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THE UNITED STATES
STRATEGIC BOMBING SURVEY

(Pacific)

Evaluation of Photographic Intelligence in the Japanese Homeland

PART FOUR
URBAN AREA ANALYSIS

REGRADED UNCLASSIFIED 1113

PHOTOGRAPHIC INTELLIGENCE SECTION

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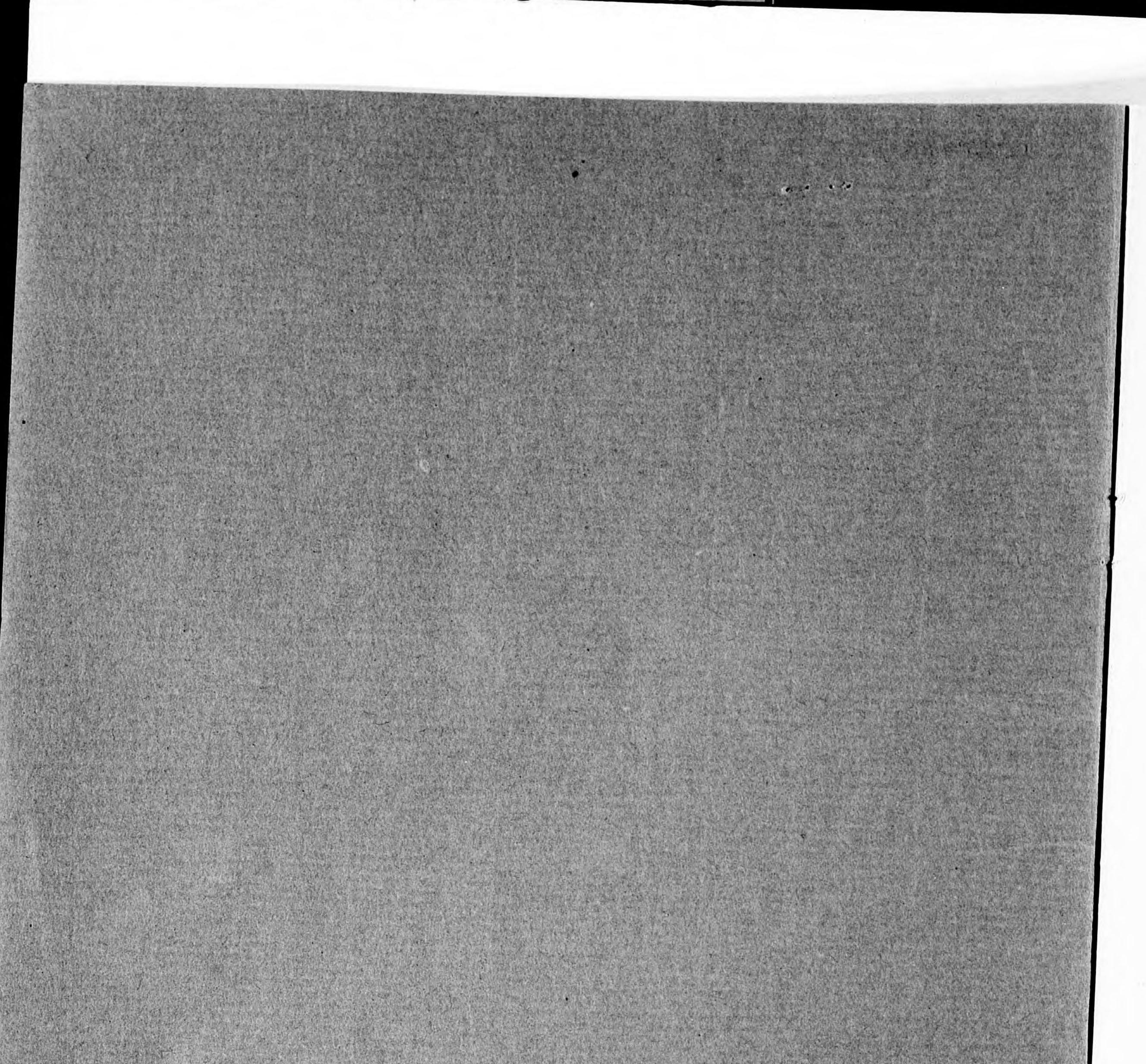
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Dates of Survey: 7 October 1945 through 15 March 1946

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JUNE 1946

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FOREWORD

The United States Strategic Combing Survey was established by the Secretary of War on 3 November 1944, pursuant to a Directive from the late President Roosevelt. Its mission was to conduct an impartial and expert study of the effects of our aerial attack on Germany, to be used in connection with air attacks on Japan and to establish a basis for evaluating the importance and potentialities of air power as an instrument of military strategy, for planning the future development of the United States armed forces, and for determing future economic policies with respect to the national defense. A summary report and some 200 supporting reports containing the findings of the Survey in Germany have been published.

On 15 August 1945, President Truman requested that the Survey conduct a similar study of the effects of all types of air attack in the war against Japan, submitting reports in duplicate to the Secretary of War and to the Secretary of the Navy. The officers of the Survey during its Japanese phase were.

Franklin D'Olier, Chairman.

Paul H. Nitze,

Henry C. Alexander, Vice-Chairmen.

Walter Wilds, Secretary.

Harry L. Bowman,

J. K. Galbraith,

Rensis Likert,

Frank A. Mckamee,

Fred Searls, Jr.,

Monroe Spaght,

Dr. Louis R. Thompson,

Theodore P. Wright, Directors.

The Survey's complement provided for 300 civilians, 350 officers, and 500 enlisted men. The military segment of the organization was drawn from the Army to the extent of 60 per cent, and from the Navy to the extent of 40 per cent. Both the Army and the Navy gave the Survey all possible assistance in furnishing men, supplies, transport and information. The Survey operated from headquarters established in Tokyo early in September, 1945, with sub-headquarters in Nagoya, Osaka, Hiroshima and Nagasaki, and with mobile teams operating in other parts of Japan, the islands of the Facific and the Asiatic mainland.

It was possible to reconstruct much of wartime Japanese military planning and execution, engagement by engagement and campaign by campaign, and to secure reasonably accurate statistics on Japan's economy and war-production, plant by plant and industry by industry. In addition, studies were conducted on Japan's overall strategic plans and the background of her entry into the war, the internal discussions and negotiations leading to her acceptance of unconditional surrender, the course of health and morale among the civilian population, the effectiveness of the Japanese civilian defense organization, and the effects of the atomic bombs. Separate reports will be issued covering each phase of the study.

The Survey interrogated more than 700 Japanese military, government and industrial officials. It also recovered and translated many documents which have not only been useful to the Survey, but will also furnish data valuable for other studies. Arrangements are being made to turn over the Survey's files to a permanent government agency where they will be available for further examination and distribution.

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COMPRENIE

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PHOTOGRAPHIC INTELLIGENCE SECTION, G-2*

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Lieut. Nicol Bissell, USNR

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Ist Lieut. A. W. Brock, AUS
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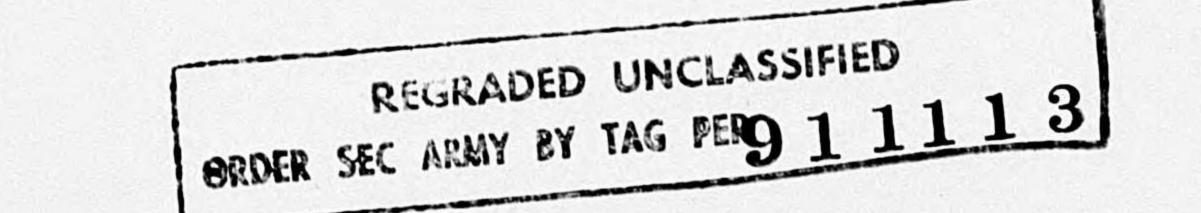
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W. H. McGowen, Ylc, USN

Personnel from the U. S. Naval Photographic Intelligence Center gave valuable assistance to USSBS personnel in the preparation and reproduction of Photographic Intelligence Section reports.

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INTRODUCTION

This report is concerned with urban area photographic intelligence procedures and consists of three sections. The first deals with the methods used by the Central Interpretation Unit, XXAF, by U.S. Navy Photographic Interpretation Squadron Two, and by the Joint Target Group. The second section consists of a detailed evaluation of both pre- and post-attack phases of urban area analysis on the basis of detailed field surveys. The third contains recommendations for the improvement and application of urban area analysis.

II URBAN AREA PHOTOGRAPHIC INTELLIGENCE METHODS

1. Central Interpretation Unit, XX AF -Urban area work at CIU was largely confined to post-attack damage assessment. Fre-attack work was limited to outlining an urban tar get area within the city and the numbered targets of the city (as assigned by AC/AS-2) on an unrectified enlargement of a pre-attack photograph. Sparsely built-up areas of the city were not considered part of the urban target area. A single building-density figure for the entire target area was obtained by casual visual inspection. Following the attack, outlines of damaged urban areas as well as building damage to numbered targets were plotted directly from post-attack photographs on the pre-attack enlargement and measured (on the enlargement) with a grid. Amount of damage was expressed in terms of ground area (usually in square miles) and also as a percentage of the urban target area.

- 2. Interpron Two Only a few post-attack assessments and no pre-attack studies were carried out by Interpron Two. Areas of damage were plotted and measured on post-attack photographs, and were then cutlined on small scale mosaics for distribution as illustrations with the report.
 - 3. Joint Target Group
 - a. Introduction

- (I) At the time JTi was organized there was no system of urban area analysis which could furnish the information required. It was necessary to develop new techniques which would not only supply this information, but which would produce satisfactory results with very little ground intelligence in a short time.
- (2) The time factor made it out of the question to consider conducting either the pre-attack or the post-attack analysis on the basis of actual measurement of buildings. In place of these time-consuming measurements a system of building-density assessment by visual inspection was developed.
- (3) The end result of these procedures was information on urban areas leading to economic assessment, and to proper determination of weapons, aiming points, force requirements, and weapon effectiveness. The analysis was broadly givided in two categories, pre-attack studies, and post-attack studies.
 - b. Pre-attack studies
 - (I) Zoning
- (a) Requirements To delineate zones in each selected urban area according to definitions established by JTG.
 - (b) Zone definitions
- L. Residential Zone R = Districts of predominantly residential occupancy, where such occupancy constitutes over 85 per cent of the total. These districts also include commercial and other public buildings, household (invisible) industry and isolated small factories or other small unidentified industrial facilities. This zone is to be divided into the following sub-zones:
- R_{\parallel} Fully built-up (building density 40% and over)
- R₂ Moderately built-up (building density 20-40%)

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 R_2 - Moderately built-up (build-ing density 20-40%)

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R2 - Sparsely built-up (building density 5-20%)

- 2. Industrial Zone I = Districts of virtually pure industrial occupancy, including large and medium size factories, together with adjacent administration and plant-site storage facilities. Public utilities (such as power, gas, water) also are included in this zone, but not transportation.
- 3. Mixed Industrial and Residential Zone - X = Districts of industrial and residential occupancy where industrial installations comprise about 50 per cent of total roof area. The following building types are considered as engaged in manufacture:
- a. Buildings and building complexes with chimney stack associated
- b. Buildings with roof ventilators

roof lights

d. Buildings with clerestory roof construction

- e. Buildings, in areas where buildings of types a, b, c or d occur, with roof cover area of at least 5000 square feet and associated in a complex with buildings of types a, b, c or d, or obviously not residential or public buildings.
- 4. Transportation Zone T = Districts devoted to repair, maintenance, operation and storage of railroad, trolley or bus systems, including yards, barns, repair shops, etc., but excluding manufacturing; also includes ferry terminals and waterfront transhipment facilities. Storage buildings devoted to goods for shipment and tracks are not to be included.
- 5. Storage Zone S = Structures devoted to any type of storage, including cil. Factory site storage and storage incidental to commercial activity are not to be included.

(c) Procedure - All available ground intelligence regarding the location and general function of all types of installations and areas in the selected urban areas was collected. Stereo examination of photographic cover of the urban areas was carried out in order to determine the general function of those installations and areas concerning which there was no ground information available. On the basis of this information the proper zone categories (sub-zone categories in the case of residential areas) were assigned, and were delineated on controlled mosaics in colors denoting the appropriate zone categories.

(2) Building density

- (a) Requirement Determination of average building density, or ratio of roof cover area to ground area, for each
- (b) Procedure It was found that this ratio, or average density figure for each zone could be obtained by a procedc. Buildings with north ure which utilized the ability of interpreers, trained in the technique, to recognize by inspection the percentage of roof cover in a given area. By combining this inspection with a system of random sampling using mathematical controls, the end result varied little from those results obtained by any time-consuming measurement process.

(3) Ground area

- (a) Requirement Determination of ground area for each zone.
- (b) Procedure The total ground area for each zone was determined by measuring the zone area outlines on the controlled zone mosaic, using a planimeter or transpar-

(4) Roof cover

- (a) Requirement Determination of area of roof cover for each zone.
- (b) Procedure The total roof cover of each zone was calculated by using the formula:

Roof cover area = ground area x building density

(5) Firebreaks

- (a) Requirement Determination of primary and secondary firebreaks.
- (b) Procedure Firebreaks were determined by making stereo examination of photographic cover of the urban area and noting streets, canals and other open spaces. Firebreaks were classed as primary, i.e., streets, canals and other open spaces exceeding 150 feet in width. and secondary. i.e., streets, canals and other open spaces 60-150 feet wide. The firebreaks were then marked on the controlled zone-mosaic, the primary firebreaks being indicated by solid lines and the secondary firebreaks by broken lines. These open spaces could not be large enough to conform to the definition of an "open area." An "open area" was defined as any open space whose area exceeds 500,000 square feet but which is not less than 500 feet on any one side. "Open areas" were left uncolored on the zone mosaics (Exhibit 6).

(6) Industrial activities

- (a) Requirement Determination of ground area, building density, and roof cover of industrial activities.
- (b) Procedure Industrial activities were defined as individual installations requiring analysis by virtue of their economic importance. They were treated in a separate phase of urban area analysis in order to provide a quantitative picture in terms of roof area of each industrial activity (e.g. Nippon Vehicle Co.) and of each industrial type (e.g. the aircraft industry). The industrial activities were outlined on a controlled mosaic, and the ground area of each was determined by measurement with a planimeter or transparent grid. The building density of each industrial activity was determined by the method of visual building density assessment and the roof cover obtained by using the formula:

Roof cover area = ground area x building density

The data thus determined for each industrial activity was transferred to individual punch cards for the tatulation of total pre-attack areas of each industrial type.

- (7) Industrial activities in residential zone
- (a) Requirement Determination of percentage of industrial activities in the residential zone, which by reason of their small size and dispersal could not be delineated on the zone map, and which because of the lack of identifying ground information, could not be tabulated with various industrial types in the industrial activities study.
- (b) Procedure In order to correct for this industrial element, studies were undertaken in which these small plants were located on photographs and their ground and roof area determined. These areas were subtracted from the residential zone total and added to the incustrial pre-attack zone

c. Post-attack studies

(1) Industrial damage

(a) Requirement -

- 1. Determination of location and amount of roof damage to individual buildings of each industrial activity and the preparation of a damage plot illustrating this damage.
- 2. The preparation of a report indicating roof area damage to each industrial activity.
- (b) Procedure Upon receipt of post-attack photography, stereo examination of the industrial activities in the urban area was conducted. New damage to individual buildings was marked on photographs. The damage plot was prepared by transferring details of the damage to a controlled mosaic on which the outlines of the industrial activity, and the previous damage to it, if any, had been marked (Fig 2). Assessment of the amount of damage was accomplished using the most convenient procedure, i.e., visual assessment or measurement, depending on the damage pattern within the industrial activity. A report of damage for each industrial activity was prepared (Fig I) and the data transferred to punch cards so that the total damaged areas of each industrial type could be determined.

FROM KOBE URBAN INDUSTRIAL DAMAGE REPORT NUMBER 2.2

PHOTO COVERAGE:

PRE RAID 3PR/5M19 2V 85-89 20 Jan 45 POST RAID 3PR/5M279 2V 15-17 10 June 45 3L 19-22 10 June 45

ANNOTATION NO.	% DAMAGE	REMARKS
1	45	
		30% demolished, 15% destroyed - burned out areas adjoin
2	50	Demolished . W & SW
3 A	75	60% demoliched
38	30	60% demolished, 15% destroyed Demolished
2 3 A 3 B	75 30 70	Buildings also
	, ,	Buildings along west edge of the yard demolished - one section
5	92	of island platforms to the S destroyed
7	18	DOMOTISHED - INTER DILLIGIAGE HERE:
8	70	12% demolished. 64 destroyed
9	10	Demotished
10	50	Demolished
11		Demolished
12	60	Demolished
13	65	No visible damage - bounded on N, E & SW by burned out areas
14	65	Demolished out areas
15	66	Demolished
16	80	Destroyed
17	5 75	Demolished
18		55% demolished, 20% destroyed
19	88	TO DECIDE ISHED 190 doc+
19	60	Building area along S side destroyed; island platforms to N
20		remain remain
20	95	Demolished - burned out areas vivia.
21	97	77% demolished, 20% destroyed
22	20	5% demolished, 15% destroyed
24	18	5% demolished, 13% destroyed
25	96	80% demolished 13% destroyed
		80% demolished, 16% destroyed - two small buildings at
26	50	extreme Sw boundary remain
		35% demolished, 15% destroyed - cluster of buildings
27	15	comprising S half of target are undamaged Demolished - this includes only small buildings 55% destroyed. 11% demolished
28	66	55% destroyed ins includes only small buildings
29	65	55% destroyed, 11% demolished
30	85	JON GESTIONED. 15% DOMOTICES
31		35% demolished, 50% destroyed
32	35 10	Dellio i i Shed
28 29 30 31 32 33	90	Demolished
	70	Demolished - one "L" shaped, reinforced concrete building
34		remains building
		No visible damage to large building but surrounding storage
36		yard damaged storage
36 37	0.5	No visible damage
40	85	Demolished
41	100	Demolished - burned out areas adjoining to N, W & S
42	17	
43	100	Demolished
84	88	Demolished - burned out areas to E & S
85		
86	20	Destroyed
	100	Demolished - burned out areas adjoining on all sides
URE 1		The second secon



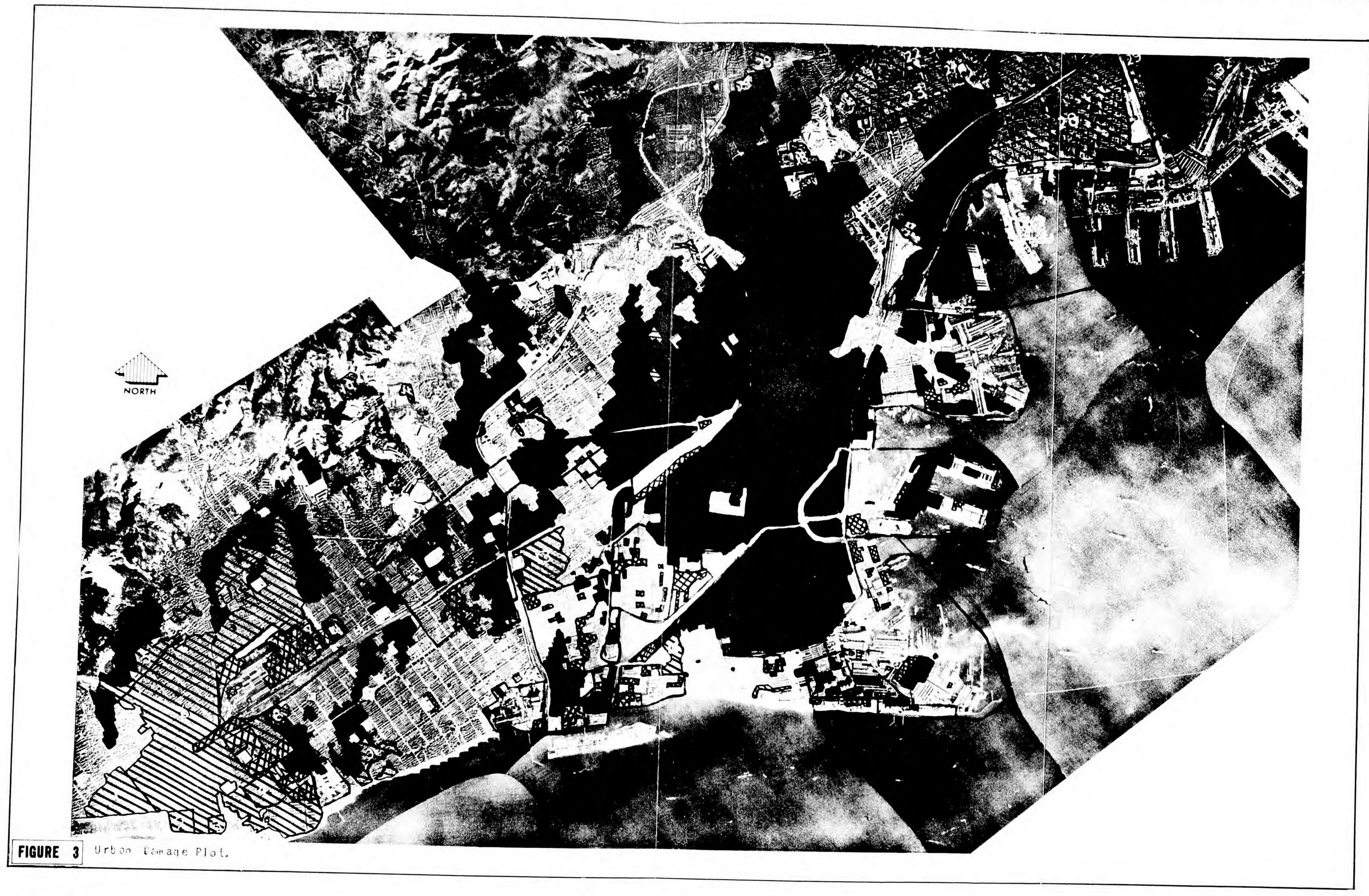
From Kobe Urban Industrial Damage Report Number 2.2





. From Kobe Urban Industrial Damage Report Number 2.2

7.00



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PHOTO INTELLIGENCE SECTION
EVALUATION BRANCH
PHOTOGRAPHIC DIVISION
AC/AS INTELLIGENCE

SUMMARY REPORT URBAN AREA DAMAGE ANALYSIS TARGET - KORE

Q	JRRENT R						CII	RRENT	DAMAGE	(AR	EAS II	TARGE	T - KOB)												
DATE	U/DA #	OF	MI SSION NO. (S)					NKENI	DAMAGE							CUMULATI	VE DAMA	G E				%	CUMU L TO TAL	ATIV	E DA	MAGE		
		ATTACK		Ground	RI	R2	R3	М	X	T	S	TOTAL	k1	€2	R3	M	X	Ť	S	TOTAL	RI	R2			AIIA	CK AR	EAS	
	PREVIO	US A	TACKS	Area Roof									53.4	5.0	-	6.9	0.9		2.8	80.0	39	6	R3		X		S	TOTAL
26 JULY 1945	2.2			Ground Area	44.6	30.1		10.0					31.6	2.5		3.2	0.4	0.1	1.2	39.0	39	0		16	6	-	15	22
1945				Roof	23. 4	11.9	4.0	10.3	2.5	•	3.4	94.9	108.0	36.1	4.0	17.2	3.4		6.2	174.9	67	39	21	10	23	6 20	32	25
				Ground Area			1. 1	4.3	1.1	0.6	2.0	44.4	55.0	14.4	1.1	7.5	1.5	0.7	3.2	83.4	69	51	35	3 9	20	39	31	53
				Roo f Area																						•		3.5
				Ground Area																								
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				Ground Area																								
				Roof Area																								
				around Area																								
				Roof Area																								
			6	round Area																								
				Roof Area																								
R ₁ - R	esi denti	al (Ful	ly Built						T	OTAL PI	RE-ATTAC	CK AREA	S															
R ₂ - Re	sidentia	1 (Mode	ratel v Bi 20% - 40%	uilt	70N F				,																			
3 - Ke	sidentia	I (Spar	sely Buil 5% - 20%)	t Up:	ZON E GROUN D		RI	R	2	R3		M	X		T	S		TOTAL										
- Man	ufacturi	ing		ntial)	AREA	16	6 1. 5	93.	1	19.0	4	3.2	15.0		19.4	19.	2	370.4										
	nsportat				% B.U.		49.2	30.	3	16.3	4	4.9	50.0		9.3	53.	6	40.4										
- 310	aye		FIGURE	4	ROO F AREA	7	9.5	28.	2	3. 1	I.	9.4	7.5		1.8	10.		149.8										

(2) Urban damage

(a) Requirements - Determination of location of all areas and instances of damage in each zone, preparation of damage plot illustrating this damage, and preparation of a report indicating the ground and roof areas by zones, including industrial activities in terms of the following: preattack; previous damage, if any; new damage; and cumulative damage.

(t) Procedure - Stereo examination of the post-attack photography was carried out in order to locate and plot on the photographs all areas and instances of new damage in each zone excluding as far as possible the larger streets, canals, and open spaces. The damage plot was prepared by transferring this damage to a controlled mosaic. In order to give a cumulative presentation of damage in the urban areas, previous areas and instances of damage if any were also transferred to the mosaic from previous damage plots. Previous damage was differentiated from new damage by blocking in areas of previous damage in solic black, while new areas of damage were ingicated by hatching. To complete the damage

plot, previous damage and new damage to selected industrial activities were also marked on the mosaic in solid black and single hatching respectively (Fig 3). The assessment of the amount of damage in each zone was accomplished by measuring on the mosaic the ground area of each instance of damage. Roof cover camage figures were then obtained by multiplying the ground area measurements by the preattack building density figure for each damaged area. A correcting factor for the damage to industrial activities in the residential zone was made on the basis of pre-attack studies (11 3b(7). A report was prepared including this information (Fig 4).

III EVALUATION OF METHODS AND REPORTS

1. Fre-attack studies

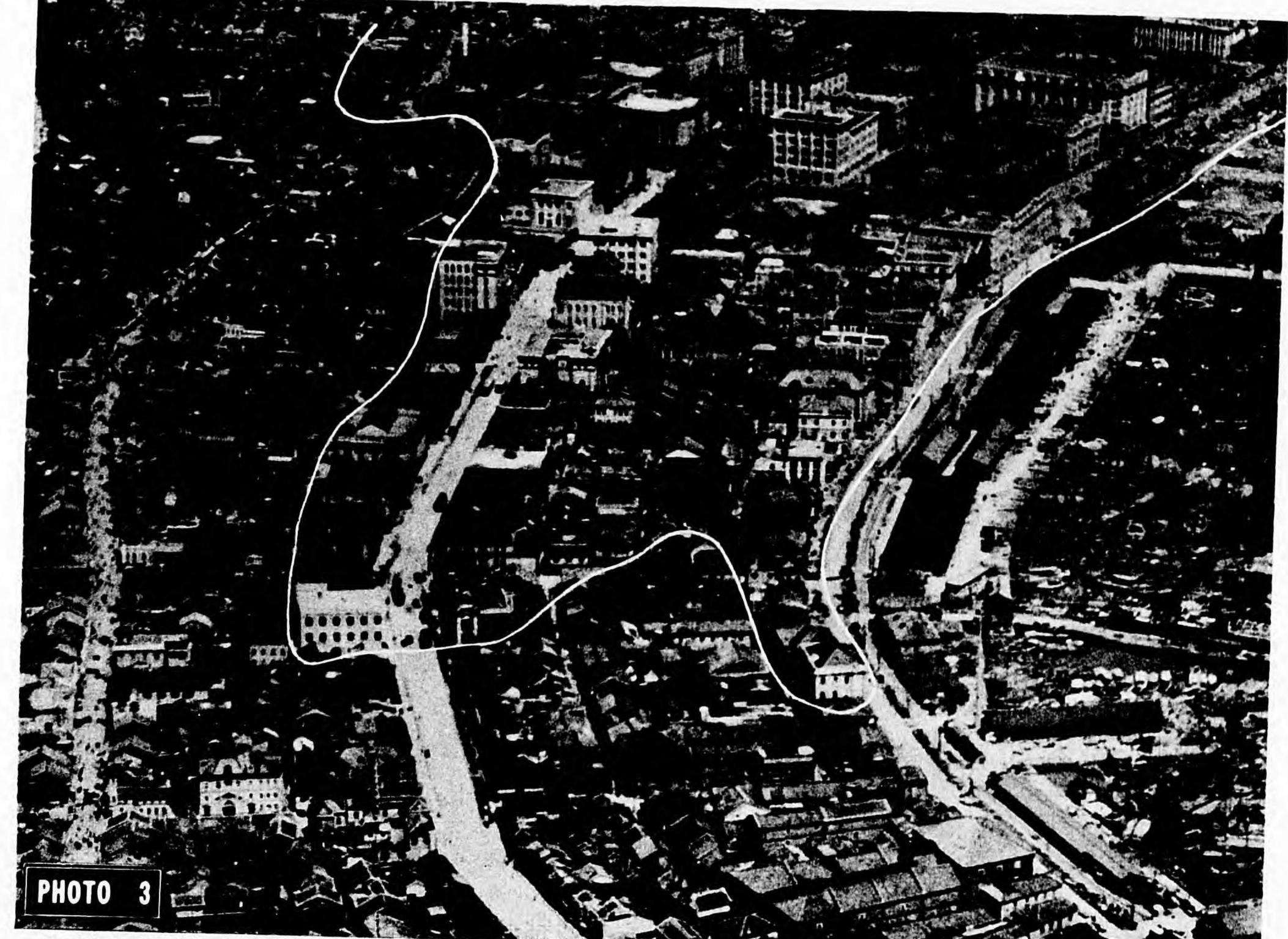
a. Introduction - Field evaluation of the urban area photographic intelligence program was concerned with the examination of undamaged areas in Tokyo, Kobe, and Osaka, in addition to the entire undamaged city of



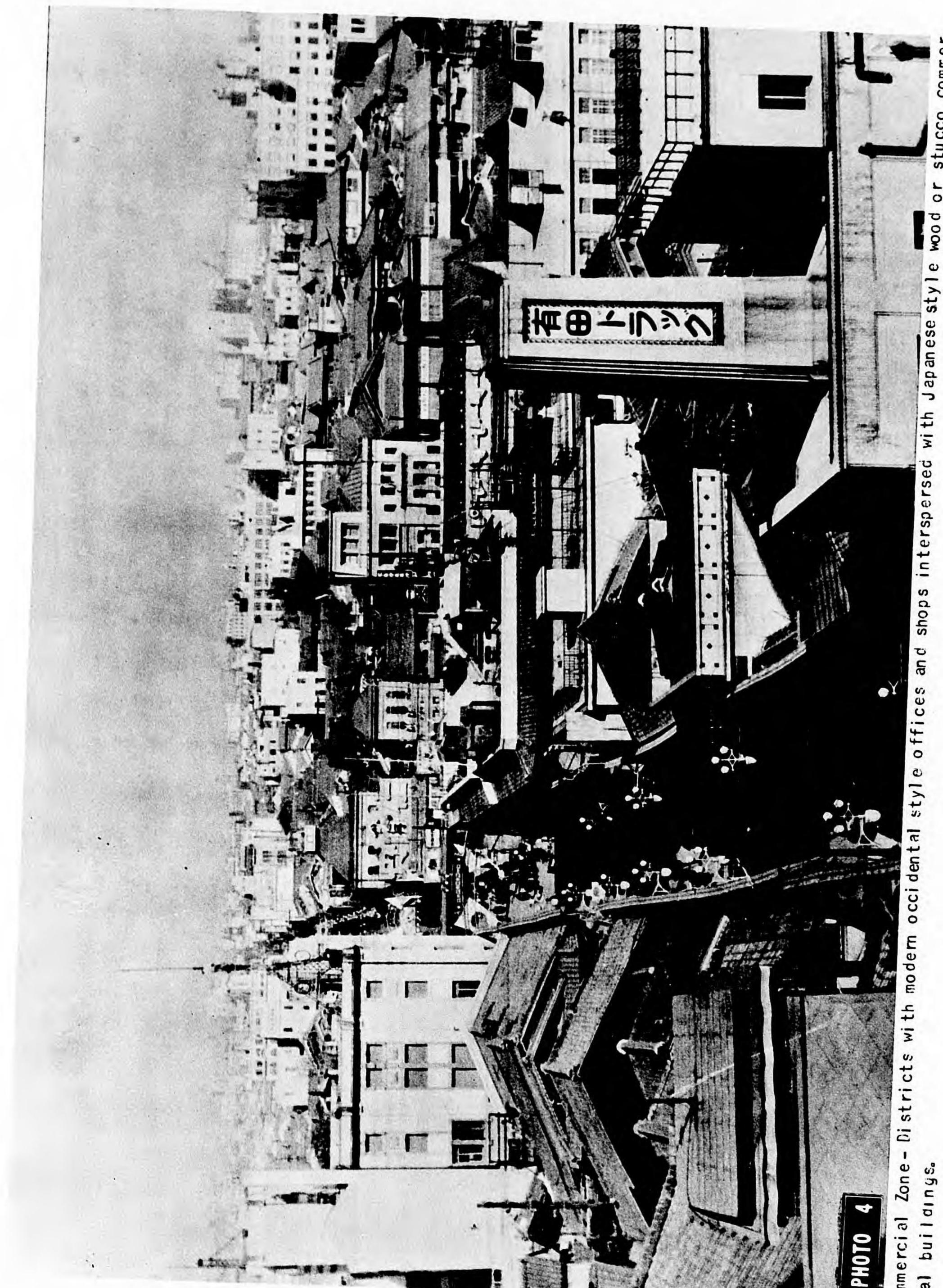
Residential Zone kI - Congested wooden houses with small home industries and shops interspersed - Note tile roofs and high building density.



Residential Zone RI - Example of better type residential area with high building density.



kesidential Lone RI - Typical central town residential area. Line indicates differentiation between districts of predominantly residential and commercial types.



of photographic intelligence in the analysis of urban areas, and to investigate the possibility of improving methods of urban area analysis. The following field work was completed.

- (1) Determination of contents of areas delineated as zones according to the JTG zone definitions.
- (2) Determination of building characteristics for photographic identification of occupancy type.
- (3) Examination of the structural content of Kyoto.
- (4) Investigation of the accuracy of the method of determining building density by visual inspection.
 - b. Zones of occurancy
 - (1) Residential zone (R)
- (a) Sub-zone RI (Building density 40% and over) - Examination of samples of this sub-zone showed that it contained (I) congested wooden bouses in a poor state of repair with small home industries and shops interspersed, and with roofs almost invariably of Japanese heavy tile (Photo I); (2) wooden row houses in better condi-

tion, with some shops and fewer small home industries, the roofs again consisting of heavy tile; (3) a few stucco type buildings, also with heavy tile roofs; relatively few occidental type residential buildings of brick or stone; and (5) areas of commercial occupancy with modern occidental style offices and shops, sometimes interspersed with wood or stucco commercial puildings of Japanese design (Photo 4). The Joint Target Group did not require the differentiation of districts of predominantly residential occupancy from commercial areas. It was found, however, that not only were the two types of occupancy sharply defined, but also that the structural content of the buildings in the two types of districts differed greatly. It is evident that separation of commercial districts from residential districts is possible by correlation of photographic intelligence and adequate ground intelligence (Photo 3).

(ii) Sub-zone R2 (Building density 2C-4C%) - Examination of samples of this sub-zone showed that it contained (1) wooden row houses of better type than those contained in R₁, with some shops interspersedalmost all with tile roofs; (2) detached wooden residences, with a few stucco buildings among them (Photo 5); (3) a very small



Residential R2 - Suburban - Detached wooden houses - Building density about 25 per cent.

number of occidental type brick or stone residences; and (4) a few small occidental style commercial buildings.

- (c) Sub-zone R3 (Euilding density 5-20%) Examination of samples of this sub-zone showed that it contained (1) detached houses of much better type than those usually found in N₁ and R₂, largely of wood-framed construction with wood facing, and usually with clay tile roofs, although a few were thatched; and (2) a very small number of detached brick houses. There was no evidence of the numerous small sheds which exist in the more congested residential areas.
- (d) The delineation of the residential zone was found to conform with the JTG definition of the zone content.
- (2) Mixed zone (λ) In order to check how satisfactory the determination of industrial buildings, and consequently the delineation of the mixed zone had been, two sample mixed zone areas were examined in considerable detail on the ground and several others were examined generally (Photo 6). Particulars of the two detailed ground checks are given in Tables I and 2 and Figs 5 and 6 It was found that the determination of industrial buildings had been satisfactory. Even the smallest buildings with roof ventilators

were found to include small industrial concerns, frequently manufacturing products of considerable importance such as tank treads, electrical accessories and component parts for many vital war products. The decision to rate buildings over 5000 square feet with flat roofsorJapanese residential type roofs as industrial turned out to be justified, though in a few cases they were found to house dormitory accommodations for factory workers. A few examples were found of very small residential type buildings housing important production such as the manufacture of bolts and screws. Keference to Tables 2 and 3 shows that the ratio of residential to industrial property, based on a comparison of roof cover area, was very close to the theoretical 50:50 in the two mixed zone areas examined in detail. In area I the residential buildings comprised 51 per cent of the total buildings in the area, and the industrial buildings 49 per cent of the total. In area Il residential buildings accounted for 46 per cent of the total, and industrial buildings for 54 per cent of the total. In these two areas all tuildings were allocated to one of the two categories - industrial or residential. Thus offices which were usually associated with manufacturing concerns were termed industrial, and schools and dormitories were classified as residential.



Mixed Zone - Mote the manner in which small factories are interspersed with houses.



Mixed Zone - Area I Tokyo

Urban Area Photographic Intelligence

Ground Check of Mixed Zone Content - Area I TOKYO

ing No.	Occupancy determined by ground check R *	Roof Area in grid square units	iny No.	determined by ground check	Roof Area in grid squar units	ing	Occupancy determined by ground check	Roof Area In grid square units	ing	Occupancy determined by ground check	Roof Area in grid Square Units
2	h; **	18	43	k	17	25	Ř	22	240	М	17
3	Ŕ	25	.44	R	9	27	M	30	241		17
4	M	15	45	R	4	88	k	12	242	N D	13
5	K		46	M	27	201	R	12	243	R	25 27
ô	M	9	47	M	24	202	ĸ	. 20	244	М	
7	R		48	R	33	203	ď	11	245	R	4
8	R	4	49	R	33	204	À	6.	245	k	8
9	М	10	50	M	55	20 5	R	10	247	М	12
10	R	13	51	R	17	203	M	98	249	k	4
11	M	6	52	ñ	3	207	, i	17	247	ı,	10
12	R	10	53	Mi	6	208	R	20	25C	F.	21
13	М	9	54	ń	14	209 .	N	28	251	N:	
4		134	55	K	15	210	R	6	253	f.	25 36
15	R	32	56	R	10	211	M	21	254	R	12
5		13	57	R	10	212	М	40	255	R	•
7	R	8	58	М	104	213	ñ	4	256	N:	12
8	h	20	59	Ŕ	39	214	h .		258		20
9	n D	ĵ .	60	.R	40	215	R -	-	259	11	40
	. R	3	61	M	24	213	ƙ		260	R	24
1	M	15	62	R	20	217	R		23 1	M	55
2	M	8	63	М	6	2 18	ĥ		232		
	n p	4	34	M	8	2 19	Ř		253	R	<u>8</u>
	R	9	65	M	136	220	R	0.1	264	â	33
	М	-	66	Ŕ	9	22 1	R		264A	R	27
	P1	9	67	Ŕ	13	222	Ř	12	265		70
	ν		68	R	17	223	R	10	263	K	
	R		69	M	28	224	R	10	37	R	37
			70	M	21	225	R		38	M	17
	N N		71	M	18	223	K		59	М	6
-	M		72	ĸ	4	277	K		70	N	
_	R		73	Ŕ	4	228	k	155 2		M;	20
-	K M		74	М	lô .	229	M		72	Ni Ni	18
	M		75	R	9	230	М		73	М	
			77	ƙ	4	231	R		4	L	77
	k .	2229	9	R	5	232	R		5	ñ	13
	M		9	Ř	6	233	R	25 27		R	16
	R	6 8		R	8	234	R	23 27		Ŕ	38
		10 8		1	4	35	R	103 27		Ř	13
	Ř	4 8	2	K	7	36	h	11 27		R	15
	k	5 8.		Ř	12 2	37	N	18 28		М	
	R	9 81		R	6 2	38	М	43 28		D -	10
	K	13 8	5	R	2	39					10

^{*} R - Residential occupancy.

** M - Industrial occupancy.

Total Residential Roof Cover Total Industrial Roof Cover Total Roof Cover in Area I

Residential Roof Cover - 51% of total roof cover in Area I Industrial Roof Cover - 40% of total roof cover in Area I



TABLE 2 Urban Area Photographic Intelligence Ground Check of Mixed Zone Content - Area II TOKYO

Build- ing No.	Occupancy determined by ground check	in Grid Square Units	ing	Occupancy determined by ground check	hoof Area in Grid Square Units	Euild- ing No.	Occupancy determined by ground check	Roof Area in Grid Square Units	Build- ing No.	Occupancy determined by ground check	Roof Area in Grid Scuare Uni
2	R	13	43	N.	18	85	26	120			
3	R	12	44	R	41	83	h		10.7	10	18
4	R	17	45	R	12	87	k	15	128	in	53
5		/	46	M	27	83	R	13	129	Ε.	46
6	R	15	47	M	114	63	Ŕ	15	130	k	15
7		12	48	М	37	90	М		131	16	8
8	Ñ	7	49	R	12	91	М	109	132	M	24
	h	32	50	M-	39	92	k		133	K	30
9	R	34	51	k	3C	93	R	53	134	М	19
10	R	18	52	М	15	94		8	135	М	9
11	M **	46	53	M	13	95	M M	129	136	Ř	18
12	M	121	54	М	38	95			137	14	39
13	7	15	55	2	42	97	h k	21	138	R	50
14	R	4	56	Ř	16	98	R	21	139	Ni Ni	147
15	- 1	2	57	R	33		- 11	40	140	<u></u>	51
16	R	20	58	R	27	99	K	31	141	M,	ôl
7	F	15	59	Ŕ	27	100	- 1	12	142	Ni Ni	72
18	R	42	30	R	33	101	-!-	91	143	i.	12
19	М .	20	31	fri .	57	102	K	31	144	1	13
20 .	K	14	52	ĸ		103	h	22	145	Ĭ.	31
21	M	27	33	k	21	104	и	43	146	i.	39
22	M	36	34	14	15	105	K	74	147	r	15
23	M	16	35	м .				14	145	M.	52
24	R	13	65	M	13	107	M	IC	146	г.	÷5
25	R	31	57	M	220	108	М	33	150	Ŕ	+2
25	R	12	38	11	339	F31	K	24	151	ň	27
27	M	90	39		3 17	110	,	ç	150	3	25
28	M	100	7C	R	34	111	ń	27	15.1	n	34
29	M	38	71		- 9	112	М	111	152	ň	45
30	M		72	M		113	R		163	ñ	j
31	М		73	L	- 75			38	164	'n	3
32	k	32				115	M		135	Ř	58
33	M	_	74	R	24		^	35	133	Ř	38
34	ĥ		75			1 17	٨	55	167	ń	18
35	M	15	77	- K		18	ñ	24	158	K	S
36	К		8	M	100	10	K	28	135	R	14 -
37	k		79	M.		20	Κ	41	175	ń	15
38	М	12 8				21	М	127	71 6	(School)	508
39	М	uo cu		,		22	M		72	R	
4C	М	0		M	- 1	23	М	37	73	n n	26
41	R	-		M	112	24	M	25	74	h	17
42	Ř			h	- H-	25	R	24	75	6	
		27 84	•	M	72 13	23	'n	25	";	H	15
									77	R	
3.									/		13

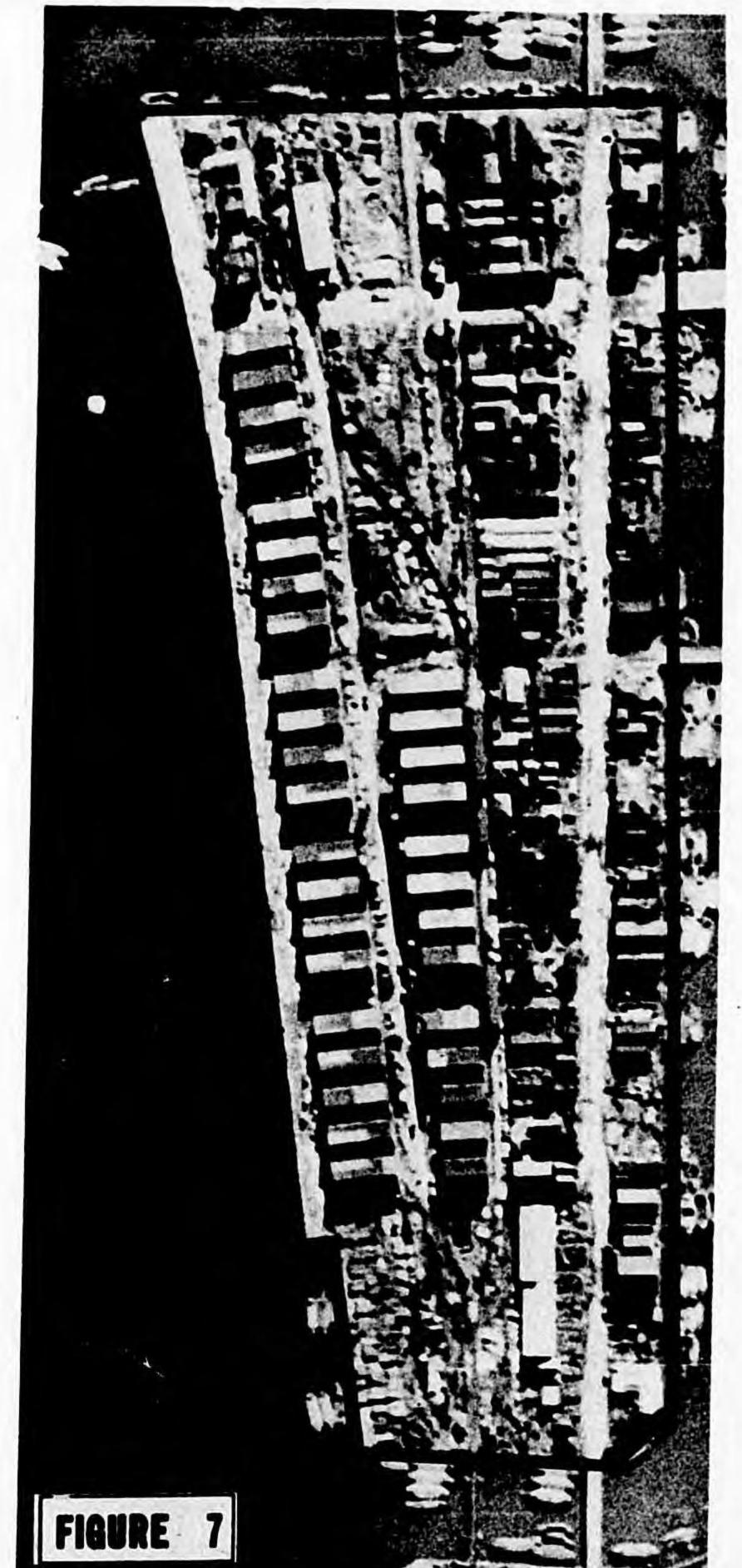
R* - Residential occupancy.

M** - Industrial occupancy.

Total kesidential koof Cover - 3355 Total Industrial koof Cover - 4008 Total Hoof Cover in Area 1 - 7474

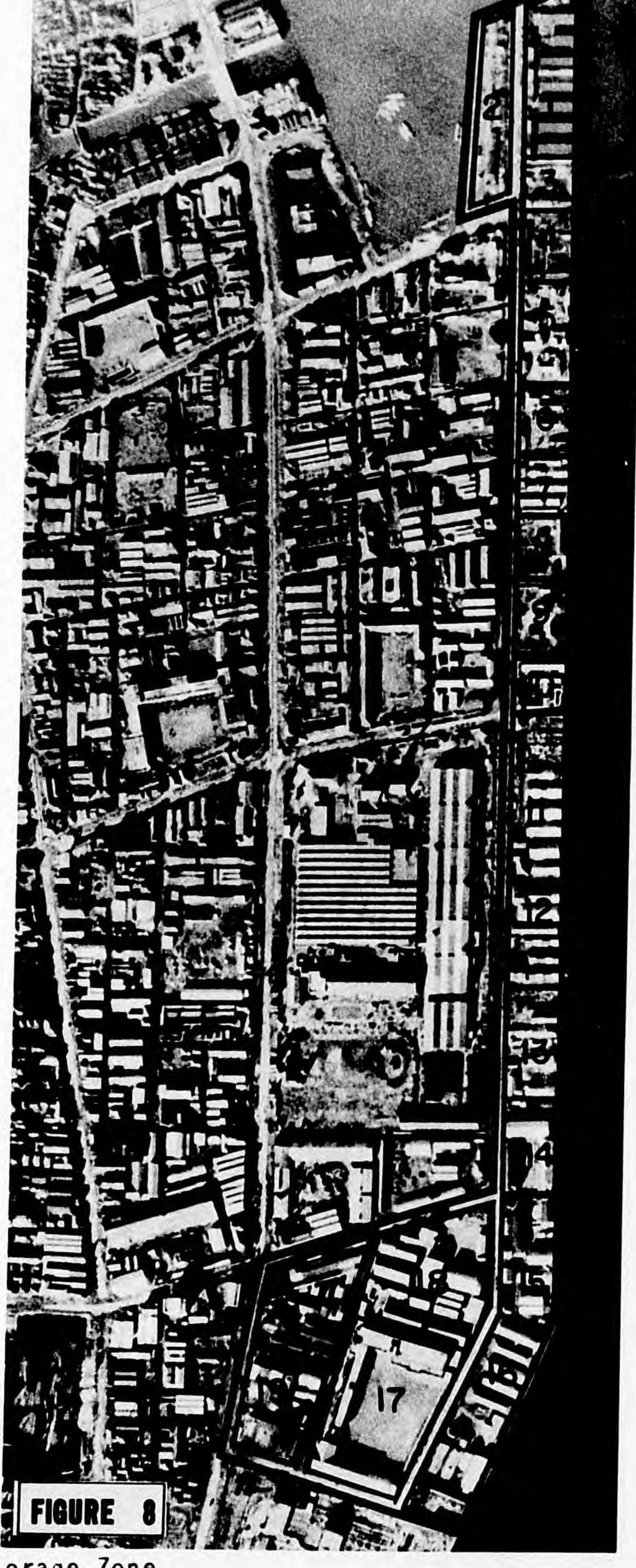
Residential Moof Cover - 43% of total roof cover in Area II. Inoustrial moof Cover - 54% of total moof cover in Area II.

(3) Storage zone (S) - Sample areas which had been zoned as storage were checked on the ground (Figs 7-10). In all areas save one most of the buildings were found to be used for storage, with a few residences or small industrial concerns intermixed. The area which proved to be an exception (Fig 8) was located in the dock area of Tokyo. Examination of Table 3, which lists the type of occupancy of various buildings in this area, shows that out of a total of 19 buildingsorbuilding complexes only three were utilized for storage, the remainder being occupied by small industries or concerns engaged in work which could be carried on in storage type buildings. It was apparent that although the location of the buildings (e.g.,



Storage Zone

in a dock area) may be an indication that they are used for storage, further evidence, generally ground information, is essential for confirmation (Photo 7).

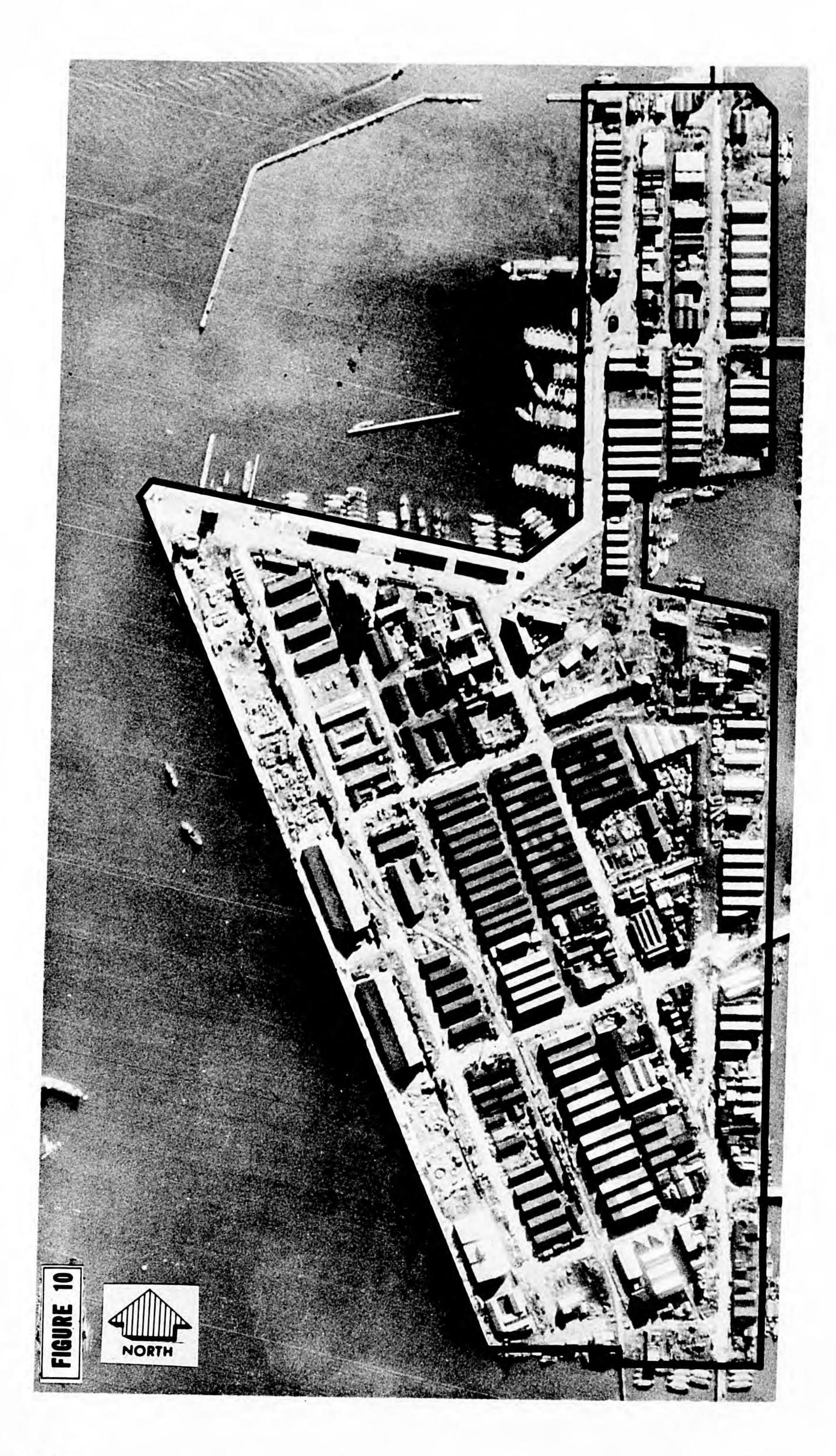


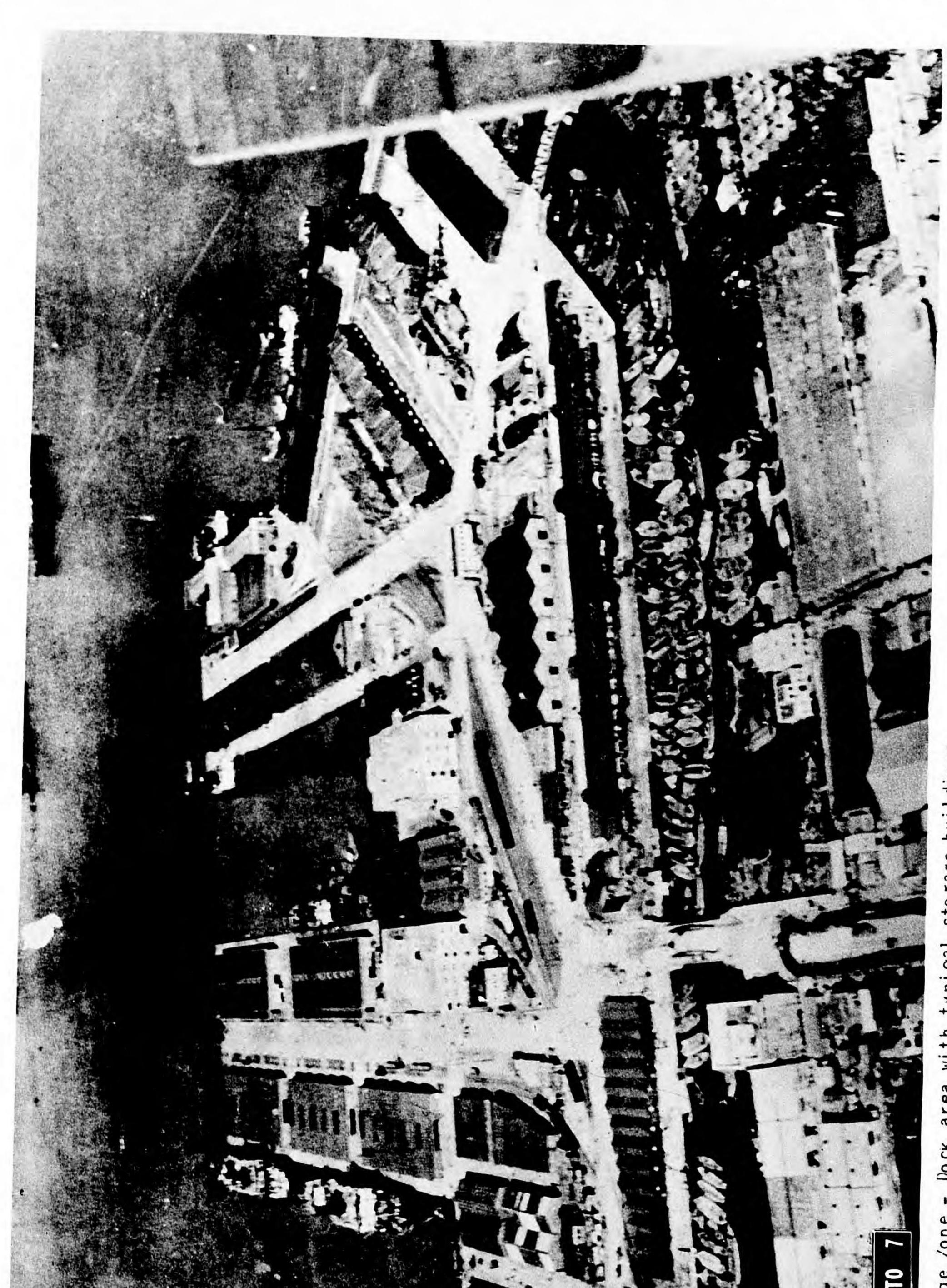
Storage Zone

	URBAN AREA PHOTOGRAPHIC INTELLIGENCE GROUND CHECK OF STORAGE ZONE CONTENT - TOKYO
Building No.	Occupancy - Determined by Ground Check
	Tank component factory.
2	Storage.
3	Residential
4	Research laboratory
5	Harbor work office
6	Public works department depot
7	Factory - production unknown
8	Canning factory
9	Storage
10	Spinning factory
11	Factory - production unknown
12	Storage
13	Workers' dormitories
14	Factory - production unknown
15	Factory - production unknown
16	Factory - production unknown
17	School
13	Industrial school
19	Factory - production unknown



Storage Zone





(4) Incustrial zone (1) and Transportation zone (T) - These areas are for the most part easily identified for zoning purposes (Photos 8 and 9). A number of samples of each zone (Figs II-I3) were examined and their identification and delineation toung to be correct.

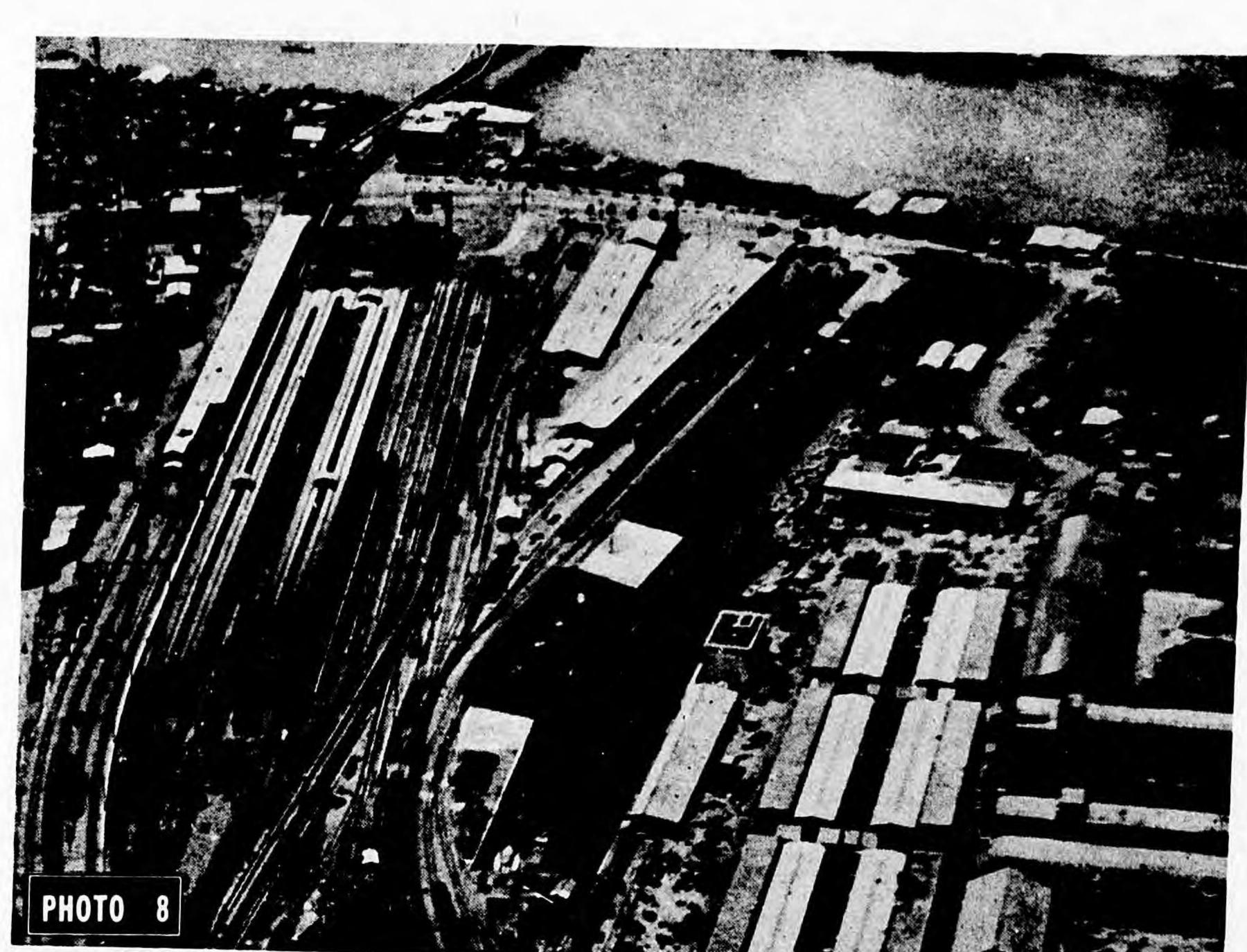
c. Method of density assessment by visual inspection.

(I) As long as aerial photographs of reasonably good quality are available on which roof outlines are sharply defined, the method of building density assessment by visual inspection will give accurate results. This is ensured by the controls which are incorporated in the system.

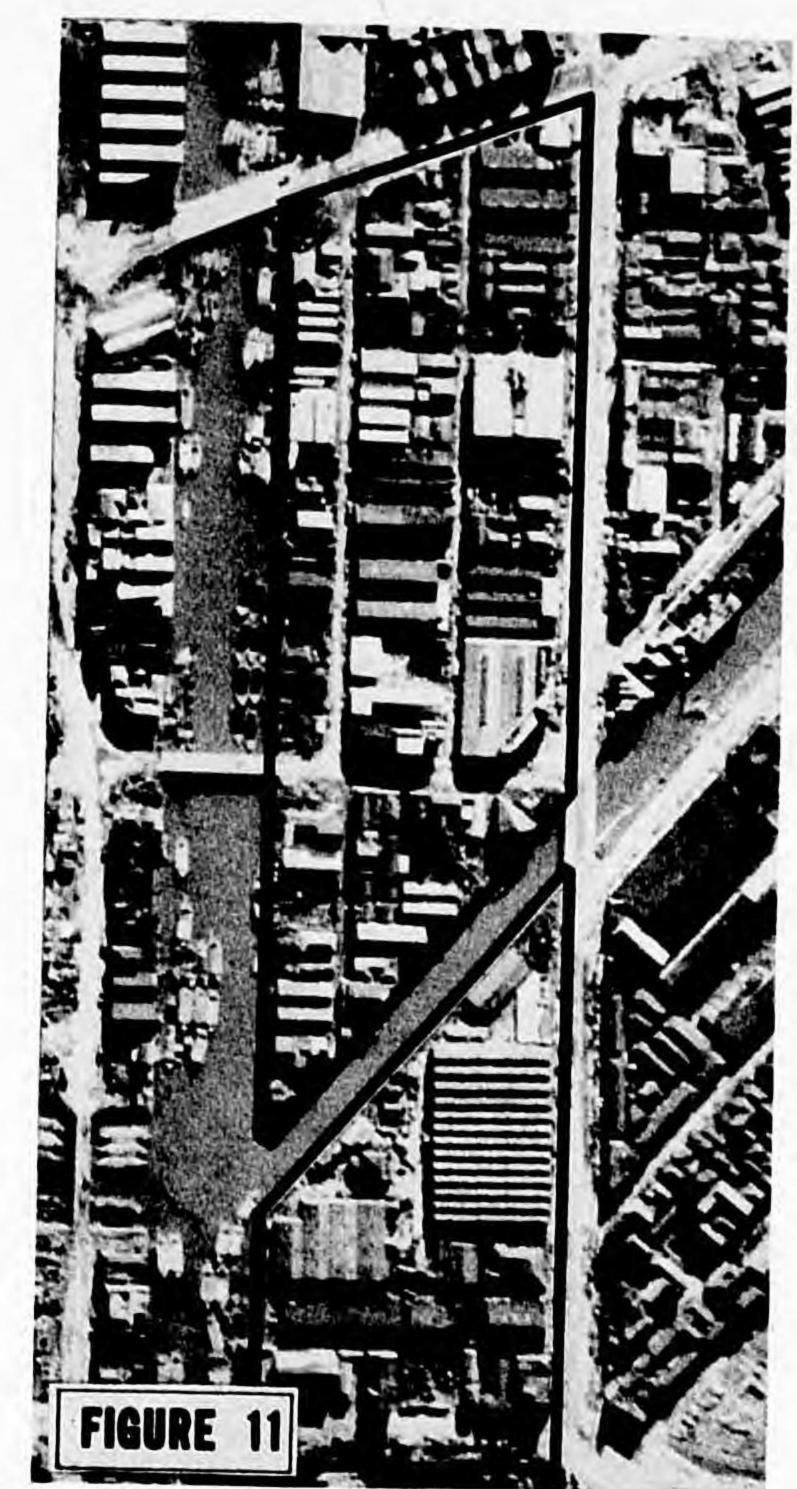
(2) There is one type of area, however, in which error may occur, a type exemplified by the slum districts of Japanese cities, where there is a maze of small buildings and sheds between houses. The roof cover of these miscellaneous structures is

sometimes difficult to determine on aerial photographs.

(3) In order to investigate the magnitude of the error which may occur in these circumstances, a sample area was selected in one of the congested slum districts in Tokyo. This district represented the extreme case of roof cover indeterminable on aerial photography. Aerial photographs of only fair quality were examined and the tuilding density assessed by visual inspection. The area was then examined on the ground and the roof cover of structures which had not been observed on the photographs noted. It was discovered that inclusion of this additional roof cover gave a building density figure slightly less than 2 per cent higher than that by visual assessment. In view of the mediocre quality of the photography available and the extreme congestion of the area examined, it is considered that errors due to the omission of small structures whose roof cover is indeterminable on photographs would normally be less than the 2 per cent error discovered in this case.



Transportation Zone - Showing railroad yards and transhipment facilities.



Incustrial Zone

d. Examination of structural content

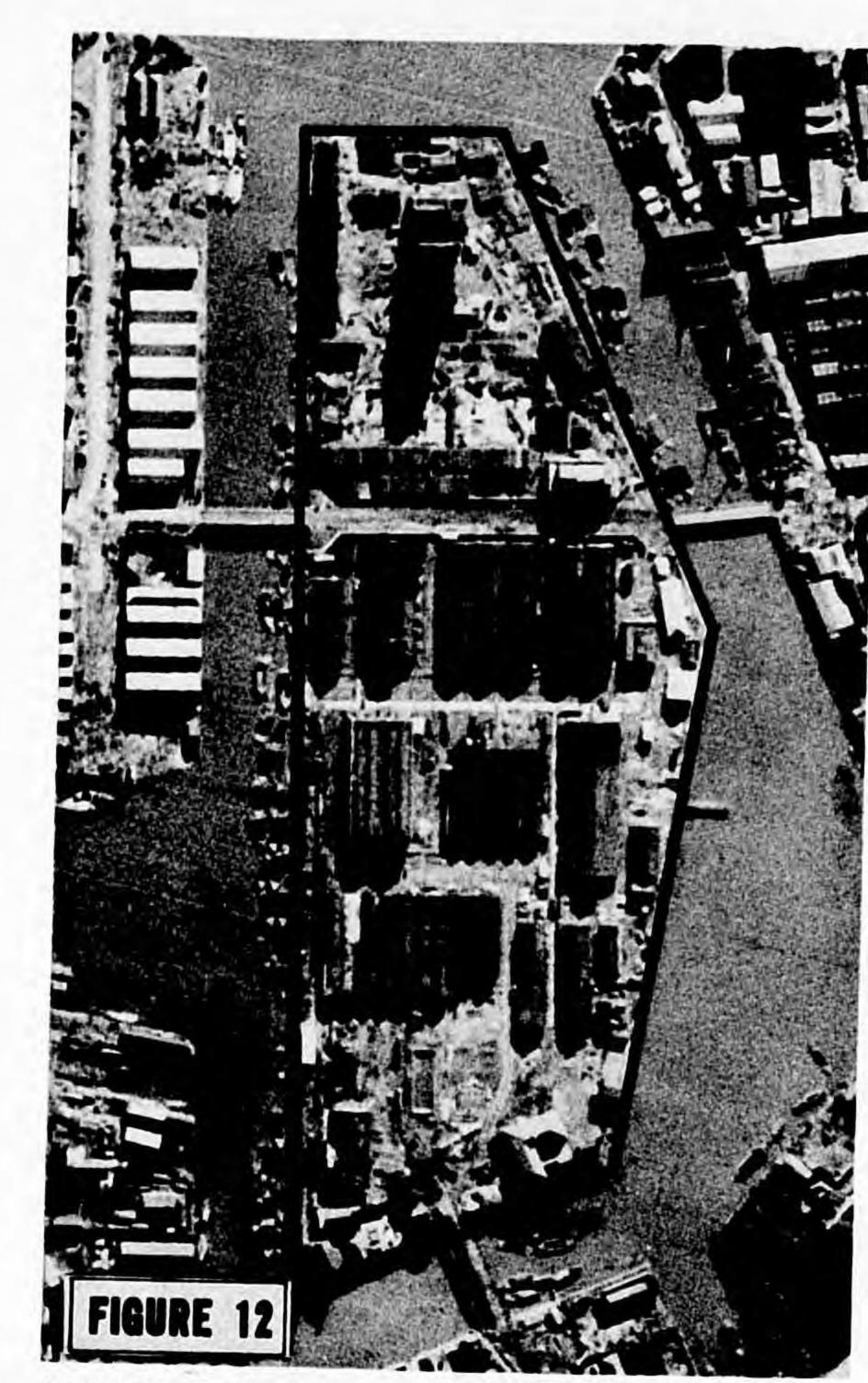
(I) The entire city of Kyoto was surveyed in order to investigate the possibility of extending the scope of pre-attack analysis to include information of types of structural content (building structure), and to determine the relative extent to which such additional analysis would depend upon ground intelligence and photographic intelligence.

(2) The survey revealed that by a study of good quality aerial photographs supplemented by ground intelligence, it was possible to divide this urban area into:

(a) vistricts in which one of the following basic types of structure predominated:

I. Buildings consisting entirely or principally of wooden construction;

2. Buildings with framework of iron, steel, or concrete;



Industrial Lone

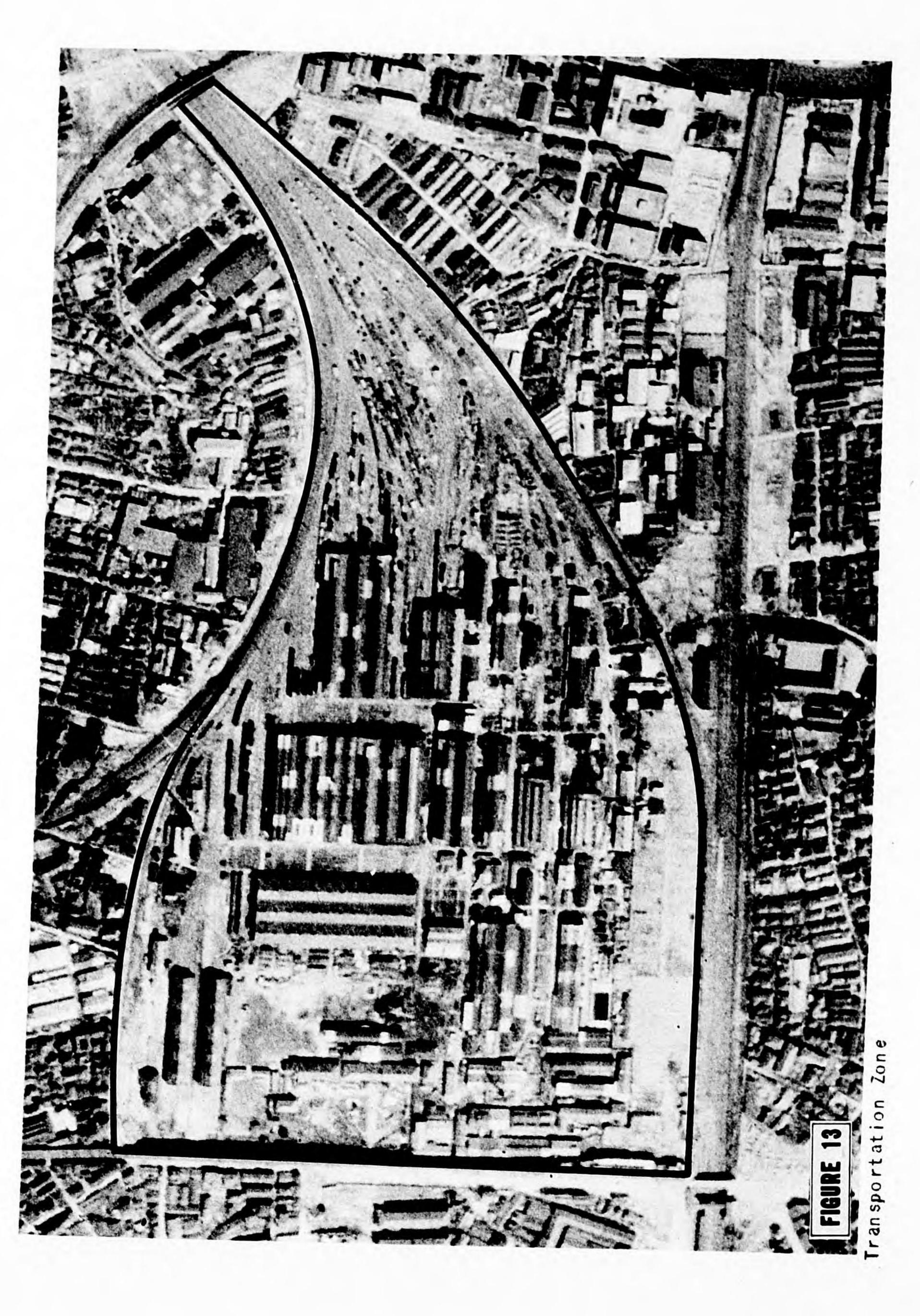
3. Duildings with load bearing walls of brick, stone, etc.

(b) Districts in which buildings of types 1 and 2 were mixed in almost equal proportions.

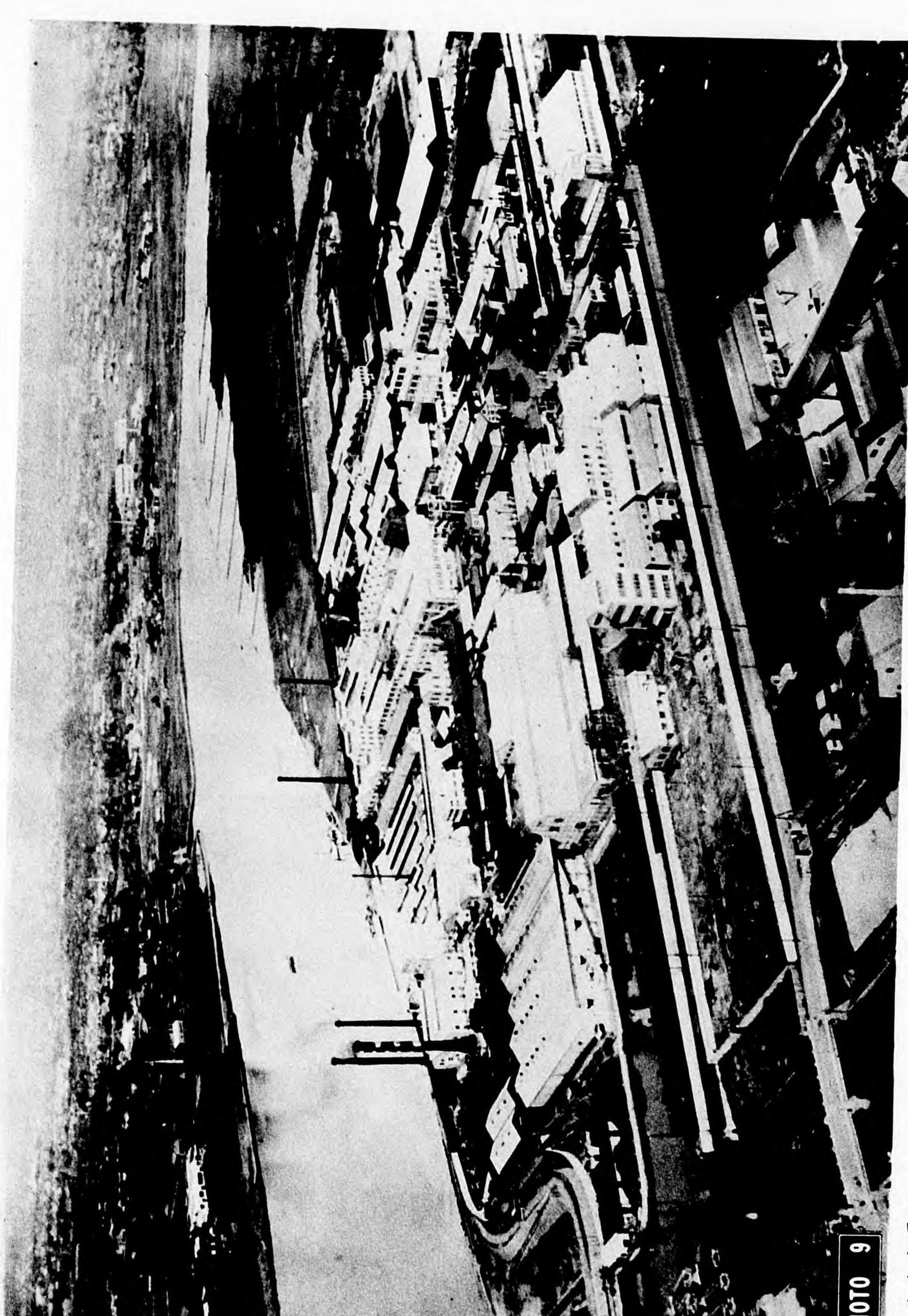
(3) The basic categories listed under (a) and any combination thereof will, in most cases, be found applicable to cities elsewhere.

2. Post-attack Studies

a. Ground area damage - Ground area damage can be defined as "areas in which damaged or destroyed buildings were once contained". The more detailed ground area measurements become by virture of eliminating open spaces, streets, etc., the more they approach roof damage. It is not practicable to make these measurements so precise that they do in fact become measurements of roof area damage, for the process is too laborious and time consuming. It is practicable, how-



THE WILL DO SELL



ever, to eliminate the larger open spaces, streets, rivers, canals, etc. in order to provide a figure which will represent more closely areas which once contained buildings.

- b. Comparison of Photographic Intelligence Reports and Ground Surveys (Table 4)
- (1) JTG vs Ground Survey Ground area damage figures for Hiroshima, Nagasaki, Oita, and Ube were determined by teams of the Physical damage division. The JTG reports gave a total ground area of damage 4.8 per cent higher at Nagasaki and 0.6 per cent lower at Hiroshima than did ground surveys. While this is toc small a sample to prove conclusively that JTG assessments were consistently accurate, it is believed that, granted adequate photography and skilled interpretation, photographic assessment of damage is of the same order of accuracy as careful ground surveys. No JTG reports on Oita and Ube were available for comparison.
- (2) CIU vs Ground Survey CIU reported 15.4 per cent more ground area of damage than did ground surveys at Hiroshima, 21.8 per cent more at Nagasaki, 32.4 per cent more at Cita, and 9.4 per cent less at Ube. The latter figure is of no significance since the photography was inadequate for a complete assessment. The CIU reports averaged 20 per cent higher than the ground surveys.
- c. Comparison of CIU and Interpron Two keports with JTG Reports (Table 4)
- (I) Since ground checks are believed to indicate the reliability of JTG ground area of damage figures, they have been used as standards of comparison for the assessments of CIU and Interpron Two.
- (2) Comparison of 9 CIU reports with those of JIG reveals that CIU reported from 1.7 to 26.2 per cent more ground area damage than did JTG. The total ground area damage reported by CIU for the 5 cities listed in Table I amounted to 17.8 per cent more than that reported by JTG, and the average difference between individual reports of the two was 15 per cent.

- (3) Comparison of the assessments of Interpron Two with those of JTG discloses little variation between the two. In one case the reported ground areas of damage were identical. The greatest variation amounted to only 3.4 per cent. The sum of the total ground area of damage in the three Interpron Two reports was 1.3 per cent more than the sum of comparable JTG reports, and the average difference between individual reports of the two was 2.1 per cent.
- d. The primary reason for the agreement between JTG and the ground survey and between JTG and Interpron Two as well as the lack of agreement of JTG, Interpron Two, and the ground survey with CIU is the different conception of the meaning of ground area of damage. JTG, Interpron Two, and the ground survey eliminated open areas (cemeteries, shrines, parks, canals, etc.) within the area of damage as far as possible; CIU did not.
- e. Roof Area Damage Because a ground area of damage figure must under any conditions include the smaller streets, the smaller open spaces, etc., the extent of which cannot be determined by this method, ground area of damage becomes an unreliable indication of actual damage. Ground area of damage figures are important, however, in the assessment of weapon effectiveness. Roof area damage is the only accurate expression of actual damage, and the visual inspection method used in the JTG program described elsewhere in this report, offers a satisfactory way of determining this in a reasonably short time.
- f. inreported Damage In the larger cities of Japan there was an element of unreported damage in the commercial areas where some modern buildings, although gutted within, had undamaged roofs and therefore appeared undamaged on vertical photographs. That the areas which contained these damaged buildings are of little significance in relation to the total amount of ground area damage reported is made clear by the fact that they represented a small percentage of the commercial areas which in turn were only small percentages of the cities in question. There were also isolated undamaged buildings within the ground areas reported

Urtan Area Photographic Intelligence - Camage Assessment Evaluation Comparison of Ground Areas of Damage Reported by JTG, CIU, Interpron Two, and Ground Survey

URBAN	ATTACK DATES 1945 (E. Long. Time)	JTG ASSESS-	CIU ASSESS-	INTERPRON	GROUND	% DIFFER	ERCE FROM	% DIFFER	ENCE FROM
	Long. Time)	MENT	MENT	ASSESSMENT	SURVEY	CIU	INT. THO	JTG	D SURVEY
KOBE	Cumulative to 18 March		85.45*	87 .C *	*	1.7	3.4		
OSAKA	13-14March	185.2	Not com- parable	191.0	_	-	3.0		
TOKYO	Cumulative to 9 March	369.9	467.0	370.0	_	26.2	0.0	-	-
TOKYO	13 April	260.3	316.9	-		21.0			
TOKYO	Cumulative to 29 May	1291.2	1564.0		_	20.0	_		
NAGOYA	Cumulative to 18 March		139.8	-	_	9.7	-		_
NAGGYA	140 17 May	179.1	194.4	-		8.5			
NAGOYA	Cumulative to 17 May	318.8	345.4	-	_	8.3	-		
HIROSHIMA	6 August	112.3	134.8	-	113.C	20.0	-	0.6	15.4
NAGASAKI	10 August	34.8	40.3	-	33.2	15.8	-	4.8	21.8
OITA.	Cumulative to IC Aug		15.5		11.7	_			32.4
USE	2 July	-	11.7	_	12.8				9.4

* Areas are in millions of square feet

Average error in individual reports comcared with ground surveys.

Given as percentages of ground survey figures:

(1) JTG - 2.7%

(2) CIU - 20.0%

Average difference in individual reports compared with JTG.

Given as percentages of JTG figures:

(1) CIU - 15.0%

(2) Interpron Two - 2.1%

TABLE 4

as damaged. These areas were also of little significance as compared to total ground area of damage, and tend to compensate for the unreported damage to gutted modern buildings.

IV RECOMMENDATIONS

- I. Introduction In this section an attempt is made to anticipate future requirements. A program is recommended which should provide a maximum amount of urban area intelligence in a form which can be readily used. The recommendations are taken up under two major headings, (I) Revision and Amplification of Existing Procedures, and (2) Application of the Amended Program.
- 2. Revision and Amplification of Existing Procedures
- a. Zoning To the five zone categories previously established, i.e., residential, industrial, mixed, storage, and transportation, two additional zones should be added, namely "military objectives" and "commercial." These types of occupancy have previously been included as parts of other zones. Inasmuch as they represent areas of great strategic importance, their location and characteristics should be individually expressed. All seven zones are shown on a proposed new basic zone map (Exhibit I).
- b. Density All seven zones should be divided into three sub-zones according to the same density categories now used for residential sub-zones. This will provide additional essential information for consideration of physical vulnerability and economic assessment. Indication of density categories on a transparent overlay to the basic zone map as shown in Exhibit 2 will make this information easy to use.
- c. Structural assessment The urban area should be assessed in terms of its structural content. Suggested categories are (a) buildings of wooden construction or predominantly wooden construction; (b) buildings with framework of iron, steel or concrete; and (c) buildings with load-bearing walls of brick, stone, concrete, etc. The structural content of the urban area represents an important consideration in physical

vulnerability assessment for determination of weapon effectiveness, aiming points, and weapon selection, and should therefore be a feature of pre-attack urban area analysis. The structural categories should also be indicated on a transparent overlay forplacing over the basic zone map (Exhibit 3).

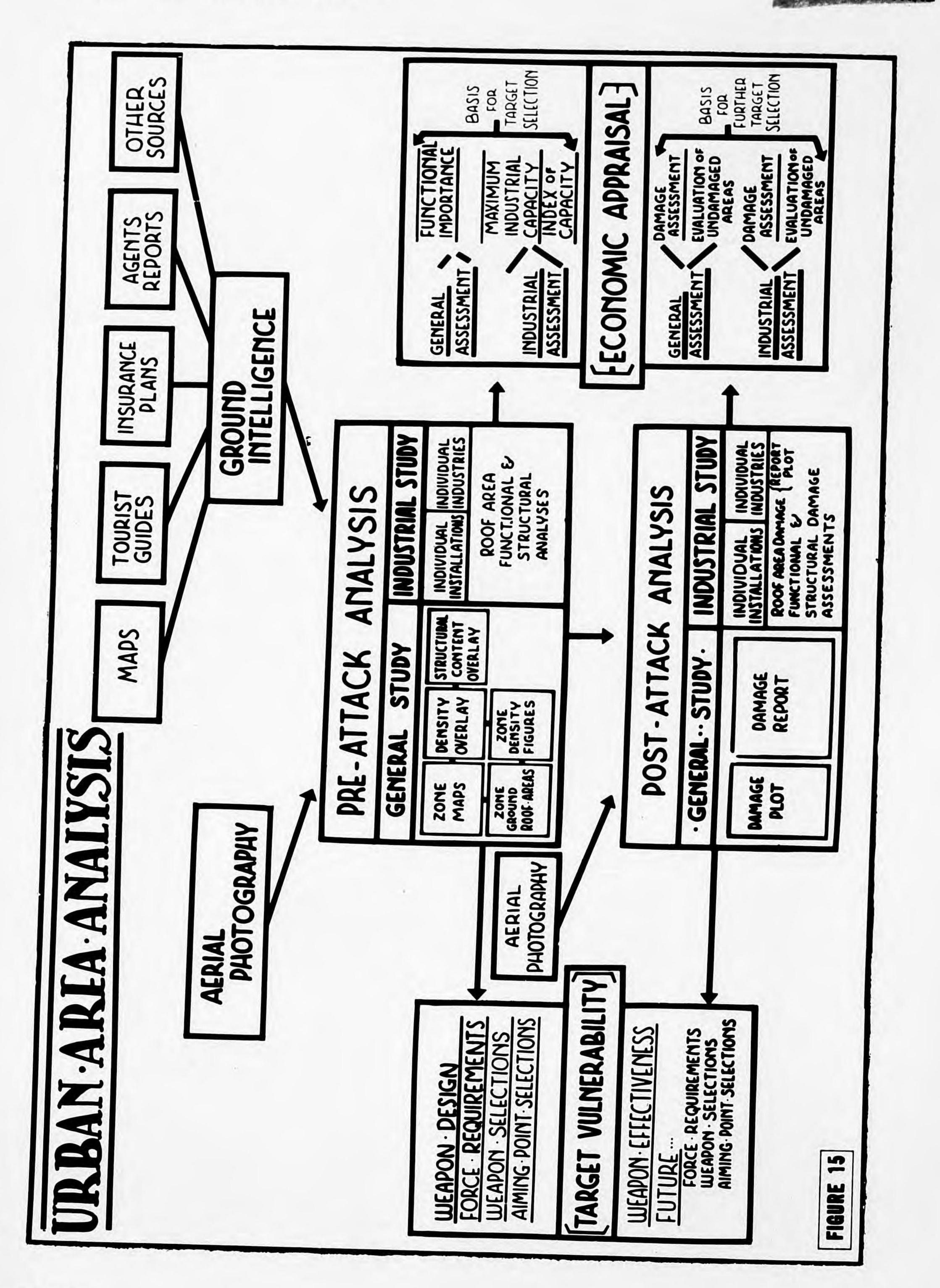
- d. Urban damage assessment Damage plots should be prepared in the form of transparent overlays to the basic zone map (Exhibits 4 and 5). These will indicate extent of damage in terms of occupancy and also, when used in conjunction with the density and structural overlays, in terms of density and structure. A damage overlay should be prepared for each attack. Cumulative damage can then be determined by superimposition of the separate plots.
- e. Data reported In both pre- and post-attack urban studies all ground area, building density, and roof area data should be presented in terms of both zones, and sub-zones (Fig 14).
- f. Industrial, functional, and structural analyses (See part II industrial analysis) Following the pre-attack determination of roof cover of industrial activities, functional and structural analyses of these activities should be made to assist in the determination of their maximum productive capacity and structural characteristics.
- g. Industrial damage assessment Following the post-attack determination of
 roof damage to industrial activities, a much
 more thorough damage assessment should be
 made with respect to function and structure
 (See part II industrial analysis) to provide
 information for further economic and physical
 damage evaluation.
- 3. Application of the Amended Program (Fig 15).

a. Standardization

(1) To achieve the ultimate intergration of intelligence material for the most effective mission planning and damage assessment, it is recommended that one standard system of methods and procedures be adopted for a more successful application

FIGURE 14				DAMAG	E ASSE	S SM EN T		ξT.				
ZON E	ARE	N E EAS	TO PRE DA	TAL VIOUS MAGE		ED AREAS	DAM AG	E DU E	CUMUL	ATIVE AGE	REMAII	
RESIDENTIAL RI	GROUN D	ROOF	GROUN D	ROO F	GROUN D	R00 F	GROUN D	R00 F	GROUN D	R00 F	GROUND	ROO
K2												
63		,										
TO TAL K												
IN DUST 11												
12												
TOTAL I												
MIXED XI												
AN & RES X2												
ХЗ												
TOTAL X												
COMMERCIAL CI												
C2												
TOTAL C												
STO KAGE SI												
S2												
TOTAL S												
TRANS TI												
T2						,						
T3												
TOTAL T												
LITARY MOI												
OFUEC 1102												
TOTAL MO										-		

KES	RESIDENTIAL MANUF				MIXE		PKE-A				_			RILT						
RI	1 10 0 0		1	1	I XED RES-MANU						STO RAGE			RAGE TRAN SPORTATION MILI						
	K2 K3 M1 M2 M3	113	λI	X2	1/3	CI	Ĉ2	C3	SI	\$2	53	TI	T2	T3	MC I	MO2	MO3			



of pre- and post-attack analyses.

Differences arising from a lack of standardization are shown in the previous comparison of results of the different wartime agencies.

b. Objectives - The program is designed to produce information which will assist in:

- (I) The evaluation of the economic potential of urban areas in order to form a basis for establishing priorIties in target selection.
- (2) The design and selection of weapons to be used in urban attacks.
- (3) Consideration of target occupancy for mission planning.
- (4) The determination of the most suitable aiming points and force requirements.
- (5) Analysis of the physical and economic effects of attacks.
- (6) Determination of weapon effectiveness.

c. Pre-attack analysis

- (I) Source material Aerial photography and ground intelligence provided the source material for pre-attack analysis. Adequate amounts of both of these elements are necessary to produce a complete study. However, when one of these is lacking, either totally or in some degree, available material can be utilized to prepare a modified form of the full analysis.
- (2) Pre-attack analysis is divided into a general study and an industrial study, the products of which are important to economic appraisal and consideration of the physical yulnerability of the target in the following way.

(a) Economic appraisal

I. General study - The zone map dividing the urban area into seven significant occupancy types or zones. and

the zone density studies resolving each of these zones into three sub zones according to building density, produce a conception of the size, quantity and location of the functional components of the urban area in their broadest aspects.

- 2. Industrial study The determination of the amount of roof cover in each industrial activity in the urban areas under consideration, and the classification of this data according to industrial types for each urban area, e.g. aircraft or steel, provide quantitative figures which are intended to produce as quickly as possible a tasis for the comparison of the industrial capacities of the various urban areas. Although this study does not allow for differences of building utilization, it remains the only index for the comparison of capacity, either by itself or in conjunction with available ground intelligences, until more detailed analyses can be accomplished. The subsequent detailed studies are functional and structural analyses for providing data necessary to determine maximum industrial capacities.
- 3. Target selection Thus with an indication of the relative industrial capacities of various urban areas and a knowledge of the location, size, and quantity of the other zones which influence industry, commerce, and general importance, comparative functional importance is determined for use as a basis for target selection.

(b) Physical vulnerability

I. General study - The zone map and the structural content and density overlays provide information which will assist in:

Weapon Cesign Weapon Selection Cetermination of Force Requirements Aiming Point Selection

2. Industrial study - Structural analyses of individual industrial activities will provide additional information on the physical characteristics illustrated in the structural and density overlays for those targets made the object

of special attack.

d. Post-attack analysis

(I) Post-attack analysis is also divided into a general study and an industrial study the products of which are important for economic and physical damage assessment in the following way.

(a) Economic appraisal

I. General study - The damage plot and report illustrating the amount and location of damage according to zones and sub zones provides information necessary for assessment of the broad economic effect of the attack in terms of dehousing, absenteeism, casualties, disruption of utilities and services, and general administration disorganization. These factors as well as direct damage to factory buildings and equipment, contribute significantly to industrial loss.

2. Industrial study - A plant building damage plot and report, and the classification of damage data according to individual industrial types illustrates the quantitative effect of the attack upon industry. This phase, an immediate appraisal of industrial damage, deals only with amount of plant area and may not be translated di-

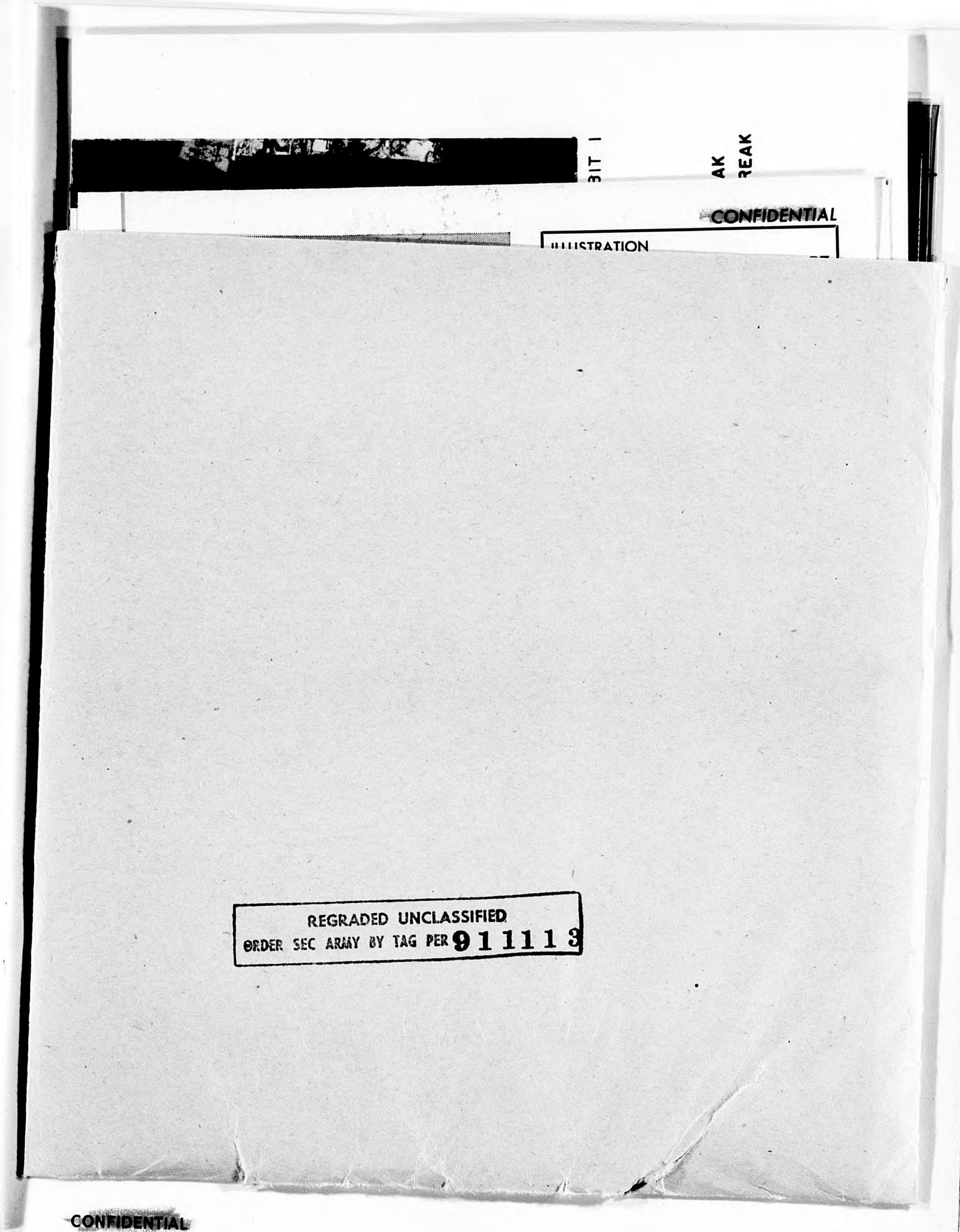
rectly into terms of production loss as it does not allow for qualitative differences among factories in a given industry. Subsequent structural and functional damage assessment will provide data necessary for the determination of effect on productive capacity.

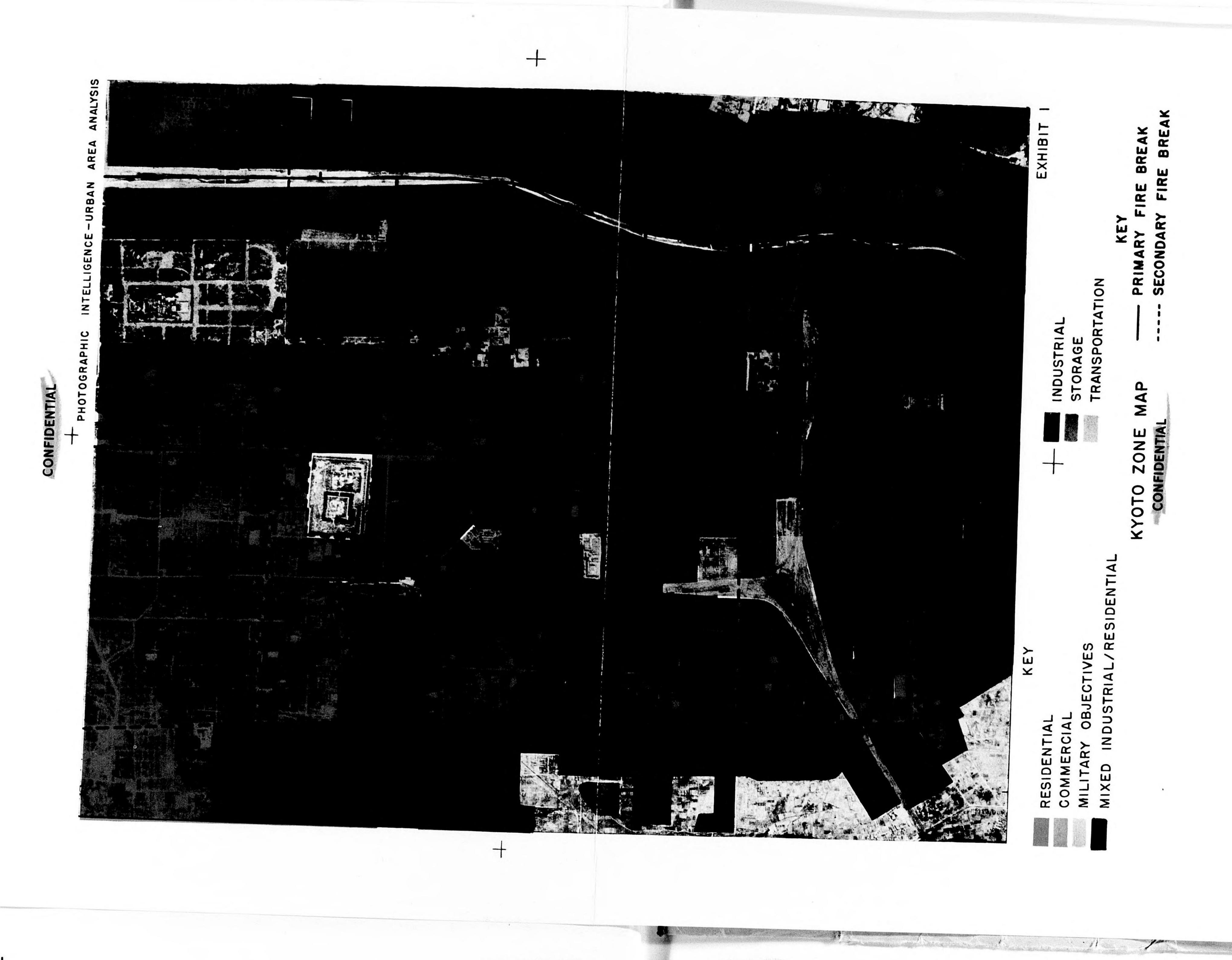
3. Further Target Selection - In light of the total economic damage assessment the undamaged areas of the target are evaluated as to target value, thus forming a basis for further target selection.

(b) Physical vulnerability

I. General study - The damage plot and report when considered in conjunction with the zone map and the structural and density overlays illustrates the location, extent and physical characteristics of the damageo areas, thus assisting in target and vulnerability studies. Should a postattack economic appraisal indicate that the undamaged target area has further target value that area can be assessed as in preattack analysis for attack recommendations.

2. Industrial study - Structural damage assessments of incividual industrial activities will give details of the type and nature of the damage. This data is related also to weapon effectiveness and further weapon requirements.





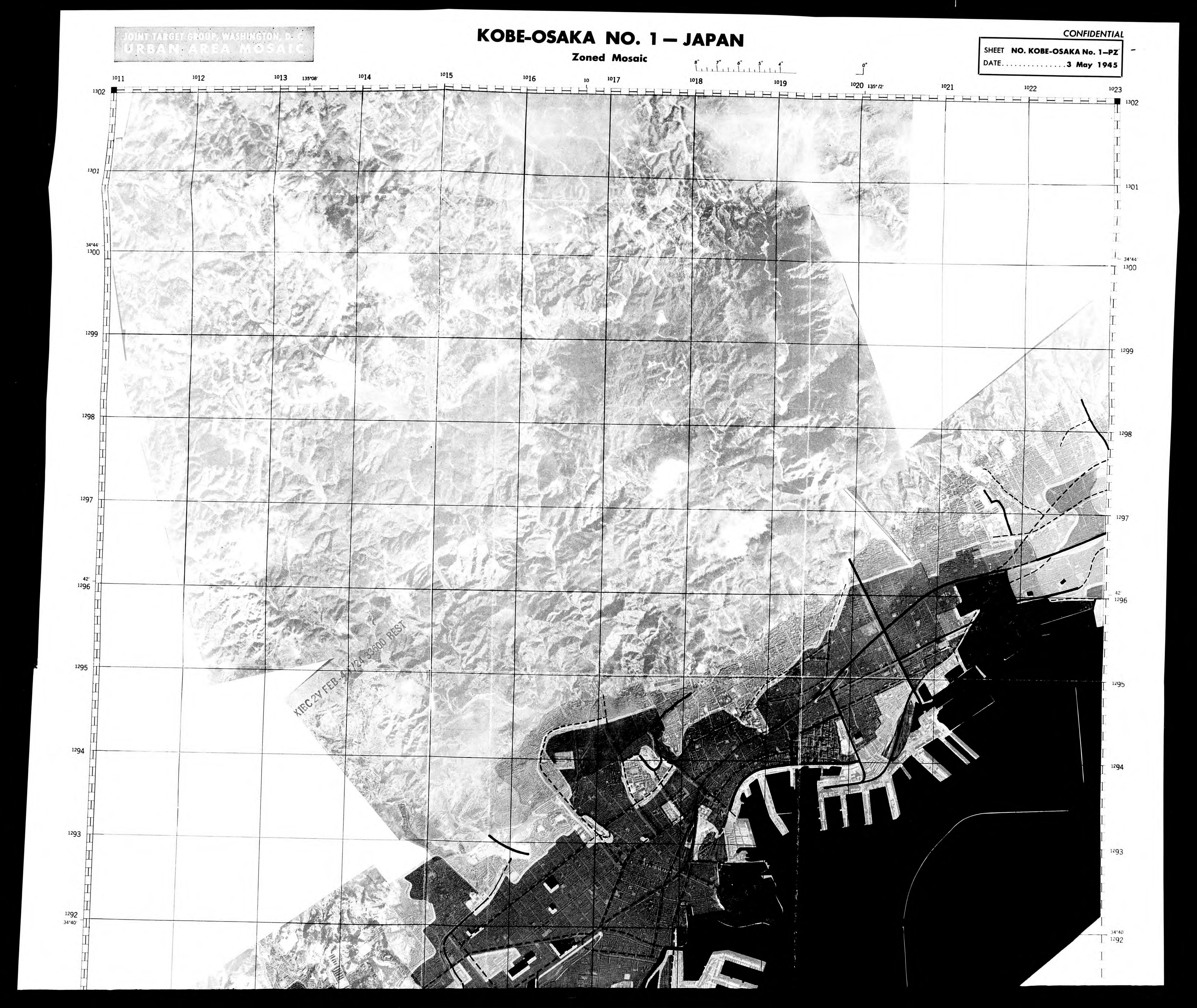
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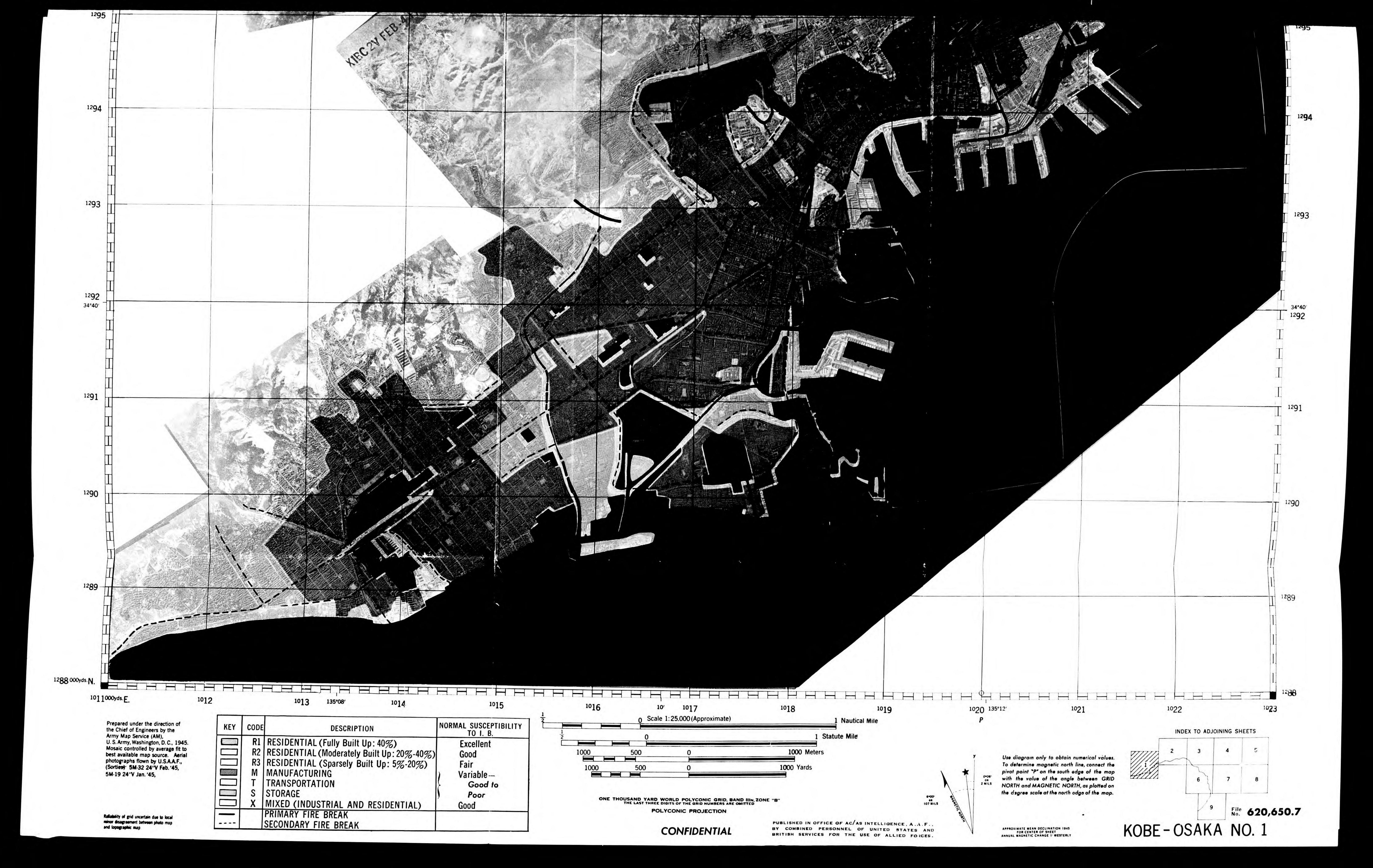
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IBITS





UNITED STATES STRATEGIC BOMBING SURVEY European War

LIST OF REPORTS

The following list of studies is a bibliography of completed reports resulting from the German survey. Reports numbers 1, 2, and 3 can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Permission to examine the remaining reports may be had by writing to the headquarters of the Survey at Gravelly Point, Washington 25, D. C.

- The United States Strategic Bombing Survey:
 Summary Report (European War)
 The United States Strategic Bombing Survey:
- Over-all Report (European War)

 The Effects of Strategic Bombing on the German
- War Economy

AIRCRAFT DIVISION

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Aircraft Division Industry Report Inspection Visits to Various Targets (Special Report)

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- 6 Junkers Aircraft and Aero Engine Works, Dessau,
- Erla Maschinenwerke G m b H, Heiterblick,
- 8 ATG Maschinenbau, GmbH, Leipzig (Mockau), Germany 9 Gothaer Waggonfabrik, A G, Gotha, Germany
- 10 Focke Wulf Aircraft Plant, Bremen, Germany Over-all Report 11. Messerschmitt A G,
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- 14 Wiener Neustaedter Flugzeugwerke, Wiener Neustadt, Austria

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- 15 Bussing NAG Flugmotorenwerke G m b H, Brunswick, Germany
 16 Mittel-Deutsche Motorenwerke G m b H, Tau-
- cha, Germany 17 Bavarian Motorworks Inc, Eisenach & Durrenhof, Germany
- 18 Bayerische Motorenwerke A G (BMW) Munich, 19 Henschel Flugmotorenwerke, Kassel, Germany
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- 20 Light Metals Industry Part I, Aluminum
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- 23 Aluminiumwerk G m b H, Plant No. 2, Bitterfeld,
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- 25 Luftschiffbau Zeppelin G m b H, Friedrichshafen on Bodensee, Germany

- Wieland Werke A G, Uım, Germany
 Rudolph Rautenbach Leichtmetallgiessereien.
 Solingen, Germany
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- 35 A Detailed Study of the Effects of Area Bombing
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- on Darmstadt 38 A Detailed Study of the Effects of Area Bombing on Lubeck
- 39 A Brief Study of the Effects of Area Bombing on Berlin, Augsburg, Bochum, Leipzig, Hagen, Dortmund, Oberhausen, Schweinfurt, and Bremen

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- 45 Bad Oldesloe Field Report 46 Augsburg Field Report 47 Reception Areas in Bavaria, Germany

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50 Optical and Precision Instrument Industry Report

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- The German Abrasive Industry
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53 The German Anti-Friction Bearings Industry

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- 55 Machine Tool Industry in Germany 56 Herman Kolb Co, Cologne, Germany 57 Collet and Engelhard, Offenbach, Germany

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84 Auto Union A G, Chemnitz and Zwickau, Ger-

85 Herschel and Sohn, Kassel, Germany 86 Maybach Motor Works, Friedrichshafen, Ger-

87 Voigtlander Maschinenfabrik A G, Plauen, Ger-

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124 Ebano Asphalt Werke A G, Harburg Refinery, Hamburg, Germany

125 Meerbeck Rheinpreussen Synthetic Oil Plant-Vol I & Vol II

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171 Submarine Pens Deutsche-Werft, Hamburg, Ger-

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177 Adam Opel A G, Russelheim, Germany

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196 I G Farbenindustrie, Leverkusen, Germany Chemische-Werke, Huels, Germany

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