 1cm Inside the Clear Area.
15. Tick Marks Will Be Placed on the Four Outermost Grid Intersections So As to Form a Rectangle. Each Leg of the Tick Mark Will Be 6mm Long.
16. A Metric Bar Scale Will Be Centered Beneath the Bottom Neatline. Numbers Will Be 2mm High.
17. An Index of the Parts of a Subdivided Sheet Will Be Placed in the Lower Right Corner of Each Part. To Avoid Encroaching on Space Required for Legends and Other Explanatory Data This Index Will Be Kept Small.
18. A Coverage of Reliability Diagram Will Be Placed to the Left of the Index Whenever a Variety of Sources Are Used or the Quality of the Data Varies.
19. All Overlays Will Be Punched Registered to the Base Map and to Each Other. Sheets With the Long Axis-North-South Will Be Registered in Left Clear Area. Sheets With the Long Axis East-West Will Be Registered in the Top Clear Area.
20. Areas With a Greatest Dimension Less Than 2mm At the Scale of the Map Will Not Be Delineated. Areas With a Greatest Dimension Less Than 8mm Will Be Identified by Lead Lines.
21. Marginal Areas Are Identified as Either A, B, C, or D. When Preparing Legends Area A Will Be Completely Used Before Recording Data in B, Area B Before C, and Area C Before D.

Figure A 2. Format for 1:50,000 Scale Factor Overlays With Long Axis E-W.

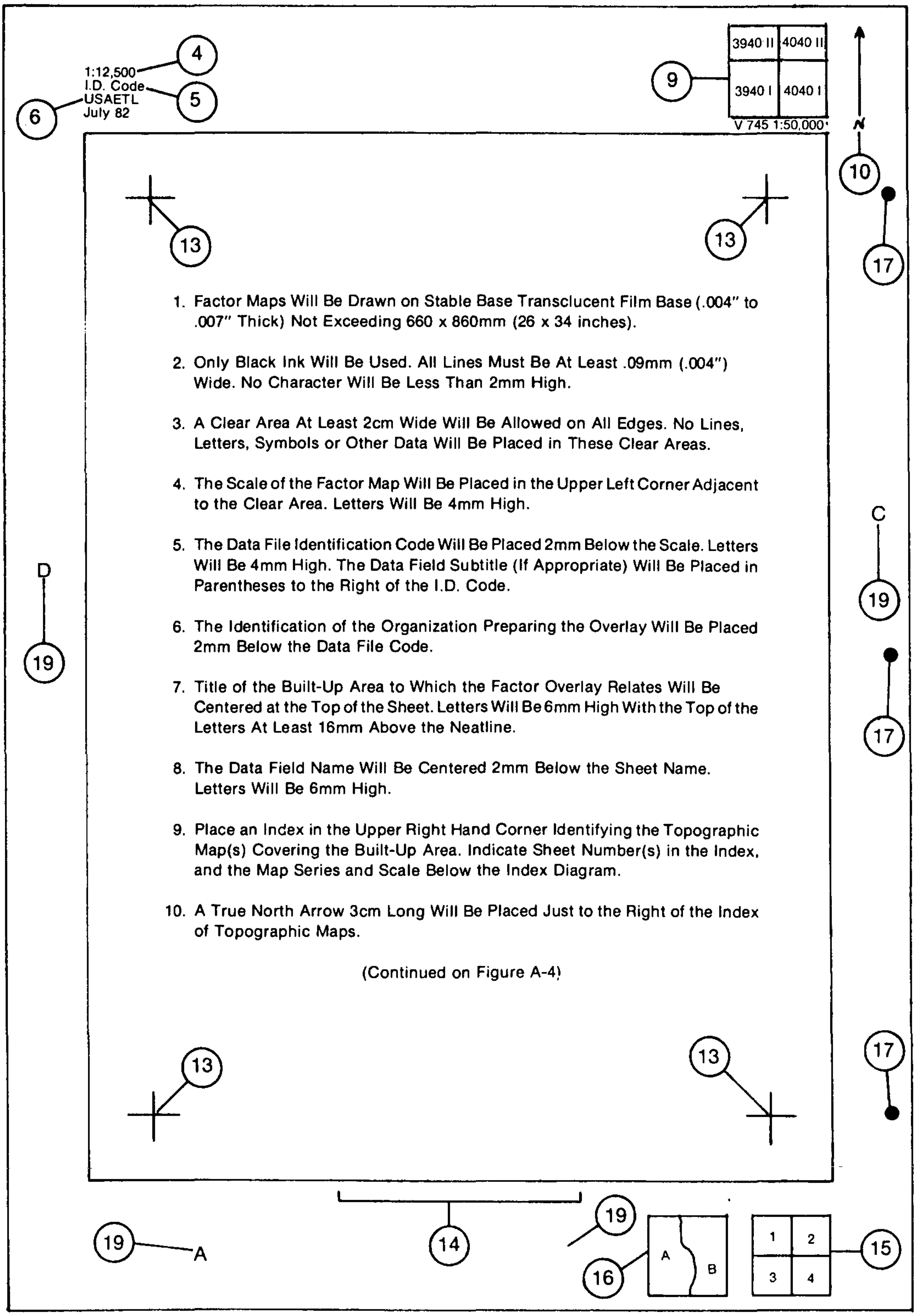


Figure A 3. Format for 1:12,500 Scale Built-Up Area Factor Overlays With Long Axis N-S.

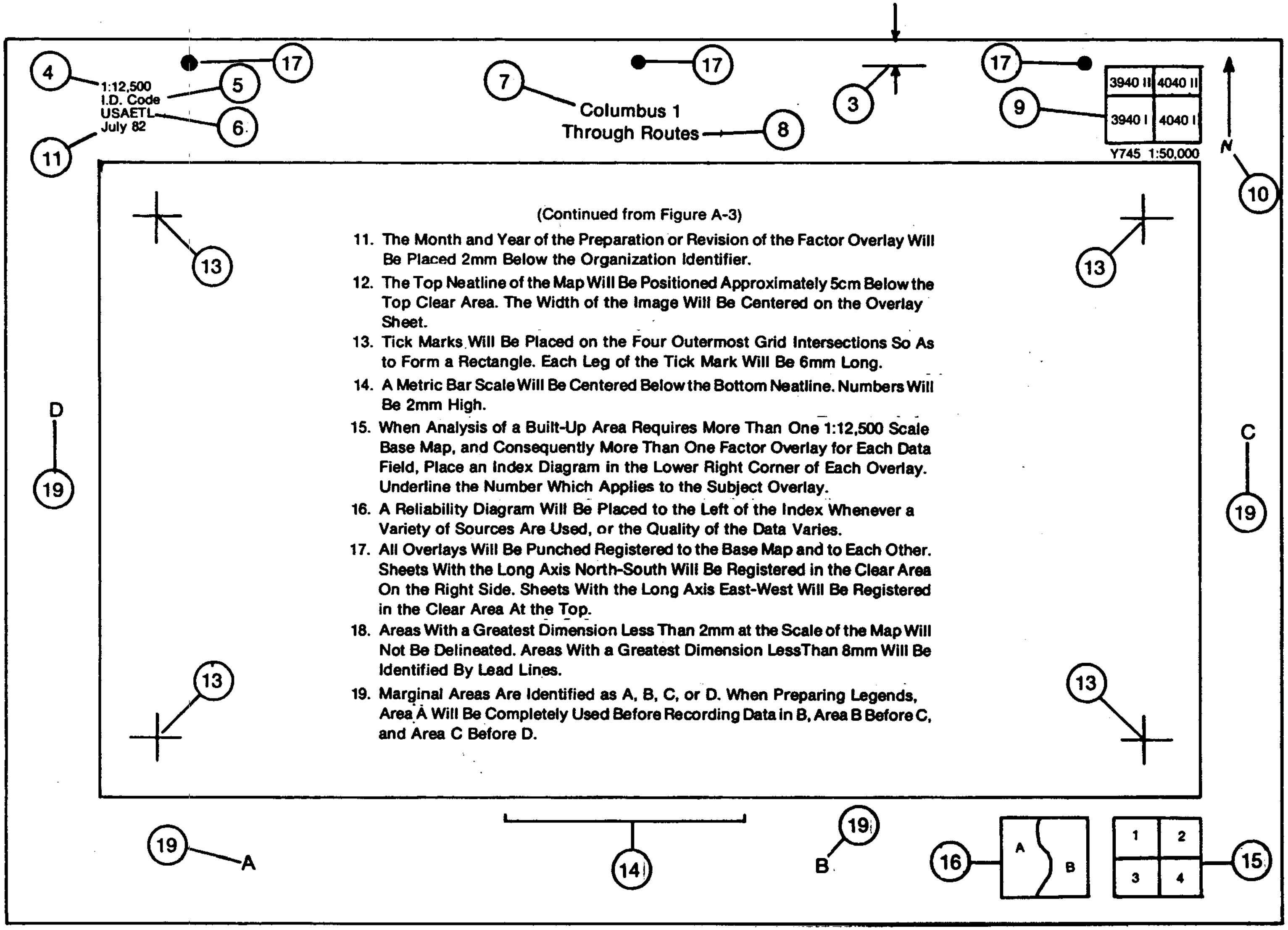


Figure A 4. Format for 1:12,500 Scale Built-Up Area Factor Overlays With Long Axis E-W.

4. Each factor overlay will be punch-registered to the base map at the four corners of the neat line.

5. A neatline 0.5 mm wide will be placed on each factor overlay. This neatline will normally coincide with the neatline of the base map.

6. Legend information will be placed on the areas identified as A, B, C, and D on figures A1 and A2 in that sequence. Area A will be used first, B second, etc. Where the legend is too large to be accommodated in the areas provided, it will be placed on a second piece of overlay material. This legend overlay will be prepared in the same format as the factor overlay and will bear the same identification data.

D. Symbolization

Symbols are specified separately for each data field. However, the following general guidelines will be followed:

1. All lines will be at least 0.09 mm (0.004") wide with a minimum spacing of 0.18 mm (0.008") between lines. When adjacent linear features would overlap if symbolized in their true position, the least significant feature will be displaced to provide the 0.18 mm clearance.

2. All letters will be at least 3.2 mm (0.125") high (elite typewriter type).

3. All letters, numbers, and symbols will be positioned so as to be readable from the bottom or right side of the sheet.

4. All symbols, letters, and numbers will be drawn in black (plastic for mylar sheets) ink or black "Prisma" pencil.

5. Areas with a greatest dimension less than 2 mm will not be delineated. Areas with a greatest dimension less than 8 mm (.32") will be identified by leadlines.

6. Tick marks will be placed on the four outermost grid intersections so as to form a rectangle. Each leg of the tick marks will extend 3 mm from the intersection. These ticks are required to permit addition of the grid during the reproduction process.

APPENDIX B. IMAGERY SOURCES

B1. Sources of Aerial Imagery

U. S. GOVERNMENT AGENCIES

Aerial Photography Field Office
Agricultural Stabilization and Conservation Service
Department of Agriculture
Western Laboratory
2222 West 2300 South
P. O. Box 30010
Salt Lake City, UT 84125

Defense Intelligence Agency
ATTN: DIAAP-10
Washington, DC 20315

Worldwide survey photography held by DMAHTC
6500 Brookes Lane
Washington, DC 20315

Bureau of Land Management
Department of Interior
Washington, DC 20240

Cartographic Archives Division
National Archives (GSA)
Washington, DC 20408

EROS Data Center
U. S. Geological Survey
Sioux Falls, South Dakota 57198

National Cartographic Information Center (Headquarters)
Geological Survey
Department of Interior
Reston, VA 22090

NCIC-Mid-Continent
USGS, 1400 Independence Road
Rolla, Missouri 65401

NCIC-Rocky Mountain
USGS, Topographic Division
Stop 510, Box 25046
Denver Federal Center
Denver, Colorado 80225

NCIC-Western
USGS, 345 Middlefield Road
Menlo Park, California 94025

National Ocean Survey
Department of Commerce
Washington Science Center
Rockville, Maryland 20852

Soil Conservation Service
Department of Agriculture
Federal Center Building
East-West Highway and Belcrest Road
Hyattsville, Maryland 20781

Tennessee Valley Authority
Maps and Surveys Branch
210 Haney Building
Chattanooga, Tennessee 37401

EASTERN US FOREST SERVICE PHOTOGRAPHY

Chief Forest Service
U. S. Department of Agriculture
Washington, DC 20250

WESTERN US FOREST SERVICE PHOTOGRAPHY

Region	
1	Federal Building, Missoula, MT 59801
2	Federal Center, Building 85, Denver, CO 80025
3	Federal Building, 517 Gold Ave., SW, Albuquerque, NM 87101
4	Forest Service Building, Ogden, UT 84403
5	630 Sansome St., San Francisco, CA 94111
6	P. O. Box 8623, Portland, OR 97208
10	Regional Forester, US Forest Service, P. O. Box 1628, Juneau, AK 99801

Technology Application Center
The University of New Mexico, Code 11
Albuquerque, New Mexico 87131

STATE AGENCIES

Arizona Highway Department
Administrative Services Division
206 South 17th Avenue
Phoenix, Arizona 85007

State of Arkansas Highway Department
Surveys, 9500 New Denton Highway
P. O. Box 2261, Little Rock, Arkansas 72203

State of Nebraska
Department of Roads
14th and Burnham Streets
Lincoln, Nebraska 68502

State of Ohio
Department of Highways
Columbus, Ohio 43216

Oregon State Highway Division
Salem, Oregon 97310

Virginia Department of Highways
Location and Design Engineer
1401 East Broad Street
Richmond, Virginia 23219

State of Washington
Department of Natural Resources
600 North Capital Way
Olympia, Washington 98501

Southeast Michigan
Council of Governments
1249 Washington Boulevard
Detroit, Michigan 48226

Illinois Department of Transportation
2300 South - 31st Street
Springfield, Illinois 62734

Southeastern Wisconsin Regional Planning Commission
916 North East Avenue
Waukesha, Wisconsin 53186

Wisconsin Department of Transportation
Engineering Services
4802 Sheboygan Avenue
Madison, Wisconsin 53702

Indiana Highway Department
608 State Office Building
Indianapolis, Indiana 46204

COMMERCIAL FIRMS

Aerial Data Service
10338 East 21st Street
Tulsa, Oklahoma 74129

Aero Service Corporation
4219 Van Kirk Street
Philadelphia, Pennsylvania 19135

Air Photographics, Inc.
P. O. Box 786
Purcellville, Virginia 23132

Alster and Associates, Inc.
6135 Kansas Avenue, NE
Washington, DC 20011

Ammann International Base Map & Air Photo Library
223 Tenth Street
San Antonio, Texas 78215

Burlington Northern, Inc.
650 Central Building
Seattle, Washington 98104

Cartwright Aerial Surveys, Inc.
Executive Airport
6151 Freeport Boulevard
Sacramento, California 95822

H. G. Chickering, Jr.
Consulting Photogrammetrist, Inc.
P. O. Box 2767
1190 West 7th Avenue
Eugene, Oregon 97402

Quinn and Associates
460 Caredean Drive
Horsham, Pennsylvania 13044

Sanborn Map Company, Inc.
P. O. Box 61
629 Fifth Avenue
Pelham, New York 10803

The Sidwell Company
Sidwell Park
28W240 North Avenue
West Chicago, Illinois 60185

Surdex Corporation
25 Mercury Boulevard
Chesterfield. Missouri 63017

Teledyne Geotronics
725 East Third Street
Long Beach, California 90812

United Aerial Mapping
5411 Jackwood Drive
San Antonio, Texas 78238

CANADA

National Air Photo Library
Surveys and Mapping Building
615 Booth Street
Ottawa, Canada K1A OE 9

B2. Sources of Ground Imagery

U. S. Army Imagery Interpretation Group
Bldg. 213, Washington Navy Yard
Washington, DC 20374

Defense Intelligence Agency
ATTN: RPP-3
Washington, DC 20301

U. S. Army DARCOM Service Support Activity
Audio-Visual Presentations Division
Room 1C13, Pentagon
Washington, DC 20310

Fairchild Aeromaps, Inc.
14437 North 73rd Street
Scottsdale, Arizona 85254

Grumman Ecosystems Corp.
Bethpage, New York 11714

Henderson Aerial Surveys, Inc.
5125 West Broad Street
Columbus, Ohio 43228

Walker and Associates, Inc.
310 Prefontaine Building
Seattle, Washington 98104

Western Aerial Contractors, Inc.
Mahlon Sweet Airport
Routh 1, Box 740
Eugene, Oregon 97401

L. Robert Kimball
615 West Highland Avenue
Ebensburg, Pennsylvania 15931

Lockwood, Kessler & Bartlett, Inc.
One Aerial Way
Syosset, New York 11791

Mark Hurd Aerial Surveys, Inc.
345 Pennsylvania Avenue South
Minneapolis, Minnesota 55426

Merrick and Company
Consulting Engineers
2700 West Evans
Denver, Colorado 80219

Murry - McCormick
Aerial Surveys, Inc.
6220 24th Street
Sacramento, California 95822

Photographic Interpretation Corporation
Box 868
Hanover, New Hampshire 03755

APPENDIX C. BUILT-UP AREA ANALYSIS USING THE ANALYTICAL PHOTOGRAMMETRIC POSITIONING SYSTEM (APPS)

In the near future, an Analytical Photogrammetric Positioning System (APPS) will be fielded in the Military Geographic Information Subsystem of the Topographic Support System (TSS). It is currently planned that an APPS with an attached plotter will be available to the terrain analyst in the Analysis Module of the TSS. The APPS is an ideal system for performing computer-assisted photographic measurements that are required and identfied in the Built-up Area (BUA) procedural guide.

It is not the intent of this appendix to fully describe the APPS in technical detail or to provide detailed instructions in the operations of the APPS. This appendix suggests those photomensuration operations that are most accurately and/or efficiently performed on the APPS when compared to older, conventional measuring techniques as used by the terrain analyst in performing BUA analysis. Specific APPS documentation and user training will be provided during delivery and deployment of the TSS. Also, a 5-day course in the use and operation of the APPS is offered at the Defense Mapping School at Fort Belvoir, Virginia.

Before briefly describing the APPS hardware and systems' initialization, it should be understood that, along with the required cartographic quality, stereographic aerial imagery, photo identifiable control points and information, and camera interior and exterior parameters are needed for operating the APPS. Presently the Defense Mapping Agency produces for the U.S. Military Establishment these stereo image pairs and cassette magnetic tapes containing the point positioning data bases (PPDB). The PPDB tapes contain the control point data and camera parameters. When these DMA image pairs and PPDB tapes are available for a built-up area that is to be analyzed, they should be used in the APPS for BUA analysis. When a DMA PPDB does not exist, but good stereo images and class A topographic maps are available, a highly experienced APPS operator may be able to use the APPS system by photo identifying and scaling map control information and by using camera parameters provided with the images. In this case, the APPS outputs will not be as accurate as when the DMA data are available, but will be adequate for most terrain analysis purposes. Also, there are techniques for transferring PPDB control point information to newer, reconnaissance aerial imagery. The newer imagery can then be used in the APPS for map revision and for the measurement of features that are not on the older, PPDB imagery.

The APPS is briefly described as a desktop type system consisting of a stereo viewing assembly mounted on a baseplate containing a data grid for accurate photo measurements with an electronic interface connecting the measuring assembly to the third main component, the calculator. A variety of calculators or computers may be used with this system. An optional add-on to the system for Army Topo applications is an HP 9872A Graphics Plotter. Other plo-ters can be used. Use of the plotter greatly expands the applications of the system.

A stereophoto pair is placed on the photoholders of the measuring assembly and oriented to the data grid by measuring four control points on each photo. The calculator, using the programs and data on the data base tape associated with the photos, converts grid measurements to photo measurements. After the photos have been oriented to the grid, the APPS operator may then measure in stereo as many points as he needs. From these measurements the true ground position of each measured point is computed. A direct coordinate output on the printer in standard Universal Transverse Mercator (UTM) coordinates or in the standard geographic latitude and longitude coordinates is produced.

Either way, the elevation of the point is computed at the same time. These coordinate outputs can be computed in any desired reference system by storing the right parameters on the tape. In addition to a direct printout of the position of each point, an operator may store these computed positions on the data tape for use in other programs. As an example, standard military tapes include an option to perform a datum transformation, converting local coordinates into the World Geodetic System coordinates, as well as an option to compute the distance and direction between points.[13]

From the foregoing description of the APPS hardware specific and implied functions, and from table C1 the terrain analyst can further organize probable applications of APPS technology for the analysis of BUAs. For all of the features listed in table C1, the location, UTM or geographic coordinates, can be determined with APPS.

To perform many of the BUA data extraction capabilities shown in table C1 will require that large scale photography 1:10,000 scale or larger, be used as input to the APPS. Most of the BUA data extraction uses shown in table C1 have not been confirmed at this date, but are noted as being highly probable uses of the APPS. The APPS is undergoing continual upgrading in both hardware and software. By the time of publication of the BUA procedural guide and this appendix, the APPS will have even greater capabilities than have been indicated in this paper.

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[13]William H. Revell, "Simplified Analytical Photogrammetry", Analytical Plotter Symposium and Workshop Proceedings, American Society of Photogrammetry, April 1980, pp. 347-353

TABLE C1. APPS Application for Built-up Areas Analysis

1. Roads and Related Features.

Roads - the widths, grades, constriction dimensions, and cut and fill heights can be determined.

Bridges and Overpasses - the length, width, and overhead clearances or heights can be determined.

Tunnels, Galleries, and Snowsheds - the length, width, roof height, and depth of overburden can be determined.

2. Ports and Harbors.

Navigational features - the location of lighthouses, beacons, and channel markers and the height and other dimensional information can be determined.

Related Structures - the width, length, and height of breakwaters, piers, drydocks, and associated buildings and structures may be determined.

3. Airfields.

Runways - the width, length, and forward and back azimuth can be determined.

Structures - can be determined, the dimensional characteristics can be determined.

4. Building Heights and Construction Material.

Buildings - the height of individual buildings and the delineation of areas of buildings of common height can be obtained; the UTM coordinates of the outlined areas of common height or for individual buildings can be determined.

Landmark or Industrial Structures - the length, width, height, and positional data can be determined for these features. Height and clearance measurements may be determined for overhead structures associated with industrial areas.

5. Vegetation.

Trees - the height, crown diameter, spacing, and positional (UTM) coordinates for grouped or isolated trees can be determined. UTM coordinates may be determined for the boundaries of grasses, scrub, and wooded areas.

TABLE C1. APPS Applications for Built-up Area Analysis - Continued

6. Watercourses and Water Bodies.

Open Water and/or Double-line Streams - stream widths and dry gap measurements can be obtained; bank heights, slope values, and cross section sketches can be determined along with UTM coordinates for the locations.

Special Features - height and other dimensional and positional information can be determined for special features, e.g., dams, locks, and levees.

APPENDIX D. GLOSSARY

BATCHING PLANT -- An assemblage of bins, conveyors, and weighing equipment arranged for the purpose of weighing the materials going into a batch of concrete.

BLOCK-TYPE CONSTRUCTION -- That type construction in which few or no gaps exist between buildings, e.g., business districts of large towns or cities.

BOUNDARIES -- The political or administrative boundaries of an urban area frequently do not coincide with the built-up area limits. In recording boundary data, care must be exercised to distinguish between the two.

BUILT-UP AREAS -- A built-up area is any group of buildings. Generally, built-up areas are concentrated into urban areas such as cities or towns, but there are nonurban built-up areas that include hamlets, farmsteads, rural schools, resort hotels, country estates, monasteries, and rural industrial installations. (See nonurban built-up areas and urban areas.)

CESSPOOL -- A lined or partially lined underground pit into which raw household wastewater is discharged and from which the liquid seeps into the surrounding soil. Sometimes called leaching cesspool.

CIVIL DEFENSE -- Civil defense in built-up areas not only includes the organization, manpower, and equipment available but also takes into consideration the existing and potential shelters that can be used in an emergency.

COMMERCIAL AREA -- A distinctive concentrated area of retail and wholesale establishments, financial institutions, office buildings, hotels, garages, public buildings, and light manufacturing plants.

COMPOSTING -- A method of refuse stabilization in which bacteria and other micro-organisms common to the soil ferment the organic matter to form humus, which is excellent for soil conditioning.

DETACHED OR SEMIDETACHED BUILDING AREAS - Areas of towns or cities in which the buildings are spaced relatively close together, e.g., residential areas with a high density of individual and duplex buildings.

DOWNTIME -- The time during which a machine, department, or factory is inoperative during normal operating hours (as for repairs or setting up or from lack of materials).

EFFLUENT -- Waste water, partially or completely treated, flowing out of a treatment plant.

ELECTRIC POWER -- Covers the availability of electric power to a built-up area. Aspects include power sources, generation and distribution facilities, connections with power networks, possible restrictions on use, and statistics on consumption.

FARMSTEAD -- Populated areas outside towns and cities usually consist of farmsteads and small settlements. A farmstead is the dwelling and adjacent buildings associated with an individual farm. The characteristics of a farmstead reflect the climate of the area and the type of agriculture. (See nonurban built-up areas.)

FUNCTIONAL AREA -- A segment of an urban area in which the greater part of the land is put to one type of use. Major functional areas are industrial, commercial, residential, transportation and storage, governmental-institutional, military and open.

GASHOLDER -- A large gastight cylindrical or spherical tank for storing combustible gases used as fuel. A "wet" gasholder consists of inner and outer tanks, the inner (and upper) one rising or falling depending on the volume of gas contained. A gastight seal between the two tanks is maintained by water or other liquid. A "dry" gasholder consists of a single tank with no liquid seal.

GAS SUPPLY -- Covers the availability of natural or manufactured gas to a built-up area. Aspects include sources, manufacturing and distribution facilities, gas pipelines serving the city, and statistics on consumption and use of bottled gas, liquified petroleum gas (LPG), and others.

GOVERNMENTAL-INSTITUTIONAL AREAS -- The grounds, structures, and facilities related to governmental administrative offices, hospitals, schools, colleges, homes for the aged or orphans, sanitariums, monasteries, and penal or research institutions, which form distinctive and generally extensive areas.

HEALTH AND SANITATION -- Urban health and sanitation not only includes statistics on the prevalent diseases, data on preventive measures, and an assessment of health problems, but also information on existing municipal sanitary regulations and their adequacy and enforcement.

IDENTIFICATION OF URBAN AREA -- An urban area may be identified by a variety of names (Florence/Firenze; Vienna/Wien; Prague/Praha; Bangkok/Krung Thep). For example, the English conventional name for the capital of the U.S.S.R. is MOSCOW; the native name romanized is MOSKVA; and the ideograph of the native name in cyrillic is MOCKBA. For some cities, alternate names are widely used (as in the case of Kinshasa which was long known as Leopoldville).

INDUSTRIAL AREA -- The grouping of individual plants and loft buildings which, together with grounds, limited storage, and transportation facilities, are normally associated with manufacturing activities.

ISOLATED HOUSING AREAS -- Includes villages, hamlets, suburban houses, and other small clusters of buildings that are surrounded by large open areas.

LANDMARKS -- Distinctive natural or manmade objects that stand out from the surroundings and serve as orientation points or that especially characterize the city.

LOCATION -- Large urban areas cover a considerable area, and precise location necessarily is arbitrary. The approximate center is usually a satisfactory reference point unless there is some well known distinctive landmark near the center that can easily be identified, e.g., U. S. Capitol, Empire State Building, Eiffel Tower.

METROPOLITAN AREA -- A region including the various settlements (suburbs) surrounding a large city, whose daily economic and social life is influenced by, or connected with, the central city.

MILITARY AREA -- An area containing structures and facilities for quartering, training, defense, hospitalization, and depots, vehicle parks, and repair facilities that are exclusively military.

NONURBAN BUILT-UP AREAS -- Nonurban built-up areas consist of farmsteads, small settlements, rural schools, resort hotels, country estates, monasteries, rural industrial plants, and similar installations. Generally, the same data tags that apply to urban built-up areas apply also to nonurban built-up areas, although not in every instance and in some cases to a lesser degree. FM 30-10 cites that the basic information requirements for nonurban areas should include: location, relation to local terrain features; size, area, population, pattern of streets or roads; facilities for quarters, maintenance and repair installations; predominant construction materials, and utilities. (See <u>built-up areas, urban areas</u>).

OPEN AREAS -- Land not occupied by buildings and not assigned to any industrial, transport, or business activity. Developed open areas include cultivated land, parks, recreation areas, cemeteries; undeveloped open areas include swamps, woods, beaches, and other vacant land.

OPEN COMPOSTING -- A method of refuse treatment that involves placing shredded refuse on the ground or on a paved area in piles or windrows. (See <u>composting</u>.)

POPULATION -- In recording the population of an urban area, care must be taken to specify the year of the figure, whether it is based on a census or an estimate, and the area encompassed by the figure (e.g., does it include suburbs, towns outside the city limit?).

PRESSURE COMPOSTING -- A method of refuse treatment that involves use of closed vessels or tanks through which the refuse is passed in a series of chambers or compartments under pressure and high temperatures. (<u>See composting</u>.)

PROPERTY RECORDS -- Access to the official city records is important to the maintenance of orderly administration. Data needed relates to location of records, identification of responsible authorities and established restrictions, and trespass prohibitions and rights.

RESIDENTIAL AREA -- An area consisting predominantly of dwellings interspersed with shopping centers, churches, schools, and fire, police, telephone, and power stations.

SANITARY LANDFILL -- A method of refuse disposal in which the refuse is buried by a covering of earth. A sanitary landfill employs compaction and covering of earth. A sanitary landfill employs compaction and covering of all refuse at the completion of each day's operation, with a final cover of 70 centimeters of earth after all filling operations are completed, which eliminates public health hazards and nuisances and is the reason for the successful operation, low cost, and widespread adoption of this method.

SEPTIC TANK -- A settling tank in which settled sludge is in immediate contact with the wastewater flowing through the tank and the organic solids are decomposed by anaerobic bacterial action.

SETTLING -- The process of subsidence and deposition of suspended matter carried by water, wastewater, or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material. Also called sedimentation.

SETTLING BASIN -- A basin or tank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter. Also called sedimentation basin, sedimentation tank, settling tank.

SEWAGE DISPOSAL -- Disposition of the liquid refuse of a built-up area. The three classifications of sewage handled by a piped system are domestic sewage (from residences, institutions, and business buildings), industrial waste (liquid resulting from manufacturing or industrial processes), and storm sewage (the runoff that occurs during or immediately after storms). In the absence of a piped system, property owners rely on septic tanks, cesspools, privies, or some means of collection.

SEWAGE GAS -- Gas resulting from the decomposition of organic matter in waste water, or gas produced during the digestion of sludge.

SEWAGE TREATMENT -- In treating sewage a variety of processes are used. Primary treatment is the first major (sometimes the only) treatment in a waste water treatment works, usually by sedimentation or the removal of a substantial amount of suspended matter but little or no colloidal and dissolved matter. Secondary treatment is the treatment of sewage after primary treatment (settlement), which involves biological oxidation. The trickling filter and the activated sludge process are the two principal methods of secondary treatment. BOD (Biochemical Oxygen Demand - a standard test used in assessing water contamination) removal of up to 90 percent is achieved by the most effective treatment installations. Tertiary treatment is the final treatment of sewage to further purify the effluent from secondary treatment, resulting in removal of more than 90 percent of BOD. This degree of treatment is unusual and is performed only where a very high degree of purity is necessary.

SEWERAGE -- A system of pipes or other channels to carry off sewage. Sewerage systems are classified according to the type of sewage they carry. (See sewage disposal.) Those carrying more than one type of sewage are combined sewers.

SIGNIFICANCE -- Evaluation of the significance of an urban area involves consideration of a number of factors. One city may be regionally important as a commercial market, another (not necessarily larger) may be both regionally and nationally important as an industrial center, a third could be an international transportation center.

SIGNIFICANT SUB-AREAS -- Built-up areas, even those of moderate size, can usually be segmented into significant sub-areas, each of which represents a particular activity or function. (See commercial area, functional area, Governmental-institutional area, industrial area, and residential area.)

SLUDGE -- The accumulated solids separated from waste water during processing, or the precipitate resulting from chemical treatment, coagulation, or sedimentation of waste water.

STANDPIPE -- In a building or structure, a fixed vertical pipe equipped with valved hose outlets, usually at each floor, to provide water for hose lines for firefighting.

STORAGE FACILITIES -- Built-up areas usually contain sizeable storage facilities in the form of sheds, warehouses, tanks or prepared open sites. A number of products must have specialized handling. Cement, for example, requires certain conditions; grain must be protected against rats and deterioration; and solid fuels present specific problems.

STREET PATTERN -- The basic arrangement of the streets of an urban area, whether regular or irregular. They generally tend to conform to rectangular, radial, concentric, or contour-conforming patterns.

STRUCTURAL FEATURES -- The construction characteristics of buildings according to materials, size and height, fire resistance, and architectural style.

TELECOMMUNICATIONS -- Facilities for telecommunications serving a built-up area include both local services and the position of the built-up area in the telecommunications network of the country.

TRANSPORTATION AND STORAGE AREA -- An area containing the terminal, the trans-shipment, storage, and repair facilities, and the quarters associated with general movement by rail, water, road, pipeline, or airway. Linear features of the transportation system are not included in the transportation area.

TROPOSCATTER -- A method of radio transmission in which radio waves are deflected from the troposphere back to a selected receiving station on the earth.

TYPE OF BUILT-UP AREAS -- Built-up areas may be categorized into urban and nonurban. (See built-up areas.)

URBAN AREAS -- An urban area is a concentration of structures, facilities, and population that forms the economic and cultural focus for some larger geographic area. (See built-up areas, nonurban built-up areas.)

URBANIZATION -- The trend of urban growth and development that is characterized by transition in the national economy from agricultural to manufacturing activities, increasing the proportion of the total population living in cities, and increasing the complexity of functions and activities in urban centers.