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RATIONALE AND PLAN FOR FIELD DATA ACQUISITION REQUIRED FOR THE RATIONAL DESIGN AND EVALUATION OF SEISMIC AND ACOUSTIC CLASSIFYING SENSORS

by

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A major objective of the Project Manager, Remotely Monitored Battlefield Surveillance System (REMBASS), is the development of sensor systems capable of classifying targets. Existing classifier design procedures rely heavily on statistical techniques, such as multiple correlation analysis, which have been shown to be strong tools for this purpose. Seismic and acoustic signals are affected by a number of target and environmental variables, and since the REMBASS sensors are intended to operate satisfactorily for a large variety of
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from → targets and terrains, it is recognized that an adequate design will require a signature data base representative of the spectrum of conditions under which the system is to operate.

This report presents a plan for assembling a data base for the development and testing of two types of seismic and acoustic classifying sensors: a sensor for classifying single targets, and a sensor for classifying single targets in a multiple-target environment. The plan also (a) defines the targets to be used in the data collection program, (b) defines the test site conditions to be used in the data collection program and develops a method for relating test site conditions to worldwide environments, (c) establishes a method for assembling a data base of realistic background noise signatures, and (d) specifies the test procedures for signature acquisition from the various target classes. The report includes maps showing predicted worldwide performance of seismic and acoustic sensors and the rationale behind their formulation.

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PREFACE

The work reported herein is a portion of a seismic research program conducted by the U. S. Army Engineer Waterways Experiment Station (WES) and sponsored by the Project Manager, Remotely Monitored Battlefield Surveillance System, U. S. Army Materiel Command, Fort Monmouth, New Jersey, under Project No. 1X764723DL73 entitled "Target Signature Data Base Study."

The work was under the direct supervision of the Chief, Mobility and Environmental Systems Laboratory (MESL), Mr. W. G. Shockley, and the Chief, Environmental Systems Division (ESD), MESL, formerly Mr. W. E. Grabau and currently Mr. B. O. Benn, and under the joint supervision of the Chiefs of the Environmental Research and Environmental Characterization Branches, ESD, MESL, Messrs. J. R. Lundien and J. L. Decell, respectively. Personnel making significant contributions to the preparation of the report include Messrs. Decell, M. A. Zappi, P. A. Smith, M. M. Culpepper, L. E. Link, and Lundien. This report was compiled by Mr. Benn.

Director of WES during this work and preparation of the report was COL G. H. Hilt, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

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

Units of measurement used in this report can be converted as follows:

Multiply	By	To Obtain
	U. S. Customary to Metric (SI)	
feet	0.3048	metres
miles	1.6093	kilometres
tons (short)	0.90718	metric tons
	Metric (SI) to U. S. Customary	
millimetres	0.0394	inches
centimetres	0.3937	inches
metres	3.2808	feet
kilometres	0.6214	miles (U. S. statute)
kilograms	2.2046	pounds (mass)
newtons per metre	0.0685	pounds (force) per feet
grams per cubic centimetre	0.0361	pounds (mass) per cubic inch
centimetres per second	1.968	feet per minute
metres per second	2.237	miles per hour
kilometres per hour	0.6214	miles per hour
kilogram-second-centimetre	0.0270	slugs-seconds-inches

RATIONALE AND PLAN FOR FIELD DATA ACQUISITION REQUIRED FOR THE RATIONAL DESIGN AND EVALUATION OF SEISMIC AND ACOUSTIC CLASSIFYING SENSORS

PART I: INTRODUCTION

Background

1. A major objective of the Project Manager, Remotely Monitored Battlefield Sensor System (REMBASS), is the development of a seismic or an acoustic sensor (or both) that can classify (at the sensor) targets, i.e. discriminate among helicopters, fixed-wing aircraft, tracked vehicles, wheeled vehicles, walking men, and background noise, in world-wide environments. The approach almost universally taken to design logic for classifying sensors uses measured signals from targets of interest. From these signals, features that can be consistently associated with a particular target are sought by means of multiple correlation techniques. It has been documented that the correlation techniques are strong tools for evaluating and correlating the discriminating features of specific target classes; however, the dependence on empirical data restricts the applicability of the desired design.

2. Experience has shown that seismic and acoustic signals are affected by a number of target and environmental variables, which often result in an inability of the sensor to associate signals collected under one set of conditions directly with signals collected under other conditions.[1] However, REMBASS sensors are intended to work satisfactorily under a large variety of target and terrain conditions, and it is recognized that an adequate design will be forthcoming only if seismic and acoustic signals representative of those that would be generated in the real world are used in the design data bases. From a simplistic viewpoint, it can be argued that a solution to the design problem rests in generating a data base of sufficient size and statistical representativeness that would permit, with existing data analysis techniques, the isolation

of the features that are unaffected by the generation and propagation of the seismic and acoustic energy. More mature consideration of the large number of variables involved brings the realization that literally thousands of empirical tests would be required to define the signature envelope for a given target class.[2] Still more tests would be required to establish that the synergistic effect of combining certain variables would not result in nearly identical signatures from two or more classes of targets.

3. In view of the problems associated with designing classifying sensors strictly on the basis of empirical data, it appears prudent to attempt to generate a design data base by using a balanced experimental and theoretical program. In this approach, well-controlled empirical tests are conducted in a spectrum of target and terrain conditions, thereby providing measured data for use as interpolation benchmarks. In the theoretical portion of the program, realistic simulation models are used to estimate how the signatures would vary (from benchmark to benchmark) if the various terrain and target factors were varied throughout the range of interest.

4. The simulation techniques required in a balanced theoretical and experimental program should be applied with the realization that there is no such thing as an "exact" theoretical description of a phenomenon, and, therefore, there would always be some uncertainty as to how representative of the total population of signatures a given signature is. In this report a systematic experimental program is proposed by the U. S. Army Engineer Waterways Experiment Station (WES) that is aimed at developing seismic and acoustic data bases of defined worldwide representativeness. The results of the program are intended to provide considerable signature data for use directly in the design of classifiers and also to verify simulation results so that as an adjunct an analytically generated data base can be used in the design process with confidence.

Purpose

5. The purpose of this report is to present a plan, and the rationale for its development, for assembling a data base for the development and testing of two types of seismic and acoustic classifying sensors:

<u>a</u>. A sensor for use in a preliminary REMBASS. The sensor must be capable of classifying single targets in terrain and background noise conditions representative of worldwide conditions. This sensor is considered by REMBASS to be in engineering development.

<u>b</u>. An advanced-development sensor that is capable of classifying single targets in a multiple-target environment. This sensor must also perform in worldwide environments.

Scope

6. The plan:

<u>a</u>. Defines the targets to be used in the data collection program.

<u>b</u>. Defines the test site conditions to be used in the data collection program and develops a method of relating test site conditions to worldwide environments.

<u>c</u>. Establishes a method of assembling a data base of realistic background noise signatures.

<u>d</u>. Specifies the test procedures for signature acquisition from the various target classes.

7. The development of the plan required study of several factors that cause instability in seismic and acoustic signatures, i.e. target, terrain, and background noise factors that induce variations in the signatures. Part II of this report presents the rationale for selecting the targets to be used in the data collection program. Part III addresses the problems associated with signature variations induced by different terrain conditions. Included in this part of the report is a

terrain matrix, the elements of which form a realistic combination of the terrain factors that affect seismic and acoustic signatures. Also included is a description of the methods used to combine the terrain element data and published terrain maps into a prediction of how seismic and acoustic sensors would be expected to work worldwide. Part IV is devoted to the development of a theoretical and empirical scheme for establishing a background signature data base. Part V summarizes the data acquisition procedures and includes a list of the tests, test sites, and targets required to implement the plan.

8. It is emphasized that this report is to be used in conjunction with Reference 3, i.e., the test sites, instrumentation used, and target conditions should be documented in accordance with Reference 3. For this reason, details concerning these aspects of the data collection program are treated only briefly in this report.

PART II: TARGET SELECTION

9. A major complication that affects the quality of the data base available for the design of classifying sensors is the fact that the largest portion of existing seismic and acoustic signature data has been collected from U. S. vehicles. Implicit in this practice is the assumption that signatures from foreign and domestic vehicles (in the same class) are very similar; however, data to demonstrate this are scarce or nonexistent. There are only a limited number of foreign vehicles available to the U. S. development agencies, and, therefore, any comprehensive signature data collection program for REMBASS will have to make extensive (although not exclusive) use of the U. S. vehicles. For this reason, it is necessary to compare U. S. and foreign vehicles on the basis of the seismic and acoustic signatures they produce. This part of the report presents a list of U. S. targets (and a rationale for selecting them) to be used in the REMBASS Engineering Development and Advanced Development programs.

U. S. Versus Foreign Vehicles

10. Since the vehicle parameters that control seismic and acoustic signatures (i.e. those vehicle parameters listed in Table 1) have been identified,[1] it seems reasonable to assume that the parameters could be used as a basis for selecting U. S. vehicles that would yield signatures similar to several types of foreign vehicles. An extensive literature survey[4-29] was undertaken to identify U. S. and foreign military vehicles and to assemble the relevant information (that listed in Table 1) on them. The following major problems emerged early in the study:

a. A large number of vehicle types are identified, many of which are modifications of the basic type. For example, Reference 4 lists three types of 5-ton,* 6x6 cargo truck,

* A table of factors for converting U. S. customary units of measurement to metric (SI) units and metric (SI) to U. S. customary units is given on page 4.

i.e. M54, M54A1, and M54A2. The M54 cargo truck has a spark-ignition engine, the M54A1 has a diesel compression-ignition engine, and the M54A2 has a multifuel compression-ignition engine. The different ignition systems will cause subtle differences in the seismic and acoustic signatures and therefore all types must be listed. However, other vehicle types have such modifications as hard cab versus canvas top, which would not change the signature of the vehicle. It was decided to inventory and list all the pertinent data on all vehicle types, including all modifications.

b. A large number of U. S. vehicle types are experimental or prototype vehicles. It was decided to include all these vehicles in the inventory because some running prototypes exist. It was felt that prototypes can possibly be used in a field program if they are the only U. S. vehicles that produce signatures similar to important foreign vehicles.

c. Complete data (listed in Table 1) exist for only a few U. S. and foreign vehicles. A single source of useful (but not complete) data was not readily available at WES or at any one Department of Defense (DOD) office. Therefore, various publications had to be ordered from a number of different sources. All material had not been received at this writing (July 1975).

11. The vehicle types identified are listed in Tables 2-9 as follows:

Table	Vehicle Class	Number of Vehicle Types Listed
2	U. S. wheeled	273
3	USSR wheeled	146
4	U. S. tracked	110
5	USSR tracked	79
6	U. S. rotary-wing aircraft	36

Table	Vehicle Class	Number of Vehicle Types Listed
7	USSR rotary-wing aircraft	13
8	U. S. fixed-wing aircraft	104
9	USSR fixed-wing aircraft	65

Because of the large number of vehicles identified early in the study, the vehicle inventory does not include any vehicles manufactured prior to 1940 and also was restricted (with a few exceptions) to vehicles of U. S. and USSR manufacture.

Selection of Foreign Vehicle Analogs

Ground vehicles

12. The large number of individual models listed for each country necessitated the comparison of the vehicle parameters by classifying the vehicles according to categories of some of the vehicle parameters listed in Table 1. As stated in paragraph 10c, all the data required were not available and a much abbreviated list of parameters had to be used. For many wheeled vehicles the following important parameters were available: weight, number of wheels, tire size, suspension type, horsepower, fuel type, and coolant type. However, only weight, horsepower, and coolant type were consistently available for many of the tracked vehicles. Each U. S. and each foreign vehicle (where sufficient data were available[4-29]) was classified or grouped (by computer) according to the parameter categories listed in Table 10. Table 11 summarizes the results of the classification for the wheeled and tracked vehicles and presents groupings of U. S. vehicle types that can be expected to yield signatures similar to groupings of foreign vehicle types. Table 11 shows two categories of foreign vehicles, "Desired Foreign" and "Other Foreign." The desired foreign vehicles were those vehicles identified in Tables 3 and 5 that met the following criteria:

a. The vehicle had to (potentially*) exist in significant numbers in Warsaw Pact countries; or if the vehicle was of new design, production had to have been initiated or was likely to be initiated.

b. All weight classes (light, medium, and heavy) had to be represented in each vehicle class.

All the foreign vehicles that met the criteria above are listed in Table 12. Those foreign vehicles that did not meet the criteria, but could be classified (data were available), are listed in Table 11 as "Other Foreign" vehicles.

13. In summary, the U. S. vehicles that should be used in the data collection program are those listed in Table 11 under the heading "Proposed U. S. Analog." It is emphasized that the listing does not always identify a specific U. S. vehicle as the proposed analog, but rather a group of U. S. vehicles. This specification was omitted deliberately to permit the final selection at the locality where the signature tests are run. The selection then can be rationally biased toward what is available at the test location.

14. Study of Tables 11 and 12 reveals that there is not a U. S. analog for all the desired foreign vehicles; i.e., no analogs were found for the following:

Wheeled	Tracked
T-111	T54
T-130	T55
T-141	T62
OT-64	M70
OT-64	

Also no data are available for certain foreign vehicles; therefore, it was impossible to determine whether or not there is a U. S. analog for the tracked M-1973 and M-1974. Based on the information summarized above, it appears prudent to:

* Data are not available to estimate the total number of vehicles of a given type. Estimates are made on the basis of TOE (Table of Organization and Equipment) allowances for the various military units.

a. Put highest priority on gathering data on those foreign vehicles that have no U. S. analogs.

b. In all cases possible, collect signature data (concurrently) on the foreign vehicle and its U. S. analog to demonstrate that the U. S. analog actually generates a facsimile signature.

c. Review and study existing DOD signature data to compare (where possible) signatures from U. S. analog vehicles and the corresponding foreign vehicles to demonstrate that the U. S analog actually generates a facsimile signature.

d. Solicit from the Foreign Science Technology Center and other intelligence sources information on those vehicles identified as important but for which no descriptive data are available.

Aircraft

15. Criteria similar to those stated in paragraph 12 for ground vehicles were applied to the foreign aircraft (Tables 7 and 9) to arrive at a listing of foreign (exclusively USSR) aircraft from which signatures are desired (Table 13). It should be noted that data on the number of any identified aircraft were not available; therefore, the listing in Table 13 should be considered tentative. As much of the target data identified in Reference 3 (Table 1) as was available was assembled for each foreign aircraft listed in Table 13, and the values of these parameters were compared by computer with the corresponding values for the U. S. aircraft. This analysis resulted in identification of USSR aircraft that could be considered analogous to a given U. S. aircraft. The characteristics of the U. S. aircraft are listed in Table 14 along with the corresponding data for as many of the desired aircraft as applicable. The U. S. aircraft (extracted from Table 14) that can be considered analogous to the foreign aircraft and should be used in the data collection program are:

Rotary-Wing	Fixed-Wing
CH-46F	None available
UH-IN	
TH-57A	
CH-3B	
HH-IK	

Study of Tables 13 and 14 reveals that a U. S. analog is not listed for every desired foreign aircraft, i.e., no analogs were found for the following aircraft:

Rotary-Wing	Fixed-Wing
Mi-12	Tu-22
Mi-10	Tu-95
Mi-6	Tu-16
Mi-4	Be-12
	Yak-25
	MiG-25
	MiG-21
	An-22
	Il-76
	Tu-144

Also no data were available for certain foreign aircraft; therefore, it was impossible to determine whether there is a U. S. analog. These aircraft are:

Rotary-Wing	Fixed-Wing
Ka-15	Tu-22
Ka-22	Tu-95
Yak-24	Tu-16
	Be-12
	Yak-25
	MiG-25
	MiG-21
	An-22
	Il-76
	Tu-144

16. In summary, there appear to be few U. S. aircraft that can be assumed to generate seismic and acoustic signatures that would be facsimiles of signatures generated by USSR aircraft. It is emphasized that the results presented in paragraph 15 are based on incomplete data: therefore, the conclusions presented on the foreign aircraft from which signatures are desired (Table 13), as well as the list of foreign vehicle analogs (paragraph 15 and Table 14), should be considered tentative.

PART III: TEST SITE REQUIREMENTS

17. It is desired that REMBASS work satisfactorily any place in the world. It is generally recognized that there will inevitably be conditions under which the terrain will constrain the operation of the system, but the goal is to develop a system that is as terrain insensitive as possible. Experience with classifying sensors has emphasized that their performance was closely related to the terrain conditions on which the design data base was generated; therefore, it is important to know where in the spectrum of world terrain a given test condition lies. From a statistical standpoint, testing in all terrain conditions that affect seismic and acoustic signatures appears impossible; so the ability to generalize, i.e. extrapolate or interpolate the signals collected at a site, is as important as the data collection effort itself. The test sites recommended for use have been selected on the assumption that the data could be generalized by analytical methods. The rationale for establishing the test site requirements is developed in the following paragraphs.

Terrain Factor Considerations

18. Seismic signatures are normally more sensitive than acoustic signatures to environmental conditions, but exceptions do occur. For example, wind has both a direct effect on acoustic signatures (i.e., it could carry the sound away from the sensor) and an indirect effect (i.e., it could cause noise as it flows around vegetation), and thereby could obscure the acoustic signals. Also, soft soil conditions can cause a vehicle target to work harder, thereby increasing the engine noise; but at the same time, the soft soil would tend to decrease tire or track and hull noise. Because of this sensitivity of seismic signatures, the test site selection criteria are based primarily on seismic considerations, but documentation of site conditions should include all the terrain data (specified in Reference 3) needed to extrapolate both seismic and acoustic signatures to other terrains.

19. The terrain factors that significantly influence the magnitude and frequency content of a generated seismic signal are:

a. Ground surface rigidity (surface spring constant, N/m; and maximum deformation, m).

b. Bulk properties (compression wave velocity, m/sec; shear wave velocity, m/sec; and bulk density, g/cm^3).

c. Depths to interfaces, m.

d. Surface roughness, rms elevation in cm (important only when it causes motion in the target mass; used primarily for vehicle targets and not walking-man targets).

These factors are discussed in the following paragraphs.

20. As a target moves along the ground surface, the material over which it moves will deform in a nonlinear manner. The amount of deformation can be estimated from load-deflection (plate-load) tests on the material.[30] The force the target applies to the ground with respect to time is related to these ground deformations, thus affecting the magnitude of the seismic signal generated by the target.

21. The properties of the various soil layers (i.e. compression wave velocity, shear wave velocity, bulk density, and thickness of each layer of material) affect to a great extent the coupling and propagation of the generated seismic signal. These parameters vary directly with the type of material present. Generally, a more rigid material will allow less coupling of the signal to the substratum, but will attenuate the signal to a lesser degree as it is propagated. Conversely, a softer material will allow more coupling of the signal energy, but will attenuate the propagated signal to a greater extent. In general, for a given surface soil condition, the shear wave velocity and depth of the first and second layers are good indicators of substratum rigidity and therefore, to a large extent, control the seismic responses from a given location. These factors used in conjunction with WES propagation models form the keystone for selecting the test site and relating the test results to worldwide conditions.

Terrain matrix

22. To approximate the spectrum of terrain conditions that affect the generation and propagation of seismic signals, the normal range of variation for each of the terrain factors (paragraph 19) was defined, and a terrain matrix, elements of which are realistic combinations of terrain factors, was compiled (Table 15). It was recognized that a matrix could not be designed that would account for every possible variation in terrain conditions that is known to exist in the world. For this reason, the following guidelines were followed in developing the terrain matrix:

- a. All elements of the matrix should be composites of terrain features that could most likely be found in the real world. The matrix elements selected should represent those conditions that would be likely to occur a significant percentage of the time.
- b. The matrix should contain combinations of factors that would result in the "best-case" and "worst-case" performances, and also combination of factors that would result in performances for several intermediate cases. Thus, the matrix should span the ranges of values that are possible in the world environment.

The derived terrain matrix (Table 15) contains 70 terrain elements. From a technical standpoint, it would be desirable to test the vehicles in real-world conditions that correspond to all 70 terrain elements; but for practical reasons, signature data will have to be obtained from much fewer locations. For this reason it is important to establish the relative significance of each element, i.e. areal extent and the degree to which each element affects the seismic signal.

Seismic response

23. From previous studies (paragraph 21 and Reference 10) at WES, it has been shown that the shear wave velocities of the surface and subsurface soils strongly influence the generation and propagation of seismic energy. This fact suggests that seismic responses could be displayed in terms of shear wave velocity and thereby provide a rational

means of grouping or further generalizing the elements listed in Table 15. Figure 1 displays the shear velocities for the various terrain matrix elements, i.e. top-layer-material shear wave velocity versus foundation-material shear wave velocity, along with the general descriptions of the materials commonly found with the various shear wave velocities (a more complete description of each element is given in Table 15). Each of the crosses in Figure 1 represents several elements in which the layer thicknesses are different (e.g., top layer is 0.25, 1.5, or 4.0 m thick). The values of shear wave velocities shown are presented to span the range of values found in nature (excluding hard, competent rock); therefore, note that the top-layer-material shear wave velocity ranges to about 1200 m/sec. Top and foundation layers can be found that exhibit the full range shown; however, velocities in surface layers greater than about 600 m/sec are relatively uncommon.

24. To generalize the relative seismic response from each matrix element, seismic signatures predicted for the PT76 (USSR light tank) at a range of 300 m were analyzed (Figure 2) in terms of the maximum signal amplitude; i.e., if the particle velocity span (maximum positive peak to negative peak) of the seismic signature was between 0 and 0.2×10^{-3} cm/sec, the matrix element was considered to have poor seismic response; if the particle velocity was between 0.2 and 0.5×10^{-3} cm/sec, the seismic response was considered fair; and if the particle velocity was 0.5×10^{-3} cm/sec or greater, the seismic response was considered good.

25. Large amounts of seismic signature data have been collected by WES and other DOD agencies at sites in the following locations:

	WES	Other DOD Agencies
Yuma, Arizona	X	X
Vicksburg, Mississippi	X	-
Fort Huachuca, Arizona	X*	-
Panama Canal Zone	X	X

*Data collected in both wet and dry seasons.

	WES	Other DOD Agencies
Fort Bragg, North Carolina	X*	X
Eglin Air Force Base, Florida	X	X
Aberdeen Proving Ground, Maryland	X	X
Fort Wainwright, Alaska	X	-
Honeywell Proving Grounds, Minnesota	X	X
Nellis Air Force Base, Nevada	X	-
Fort Lewis, Washington	X	-
Puerto Rico	X	-
West Germany	X	-
Fort Carson, Colorado	X	-
General Motors Proving Ground, Milford, Michigan	X	X
Fort Belvoir, Virginia	X	X

* Data collected in both wet and dry seasons.

Figure 3 shows a plot of shear wave velocity for the top and foundation layers at all sites at which WES has collected data. Comparison of Figures 2 and 3 reveals that the bulk of the signature data have been collected at sites that have relatively good seismic responses. For this reason priority should be given to testing at sites that have relatively poor seismic responses, i.e. sites that have high shear wave velocities in their first and second layers.

Areal extent of the terrain elements

26. To arrive at an estimate of the relative occurrence of each of the terrain elements, they were correlated with published map information. As indicated in paragraph 19, the terrain factors in the matrix are quite specific; but the published information on the world's terrain conditions is normally thematic maps of physiography, agriculture (soil type and texture), lithology, etc. Correlation between the terrain matrix elements and the more general mapped data can be established in only a qualitative sense, and then only if several of the general terrain factors are combined and considered simultaneously.

27. The published maps were reviewed to determine (a) the types and quality of thematic maps available, (b) their scale and usefulness

in meeting the required objectives, and (c) their immediate availability. Five thematic maps depicting regional associations of terrain characteristics (factor families) were selected: surface configuration, surface soil texture, subsurface lithology, state of ground (water table regimes), and vegetation (see Tables 16-20). These maps were regionally interpreted and adapted to provide the required input data for the compilation (or superposition) of thematic maps of the world. A map scale of 1:50,000,000 was chosen as being the most compatible for the mapping task.

28. The five thematic maps were stacked manually to compile and produce a thematic factor complex map. This compilation process generated "unique" map units of the world that are characterized by an array of five separate terrain characteristics (factor families). A total of 1052 unique map units were thus identified (Plate 1). Table 21 is the legend for the factor complex map (Plate 1). The numbers in the legend under surface configuration, soils, lithology, etc., correspond to the category numbers identified in Tables 16-20. For example, map unit 1 (Table 21) is situated in a plain (Table 16, category 1), the soil is predominantly sand (Table 17, category 1), and the lithology is consolidated rock (Table 18, category 1), etc.

29. The terrain descriptions that identify the various terrain matrix elements (Table 15) were qualitatively correlated with the array of terrain characteristics obtained from the five thematic maps (Table 22). For example, terrain description 1.10 could exist in each terrain factor under which a 1 is entered in the first line of Table 22. A computer program was developed to associate the unique map units of the thematic factor complex map with all the possible terrain descriptions that could be associated with the various terrain matrix elements. Table 23 is a portion of the computer-generated key that identifies the terrain matrix element terrain description numbers associated with the unique map units of the thematic factor complex map.

30. On the basis of the shear wave velocity criteria shown in Figure 2, for both the surface and foundation materials, and the thickness of the surface layer, the terrain matrix elements were classified

into the seven categories of seismic response (Table 24). Using this classification scheme, each unique map unit of the thematic factor complex map, which had been previously correlated with the terrain matrix element terrain description numbers, was assigned to a category of seismic response, thus producing a world map that delineates areas of relative seismic response (Plate 2). It is emphasized that the map depicts the predominant seismic response of each area. Within each area delineated, the seismic response will vary because of local variation in terrain conditions that could not be identified at the mapping scale used. Study of Plate 2 illustrates two points:

a. A significant portion of the world will exhibit fair to good seismic response (category 3); therefore, it can be assumed that seismic sensors can be designed to function adequately in a large portion of the land mass of the world.

b. Figure 3 shows that relatively few tests have been conducted at sites that fall in category 3; therefore, additional signature data should be collected in these types of seismic-response areas. Also, significant portions of the world's land mass exhibit fair to poor seismic response, and extensive signature data should be collected in these areas also (categories 6 and 7).

Test Site Recommendations

31. In general, a spectrum of sites (based on their shear wave velocities) should be selected to span the range of variation found in nature. Because the bulk of available signature data has been collected in areas of relatively good seismic response, priority should be given to data collection at sites with top-layer shear wave velocities greater than about 400 m/sec. The foundation-material velocities should range from about 200 to 1600 m/sec. The sites should exhibit a variety of first-layer thicknesses. Since surface conditions affect seismic and acoustic signatures, tests should be conducted on a range of surface

conditions; i.e., tests should be conducted on both smooth roads (good-quality gravel or pavement) and cross-country, and one site should have soil soft enough to result in extensive rutting. More specifically, the following tabulation can be used as a general guide to selecting sites.

Condition	Top-Layer Shear Wave Velocity m/sec	Foundation-Material Shear Wave Velocity m/sec	First-Layer Thickness m	Site Surface	Priority
1	>500	300	>2.0	Cross-country	2
2	>400	>400	N/A	Smooth road	1
3	>400	>400	N/A	Cross-country	2
4	>400	>600	<0.5	Cross-country	2
5	>400	>600	<0.5	Smooth road	1
6	>400	>600	>1.0	Cross-country or smooth road	2
7	>700	>1000	<0.5	Cross-country	2
8	>700	>1000	>1.0	Cross-country or smooth road	1
9	<200	>200-<600	<0.5	Smooth road	2
10	<200	>600	>0.5	Smooth road	3
11	<200	>600	>1.0	Smooth road	3
12	>400	>600	<0.25	Smooth road	2
13	<200	>600	>1.75	Smooth road	2
14	<200	<600	>1.0	Smooth, soft surface (extensive rutting desired)	1

32. Other factors that must be considered in the selection include:

a. Ease of access to the site.

b. Vehicle logistic and security support.

c. Weather conditions; for example, testing in Alaska in the winter would not be cost-effective.

d. Background noise, cultural and natural.

No site will be optimum with respect to site and support conditions, and the selection should be biased toward the site conditions and priorities listed in paragraph 31. Also, specific sites used for collection of design data should be situated where the background noise is relatively quiet. Sites meeting almost all the criteria listed above can be found on government property at Yakima Firing Center, Yakima, Washington; Fort Hood, Texas; and test areas available at the WES, Vicksburg, Mississippi.

PART IV: BACKGROUND NOISE CONSIDERATIONS

33. One major complication in designing classifying sensors is the impossibility of incorporating a sufficient number of realistic background noise signatures into the design data base. A sensor must be designed to operate at any arbitrary point where the background noise is the result of a combination of various noise sources. The noise source will often be transitory (storms, highway and air traffic), but can be permanent (pumping stations, stream noise, etc.). Furthermore, the distance from the noise source will affect the resultant noise signature.

34. To attempt the collection of a sufficient number of background signatures that would constitute a statistically representative sample of the total population of background signatures is probably foolhardy. It appears much more feasible to collect data from a number of independent noise sources and combine them analytically by using seismic- and acoustic-signal propagation models.

35. Figure 4 shows the five major steps required to develop a realistic background noise design data base: (a) catalog background noise sources, (b) obtain signatures from the various sources, (c) determine interrelation of sources, (d) compile a matrix of sources and their corresponding distances from arbitrary points in the world environments, and (e) superimpose signatures from sources by using WES propagation models. The following paragraphs discuss these steps in more detail.

Noise Sources

36. Independent noise sources are grouped into two categories: cultural and natural. Cultural background noises are those nontarget noises that are the result of man's presence or activities. Natural background noises are those nontarget noises that are the result of nature's activities. Table 25 is a tentative list of noise sources that are considered to be sufficiently independent (or unique) to yield representative signatures. The field data collection program should be directed toward measuring signatures from these sources. Measurement

duration should include at least one 24-hr cycle.

Map Study

37. In any geographic location of the world, at any selected point on the ground, at least one and probably more of the cultural noise sources listed in Table 25 will be encountered. In some large geographic areas, such as countries or segments of countries, there will be a certain mix of cultural sources that could be expected to occur at any given location. This may be due to such factors as the overall level of development, long-term cultural history, or primary commercial products (industrial, agricultural, etc.). One factor that would certainly affect the mix would be the proximity to the point source selected. That is, the larger the area (around a selected point) considered, the greater the probability that a large number of background noises will be encountered. Thus, to determine the probable mix to be encountered, the sampling points for a given geographic area must be not only randomly selected, but also sufficient in quantity to ensure a statistical representation within some desired confidence limits. In the case of a particular interest, the purely random aspects might be partially abandoned in the form of influencing the sampling locations so that they are representative of the range in variation of the contributing factors. For instance, in considering seismic signatures, such factors as soils, geology, vegetation, slope, etc., play a part in contributing to the resulting signature. Thus, it is desirable to select areas (on the basis of an analysis of the combination of these factors) that are representative of the range of variations existing. This was accomplished in West Germany. Figure 5 shows the locations of the 1:50,000 quadrangle areas that are deemed to be most representative of the range of variations that exist in the terrain factors mentioned above.

38. Within each 1:50,000 quadrangle selected for study the noise sources had to be sampled. The following paragraphs describe the procedures by giving an example using the Fulda quadrangle northeast of

Frankfurt. The geographic boundaries defining the quadrangle were used as the limits of consideration, and a random number generator was used to select 20 points within the sample quadrangle boundaries (see Figure 6). Each of these 20 points was plotted on the quadrangle and used as a reference in determining the mix of background noise sources that was encountered at various distance classes from the randomly selected points, i.e. 0-0.5, 0.5-1.0, and 1.0-2.0 km (see Figure 7). For each distance class, an inventory of the cultural background noise sources was made. The method described above was applied universally to all 20 points (Universal Transverse Mercator Grid coordinates are listed in Table 26), which resulted in the inventory of noise sources listed in Table 27. This inventory shows the types and numbers of background noise sources encountered as a function of the distance from the sampling point. The numeric codes for the types of background noise sources are identified in Table 25.

A Method of Compiling the Noise Signature Data Base

39. A terrain matrix element can be associated with each sampling point, thereby providing the necessary terrain data for using the WES propagation models to make a realistic composite signature for each sampling point. The composite signature is produced by associating each noise source identified (Table 25) with a random distance selected within the various distance ranges (0-0.5, 0.5-1.0, and 1.0-2.0 km), from the point at which the signature is desired. Then for each noise source identified, a measured signal (a facsimile of the noise source identified) is input to the propagation models and a new signal is calculated for the proper range. Once calculations are made for all the measured signals (i.e., these signals are propagated to the desired point), the signals are summed to make a composite background noise signal that is directly related to the real-world environment. The immediate objective that emerges for the field sampling program is the collection of the background noise signatures for the noise sources listed in Table 25.

PART V: DATA COLLECTION PLAN

40. As stated earlier, state-of-the-art techniques for correlating target signature features with the various vehicle classes require a signature data base representative of the total signature population. A rigorous definition of an adequate data base cannot be made at this time (July 1975) because information is not available to define the expected signature variation from a given vehicle type (i.e. the M113 type or the M151 type) nor the signature variation from a given vehicle class. Table 1 identifies the target variables, i.e. components of the ground (wheeled and tracked) and air (rotary-wing and fixed-wing) vehicles that are known to affect seismic and acoustic signatures to some degree. Table 1 contains a sufficient number of variables to suggest that there can be a great deal of signature variation within a given target class. Furthermore, some signature variations within a target type can be expected because of differences in manufacturer and because of the normal variations in mechanical performance caused by changes in part tolerances with age (wear).

41. The design data base should have signatures that span the range of signature variations not only as a function of the various types of vehicles within a class, but also as a function of the environment within which the signature is generated. Data to define the signal variation associated with a target type and class should be generated with single targets. These data are intended to provide the required data for REMBASS engineering development, i.e. for the simpler single-target classifiers. For a classifier capable of performing in a multiple-target environment (advanced-development classifiers), data must be generated to permit definition of the information extractable (about a single target) from signatures made up of two or more targets.

42. This part of the report describes a series of tests that will yield data critical to the definition of the seismic and acoustic signal variations within a target type and target class. Also, a plan is presented for the collection of seismic and acoustic response data

from multiple targets such that an information extraction threshold (concerning a single vehicle) can be defined. Further, data collection from background noise sources (Table 25) is described.

Single-Target Data Acquisition

Signature variations from targets of a single type

43. Signature data collection programs are often conducted using only one vehicle to represent a vehicle type. Often, as in the case of foreign vehicles, only one vehicle is available; furthermore, excessive costs preclude use of more than one target type if U. S. vehicles are used. The danger exists, however, that a specific vehicle could have a discrepancy that generates a signature feature that could bias the design of the logic of a classifying sensor. During the production of a specific type of vehicle, production controls ensure that the component parts meet certain specifications. During assembly, these parts are connected, again within certain tolerances, into a working mechanical system.

44. The performance of this assembled system must also meet certain specified criteria, and it is probable that only slight signature variations will result from vehicle to vehicle, especially when the measurement being used considers the synergistic effect of the many slight variations, i.e., variations in one component may tend to compensate for variations in another. Certain vehicle components may tend to wear unevenly; therefore, old vehicles may produce more erratic or significantly different signatures than new ones.

45. To rigorously ascertain the signature variations for all the vehicle types of interest would be extremely costly and time-consuming. Some data, however, are badly needed to demonstrate that signatures from a single vehicle are representative of signatures from that vehicle type. The following paragraphs present a plan for determining signature variations in a specific target type. A set of tests to be conducted, in which signatures are measured under controlled conditions, will be

described, and the data necessary for characterizing the target and terrain conditions will be specified.

Targets

46. The tests will be restricted to types of vehicles within two target classes: wheeled and tracked vehicles. Based on the comparisons according to probable seismic and acoustic signatures (Table 11), and the resulting targets defined for use in the data collection program, the tests will use an M35A1 wheeled vehicle and an M113 Armored Personnel Carrier tracked vehicle. The data to be collected and the test conditions specified will apply to both vehicles.

47. Three vehicles of each type should be selected at random from a large pool (more than 20) of vehicles whose overall condition is determined to be "reasonably representative of live conditions," e.g. have been readied for unit training by normal maintenance procedures. The selection of these vehicles, from those available for use at the test site, should be accomplished with a minimum of bias.

48. Once the vehicles have been selected, they should be inspected for major deficiencies such as a bad muffler, etc. If such deficiencies exist, the vehicle should be rejected and another vehicle selected. The vehicle data listed in Table 1 should be compiled for each vehicle type to provide data for predicting seismic and acoustic signatures. In addition, the overall condition of each test vehicle should be documented so that variations in signal characteristics can be related to variations in vehicle conditions. At one test site it would be desirable to obtain signatures from a vehicle (if a multifuel vehicle is available) using both diesel oil and gasoline to provide a basis for comparing the signatures of significance as related to fuel.

Test site conditions and layout

49. No special test site condition is specified for these tests. Therefore, any of the 14 terrain conditions recommended in paragraph 31 would be satisfactory. However, the tests should be repeated in at least two different areas, e.g. Yakima Firing Center, Fort Hood, or Mississippi (total of 12 vehicles, six from each class).

50. The general layout for these tests is shown in Figure 8.

Three test conditions will be required: (a) a paved road; (b) a cross-country condition, i.e., characterized by soil covered with some type of low vegetation; and (c) an obstacle course that is level except for an obstacle, wider than the vehicle, placed at the closest point of approach to the sensor and perpendicular to the direction of travel. The obstacle should have a semicircular cross section whose height (radius) is 20 cm and base (diameter) is 40 cm. Each of these test conditions should be situated in the same environmental setting.

51. The constant-speed section (see Figure 8) of each test lane will vary in length depending upon the terrain conditions and target being tested. This distance will be the result of a field decision subsequent to determination of the seismic response characteristics of the site. In the past, this distance has varied from less than 500 to about 2000 m for the M35A1 and the M113. The acceleration and deceleration sections of the course should be at least 100 m long, but for the faster test speeds, more than 100 m may be needed for the acceleration lane.

Conduct of tests

52. Each vehicle should be run at two constant speeds through the smooth paved-road course--10 km/hr and convoy speed. The vehicle should be accelerated and decelerated gradually up to and from the desired constant velocity. For the cross-country test course, the tests should be conducted in the same manner except for speeds. For this course, each vehicle should be run at 7.5 and 30 km/hr. For the obstacle course, each vehicle should be run at constant speeds of 5 and 12 km/hr. An event mark should be placed on the signature recording to indicate entrance into and exit from the constant speed zone, and at each 50-m interval throughout the test course. Recordings of seismic and acoustic signatures should be initiated in the acceleration lane and be continued until the vehicle comes to a stop in the deceleration lane.

Signature variations from targets of a single class

53. As stated in paragraph 41, data to define the signature variations associated with a target class should be generated with

single targets. These variations result from differences in the vehicle types within the class in addition to differences resulting from travel mode of the target, site conditions, and range from target to sensor. Targets of interest for this data collection effort are: wheeled ground vehicles, tracked ground vehicles, rotary-wing aircraft, fixed-wing aircraft, men, and backgrounds. The U. S. ground vehicles selected as most desirable are listed in Table 11, and the desired aircraft are listed in Table 14 (note that no U. S. fixed-wing aircraft have been identified as analogous to Warsaw Pact aircraft). Walking-man targets, though not addressed in detail thus far in this report, are required and data should be collected from both single-man and squad targets (i.e. one, three, and seven men). Site requirements are recommended in paragraph 31. The following paragraphs discuss the test method and course layout for each target class.

54. Ground vehicles. The test method and layout should be identical to those described in paragraph 52 and shown in Figure 8, respectively. Duplicate tests should be run for each vehicle referred to in paragraph 13 on both improved road, cross-country, and obstacle sites on as many of the test (terrain) conditions listed in paragraph 31 as possible. The wheeled vehicle data acquisition should be conducted first, starting with the lightest vehicle and proceeding to the heaviest. The tracked vehicle data acquisition should follow in a similar manner. This sequence will minimize the influence of previous vehicle runs (i.e. on the geometry of the test path) on the on-going tests and eliminate the wheeled vehicle reaction to track pad imprints in the ground. This is especially important on cross-country sites; in very soft soils separate test lanes should be selected for wheeled and tracked vehicles.

55. Aircraft. Signatures from aircraft are less sensitive to terrain conditions but are affected more by atmospheric conditions than are signatures from ground vehicles. In addition, aircraft travel mode affects the resulting signature appreciably. The test layout for acquisition of aircraft signatures should consist of positioning a single triaxis geophone in the ground at some convenient position and burying a second triaxis geophone near the first and covering it with a

sufficient acoustical barrier to prevent direct coupling of acoustic waves to the geophone. The acoustical barrier should consist of a thickness (empirically determined) of sound-absorbing material such as fiberglass insulation. Both geophones should be positioned so that the axis of one of the horizontal geophones is oriented in the direction of the aircraft approach path for the tests. In addition to the geophones, an acoustic transducer should be located near the geophones to record the acoustic signatures of the targets. The aircraft test path should begin at a distance of 2 km from ground zero and proceed beyond ground zero for the same distance. It should be noted that the test layout above can be achieved by simply adding an acoustically protected triaxis geophone to the triaxis geophone-acoustic sensor array shown in Figure 8 (i.e. the array closest to the vehicle test path) and recording only the outputs from these three sensors. The aircraft test path would then parallel the vehicle test path and the vehicle test path could be used as a navigation aid by the aircraft pilots.

56. Duplicate tests should be run with the aircraft specified in Table 28. It is noteworthy that only rotary-wing aircraft are specified by name in this list. Fixed-wing aircraft (approximately three) should be included as they are determined to be applicable to the data-collection effort.

57. The travel modes for each aircraft should consist of horizontal flight at speeds one-half the normal cruising speed and at the normal cruising speed, at two heights above the ground of 150 to 750 m. In addition, signatures should be acquired for the aircraft descending from 750 m to approximately 50 m and ascending back to 750 m. The descent should begin at a position along the aircraft test path approximately 0.5 km from ground zero and terminate at ground zero. The ascent should begin at ground zero and be completed at a distance of 0.5 km from ground zero. The descent and ascent tests can be conducted as a single overpass; no touchdown is necessary.

58. The tests described above should be conducted in as many of the different subsurface conditions in paragraph 31 as possible so that the effect of terrain conditions can be completely evaluated. The

atmospheric conditions cannot be easily specified prior to testing, but should be thoroughly documented at the time the test is conducted.

Walking-man target

59. The layout for acquisition of signatures from walking-man targets should be identical to that shown in Figure 8, except that only the response of the triaxis geophone and the acoustic sensor closest to the travel path should be recorded. The targets should consist of one, three, and seven men and the travel modes should include normal route walk and march step (marching in unison). Two walk paths should be used, the first emphasizing low signal levels having a closest point of approach (CPA) of 15 m and the second having a CPA of 5 m from the triaxis geophone. Each target should start at a position 100 m from the CPA point and proceed beyond the CPA 100 m on both walk paths. When a road is available, one walk path should be identical to the vehicle test paths on the road, and the other should parallel the road in natural terrain. The tests should be conducted in as many of the 14 conditions listed in paragraph 31 as possible.

Summary

60. Table 28 summarizes the targets, site conditions, and travel modes needed for the definition of the variations within target types and classes. A total of 1420 test runs are identified with 740 considered essential, 544 considered second priority, and 136 considered third priority. The first column (Table 28) shows that none of the target types for fixed-wing aircraft are listed. Further study is needed to define the U. S. aircraft that should be used in the data acquisition program.

Multiple-Target Signature Acquisition

61. An advanced-development (AD) sensor must be capable of classifying single targets in a multiple-target environment and in worldwide terrain environments. Data must be collected in these environments so that specifications for the design of AD sensors can be prepared. Unfortunately, multiple targets present special problems in

an AD data collection program because the ranges of each vehicle to the sensor are restricted by the dynamic limits of recording system. If the recording limits are set so that a primary vehicle produces slightly below the maximum recordable signal, all secondary targets must be restricted in range so that the total combined signal level from all targets remains below the maximum. Thus, the choice in signal level dictates the nearest range at which secondary targets can approach the sensor. Also, a lower limit in signal amplitude is established by the noise level inherent in the recording process. A secondary target whose range increases to the point at which its signal falls below the noise level of the recorder does not produce usable information.

62. In summary, the combined signal strengths from all targets in a multiple-target data collection program must be restricted to the dynamic range of the recording system (i.e. above the noise level and below the recording saturation limit). For good analog recording systems, this dynamic range is restricted to approximately 30-40 dB, and for good digital recording systems, the dynamic range is restricted to approximately 50-60 dB. The dynamic range of the recorder can be shifted up or down to accommodate nearly all primary target requirements, but once it is set, the dynamic range then restricts the recordable signal level (and thus the range from target to sensor) of all secondary targets.

63. In the following paragraphs, a procedure is described in which the dynamic range of the recording system can be used to specify the ranges of both primary and secondary targets.

Range relations

64. The variation in the seismic signal from a target as it travels along a given path is the result of a complex interaction of the target with the ground surface. Both the signal amplitude and frequency change as a function of range even if the ground parameters remain constant and the vehicle continues at the same speed. Data summarized from tests on good sites (Fort Bragg, North Carolina), poor sites (Fort Wainwright, Alaska), and computer study results suggest that an inverse-square relation can be used to estimate the relative sensor-to-target

ranges for the primary and secondary targets for the ranges of interest to REMBASS for both good and poor seismic sites. Thus, if the range (R) from target to sensor doubles, the signal amplitude is reduced approximately by a factor of four (for ground targets).

Target relations

65. If only multiple targets of the same type were of interest, the $1/R^2$ relation could be used to set relations so that the dynamic range is not exceeded. Since targets of mixed types should be tested, a guide has been prepared to indicate relative amplitude between targets. In the tabulation below, the target seismic-signal amplitudes are normalized to the footstep-signal amplitudes (at the same range):

	Normalized Amplitude
Footstep	1
Light wheeled vehicle (M151)	10
Heavy wheeled vehicle (M35)	20
Light tracked vehicle (M113)	100
Heavy tracked vehicle (M60A1)	150

66. The differences in signal amplitude shown in the tabulation above must be compensated for by a difference in range between the primary and secondary targets. Thus, if equal signal amplitudes are desired for a heavy tracked vehicle and a light wheeled vehicle for example, the heavy tracked vehicle must be run at a longer target-to-sensor range than the light wheeled vehicle. The approximate range can be established by the $1/R^2$ relation as shown in the tabulation below.

Range for Secondary Target Amplitude to Equal Primary Target Amplitude

Secondary Targets at Range R_2 from Sensor	Primary Target at Range R_1 from Sensor: Footstep	Light Wheeled M151	Medium Wheeled M35	Light Tracked M113	Heavy Tracked M60
Footstep	$R_2 = R_1$	$R_2 = R_1/\sqrt{10}$	$R_2 = R_1/\sqrt{20}$	$R_2 = R_1/10$	$R_2 = R_1/\sqrt{150}$
Light Wheeled (M151)	$R_2 = \sqrt{10}\, R_1$	$R_2 = R_1$	$R_2 = R_1/\sqrt{2}$	$R_2 = R_1/\sqrt{10}$	$R_2 = R_1/\sqrt{15}$
Medium Wheeled (M35)	$R_2 = \sqrt{20}\, R_1$	$R_2 = \sqrt{2}\, R_1$	$R_2 = R_1$	$R_2 = \sqrt{0.2}\, R_1$	$R_2 = \sqrt{2/15}\, R_1$
Light Tracked (M113)	$R_2 = 10\, R_1$	$R_2 = \sqrt{10}\, R_1$	$R_2 = \sqrt{5}\, R_1$	$R_2 = R_1$	$R_2 = R_1/\sqrt{1.5}$
Heavy Tracked (M60)	$R_2 = \sqrt{150}\, R_1$	$R_2 = \sqrt{15}\, R_1$	$R_2 = \sqrt{7.5}\, R_1$	$R_2 = \sqrt{1.5}\, R_1$	$R_2 = R_1$

Multiple-target
<u>test program</u>

67. Multiple-target signals are desirable as part of the AD design data bank because the unique combination of signal levels that can result from such tests may not be amenable to single-target processing techniques. Targets of interest for this data collection effort are: wheeled ground vehicles, tracked ground vehicles, men, rotary-wing aircraft, and fixed-wing aircraft. Three vehicles in each vehicle target class and one man should be used in the test program as summarized in Table 29. The site requirements, target travel modes, target combinations, and test iterations for the program are listed in Table 30. The site requirements were selected from those test conditions listed in paragraph 21.

68. The following paragraphs briefly discuss the site layout and additional details of the test program. It is felt that the magnitude of the test program outlined is in the proper order; however, some deviations from the test plan are expected as the test program progresses because some of the data specified will become obviously redundant. Also, omissions will surface as the data are analyzed.

69. <u>Test layout</u>. The general test layout for multiple targets is shown in Figure 9. For each test two targets should be used, a primary target and a secondary target. As can be seen from Table 29, in part of the tests the primary and secondary vehicles can be the same type of vehicle (e.g. two M113 vehicles), but for most of the tests they should be different and represent all combinations of the listed targets. Note that during the conduct of a test, both high-level signals and low-level signals will be recorded at the same time depending on the ranges from targets to sensor and the type of target involved. An alternate walk path (path 2 for the walking-man target) is shown in Figure 9 and should be used as a substitute for the primary target path on the test lane when a high-signal-level condition for footsteps is desired. The gain of each recording channel should be set so that the primary target signal falls at approximately half of the dynamic range of each sensor channel. The secondary target signal will vary about this reference for all

secondary target ranges (even though some channels will be saturated for part of the run). The target and range relations listed in paragraph 66 can be used as a guide in selecting secondary target positions which will permit the collection of secondary target signals within the dynamic range of the recording system.

70. Ground vehicles. All ground vehicle paths include an acceleration section, a constant-speed section, and a deceleration section, as shown in Figure 9. For the primary target and the secondary target, each of the three sections should be at least 100 m long (for some speeds the acceleration and deceleration sections will have to be longer than 100 m). All accelerations and decelerations for each test should be synchronized as closely as possible so that the vehicles enter and leave the constant-speed sections together. Signal recording should be initiated at the beginning of the acceleration period and continue through to the end of the deceleration period. The constant-speed section for the primary vehicle should be centered about the zero CPA point (i.e. ± 50 m on either side of the zero marker), and the constant-speed section for the secondary vehicle should start at the 50-, 200-, 500-, 1000-, and 2000-m stakes on the test lane (i.e. D = 50, 200, 500, and 2000 m in Figure 9). Ground vehicle speeds for the tests are shown in Table 30. One exception to these guidelines is that for the test in which the primary and secondary vehicles are the same and the secondary target test range is 50 m. In this case, the constant-speed section should be extended until the combined signal amplitudes decrease to the noise level of the recording system. Secondary target signal amplitudes should remain within the dynamic range of the recorder (once set for the primary target). Any secondary target ranges that produce signal amplitudes larger than that from the primary target (i.e. for both the high-signal-level and low-signal-level conditions) should be eliminated; any secondary target ranges that produce signal amplitudes below the noise level of the recorder (i.e. for both the high-signal-level and low-signal-level conditions) should also be eliminated. These ranges can be estimated from relations discussed in paragraphs 64 and 65 and verified in the field by setting the dynamic range for the primary vehicle and

monitoring the signal levels from the secondary vehicle as it moves from CPA out to the maximum range.

71. Walking-man target. The paths for the walking-man target can be much shorter than those specified for the vehicle targets, but should take approximately the same travel time. For example, a vehicle traveling over a 100-m section at a constant speed of 10 km/hr and a man walking a 40-m section will require approximately the same travel time. Also, since the walking man can quickly repeat the primary target path (for both the high- and low-signal-level conditions) by merely reversing his direction of travel, the secondary target can continue its travel over the complete secondary path at a constant speed without stopping.

72. Aircraft. Because of the much higher travel speeds of aircraft than of ground targets and because of the difficulty in controlling aircraft position precisely, aircraft should be tested as secondary targets only for all aircraft-vehicle target combinations. Any ground target tested with an aircraft target should be considered the primary target and be positioned in the primary target constant-speed section during the test. Each test should consist of a single pass of the aircraft at a constant speed and altitude as the ground target travels over its primary target path at a constant speed. Aircraft speeds and altitudes should be as shown in Table 30; they are identical to those for the single-target tests (Table 28).

73. Multiple aircraft tests should be conducted in the same manner as for ground target tests when the primary and secondary targets are the same (see paragraph 70). The aircraft should be synchronized so that they pass the CPA at different altitudes at the same time going in opposite directions. The recording should be continued until the combined signal level decreases to the recording noise level for both the 40-m and 500-m sensors.

74. Summary. Table 30 summarizes the multiple-target test program. A total of 2952 test runs are identified and made up of various combinations of targets (fourth column of Table 30 and the target type and target combination matrix shown in Table 29), site conditions, and target travel modes.

Background Noise Signatures

75. Background noise signatures should be collected: (a) on an opportunity basis during the conduct of the previously described tests or enroute to these test areas, or (b) using a small sensor and recorder package at specific isolated noise sources. Signatures should be obtained for all cultural noise sources listed in Table 25 and as many of the natural sources as possible. The sensor systems used should include one triaxis geophone and an acoustic sensor located at ranges of 50, 200, and 1000 m from the noise source. The terrain conditions at each noise measurement area should be described according to the procedures outlined in Reference 3. Noise should be measured for a continuous 10-min segment of each hour of a period of 24 continuous hours. An effort should be made to obtain noise data in more than one terrain condition (perhaps two) from as many of the sources as possible.

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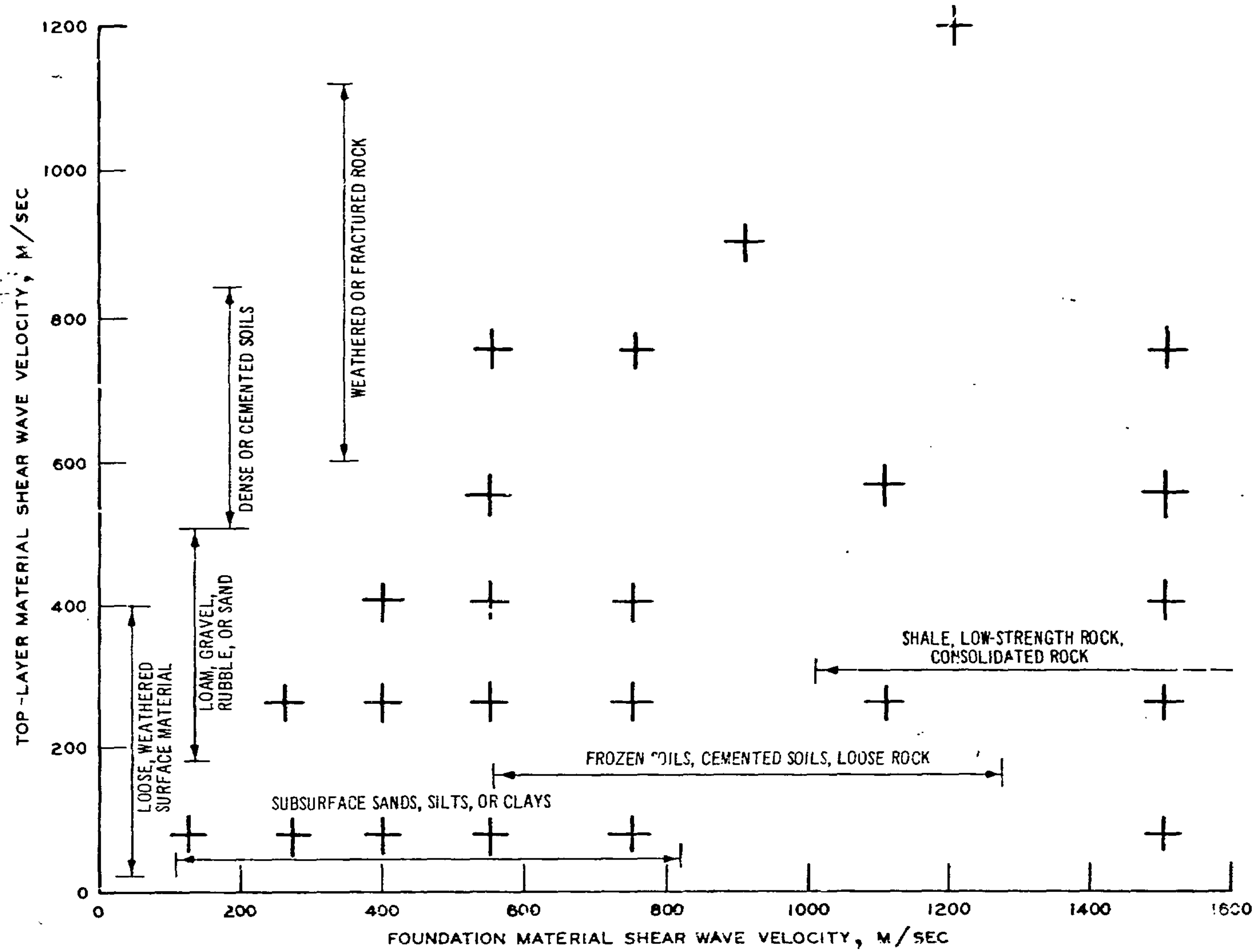

Figure 1. Terrain matrix elements displayed in shear wave space

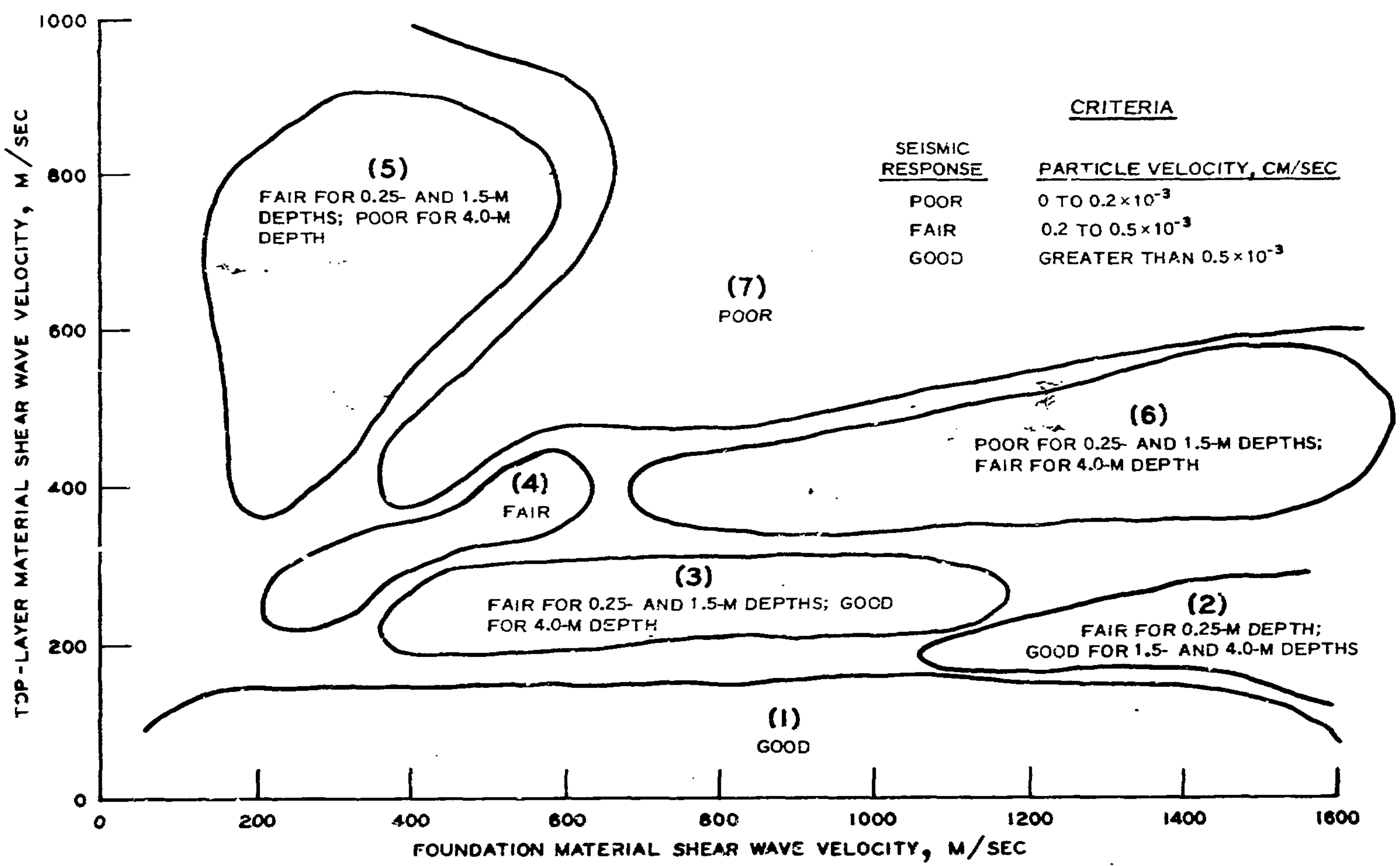

Figure 2. Relative seismic response from a PT76 (light tank) at a range of 300 m

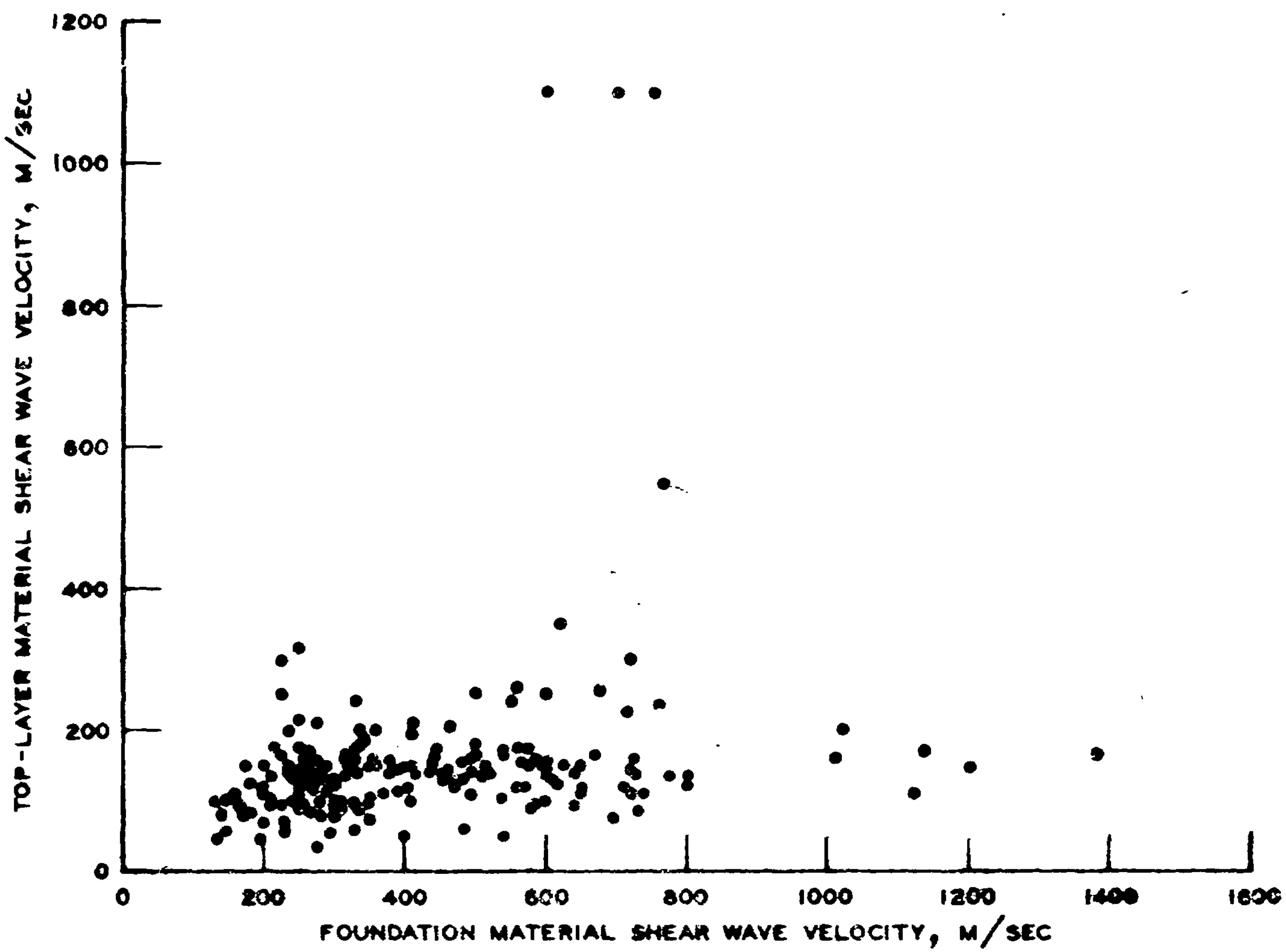

Figure 3. Shear wave velocity characteristics at all WES sites at which seismic signature data were collected

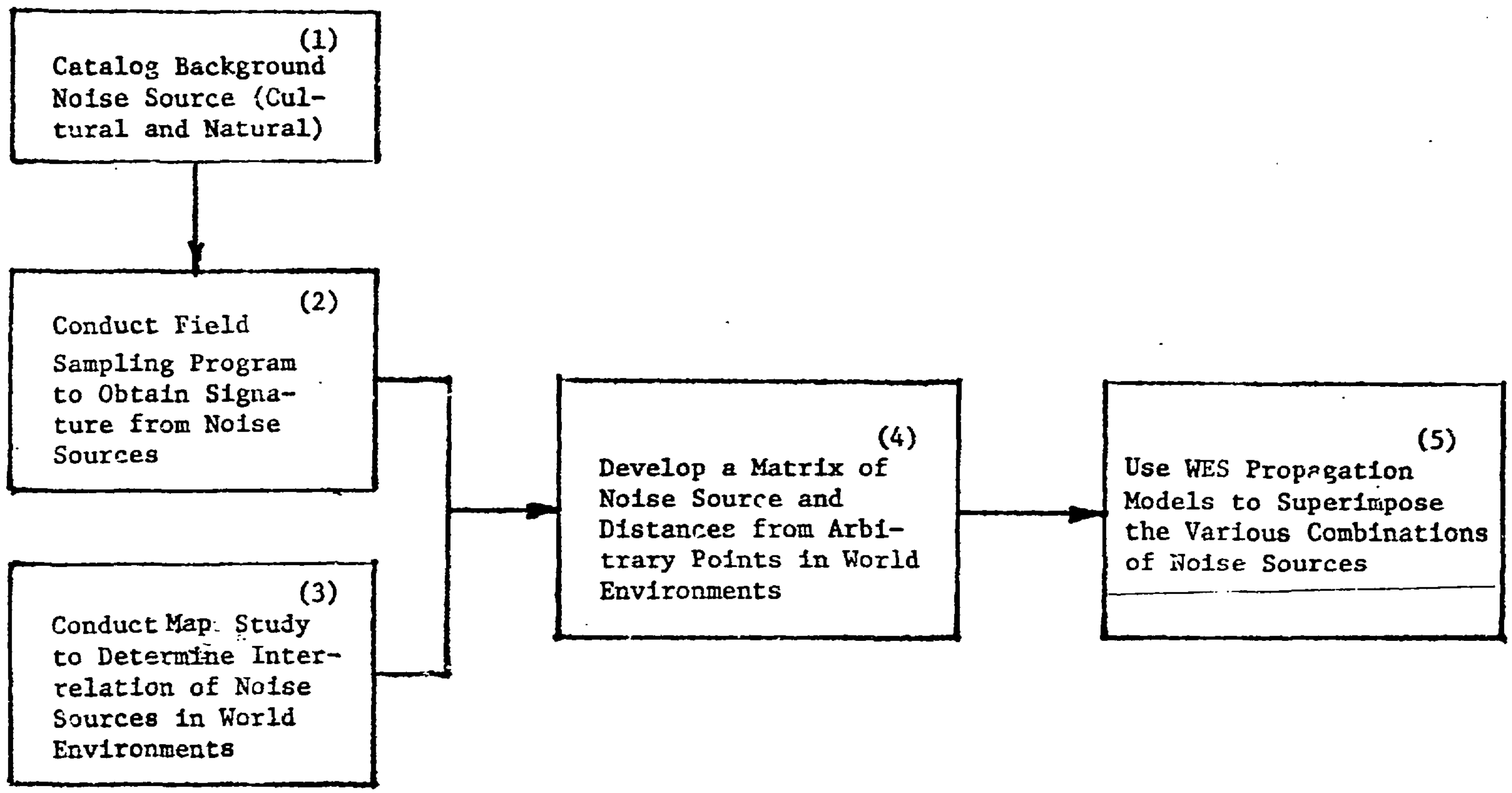

Figure 4. Major steps in developing a realistic background noise signature data base

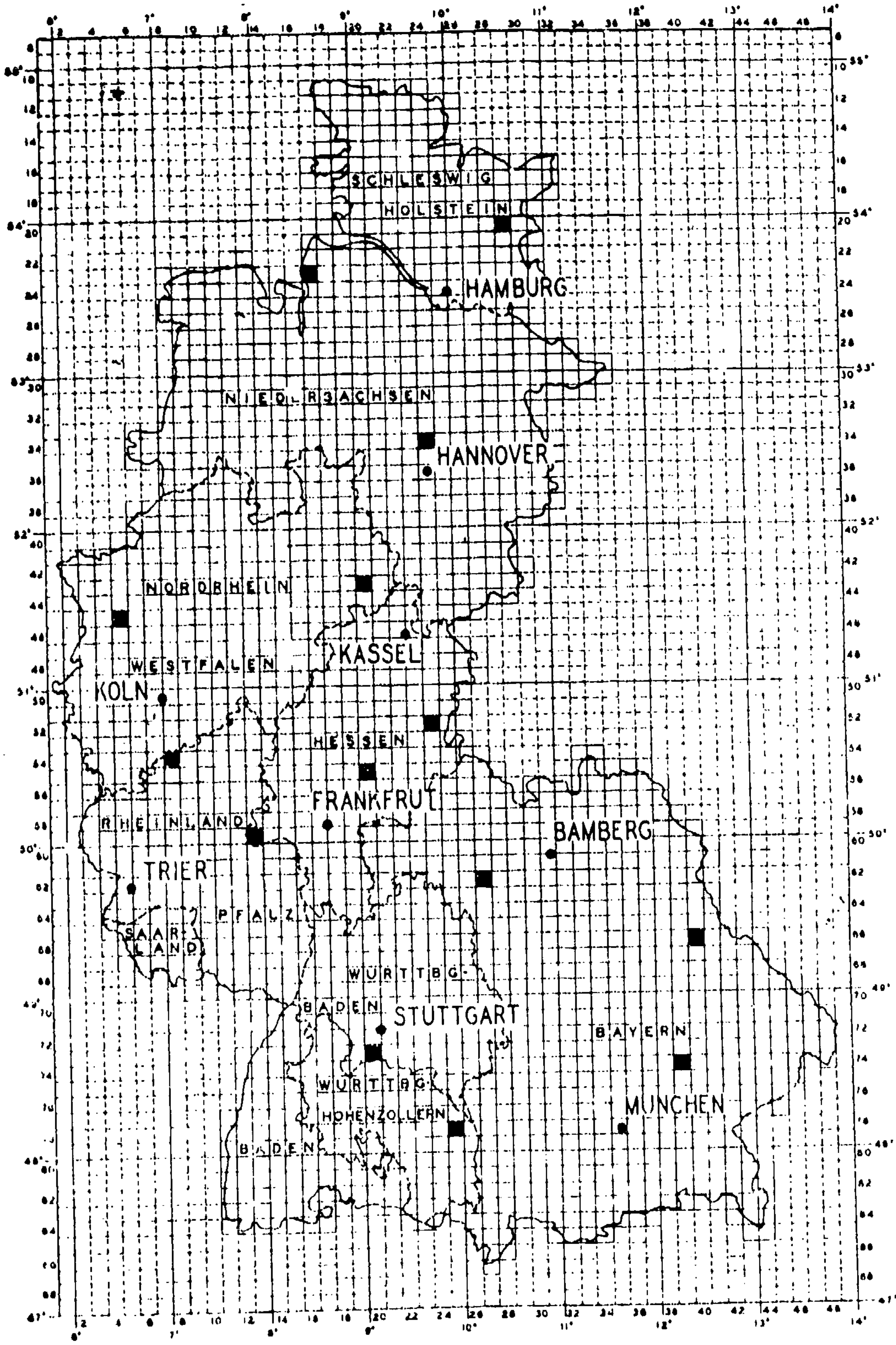

Figure 5. Location of 1:50,000 quadrangles that cover the range of terrain variations in West Germany

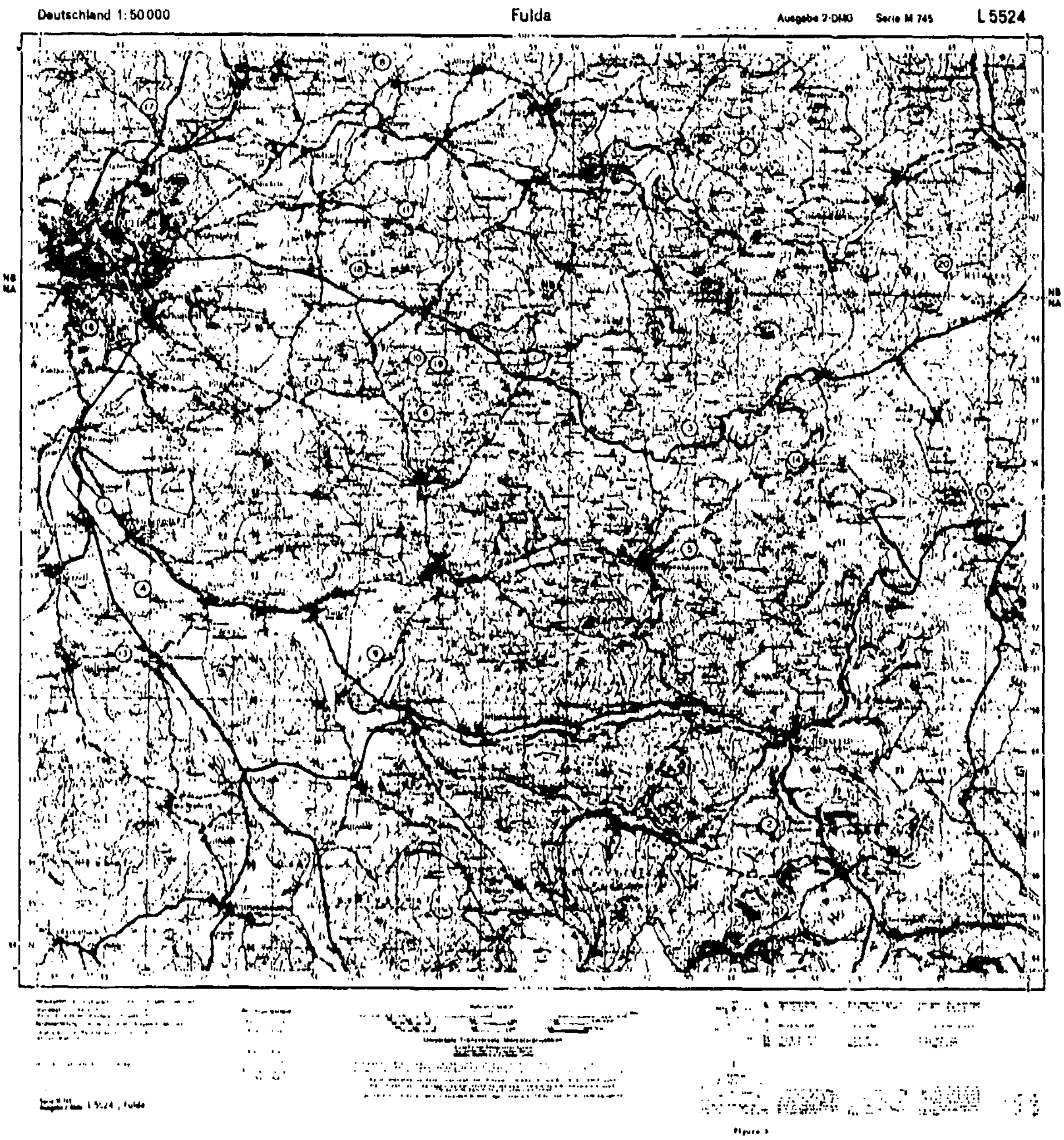

Figure 6. Sample locations, Fulda quadrangle

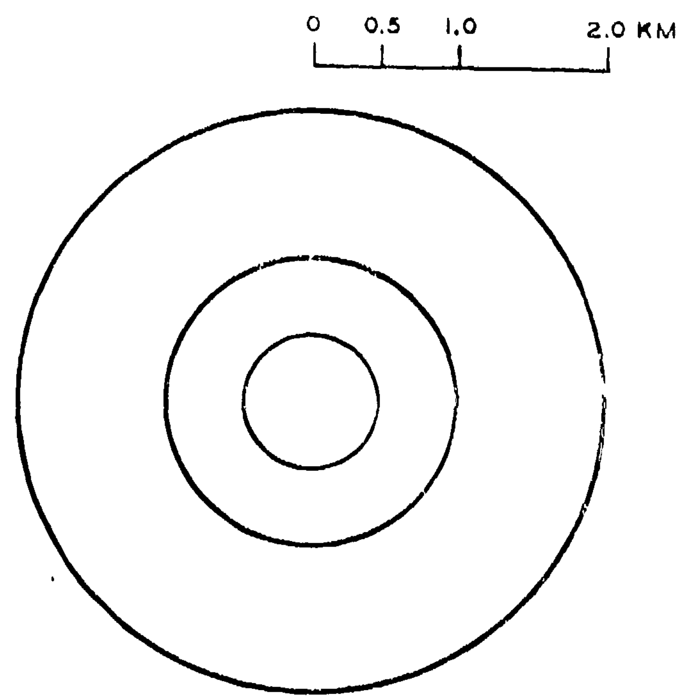

Figure 7. Sampling template for identifying a mix of background noise sources

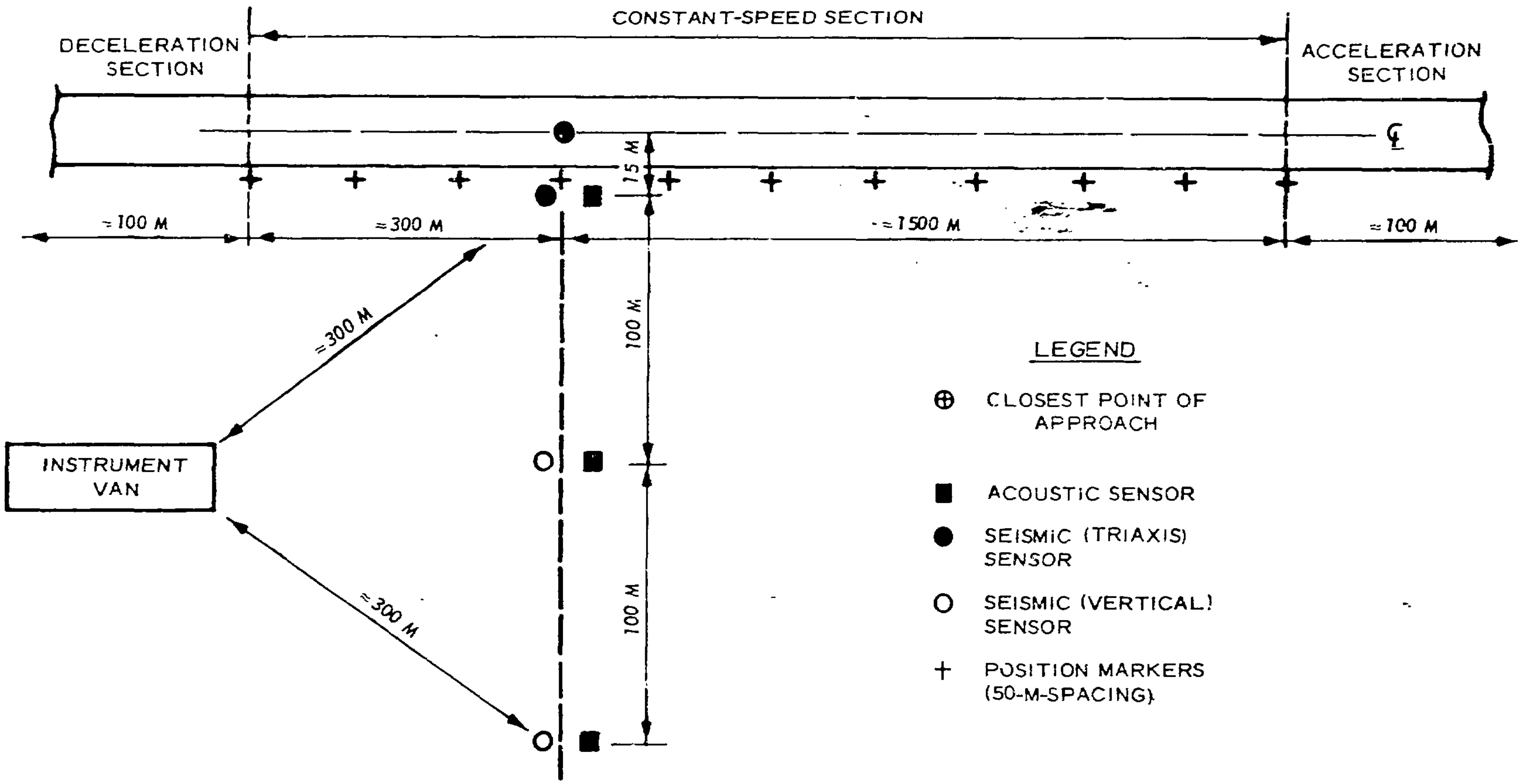

Figure 8. Test site layout for collecting signatures to establish the signature variations within a target type and class

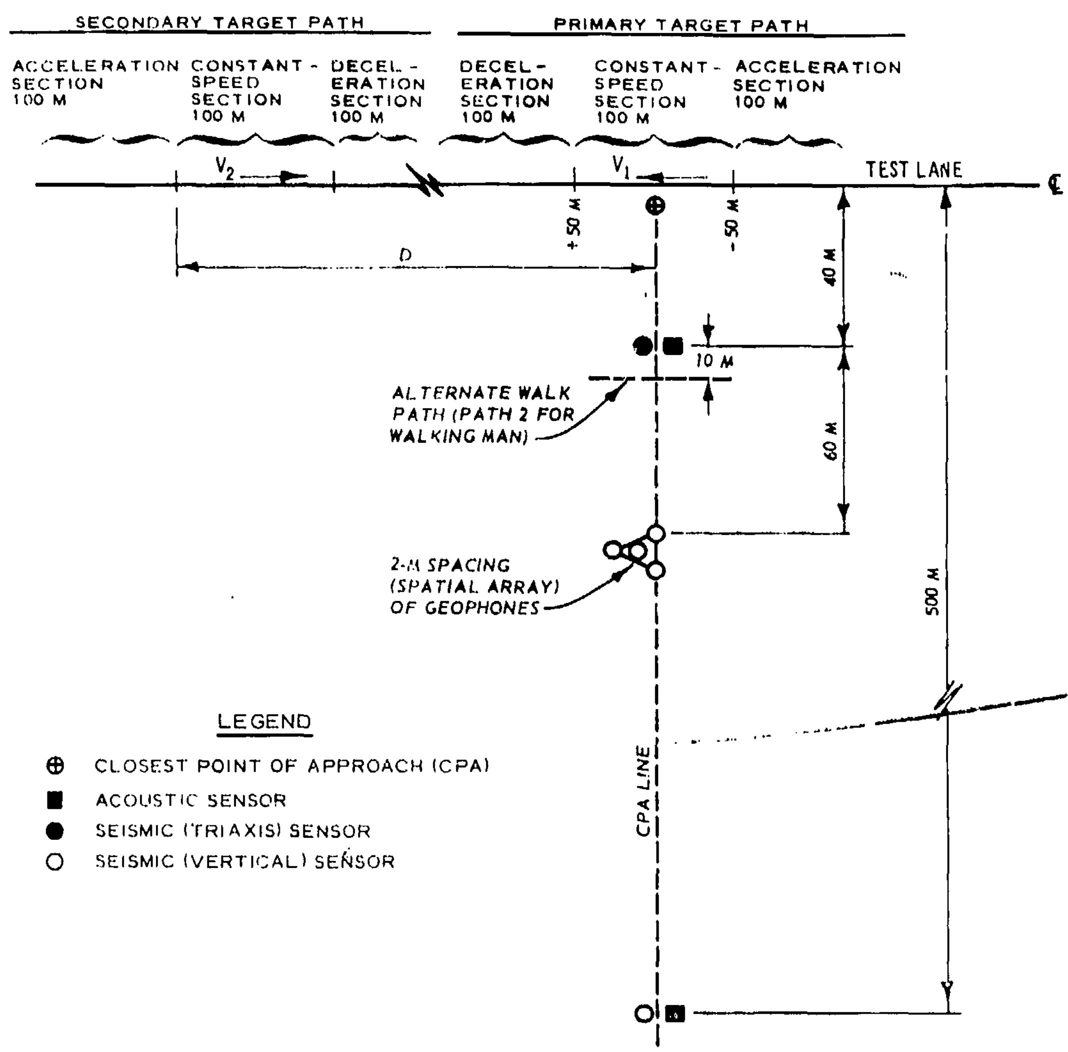

Figure 9. Test layout for multiple-target test program (not to scale)

Table 1

Target Characteristics that Affect Vehicle Seismic and Acoustic Signatures

Wheeled Ground-Contact Vehicles

Weight (empty)

Payload

Number of wheels

Tire size(s)

Number of tire lugs per wheel

Tire pressure

Tread depth (average)

Ground-contact area

Number of teeth in the axle gear in the final drive differential

Final drive differential gear ratio

Engine rpm versus vehicle speed curves for all gears. Vehicle should be loaded and run on level terrain at speeds up to 60 km/hr

Engine model

(1) Horsepower

(2) Number of cylinders

(3) Number of cycles

(4) Fuel type

(5) Cooling type

(6) Location of exhaust

(7) Number of blades in cooling fan

(8) Ratio of fan rpm to engine rpm

Suspension type, i.e. whether the vehicle has:

(1) Independent suspension

(2) No suspension, or any combination of independent and no suspension

(3) Bogie, walking-beam, or any combination of independent, bogie, and walking-beam

(4) Any combination of (1), (2), and (3)

(Continued)

Table 1 (Continued)

Wheeled Ground-Contact Vehicles (Continued)

Weight (kg) of unsprung mass, i.e. the weight of each wheel assembly. For a solid-axle suspension, use one-half weight of each axle assembly; for no suspension, use zero weight

Longitudinal distance(s) (cm) of each wheel center from the center of gravity

Static tire deflection at normal (or noted) tire pressure at combat load

Pitch inertia (kg-sec^2-cm) of sprung mass about center of gravity

Longitudinal distance(s) (cm) of driver from center of gravity

For each suspension unit (wheel assembly), complete suspension spring force-deflection relations from rebound to full bump

Tracked Ground-Contact Vehicles

Weight (empty)

Payload

Track pitch

Track width

Track condition, i.e., actual dimensions of track pads, number and location of broken shoes, etc.

Number of track pads on each side in contact with ground

Number of teeth on the track sprocket gear

Number of teeth in the axle gear in the final drive differential

Final drive differential gear ratio

Engine rpm versus vehicle speed curves for all gears. Vehicle should be loaded and run on level terrain at speeds up to 60 km/hr

Engine model

(1) Horsepower

(2) Number of cylinders

(3) Number of cycles

(4) Fuel type

(5) Cooling type

(Continued)

(Sheet 2 of 4)

Table 1 (Continued)

Tracked Ground-Contact Vehicles (Continued)

Engine model (Continued)

(6) Number of blades in the cooling fan

(7) Ratio of fan rpm to engine rpm

Suspension type, i.e. whether the vehicle has:

(1) Independent suspension

(2) No suspension, or any combination of independent and no suspension

(3) Bogie, walking-beam, or any combination of independent, bogie, and walking-beam

(4) Any combination of (1), (2), and (3)

Weight (kg) of unsprung mass, i.e., weight of the road wheel or bogie and one-half weight of the track

Longitudinal distance(s) (cm) of each wheel center from the center of gravity

Pitch inertia ($kg\text{-}sec^2\text{-}cm$) of sprung mass about center of gravity

Longitudinal distance(s) (cm) of driver from center of gravity

For each suspension unit (wheel assembly), complete suspension spring force-deflection relations from rebound to full bump

For each suspension unit with damping, complete force-velocity relations, both in jounce and rebound

The length (cm) along the leading portion of the track, measured from beneath the leading road wheel to the foremost part of the track

The approach angle (deg) (angle determined by a horizontal line beneath the leading road wheel and the leading force of the track)

Normal operating track tension (static)

Rotary-Wing and Fixed Aircraft

Weight

Payload

Number of engines

(Continued)

(Sheet 3 of 4)

Table 1 (Concluded)

Rotary-Wing and Fixed Aircraft (Continued)

Engine specifications:

(1) Type, i.e. turbine or piston engine

(2) Model

(3) Horsepower

(4) Number of cylinders

(5) Fuel type

(6) Type of cooling

(7) Exhaust configuration and location

(8) Number of fan blades

Table 2

Nomenclature of U. S. Wheeled Vehicles

1.	M1	33.	M43E1
2.	M1A1	34.	M43E2
3.	M6	35.	M44
4.	M20	36.	M44A1
5.	M26	37.	M44A2
6.	M26A1	38.	M44C
7.	M27	39.	M45
8.	M27B1	40.	M45A1
9.	M34	41.	M45A2
10.	M35	42.	M45A2G
11.	M35A1	43.	M45C
12.	M35A2	44.	M46
13.	M35A2C	45.	M46A1C
14.	M36	46.	M46A2C
15.	M36A1	47.	M46C
16.	M36A2	48.	M47
17.	M36C	49.	M48
18.	M37	50.	M48A2
19.	M37B1	51.	M49
20.	M38	52.	M49A1C
21.	M38A1	53.	M49A2C
22.	M38A1C	54.	M49C
23.	M38A1D	55.	M50
24.	M39	56.	M50A1
25.	M40	57.	M50A2
26.	M40A2	58.	M51
27.	M40A2C	59.	M51A1
28.	M40C	60.	M51A2
29.	M41	61.	M52
30.	M42	62.	M52A1
31.	M43	63.	M52A2
32.	M43B1	64.	M53

(Continued)

(Sheet 1 of 4)

Table 2 (Continued)

65.	M53B1	99.	M113A1
66.	M54	100.	M114
67.	M54A1	101.	M121
68.	M54A1C	102.	M123
69.	M54A2	103.	M123A1C
70.	M54A2C	104.	M123C
71.	M55	105.	M123D
72.	M55A1	106.	XM123E2
73.	M55A2	107.	M125
74.	M56	108.	M125A1
75.	M56B1	109.	XM125E1
76.	M56C	110.	M133
77.	M57	111.	M135
78.	M58	112.	M139
79.	M59	113.	M139C
80.	M60	114.	XM142
81.	M61	115.	XM145
82.	M61A2	116.	XM147E3
83.	M62	117.	M151
84.	M63	118.	M151A1
85.	M63A2	119.	M151A1C
86.	M63A2C	120.	M151A2
87.	M63C	121.	XM151
88.	M106	122.	XM151E1
89.	M107	123.	XM151E2
90.	M108	124.	XM157
91.	M109	125.	M170
92.	M109A1	126.	XM190
93.	M109A2	127.	XM191
94.	M109A3	128.	M201
95.	M109C	129.	M201B1
96.	M109D	130.	M207
97.	M110	131.	M207C
98.	M113	132.	XM207

(Continued)

Table 2 (Continued)

133. M209
134. M211
135. M215
136. M217
137. M217C
138. M220
139. M220C
140. M220D
141. M221
142. M222
143. M246
144. M246A1
145. M246A2
146. M249
147. XM249
148. M250
149. XM250
150. M274
151. M274A1
152. M274A2
153. M274A3
154. M274A5
155. M275
156. M275A1
157. M275A2
158. XM282
159. XM282E2
160. XM282E3
161. M291A1
162. M291A1D
163. M291A2
164. M291A2C
165. M291A2D
166. M292
167. M292A1
168. M292A2
169. M292A3
170. M292A4
171. M292A5
172. M328A1
173. M342
174. M342A2
175. XM342
176. M343A2
177. XM357
178. XM375
179. XM376
180. XM377
181. XM381
182. XM384
183. XM401
184. XM408
185. XM410
186. M422
187. M422A1
188. M425
189. M426
190. M427
191. XM434E1
192. XM434E2
193. XM437
194. XM437E1
195. XM437E2
196. XM438E2
197. XM443
198. XM453E1
199. XM453E2
200. XM453E3

(Continued)

(Sheet 3 of 4)

Table 2 (Concluded)

201. XM512
202. XM512E1
203. XM512E2
204. XM512E3
205. XM512E4
206. XM520
207. XM520E1
208. XM521
209. XM523
210. XM523E2
211. XM531
212. M535
213. M543
214. M543A1
215. M543A2
216. M548
217. M551
218. M553
219. XM554
220. M559
221. M561
222. XM561
223. M577
224. M578
225. M602
226. M607
227. M609A1
228. M610
229. M611
230. M611C
231. M613
232. M614
233. M616
234. M617
235. M618
236. M619
237. M621
238. M622
239. M623
240. M624
241. M656
242. XM656
243. M708
244. M708A1
245. M711
246. M715
247. M718
248. M718A1
249. M724
250. M725
251. M726
252. M746
253. M748A1
254. M751A1
255. M757
256. M764
257. XM791
258. M792
259. M813
260. M813A1
261. XM813
262. M814
263. M815
264. M816
265. M817
266. M818
267. M819
268. M820
269. M820A2
270. M821
271. M825
272. M1185A3
273. V-100

(Sheet 4 of 4)

Table 3

Nomenclature of USSR Wheeled Vehicles

Vehicle Code No.	Model No.
1	GAZ(UAZ)-69
2	GAZ-62
3	MAZ-205
4	KRAZ-214
5	ZIL-157K
6	ZIL-583
7	GAZ-56
8	ZIL-164
9	MAZ-502
10	UAZ-450D
11	URAL-355M
12	ZIL-131
13	URAL-375
14	URAL-375D
15	KRAZ-222
16	KRAZ-219
17	KAZ-605
18	GAZ-66
19	MAZ-500A
20	UAZ-452D
21	GAZ-53F
22	MAZ-505
23	ZAZ-971
24	ZIL-135
25	MAZ-535A
26	MAZ-543
27	ZIL-E-167
28	MAZ-514
29	BELAZ-548
30	TZ-200

(Continued)

(Sheet 1 of 5)

Table 3 (Continued)

Vehicle Code No.	Model No.
31	ATS-8-200
32	ATSM-4-157
33	ATZ-3-157
34	ATZ-4-164
35	UAZ-469
36	ZAZ-969
37	ZIL-133
38	BELAZ-540
39	MOAZ-522
40	UMZ-ZIL-151
41	MAZ-503
42	PSG-65/130
43	KRAZ-255B
44	PSG-160
45	GAZ-SAZ-53B
46	NAMI-076
47	TZ-63
48	TZ-150
49	ATSM-4-150
50	ATZ-3-151
51	MZ-51
52	MZ-150
53	MI-964
54	ATZ-3.8-130
55	ATS-26-355M
56	MAZ-200V
57	GAZ-63P
58	KRAZ-221
59	GAZ-53P
60	ZIL-164AN
61	KAZ-606A
62	GAZ-51P
63	MAZ-537

(Continued)

Table 3 (Continued)

Vehicle Code No.	Model No.
64	ZIL-133V
65	KRAZ-258
66	KAZ-608B
67	ZIL-137
68	ZIL-131V
69	MAZ-529
70	URAGAN-8
71	ZIL-157KV
72	ZIL-130V1
73	KAZ-608
74	MAZ-504
75	URAL-377S
76	URAL-375S
77	GAZ-93A
78	KAZ-600AV
79	ZIL-MMZ-585L,585M
80	ZIL-MMZ-555
81	MAZ-503A
82	GAZ-53B
83	KRAZ-256B
84	MAZ-525
85	MAZ-530
86	BELAZ-548A
87	GAZ-69
88	GAZ-69A
89	GAZ-63
90	GAZ-63A
91	MAZ-501
92	ATS-51A
93	ATSPT-1.9
94	AVV-2
95	ATZ-2.2-51A
96	ATZ-3.8-53A

(Continued)

Table 3 (Continued)

Vehicle Code No.	Model No.
97	ATSM-4-157K
98	ATS-1.9-51A
99	ATS-2.6-355M
100	ATS-2.6-53F
101	ATS-2.9-53F
102	ATS-4.2-53A
103	ATS-4.2-130
104	MZ-51M
105	ATSPT-1.7
106	ATSPT-1.9
107	ATSPT-2.8
108	ATSPT-5.6
109	AVTS-1.7
110	AVV-2
111	S-956
112	GAZ-67B
113	GAZ-46
114	UAZ-450A
115	UAZ-452A,452B
116	KMAZ-5410
117	KMAZ-5510
118	KMAZ-53202
119	UAZ-4510
120	MAV(GAZ)-46
121	BAV-485
122	GAZ-51
123	ZIL-150
124	ZIL-151
125	ZIL-137
126	BTR-60P
127	BTR-152

(Continued)

Table 3 (Concluded)

Vehicle Code No.	Model No.
128	BRDM SCOUT CAR
129	BRDM-2 SCOUT CAR
130	BM-14
131	BM-21
132	BRDM (SNAPPER)
133	BA 64
134	BTR-40
135	BTR-152VI
136	BTR-60P
137	BRDM
138	MAZ-535
139	T-111
140	T-138
141	T-1141
142	ARS-12/14
143	DDA-53
144	KRAZ-255
145	OT-64
146	OT-65

(Sheet 5 of 5)

Table 4

Nomenclature of U. S. Tracked Vehicles

Vehicle Code No.	Model No.
1	T6
2	T23
3	T23E3
4	T25
5	T48
6	T74
7	M3A3 (light)
8	M3A3
9	M3A2
10	M3A3 (medium)
11	M3A4
12	M3A5
13	M4 (full track)
14	M8
15	M10
16	M48A1
17	M56
18	M60
19	M103
20	M2
21	M3
22	M4 (half track)
23	LVT1
24	LVT2
25	LVTA2
26	LVTA1
27	LVTA4
28	LVTA5
29	M29
30	M29C
31	M76

(Continued)

Table 4 (Continued)

Vehicle Code No.	Model No.
32	M59
33	M75
34	T113E2, M113
35	MK4, LVT4
36	M51
37	M74
38	M88
39	M41
40	M41A1
41	M41A2
42	M41A3
43	M47
44	M48
45	M48C
46	M48A2
47	M48A2C
48	M5
49	M5-A1
50	M5-A2
51	M5-A3
52	M5-A4
53	MK5, LVTA-5
54	M24
55	M4A1 (w/75-mm gun)
56	M4A3 (w/75-mm gun)
57	T41E1
58	M4A1 (w/76-mm gun)
59	M4A3 (w/76-mm gun)
60	M26
61	M26A1
62	M46
63	M46A1

(Continued)

Table 4 (Continued)

Vehicle Code No.	Model No.
64	M4 (full track)
65	M4A3 (w/105-mm howitzer)
66	M45
67	M8E2
68	M4
69	M4A1
70	M4C
71	M4A1C
72	M6
73	T18E1
74	M32
75	M39
76	M2A1
77	M16
78	M15A1
79	M19A1
80	M18
81	M36
82	M36B1
83	M36B2
84	M7
85	M7B1
86	M37
87	T106
88	M40
89	M41
90	M43
91	T46E1
92	M3A1
93	M4A1
94	M21
95	T16

(Continued)

Table 4 (Concluded)

Vehicle Code No.	Model No.
96	M60A1
97	M48A3
98	M551
99	M114A1
100	M113A1
101	LVTP-7
102	M42
103	M110
104	M55
105	M107
106	M109
107	M53
108	M44
109	M108
110	M52

(Sheet 4 of 4)

Table 5

Nomenclature of USSR Tracked Vehicles

Vehicle Code No.	Model No.
1	T54, T55
2	T-62
3	BTR
4	M-1967
5	ZSU-57/2
6	ZSU-23/4
7	BM-24
8	BTU
9	BAT/M
10	MTU-54
11	Mineclearing Tank
12	K-61
13	PTS/M
14	GAZ-47
15	GAZ-71
16	K-61
17	PTS
18	GT-T
19	V-1, VITYAZ
20	AT-L
21	AT-S
22	ATS-59
23	AT-T
24	T-34
25	T-54-T
26	JSU-T-B
27	JSU-T-E
28	T-54A
29	JS-3
30	T10-M
31	PT76

(Continued)

Table 5 (Continued)

Vehicle Code No.	Model No.
32	T54
33	SU-37
34	SU-85
35	SU-100
36	JSU-122
37	JSU-152
38	T60
39	T70
40	KW11
41	JS-Z
42	ASU-57
43	ASU-85
44	ZSU-57-2
45	ZSU-23-4
46	BTR-50PK
47	BTR-40
48	M1967
49	AT-P
50	GAS-47
51	T-80
52	PT-76
53	PT-85
54	T-34/76
55	T-34/85
56	T-44
57	T-54
58	T-55
59	T-62
60	T-100
61	KV
62	KV85
63	JSI, II, III

(Continued)

(Sheet 2 of 3)

Table 5 (Concluded)

Vehicle Code No.	Model No.
64	T-10
65	SU-76
66	SU-122
67	SU-152
68	BMP-76PB
69	V-1, VITYAZ
70	Carrier Penguin
71	Carrier Utility
72	GT-SM
73	GAZ-71
74	M-1970
75	OT-62B
76	M-70
77	M-1973
78	M-1974
79	OT-62C

(Sheet 3 of 3)

Table 6

Nomenclature of U. S. Rotary-Wing Aircraft

Vehicle Code No.	Model No.
1	UH-1F
2	HH-1K
3	UH-1L
4	UH-1H
5	UH-1N
6	AH-1G
7	TH-1L
8	OH-13S
9	AH-1J
10	TH-13J
11	TH-57A
12	OH-58A
13	QH-50D
14	TH-55A
15	OH-6A
16	HH-43B
17	HH-43F
18	UH-2C
19	HH-2D
20	SH-2D
21	HH-2C
22	SH-2F
23	CH-3B
24	SH-3D
25	CH-3E
26	HH-52A
27	CH-54A
28	CH-54B
29	CH-53A
30	HH-53C

(Continued)

Table 6 (Concluded)

Vehicle Code No.	Model No.
31	CH-53D
32	RH-53D
33	CH-46F
34	CH-47C
35	CH-34C
36	OH-23D

Table 7

Nomenclature of USSR Rotary-Wing Aircraft

Code	Designation	NATO Code Name
1	V-12(Mi-12)	Homer
2	Mi-10	Harke
3	Mi-8	Hip
4	Mi-6	Hook
5	Mi-4	Hound
6	Mi-2	Hoplite
7	Ka-26	Hoodlum
8	Ka-25K	Hormone
9	Ka-20	Harp
10	Ka-18	Hog
11	Yak-24	
12	Ka-15	Hen
13	Ka-22	

Table 8

Nomenclature of U. S. Fixed-Wing Aircraft

Vehicle Code No.	Model No.
1	A-3B
2	A-4F
3	A-4M
4	A-6A
5	A-7D
6	A-7E
7	AV-8A
8	A-37B
9	A-10
10	B-52F
11	B-52G
12	B-52H
13	B-66D
14	FB-111A
15	B-1
16	F-101B
17	F-102A
18	F-104C
19	F-104G
20	F-105D
21	F-106A
22	F-111F
23	F-4J
24	F-4E
25	F-5A/B
26	F-5E
27	F-8J
28	XFV-12A
29	F-14A
30	F-15A

(Continued)

Table 8 (Continued)

Vehicle Code No.	Model No.
31	P-530
32	YF-16
33	YF-17
34	WU/U-2
35	SR-71
36	RF-46
37	RA-5C
38	RB-57F
39	O-1G
40	O-2A
41	OV-1A
42	OV-10A
43	YO-3A
44	P-2H
45	P-3C
46	S-2E
47	S-3A
48	E-1B
49	E-2B
50	E-3A
51	E-4A
52	C-121G
53	C-130B
54	C-130E
55	HC-130H
56	C-131E
57	KC-135A
58	VC-137C
59	C-140A
60	C-141A
61	C-1A

(Continued)

Table 8 (Continued)

Vehicle Code No.	Model No.
62	C-2A
63	C-7A
64	C-8A
65	C-5A
66	VC-6B
67	C-9A
68	C-9B
69	T-2C
70	T-28D
71	T-29D
72	T-33A
73	T-34B
74	T-37B
75	T-38A
76	T-39A
77	T-41A
78	T-42A
79	TC-4C
80	T-43A
81	U-1A
82	U-3B
83	U-4B
84	U-5A
85	U-6A
86	U-7A
87	U-8D
83	U-8F
89	U-10D
90	U-11A
91	HU-16A/E
92	U-17A

(Continued)

Table 8 (Concluded)

Vehicle Code No.	Model No.
93	U-21A
94	U-21F
95	AU-23A
96	AU-24A
97	YC-119K
98	AC-119K
99	A-6E
100	VC-11A
101	X-24B
102	YE-5
103	U-9C
104	U-21A

(Sheet 4 of 4)

Table 9

Nomenclature of USSR Fixed-Wing Aircraft

Code	Designation	NATO Code Name
1	TU-22	Blinder
2	TU-?	Backfire
3	M-4	Bison
4	Tu-95	Bear
5	Tu-16	Badger
6	Il-28	Beagle
7	Yak-28	Brewer
8	Be-10	Mallow
9	Be-12	Mail
10	Yak-?	Mandrake
11	Yak-25	Mangrove
12	MiG-25	Foxbat
13	MiG-25	--
14	MiG-25	--
15	MiG-23	Flogger
16	MiG-?	Faithless
17	MiG-?	Flipper
18	MiG-21	Fishbed G
19	MiG-21	Fishbed F/J/K
20	MiG-21	Fishbed D/H
21	MiG-21	Fishbed C
22	MiG-19	Farmer
23	MiG-17	Fresco
24	Su-11	Flagon A
25	Su-?	Flagon B
26	Su-?	Fitter B
27	Su-7	Fitter
28	Su-9	Fishpot
29	Tu-29P	Fiddler
30	Yak-?	Freehand
31	Yak-28P	Firebar

(Continued)

Table 9 (Concluded)

Code	Designation	NATO Code Name
32	An-26	Coke
33	An-24V	Coke
34	An-22	Coke
35	An-14	Clod
36	An-12	Cub
37	An-10	Cat
38	M-15	--
39	Be-30	Cuff
40	Il-86	--
41	Il-76	Candid
42	Il-62	Classic
43	Il-62M200	Classic
44	Il-18V	Coot
45	Il-14	Crate
46	Il-14M	Crate
47	Il-12	Coach
48	Tu-154	Careless
49	Tu-154A	Careless
50	Tu-144	Charger
51	Tu-134	Crusty
52	Tu-134A	Crusty
53	Tu-124	Cookpot
54	Tu-114	Cleat
55	Tu-104A	Camel A
56	Tu-104B	Camel B
57	Yak-40	Coding
58	Yak-40M	Coding
59	Yak-18T	--
60	Yak-32	Mantis
61	Yak-30	Magnum
62	Yak-18A	Max
63	Yak-18P	--
64	AN-10	Janes
65	BE-30	Janes

Table 10

Vehicle Parameter Codes

Wheeled Vehicles

Weight, kg

Class	Class Range
1	0-2000
2	>2000-4000
3	>4000-5500
4	>5500-8000
5	>8000-10,000
6	>10,000

Number of Wheels Per Side

Class	No. of Wheels Per Side
1	2
2	3
3	4

Tire Size

Class	
1	All

Suspension

Class	Type
1	Semielliptical (IS) Timken-Detroit #2034 Timken-Detroit SFD-375-A-1 Semielliptical; inverted Hotchkies Drive; 10871261 Bogie Model SWD-321 Bogie Model SWD-322 Bogie Model GMC Leaf springs Bogie Model FWD (Spal) Bogie Model SFD 4600

(Continued)

Table 10 (Continued)

Class	Type
	Bogie Model Rockwell STD Bogie Model KENW BM 2150-1
2	Civil
3	Air shock absorbers, double acting
4	Torsion bar
5	Solid mount walking beam
6	No suspension

Horsepower

Class	
1	All

Fuel Type

Class	Type Fuel
1	Gasoline
2	Diesel
3	Multifuel

Coolant Type

Class	Type Cooling
1	Air
2	Liquid

(Continued)

Table 10 (Concluded)

Tracked Vehicles

Weight, kg

Class	Class Range
1	0-9999
2	10,000-19,999
3	20,000-29,999
4	30,000-39,999
5	>40,000

Horsepower

Class	Class Range
1	0-400
2	>400

Fuel Type

Class	Type Fuel
1	Gasoline
2	Diesel
3	Multifuel

Table 11

Comparison of U. S. and Foreign Vehicles

Proposed U. S. Analog	Desired Foreign	Other Foreign	Weight kg	No. of Wheels Total	No. of Wheels Per Side*	Tire Size	Suspension	Horse-power	Fuel Type	Coolant Type
						Wheeled				
XM443			544	4	2	7.50-10	Semielliptic	18	Gas	Air
M422			771	4	2	6.00-16		55		
M422A1			807	4	2	6.00-16		54		
	ZAZ-971		750	4	2	5.20-13		27		
		ZAZ-969	825	4	2	5.90-13		23		
M170			1,343	4	2	7.00-16		68		Liquid
	UAZ-450D		1,700	4	2	8.40-15		62		
	GAZ-69		1,525	4	2	6.50-16		52		
		GAZ-69A	1,535	4	2	6.50-16		52		
		UAZ-469	1,540	4	2	8.40-15		72		
		UAZ-452D	1,670	4	2	8.40-15		70		
		GAZ-56	1,850	6	2	8.00-18		70		
M724			2,177	4	2	9.00-16		132		
M715			2,267	4	2	9.00-16		132		
M53			2,313	4	2	9.00-16		94		
M37			2,585	4	2	11.00-16		94		
M37B1			2,585	4	2	9.00-16		77		
M201			3,039	4	2	9.00-16		94		
M201B1			3,039	4	2	9.00-16		94		
	GAZ-63		3,200	4	2	10.00-18		70		
	GAZ-66		3,470	4	2	12.00-18		115		
	ZIL-130V1		3,860	6	2	2.60-26		150		
		GAZ-53P	2,425	6	2	8.25-20		115		

(Continued)

* Duals considered as one wheel.

Table 11 (Continued)

Proposed U. S. Analog	Desired Foreign	Other Foreign	Weight kg	No. of Wheels Total	No. of Wheels Per Side	Tire Size	Suspension	Horse-power	Fuel Type	Coolant Type
					Wheeled (Continued)					
		GAZ-53F	2,950	6	2	8.25-20	Semielliptic	80	Gas	Liquid
		GAZ-93A	3,000	6	2	7.50-20		70		
		GAZ-63	3,200	4	2	10.00-18		70		
		URAL-355M	3,360	6	2	8.25-20		95		
		GAZ-63A	3,440	4	2	10.00-18		70		
		GAZ-SAZ-53B	3,750	4	2	8.25-20		115		
		GAZ-53B	3,750	6	2	8.25-20		115		
		TZ-63	3,890	4	2	9.75-18		70		
		KAZ-608	4,000	6	2	9.00-20		150		
		GAZ-51P	2,485	10	3	7.50-20		70		
		GAZ-62	2,570	4	2	11.00-16		80		
		AVV-2	2,900	4	2	7.50-20		70		
		ATZ-2.2-51A	2,904	6	2	7.50-20		115		
M46C			5,570	10	3	9.00-20		146		
M35			5,653	10	3	9.00-20		146		
M211			5,973	10	3	9.00-20		145		
M35A1			6,078	10	3	9.00-20		146		
M49			6,118	10	3	9.00-20		146		
M49C			6,118	10	3	9.00-20		146		
M36			6,123	10	3	9.00-20		146		
M35A2C			6,196	10	3	9.00-20		146		
M59			6,372	10	3	9.00-20		146		
M217			6,504	10	3	9.00-20		145		
M217C			6,504	10	3	9.00-20		145		
M215			6,558	10	3	9.00-20		145		
M36A1			6,626	10	3	9.00-20		146		
M36A2			6,626	10	3	9.00-20		146		

(Continued)

(Sheet 2 of 6)

Table 11 (Continued)

Proposed U. S. Analog	Desired Foreign	Other Foreign	Weight kg	No. of Wheels Total	No. of Wheels Per Side	Tire Size	Suspension	Horse-power	Fuel Type	Coolant Type
				Wheeled (Continued)						
M36C			6,726	10	3	9.00-20	Semielliptic	146	Gas	Liquid
M50			6,887	10	3	9.00-20	↓	146	↓	↓
M40			7,613	10	3	11.00-20		224		
M39			7,631	6	3	14.00-20		224		
M40A2			7,661	10	3	11.00-20		224		
M61			7,874	10	3	11.00-20		224		
M50A1			6,404	10	3	9.00-20		140	Multi	
M50A2			6,404	10	3	9.00-20		140	↓	
M49A1C			6,633	10	3	9.00-20		140		
M49A2C			6,633	10	3	9.00-20		140		
M61A2			7,720	10	3	11.00-20		210		
	ZIL-151		5,580	10	3	8.25-20		92	Gas	
	ZIL-157KV		5,700	6	3	12.00-18		112	↓	
	ZIL-157K		5,800	6	3	12.00-18		112		
	ARS-12/14		6,135	6	3	12.00-18		109		
	ZIL-131		6,460	6	3	12.00-20		150		
	ZIL-131V		6,225	6	3	12.00-20		150		
		ZIL-133	6,200	10	3	9.00-20		220		
		ATSM-4-157	6,250	6	3	12.00-18		104		
		ZIL-133V	6,350	10	3	9.00-20		220		
		ATZ-3-157	6,700	6	3	12.00-18		104		
		ZIL-E-167	6,800	6	3	21.00-28		180		
		URAL-377S	6,830	6	3	14.00-20		180		
		URAL-375S	7,500	6	3	14.00-20		180		
		UMZ-ZIL-151	7,625	10	3	8.25-20	↓	92	↓	↓

(Continued)

Table 11 (Continued)

Proposed U. S. Analog	Desired Foreign	Other Foreign	Weight kg	No. of Wheels Total	Per Side	Tire Size	Suspension	Horse-power	Fuel Type	Coolant Type
				Wheeled (Continued)						
		ATZ-3-151	6,700	10	3	8.25-20	Semielliptic	92	Gas	Liquid
M63C			8,161	10	3	12.00-20		224		
M63			8,263	10	3	11.00-20		224		
M41			8,672	10	3	14.00-20		224		
M108			8,788	10	3	9.00-20		146		
M63A2C			8,060	10	3	12.00-20		210	Multi	
M52A2			8,092	10	3	11.00-20		210		
M63A2			8,123	10	3	11.00-20		210		
M40A2C			8,640	10	3	11.00-20		210		
M40C			8,686	10	3	11.00-20		210		
M54A2			8,915	10	3	11.00-20		210		
M813			9,736	10	3	11.00-20		250		
M51A2			9,942	10	3	11.00-20		210		
	BTR-152V1		8,119	6	3	12.00-18		110	Gas	
	BTR-152		8,368	6	3	12.00-18		110		
	URAL-375		8,400	6	3	14.00-20		180		
		URAL-375D	8,400	6	3	14.00-20		180		
		MAZ-514	8,700	10	3	11.00-22		180	Diesel	
		KRAZ-258	9,680	10	3	12.00-20		240	Diesel	
M125			14,765	10	3	14.00-24		297	Gas	
	KRAZ-214		12,300	6	3	15.00-20		205	Diesel	
	KRAZ-255B		11,950	6	3	15.00-20		240		
	KRAZ-256B		11,400	10	3	12.00-20		215		
		NAMI-076	19,000	6	3	--	--	--		
		KRAZ-219	11,300	10	3	12.00-20	Semielliptic	180		
		KRAZ-222	12,200	10	3	12.00-20	Semielliptic	180		
V-100			7,370	4	2	No data	No data	191	Gas	No data

(Continued)

Table 11 (Continued)

Proposed U. S. Analog	Desired Foreign	Other Foreign	Weight kg	No. of Wheels Total	No. of Wheels Per Side	Tire Size	Suspension	Horse-power	Fuel Type	Coolant Type
				Wheeled (Continued)						
	OT-65		5,535	4	2	12.00-18	No data	100	Diesel	Liquid
	BRDM-2		6,930		2	13.00-18	Semielliptic	140	Gas	Liquid
	BTR-40		4,808	4	2	9.75-18	Semielliptic	80	Gas	Liquid
				Tracked						
M116			3,467	Not used		N/A	Not used	160	Gas	Liquid
M76			5,500					135	Gas	Air
	ASU-57		3,350					55	Gas	Liquid
M551			15,276					300	Gas/ diesel	
M113			10,670					209	Gas/ diesel	
M132			10,600					194	Gas	
M577			10,800					210	Gas	
	M1967		10,069					280	Diesel	Liquid (oil)
	K61		9,548					130		No data
	M1970		10,000					280		No data
	BMP-76PB		10,000					280		No data
	BTR-50PK		14,500					240		Liquid
	OT-62B		15,000					300		
	OT-62C		16,390					300		
	PT-76		14,000					280		
	ZSU-23-4		14,000					240		
	ASU-85		14,000					240		
		BMP-2	12,500					280		

(Continued)

Table 11 (Concluded)

Proposed U. S. Analog	Desired Foreign	Other Foreign	Weight kg	No. of Wheels Total	Per Side	Tire Size	Suspension	Horse-power	Fuel Type	Coolant Type
				Tracked (Continued)						
M180			21,274	Not used		N/A	Not used	240	Diesel	Liquid
M107			27,324	↓		↓	↓	405	↓	↓
M110			25,740	↓		↓	↓	405	↓	↓
M105			20,636	↓		↓	↓	405	↓	↓
M109			23,082	↓		↓	↓	405	↓	↓
	SU-85		29,600	↓		↓	↓	500	↓	↓
	ZSU-57-2		28,100	↓		↓	↓	520	↓	↓
	SU-100		31,600	↓		↓	↓	500	↓	↓
		M36B2	29,900	↓		↓	↓	375	↓	↓
M48A1E2			45,760	↓		↓	↓	750	↓	Air
M60			44,880	↓		↓	↓	750	↓	Air
	T-10		50,000	↓		↓	↓	700	↓	Liquid
		JS-2	46,300	↓		↓	↓	650	↓	Liquid
		JS-3	45,800	↓		↓	↓	650	↓	Liquid
		JS-4	50,000	↓		↓	↓	650	↓	Liquid

(Sheet 6 of 6)

Table 12

Foreign Ground Vehicles from Which Signatures are Desired

Wheeled Vehicles	Tracked Vehicles
Trucks	**APC**
ZAZ-971	
ZIL-157K/157KV	M1967
URAL-375	K61
UAZ/GAZ-69	M1970
GAZ-66	BMP-76PB
GAZ-63	BTR-50PK
ZIL-130V1	OT-62B
ZIL-131/131V	OT-62C
ZIL-151	
T-111	**Tanks**
T-141	
T-138	PT-76
UAZ-450D	T54 or T55
ARS-12/14	T62
KRAZ-214/255/255B/256B	T10
	M70
APC	
	Weapons
BTR-152	
BTR-60P	ASU-57
BRDM-2	ASU-85
BTR-152V1	SU-85
BTR-40	SU-100
OT-65	ZSU-23-4
OT-64	ZSU-57-2
	M1974
	M1973

Table 13

Foreign Aircraft from Which Signatures are Desired

Rotary-Wing	Fixed-Wing
Mi-8	Tu-22
Mi-2	Tu-95
Ka-18	Tu-16
Ka-25K	Be-12
Ka-26	Yak-25
Mi-12	MiG-25
Mi-10	MiG-21
Mi-6	An-22
Mi-4	I-76
Ka-15	Tu-144
Ka-22	
Yak-24	

Table 14

Comparison of U. S. and Foreign Aircraft

	Proposed U. S. Analog CH-46F	Desired Foreign Aircraft Mi-8	Proposed U. S. Analog UH-1N	Desired Foreign Aircraft Mi-2	Proposed U. S. Analog TH-57A	Desired Foreign Aircraft Ka-18	Proposed U. S. Analog CH-3B	Desired Foreign Aircraft Ka-25K	Proposed U. S. Analog HH-1K	Desired Foreign Aircraft Ka-26
					Rotary-Wing					
Wt, empty, kg	6044	6,816	2517	2424	695	--	4393	4400	2349	2085
Payload, kg	--	4,000	--	800	--	--	--	2000	1759	1065
No. rotors	2	1	1	1	1	2	1	2	1	2
No. engines	2	2	2	2	1	1	2	2	1	2
Horsepower	1400	1,500	900	437	--	--	1400	900	1400	325
Type engine	Turbine	Turbine	Turbine	Turbine	Turbine	--	Turbine	Turbine	Turbine	Piston
Wt, gross, kg	9360	11,880	4725	3750	1305	1300	9225	7045	3825	2970

	USSR Mi-12	Mi-10	Mi-6	Mi-4	Ka-15	Ka-22	Yak-24
			Rotary-Wing				
Wt, empty, kg	--	27,300	27,240	--	--	--	--
Payload, kg	30,000	15,000	12,000	1,740	--	--	--
No. rotors	2	1	1	1	2	2	2
No. engines	4	2	2	1	--	--	--
Horsepower	6,500	5,500	5,500	1,700	--	--	--
Type engine	Turbine	Turbine	Turbine	Piston	--	--	--
Wt, gross, kg	103,950	43,113	42,170	38,220	--	--	15,874

	USSR 1 Tu-22	4 Tu-95	5 Tu-16	9 Be-12	11 Yak-25	12 MiG-25	18 MiG-21	34 An-22	41 Il-76	50 Tu-144
					Fixed-Wing					
Wt, gross, kg	78,750	148,500	67,500	31,500	13,500	28,030	7650	225,000	159,300	177,750
No. engines	2	4	2	2	2	2	1	4	4	4
Thrust, kg	11,700	--	8,775	--	3,375	--	5400	--	11,385	17,361
Horsepower	--	12,000	--	4,000	--	--	--	15,000	--	--

Table 15

Terrain Matrix

Terrain Matrix Element	Terrain Factors Used in Terrain Matrix: Characteristics of Surface Material — Rigidity: Spring Constant N/m	Rigidity: Maximum Spring Travel m	Roughness rms Elevation cm	Characteristics of Top Layer/Foundation Material: Compression Wave Velocity m/sec	Shear Wave Velocity m/sec	Bulk Density g/cm^3	First Layer Thickness m	No.	Qualitative Terrain Descriptors
1	0.775×10^7	0.1	5.08	150/300	75/125	1.60/1.70	0.25	1.10	Recently cultivated (loosened) top soil overlying moist loam
2	0.775×10^7	0.1	5.08	150/300	75/125	1.60/1.70	1.5	1.20	Recently cultivated (loosened) top soil overlying slightly sandy or gravelly soft clay
3	0.775×10^7	0.1	5.08	150/300	75/125	1.60/1.70	4.0	1.30	Loose cohesionless top soil overlying dry sand
								1.40	Organic saturated clay overlying slightly sandy or gravelly soft clay
4	0.775×10^7	0.1	5.08	150/680	75/275	1.60/2.00	0.25	2.10	Recently cultivated (loosened) top soil overlying moist sandy or gravelly loam
5	0.775×10^7	0.1	5.08	150/680	75/275	1.60/2.00	1.5	2.20	Recently cultivated (loosened) top soil overlying medium clay
6	0.775×10^7	0.1	5.08	150/680	75/275	1.60/2.00	4.0	2.30	Loose cohesionless top soil overlying dry gravel
								2.40	Organic saturated clay overlying medium clay
7	0.775×10^7	0.1	5.08	150/1450	75/400	1.60/2.05	0.25	3.10	Recently cultivated (loosened) top soil overlying heavy gravelly clay (till)
8	0.775×10^7	0.1	5.08	150/1450	75/400	1.60/2.05	1.5	3.20	Loose cohesionless top soil overlying moist medium gravel
9	0.775×10^7	0.1	5.08	150/1450	75/400	1.60/2.05	4.0	3.30	Organic saturated clay overlying wet medium dense sand
								3.40	Organic saturated clay overlying heavy gravelly clay (till)
10	0.775×10^7	0.1	5.08	150/2000	75/550	1.60/1.80	0.25	4.10	Recently cultivated (loosened) top soil overlying dense soil with high water table
11	0.775×10^7	0.1	5.08	150/2000	75/550	1.60/1.80	1.5	4.20	Organic saturated clay overlying frozen silty or clayey loam
12	0.775×10^7	0.1	5.08	150/2000	75/550	1.60/1.80	4.0	4.30	Organic saturated clay overlying dense soil with high water table

(Continued)

Table 15 (Continued)

Terrain Matrix Element	Terrain Factors Used in Terrain Matrix: Characteristics of Surface Material: Rigidity: Spring Constant N/m	Maximum Spring Travel m	Roughness rms Elevation cm	Characteristics of Top Layer/Foundation Material: Compression Wave Velocity m/sec	Shear Wave Velocity m/sec	Bulk Density g/cm^3	First Layer Thickness m	No.	Qualitative Terrain Descriptors
13	0.775×10^7	0.1	5.08	150/2000	75/750	1.60/2.10	0.25	5.10 5.20 5.30 5.40 5.50 5.60 5.70	Recently cultivated (loosened) top soil overlying hard clay Loose cohesionless top soil overlying dense sand and gravel Loose cohesionless top soil overlying weathered rock Organic saturated clay overlying dense sand and gravel Organic saturated clay overlying cemented soil Organic saturated clay overlying weathered rock Organic saturated clay overlying hard clay
14	0.775×10^7	0.1	5.08	150/2000	75/750	1.60/2.10	1.5		
15	0.775×10^7	0.1	5.08	150/2000	75/750	1.60/2.10	4.0		
16	0.775×10^7	0.1	5.08	150/3500	75/1500	1.60/2.50	0.25	6.10	Organic saturated clay overlying competent unweathered rock
17	0.775×10^7	0.1	5.08	150/3500	75/1500	1.60/2.50	1.5		
18	0.775×10^7	0.1	5.08	150/3500	75/1500	1.60/2.50	4.00		
19	0.36×10^7	0.26	1.20	200/2000	60/750	1.30/2.10	0.25	6.11 6.12	Organic material (peat) overlying dense sand and gravel Organic material (peat) overlying weathered rock
20	0.94×10^6	0.50	1.20	200/2000	60/750	1.30/2.10	1.5		
21	0.94×10^6	0.50	1.20	200/2000	60/750	1.30/2.10	4.0		
22	1.45×10^7	0.09	3.81	400/2000	200/750	1.80/2.10	0.25	6.13 6.14	Dense loam overlying dense sand and gravel Dense loam overlying weathered rock
23	1.45×10^7	0.09	3.81	400/2000	200/750	1.80/2.10	1.5		
24	1.45×10^7	0.09	3.81	400/2000	200/750	1.80/2.10	4.0		
25	2.33×10^7	0.075	3.05	655	260	1.70	10.0	7.10 7.20 7.30	Dry loose gravel Medium sand Moist sandy or silty clay

(Continued)

(Sheet 2 of 7)

Table 15 (Continued)

Terrain Matrix Element	Spring Constant N/m	Maximum Spring Travel m	Roughness rms Elevation cm	Compression Wave Velocity m/sec	Shear Wave Velocity m/sec	Bulk Density g/cm^3	First Layer Thickness m	No.	Qualitative Terrain Descriptors
	Terrain Factors Used in Terrain Matrix								
	Characteristics of Surface Material			Characteristics of Top Layer/Foundation Material					
	Rigidity								
26	2.33×10^7	0.075	3.05	655/1450	260/400	1.70/2.05	0.25	8.10 8.20 8.30 8.40 8.50 8.60 8.70	Dry loose gravel overlying moist medium gravel Dry loose gravel overlying heavy gravelly clay (till) Medium sand overlying wet medium-dense sand Medium sand overlying moist medium gravel Medium sand overlying heavy gravelly clay (till) Moist sandy or silty clay overlying wet medium-dense sand Moist sandy or silty clay overlying heavy gravelly clay (till)
27	2.33×10^7	0.075	3.05	655/1450	260/400	1.70/2.05	1.50		
28	2.33×10^7	0.075	3.05	655/1450	260/400	1.70/2.05	4.00		
29	2.33×10^7	0.075	3.05	655/2000	260/550	1.70/1.80	0.25	9.10 9.20 9.30 9.40 9.50 9.60	Dry loose gravel overlying frozen silty or clayey loam Dry loose gravel overlying dense cohesionless soil with high water table Medium sand overlying frozen silty or clayey loam Medium sand overlying dense cohesionless soil with high water table Moist sandy or silty clay overlying frozen silty or clayey loam Moist sandy or silty clay overlying dense cohesionless soil with high water table
30	2.33×10^7	0.075	3.05	655/2000	260/550	1.70/1.80	1.50		
31	2.33×10^7	0.075	3.05	655/2000	260/550	1.70/1.80	4.00		

(Continued)

Table 15 (Continued)

Terrain Factors Used in Terrain Matrix										
	Characteristics of Surface Material			Characteristics of Top Layer/ Foundation Material						
	Rigidity									
Terrain Matrix Element	Spring Constant N/m	Maximum Spring Travel m	Roughness rms Elevation cm	Compression Wave Velocity m/sec	Shear Wave Velocity m/sec	Bulk Density g/cm^3	First Layer Thickness m	No.	Qualitative Terrain Descriptors
32	2.33×10^7	0.075	3.05	655/2000	260/750	1.70/2.10	0.25		
33	2.33×10^7	0.075	3.05	655/2000	260/750	1.70/2.10	1.50		
34	2.33×10^7	0.075	3.05	655/2000	260/750	1.70/2.10	4.00		
								10.10	Dry loose gravel overlying dense sand and gravel
								10.20	Dry loose gravel overlying cemented soil
								10.30	Dry loose gravel overlying weathered rock
								10.40	Dry loose gravel overlying hard clay
								10.50	Medium sand overlying dense sand and gravel
								10.60	Medium sand overlying cemented soil
								10.70	Medium sand overlying weathered rock
								10.80	Medium sand overlying hard clay
								10.90	Moist sandy or silty clay overlying dense sand and gravel
								10.91	Moist sandy or silty clay overlying cemented soil
								10.92	Moist sandy or silty clay overlying weathered rock
								10.93	Moist sandy or silty clay overlying hard clay
35	2.33×10^7	0.075	3.05	655/2750	260/1100	1.70/2.30	0.25		
36	2.33×10^7	0.075	3.05	655/2750	260/1100	1.70/2.30	1.50		
37	2.33×10^7	0.075	3.05	655/2750	260/1100	1.70/2.30	4.00		
								11.10	Dry loose gravel overlying poorly consolidated calcareous silt or clay (marl)
								11.20	Dry loose gravel overlying sandy consolidated gravel (conglomerate)
								11.30	Medium sand overlying poorly consolidated calcareous silt or clay (marl)
								11.40	Medium sand overlying sandy consolidated gravel (conglomerate)
								11.50	Moist sandy or silty clay overlying poorly consolidated calcareous silt or clay (marl)
								11.60	Moist sandy or silty clay overlying sandy consolidated gravel (conglomerate)
38	2.33×10^7	0.075	3.05	655/3500	260/1500	1.70/2.50	0.25		
39	2.33×10^7	0.075	3.05	655/3500	260/1500	1.70/2.50	1.50		
40	2.33×10^7	0.075	3.05	655/3500	260/1500	1.70/2.50	4.00		
								12.10	Dry loose gravel overlying competent unweathered rock
								12.20	Medium sand overlying competent unweathered rock
								12.30	Moist sandy or silty clay overlying competent unweathered rock

(Continued)

Tabl. 15 (Continued)

Terrain Matrix Element	Terrain Factors Used in Terrain Matrix: Characteristics of Surface Material — Rigidity: Spring Constant N/m	Maximum Spring Travel m	Roughness rms Elevation cm	Characteristics of Top Layer/Foundation Material: Compression Wave Velocity m/sec	Shear Wave Velocity m/sec	Bulk Density g/cm^3	First Layer Thickness m	No.	Qualitative Terrain Descriptors
41	5.43×10^7	0.05	1.90	1450	400	1.90	10.0	13.10 13.20 13.30	Wet medium dense sand Moist medium gravel Heavy gravelly clay (till)
42 43 44	5.43×10^7 5.43×10^7 5.43×10^7	0.05 0.05 0.05	1.90 1.90 1.90	1450/2000 1450/2000 1450/2000	400/550 400/550 400/550	1.90/1.80 1.90/1.80 1.90/1.80	0.25 1.5 4.0	14.10 14.20 14.30 14.40 14.50 14.60	Wet medium dense sand overlying frozen silty or clayey loam Wet medium dense sand overlying dense cohesionless soil with high water table Moist medium gravel overlying frozen silty or clayey loam Moist medium gravel overlying dense cohesionless soil with high water table Heavy gravelly clay (till) overlying frozen silty or clayey loam Heavy gravelly clay (till) overlying dense cohesionless soil with high water table
45 46 47	5.43×10^7 5.43×10^7 5.43×10^7	0.05 0.05 0.05	1.90 1.90 1.90	1450/2000 1450/2000 1450/2000	400/750 400/750 400/750	1.90/2.10 1.90/2.10 1.90/2.10	0.25 1.5 4.0	15.10 15.20 15.30 15.40 15.50 15.60 15.70 15.80 15.90 15.91 15.92 15.93	Wet medium dense sand overlying dense sand and gravel Wet medium dense sand overlying cemented soil Wet medium dense sand overlying weathered rock Wet medium dense sand overlying hard clay Moist medium gravel overlying dense sand and gravel Moist medium gravel overlying cemented soil Moist medium gravel overlying weathered rock Moist medium gravel overlying hard clay Heavy gravelly clay (till) overlying dense sand and gravel Heavy gravelly clay (till) overlying cemented soil Heavy gravelly clay (till) overlying weathered rock Heavy gravelly clay (till) overlying hard clay

(Continued)

Table 15 (Continued)

Terrain Factors Used in Terrain Matrix										
	Characteristics of Surface Material			Characteristics of Top Layer/Foundation Material						
	Rigidity									
Terrain Matrix Element	Spring Constant N/m	Maximum Spring Travel m	Roughness rms Elevation cm	Compression Wave Velocity m/sec	Shear Wave Velocity m/sec	Bulk Density g/cm^3	First Layer Thickness m	No.	Qualitative Terrain Descriptors
48	5.43×10^7	0.05	1.90	1450/3500	400/1500	1.90/2.50	0.25	16.10	Wet medium sand overlying competent unweathered rock
49	5.43×10^7	0.05	1.90	1450/3500	400/1500	1.90/2.50	1.50	16.20	Moist medium gravel overlying competent unweathered rock
50	5.43×10^7	0.05	1.90	1450/3500	400/1500	1.90/2.50	4.00	16.30	Heavy gravelly clay (till) overlying competent unweathered rock
51	10.85×10^7	0.025	2.54	2000	550	1.80	10.0	17.10	Frozen silty or clayey loam
								17.20	Dense cohesionless soil with high water table
52	10.85×10^7	0.025	2.54	2000/2750	550/1100	1.80/2.30	0.25	18.10	Frozen silty or clayey loam overlying poorly consolidated calcareous silt or clay (marl)
53	10.85×10^7	0.025	2.54	2000/2750	550/1100	1.80/2.30	1.50	18.20	Frozen silty or clayey loam overlying sandy consolidated gravel (conglomerate)
54	10.85×10^7	0.025	2.54	2000/2750	550/1100	1.80/2.30	4.00	18.30	Dense cohesionless soil with high water table overlying sandy consolidated gravel (conglomerate)
55	10.85×10^7	0.025	2.54	2000/3500	550/1500	1.80/2.50	0.25	19.10	Frozen silty or clayey loam overlying competent unweathered rock
56	10.85×10^7	0.025	2.54	2000/3500	550/1500	1.80/2.50	1.50	19.20	Dense cohesionless soil with high water table overlying unweathered rock
57	10.85×10^7	0.025	2.54	2000/3500	550/1500	1.80/2.50	4.00		
58	8.14×10^7	0.03	3.81	2000	750	2.10	10.0	20.10	Dense sand and gravel
								20.20	Cemented residual soil
								20.30	Hard clay
								20.40	Weathered rock

(Continued)

Table 15 (Concluded)

Terrain Matrix Element	Spring Constant N/m (Rigidity; Characteristics of Surface Material)	Maximum Spring Travel m (Rigidity; Characteristics of Surface Material)	Roughness rms Elevation cm (Characteristics of Surface Material)	Compression Wave Velocity m/sec (Characteristics of Top Layer/Foundation Material)	Shear Wave Velocity m/sec (Characteristics of Top Layer/Foundation Material)	Bulk Density g/cm^3 (Characteristics of Top Layer/Foundation Material)	First Layer Thickness m (Characteristics of Top Layer/Foundation Material)	No.	Qualitative Terrain Descriptors
								21.10	Dense sand and gravel overlying frozen silty or clayey loam
								21.20	Dense sand and gravel overlying dense cohesionless soil with high water table
59	8.14×10^7	0.03	3.81	2000/2000	750/550	2.10/1.80	0.25	21.30	Cemented soil overlying frozen silty or clayey loam
60	8.14×10^7	0.03	3.81	2000/2000	750/550	2.10/1.80	1.50		
61	8.14×10^7	0.03	3.81	2000/2000	750/550	2.10/1.80	4.00	21.40	Cemented soil overlying dense cohesionless soil with high water table
								21.50	Hard clay overlying frozen silty or clayey loam
								21.60	Hard clay overlying dense cohesionless soil with high water table
								22.10	Dense sand and gravel overlying competent unweathered rock
62	8.14×10^7	0.03	3.81	2000/3500	750/1500	2.10/2.50	0.25	22.20	Cemented residual soil overlying competent unweathered rock
63	8.14×10^7	0.03	3.81	2000/3500	750/1500	2.10/2.50	1.50		
64	8.14×10^7	0.03	3.81	2000/3500	750/1500	2.10/2.50	4.00	22.30	Hard clay overlying competent unweathered rock
								22.40	Weathered rock overlying competent unweathered rock
								23.10	Hard cemented clay (hardpan)
65	12.40×10^7	0.020	3.18	2400	900	2.00	10.00	23.20	Boulder till
								23.30	Compact cobbly and bouldery material
								23.40	Moderately hard shale or sandstone
66	1.8×10^{10}*	0.005*	4.45	3200	1200	2.40	10.00	24.00	Competent slightly weathered rock
67	1.8×10^{10}	0.005	1.20	3700	1900	1.00	10.00	25.00	Solid or massive ice (Ice cap)
68	1.8×10^{10}	0.005	1.20	3700/2000	1900/750	1.0/2.10	0.25	26.10	Ice overlying dense sand and gravel
69	1.8×10^{10}	0.005	1.20	3700/2000	1900/750	1.0/2.10	1.50	26.20	Ice overlying weathered rock
70	1.8×10^{10}	0.005	1.20	3700/2000	1900/750	1.0/2.10	4.00		

* Rock surface; not a pavement.

Table 16

Surface Configuration Categories with Slope Characteristics *

Category	Slope Range %	Slope Areal Occurrence %
1. Plains (generally level)	< 10	> 90
	> 30	< 10
2. Plains (undulating or rolling)	< 10	50-90
	> 30	< 10
3. Tablelands and plateaus**	< 10	50-90
	> 30	10-25
4. Plains and hills or mountains complex†	< 10	50-90
	> 30	10-25
5. Hills	< 10	< 50
	> 30	10-50
6. Mountains	< 10	< 25
	> 30	> 50

* Adapted from Reference 31.

** Gentler slopes occur at higher elevations.
[illegible] slopes occur at lower elevations.

Table 17

Surface Soil Categories*

Surface Soil Texture** (Upper 15 cm)		Range in Composition (%) † Sand	Silt	Clay
1.	Sand††	85-100	0-15	0-10
2.	Sand and loam			
3	Sand and clay			
4.	Sand and organic material			
5.	Sand and bare area			
6.	Loam	23-52	28-50	7-27
7.	Loam and silt			
8.	Loam and clay			
9.	Loam and organic material			
10.	Loam and bare area			
11.	Silt	0-20	80-100	0-12
12.	Silt and clay			
13.	Clay	0-45	0-40	40-100
14.	Clay and bare area			
15.	Organic material			
16.	Bare area‡			

* Adapted from Reference 32.

** Where two soil categories are identified means that two textures or conditions are extensive in the area mapped; the second texture or condition is of equal or lesser areal extent than the first.

† Adapted from Reference 33.

†† Includes particles coarser than sand (e.g. gravel).

‡ Areas generally devoid of soil.

Table 18

Subsurface Lithologic Categories*

Rock Category	Rock Types
1. Consolidated rock	Igneous and metamorphic rocks, well-consolidated sedimentary rocks, mixed or intermingled rock types
2. Unconsolidated rock	Weakly consolidated or unconsolidated sedimentary rocks
3. Alluvium	Restricted to detrital deposits of streams
4. Ice cap	Frozen material plus ice blocks

* Adapted from Reference 34.

Table 19

State-of-Ground Categories*

Water-Table Regime	Description
1. Permafrost	Includes areas of continuous permafrost, where very little land is unfrozen; and areas of discontinuous permafrost, where scattered patches of unfrozen land occur
2. High water table	High-water-table conditions can be expected most of the year. Water table generally <5 m deep
3. Water table fluctuates	Water-table conditions cannot be predicted with any degree of accuracy
4. Low water table	Low-water-table conditions can be expected most of the year. Water table generally >5 m deep
5. Rock or ice	Ice caps and rocky areas where water-table conditions are not considered significant

* Adapted from References 32 and 35.

Table 20

Vegetation Categories with Selected Characteristics

Category *		Average Plant Height, m**	Average Plant Coverage, %†
1. Needleleaf forest		15.0 - 35.0	75-100
2. Broadleaf forest		15.0 - 35.0	75-100
3. Mixed needleleaf and broadleaf forest		15.0 - 35.0	75-100
4. Montane forest		2.0 - 10.0	50-100
5. Savanna	Woody:	5.0 - 10.0	50-100
	Nonwoody:	0.5 - 2.0	75-100
6. Forest and grassland	Woody:	10.0 - 15.0	25-50
	Nonwoody:	0.5 - 1.0	50-100
7. Woodland and scrubland		2.0 - 5.0	50-100
8. Tundra and alpine		0.1 - 2.0	50-100
9. Grassland		0.2 - 1.0	50-100
10. Semidesert scrub and desert		0.2 - 5.0	>0-50
11. Barren		-	-
12. Commercial grain and horticulture		0.5 - 2.0	50-100
13. Commercial plantation		2.0 - 15.0	50-100

* Adapted from Reference 36.
** Average height of plants in the main vegetation layer.
† Area of ground covered by vegetation.

Table 21

Thematic Factor Complex Map Legend

Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation
1	1	01	1	3	05	54	1	06	1	2	05	107	1	08	2	1	09
2	1	01	1	4	07	55	1	05	1	2	09	108	1	08	2	1	12
3	1	01	1	4	09	56	1	06	1	2	10	109	1	08	2	2	02
4	1	01	1	4	10	57	1	06	1	3	01	110	1	08	2	2	09
5	1	01	1	4	12	58	1	06	1	3	02	111	1	08	2	3	02
6	1	01	2	1	08	59	1	06	1	3	03	112	1	08	2	3	05
7	1	01	2	2	02	60	1	06	1	3	05	113	1	08	2	3	06
8	1	01	2	3	02	61	1	06	1	3	06	114	1	08	2	3	09
9	1	01	2	3	05	62	1	06	1	3	07	115	1	08	2	3	12
10	1	01	2	4	05	63	1	06	1	3	12	116	1	08	2	4	02
11	1	01	2	4	07	64	1	06	1	4	02	117	1	08	2	4	07
12	1	01	2	4	09	65	1	06	1	4	05	118	1	08	2	4	09
13	1	01	2	4	10	66	1	06	1	4	07	119	1	08	3	2	01
14	1	01	3	3	02	67	1	06	1	4	10	120	1	08	3	2	02
15	1	01	3	4	10	68	1	06	1	5	11	121	1	08	3	2	12
16	1	01	3	4	12	69	1	06	2	1	02	122	1	08	3	3	02
17	1	02	1	3	01	70	1	06	2	1	06	123	1	08	3	3	12
18	1	02	1	4	02	71	1	06	2	2	01	124	1	08	3	4	02
19	1	02	1	4	05	72	1	06	2	2	02	125	1	08	3	4	12
20	1	02	1	4	09	73	1	06	2	2	04	126	1	09	1	1	01
21	1	02	2	1	01	74	1	06	2	2	05	127	1	09	1	1	08
22	1	02	2	1	02	75	1	06	2	3	02	128	1	09	1	3	01
23	1	02	2	1	06	76	1	06	2	3	03	129	1	09	1	3	08
24	1	02	2	1	08	77	1	06	2	3	04	130	1	09	2	1	01
25	1	02	2	2	01	78	1	06	2	3	07	131	1	09	2	1	08
26	1	02	2	2	02	79	1	06	2	3	09	132	1	09	3	1	08
27	1	02	2	2	05	80	1	06	2	3	12	133	1	10	2	2	02
28	1	02	2	3	01	81	1	06	2	4	02	134	1	10	2	3	12
29	1	02	2	3	02	82	1	06	2	4	04	135	1	10	3	2	02
30	1	02	2	3	06	83	1	06	2	4	05	136	1	11	2	3	07
31	1	02	2	3	08	84	1	06	2	4	07	137	1	11	2	3	09
32	1	02	2	4	02	85	1	06	2	4	09	138	1	11	2	3	12
33	1	02	2	4	04	86	1	06	2	4	10	139	1	11	3	3	07
34	1	02	2	4	05	87	1	06	2	4	12	140	1	11	3	3	09
35	1	02	2	4	07	88	1	06	3	2	02	141	1	11	3	3	12
36	1	02	2	4	09	89	1	06	3	2	07	142	1	13	1	4	05
37	1	02	3	2	02	90	1	06	3	2	12	143	1	13	2	3	12
38	1	02	3	2	03	91	1	06	3	3	07	144	1	13	2	4	02
39	1	02	3	2	12	92	1	06	3	3	09	145	1	13	3	2	02
40	1	02	4	5	11	93	1	06	3	3	12	146	1	13	3	2	12
41	1	03	1	2	05	94	1	06	3	4	12	147	1	13	3	2	13
42	1	03	1	4	05	95	1	07	1	4	09	148	1	13	3	3	09
43	1	04	2	1	01	96	1	07	1	4	12	149	1	13	3	3	12
44	1	04	2	1	02	97	1	07	2	4	09	150	1	13	3	4	13
45	1	04	2	1	08	98	1	08	1	2	12	151	1	15	2	2	02
46	1	04	2	3	01	99	1	08	1	3	02	152	1	16	1	5	11
47	1	04	2	3	02	100	1	08	1	3	05	153	1	16	4	1	11
48	1	04	2	3	06	101	1	08	1	3	06	154	1	16	4	5	11
49	1	04	3	2	02	102	1	08	1	3	07	155	2	01	1	3	02
50	1	04	3	3	02	103	1	08	1	3	12	156	2	01	1	3	05
51	1	05	1	4	05	104	1	08	1	4	02	157	2	01	1	3	08
52	1	06	1	1	01	105	1	08	1	4	05	158	2	01	1	3	12
53	1	06	1	2	02	106	1	08	2	1	06	159	2	01	1	4	02

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Table 21 (Continued)

Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation
160	2	01	1	4	05	213	2	02	2	3	03	266	2	06	1	4	10
161	2	01	1	4	07	214	2	02	2	3	05	267	2	06	1	4	12
162	2	01	1	4	09	215	2	02	2	3	07	268	2	06	2	2	01
163	2	01	1	4	10	216	2	02	2	3	09	269	2	06	2	2	02
164	2	01	1	4	12	217	2	02	2	3	12	270	2	06	2	2	04
165	2	01	1	5	07	218	2	02	2	4	02	271	2	06	2	2	05
166	2	01	2	3	02	219	2	02	2	4	05	272	2	06	2	2	12
167	2	01	2	3	05	220	2	02	2	4	07	273	2	06	2	3	01
168	2	01	2	3	08	221	2	02	2	4	09	274	2	06	2	3	02
169	2	01	2	3	11	222	2	02	2	4	10	275	2	06	2	3	03
170	2	01	2	4	02	223	2	02	2	4	11	276	2	06	2	3	04
171	2	01	2	4	05	224	2	02	2	5	07	277	2	06	2	3	05
172	2	01	2	4	06	225	2	02	3	2	02	278	2	06	2	3	07
173	2	01	2	4	07	226	2	02	3	3	02	279	2	06	2	3	08
174	2	01	2	4	08	227	2	02	3	4	07	280	2	06	2	3	09
175	2	01	2	4	09	228	2	03	1	3	05	281	2	06	2	3	12
176	2	01	2	4	10	229	2	03	1	4	02	282	2	06	2	4	02
177	2	01	2	4	11	230	2	03	1	4	04	283	2	06	2	4	04
178	2	01	2	4	12	231	2	03	1	4	05	284	2	06	2	4	05
179	2	01	2	5	09	232	2	03	1	4	10	285	[illegible]	06	2	4	06
180	2	01	2	5	11	233	2	03	2	4	05	286	2	06	2	4	07
181	2	01	3	4	05	234	2	03	2	4	10	287	2	06	2	4	09
182	2	01	3	4	07	235	2	04	1	1	01	288	2	06	2	4	10
183	2	01	3	4	08	236	2	04	1	3	02	289	2	06	2	4	12
184	2	01	3	4	09	237	2	04	2	1	01	290	2	06	3	2	02
185	2	01	3	4	10	238	2	04	2	1	02	291	2	06	3	2	12
186	2	01	3	4	11	239	2	04	2	1	08	292	2	06	3	3	02
187	2	01	3	4	12	240	2	04	2	3	01	293	2	06	3	3	09
188	2	02	1	1	01	241	2	04	3	2	02	294	2	06	3	3	12
189	2	02	1	1	02	242	2	05	1	4	09	295	2	06	3	3	13
190	2	02	1	1	08	243	2	05	1	4	10	296	2	06	3	4	12
191	2	02	1	2	02	244	2	05	2	2	04	297	2	07	1	3	02
192	2	02	1	3	01	245	2	05	2	4	05	298	2	07	1	3	09
193	2	02	1	3	02	246	2	05	2	4	10	299	2	07	1	3	12
194	2	02	1	3	03	247	2	06	1	1	01	300	2	07	1	4	01
195	2	02	1	3	05	248	2	06	1	1	02	301	2	07	1	4	09
196	2	02	1	3	07	249	2	06	1	1	06	302	2	07	1	4	12
197	2	02	1	3	12	250	2	06	1	1	08	303	2	07	2	2	01
198	2	02	1	4	02	251	2	06	1	2	02	304	2	07	2	3	01
199	2	02	[illegible]	4	05	252	2	06	1	2	05	305	2	07	2	3	03
200	2	02	1	4	07	253	2	06	1	2	09	306	2	07	2	4	09
201	2	02	1	4	09	254	2	06	1	3	01	307	2	07	2	4	12
202	2	02	1	4	10	255	2	06	1	3	02	308	2	08	1	1	01
203	2	02	2	1	01	256	2	06	1	3	03	309	2	08	1	1	08
204	2	02	2	1	02	257	2	06	1	3	05	310	2	08	1	1	12
205	2	02	2	1	08	258	2	06	1	3	06	311	2	08	1	2	05
206	2	02	2	2	01	259	2	06	1	3	09	312	2	08	1	3	01
207	2	02	2	2	02	260	2	06	1	3	12	313	2	08	1	3	02
208	2	02	2	2	03	261	2	06	1	4	01	314	2	08	1	3	03
209	2	02	2	2	05	262	2	06	1	4	02	315	2	08	1	3	05
210	2	02	2	2	12	263	2	06	1	4	05	316	2	08	1	3	06
211	2	02	2	3	01	264	2	06	1	4	07	317	2	08	1	3	07
212	2	02	2	3	02	265	2	06	1	4	09	318	2	08	1	3	08

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Table 21 (Continued)

Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation
319	2	08	1	3	09	372	2	11	1	3	03	425	3	02	1	4	04
320	2	08	1	3	12	373	2	11	1	3	12	426	3	02	1	4	05
321	2	08	1	3	13	374	2	12	1	2	09	427	3	02	1	4	07
322	2	08	1	4	01	375	2	12	1	3	09	428	3	02	1	4	09
323	2	08	1	4	02	376	2	13	1	1	01	429	3	02	1	4	10
324	2	08	1	4	05	377	2	13	1	3	02	430	3	02	2	4	09
325	2	08	1	4	07	378	2	13	1	4	05	431	3	03	1	3	05
326	2	08	1	4	09	379	2	13	1	4	07	432	3	03	1	4	02
327	2	08	1	4	10	380	2	13	2	2	02	433	3	03	1	4	05
328	2	08	1	4	12	381	2	13	2	2	04	434	3	04	1	3	02
329	2	08	1	4	13	382	2	13	2	2	12	435	3	04	1	3	05
330	2	08	2	1	02	383	2	13	2	3	02	436	3	05	1	4	10
331	2	08	2	1	06	384	2	13	2	3	05	437	3	05	2	4	10
332	2	08	2	1	09	385	2	13	2	3	09	438	3	06	1	1	01
333	2	08	2	1	12	386	2	13	2	3	12	439	3	06	1	1	02
334	2	08	2	2	02	387	2	13	2	4	02	440	3	06	1	1	08
335	2	08	2	2	04	388	2	13	2	4	05	441	3	06	1	1	09
336	2	08	2	2	11	389	2	13	2	4	07	442	3	06	1	2	02
337	2	08	2	2	12	390	2	13	3	2	02	443	3	06	1	2	05
338	2	08	2	3	01	391	2	13	3	2	12	444	3	06	1	3	01
339	2	08	2	3	02	392	2	13	3	3	09	445	3	06	1	3	02
340	2	08	2	3	03	393	2	15	1	3	02	446	3	06	1	3	03
341	2	08	2	3	04	394	2	15	1	3	05	447	3	06	1	3	05
342	2	08	2	3	05	395	2	15	2	2	02	448	3	06	1	3	07
343	2	08	2	3	06	396	2	15	2	3	02	449	3	06	1	3	08
344	2	08	2	3	07	397	2	16	1	3	11	450	3	06	1	3	09
345	2	08	2	3	09	398	2	16	1	4	01	451	3	06	1	3	12
346	2	08	2	3	12	399	2	16	1	4	07	452	3	06	1	4	01
347	2	08	2	4	05	400	2	16	1	4	08	453	3	06	1	4	02
348	2	08	2	4	07	401	2	16	1	4	10	454	3	06	1	4	05
349	2	08	2	4	09	402	2	16	1	5	11	455	3	06	1	4	07
350	2	08	2	4	10	403	2	16	2	4	08	456	3	06	1	4	09
351	2	08	2	4	12	404	2	16	2	4	11	457	3	06	1	4	10
352	2	08	3	2	02	405	2	16	2	4	12	458	3	06	1	4	12
353	2	08	3	2	12	406	2	16	2	5	11	459	3	06	1	5	11
354	2	08	3	3	02	407	2	16	2	5	12	460	3	06	2	3	01
355	2	08	3	3	12	408	2	16	3	4	11	461	3	06	2	3	08
356	2	08	3	4	07	409	3	01	1	3	02	462	3	06	2	3	09
357	2	08	3	4	12	410	3	01	1	3	05	463	3	06	2	3	12
358	2	09	1	1	01	411	3	01	1	4	02	464	3	06	2	4	02
359	2	09	1	1	08	412	3	01	1	4	05	465	3	06	2	4	04
360	2	09	1	1	11	413	3	01	1	4	07	466	3	06	2	4	05
361	2	09	1	3	01	414	3	01	1	4	10	467	3	06	2	4	09
362	2	09	1	5	11	415	3	01	2	4	04	468	3	06	2	4	12
363	2	09	2	1	01	416	3	01	2	4	07	469	3	06	3	2	02
364	2	09	2	1	08	417	3	01	2	4	10	470	3	07	1	4	09
365	2	09	2	5	11	418	3	01	3	4	10	471	3	08	1	3	02
366	2	10	2	2	02	419	3	02	1	1	01	472	3	08	1	3	05
367	2	10	2	2	05	420	3	02	1	2	05	473	3	08	1	3	12
368	2	10	2	3	02	421	3	02	1	3	02	474	3	08	1	4	02
369	2	10	2	3	12	422	3	02	1	3	05	475	3	08	1	4	05
370	2	10	3	2	02	423	3	02	1	4	01	476	3	08	1	4	10
371	2	10	3	2	05	424	3	02	1	4	02	477	3	08	1	4	12

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Table 21 (Continued)

Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation
478	3	08	2	3	02	531	4	02	1	4	10	584	4	06	1	4	09
479	3	08	2	4	07	532	4	02	1	4	12	585	4	06	1	4	10
480	3	08	2	4	10	533	4	02	2	3	02	586	4	06	1	4	11
481	3	09	1	1	01	534	4	02	2	3	04	587	4	06	1	4	12
482	3	09	1	1	08	535	4	02	2	3	05	588	4	06	2	2	02
483	3	09	1	5	11	536	4	02	2	3	12	589	4	06	2	2	05
484	3	10	1	1	01	537	4	02	2	4	01	590	4	06	2	3	02
485	3	10	1	1	08	538	4	02	2	4	04	591	4	06	2	3	04
486	3	10	1	3	08	539	4	02	2	4	05	592	4	06	2	3	05
487	3	10	2	4	12	540	4	02	2	4	07	593	4	06	2	3	07
488	3	13	1	3	12	541	4	02	2	4	10	594	4	06	2	3	12
489	3	13	1	4	02	542	4	02	3	3	02	595	4	06	2	4	01
490	3	13	1	4	04	543	4	03	1	4	02	596	4	06	2	4	02
491	3	13	1	4	05	544	4	03	1	4	04	597	4	06	2	4	03
492	3	15	1	1	01	545	4	03	1	4	05	598	4	06	2	4	04
493	3	15	1	1	08	546	4	03	1	4	07	599	4	06	2	4	05
494	4	01	1	3	02	547	4	03	1	4	10	600	4	06	2	4	06
495	4	01	1	3	05	548	4	03	2	4	05	601	4	06	2	4	07
496	4	01	1	3	08	549	4	03	2	4	07	602	4	06	2	4	08
497	4	01	1	3	09	550	4	05	1	3	05	603	4	06	2	4	09
498	4	01	1	4	02	551	4	05	1	3	08	604	4	06	2	4	10
499	4	01	1	4	05	552	4	05	1	4	01	605	4	06	2	4	12
500	4	01	1	4	07	553	4	05	1	4	04	606	4	06	3	2	02
501	4	01	1	4	08	554	4	05	1	4	05	607	4	06	3	2	12
502	4	01	1	4	09	555	4	05	1	4	07	608	4	06	3	3	02
503	4	01	1	4	10	556	4	05	1	4	09	609	4	06	3	4	12
504	4	01	1	4	12	557	4	05	1	4	10	610	4	08	1	2	04
505	4	01	1	5	09	558	4	05	1	4	12	611	4	08	1	3	02
506	4	01	2	3	02	559	4	05	1	5	08	612	4	08	1	3	04
507	4	01	2	3	05	560	4	05	2	4	01	613	4	08	1	3	05
508	4	01	2	3	09	561	4	05	2	4	05	614	4	08	1	3	07
509	4	01	2	4	02	562	4	05	2	4	10	615	4	08	1	4	02
510	4	01	2	4	05	563	4	06	1	1	01	616	4	08	1	4	05
511	4	01	2	4	07	564	4	06	1	1	07	617	4	08	1	4	07
512	4	01	2	4	09	565	4	06	1	2	02	618	4	08	1	4	10
513	4	01	2	4	10	566	4	06	1	2	12	619	4	08	1	4	12
514	4	01	3	4	07	567	4	06	1	3	01	620	4	08	2	2	12
515	4	01	3	4	09	568	4	06	1	3	02	621	4	08	2	3	02
516	4	02	1	1	08	569	4	06	1	3	03	622	4	08	2	3	04
517	4	02	1	3	01	570	4	06	1	3	05	623	4	08	2	3	05
518	4	02	1	3	02	571	4	06	1	3	06	624	4	08	2	3	07
519	4	02	1	3	03	572	4	06	1	3	07	625	4	08	2	3	12
520	4	02	1	3	04	573	4	06	1	3	09	626	4	08	2	4	05
521	4	02	1	3	05	574	4	06	1	3	10	627	4	08	2	4	07
522	4	02	1	3	08	575	4	06	1	3	12	628	4	08	3	4	02
523	4	02	1	3	13	576	4	06	1	3	13	629	4	08	3	4	05
524	4	02	1	4	01	577	4	06	1	4	01	630	4	08	3	4	12
525	4	02	1	4	02	578	4	06	1	4	02	631	4	09	1	1	01
526	4	02	1	4	04	579	4	06	1	4	03	632	4	09	1	1	08
527	4	02	1	4	05	580	4	06	1	4	04	633	4	09	1	2	02
528	4	02	1	4	07	581	4	06	1	4	05	634	4	09	1	3	01
529	4	02	1	4	08	582	4	06	1	4	07	635	4	10	1	1	01
530	4	02	1	4	09	583	4	06	1	4	08	636	4	10	1	3	01

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Table 21 (Continued)

Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation
637	4	10	1	3	08	690	5	05	2	4	10	743	5	08	1	4	13
638	4	10	2	2	02	691	5	06	1	1	01	744	5	08	2	3	02
639	4	10	2	3	02	692	5	06	1	1	02	745	5	08	2	3	03
640	4	11	2	3	12	693	5	06	1	1	03	746	5	08	2	3	06
641	4	11	3	3	12	694	5	06	1	1	06	747	5	08	2	4	07
642	4	12	1	3	09	695	5	06	1	1	08	748	5	09	1	1	01
643	4	13	1	2	02	696	5	06	1	1	09	749	5	09	1	1	08
644	4	13	1	3	02	697	5	06	1	2	02	750	5	09	1	1	11
645	4	13	1	4	05	698	5	06	1	2	05	751	5	09	1	2	02
646	4	13	3	2	02	699	5	06	1	2	08	752	5	09	1	3	08
647	4	13	3	2	12	700	5	06	1	3	01	753	5	09	1	4	07
648	4	13	3	3	02	701	5	06	1	3	02	754	5	09	1	5	11
649	4	13	3	3	12	702	5	06	1	3	03	755	5	09	2	1	01
650	4	15	1	3	01	703	5	06	1	3	05	756	5	09	2	1	08
651	4	15	1	3	02	704	5	06	1	3	06	757	5	10	2	3	02
652	4	15	1	3	03	705	5	06	1	3	07	758	5	11	1	3	03
653	5	01	1	3	02	706	5	06	1	3	08	759	5	13	1	3	03
654	5	01	1	3	05	707	5	06	1	3	09	760	5	13	1	3	06
655	5	01	1	3	12	708	5	06	1	3	10	761	5	13	1	3	12
656	5	01	1	4	02	709	5	06	1	3	12	762	5	13	1	4	05
657	5	01	1	4	05	710	5	06	1	4	02	763	5	13	2	1	08
658	5	01	1	4	10	711	5	06	1	4	03	764	5	13	2	3	01
659	5	01	2	3	05	712	5	06	1	4	04	765	5	13	2	3	02
660	5	01	2	4	05	713	5	06	1	4	05	766	5	13	2	4	05
661	5	01	2	4	09	714	5	06	1	4	07	767	5	16	1	5	11
662	5	01	2	4	10	715	5	06	1	4	09	768	6	01	1	1	08
663	5	01	2	4	12	716	5	06	1	4	10	769	6	01	1	3	01
664	5	02	1	1	01	717	5	06	1	4	12	770	6	01	1	3	02
665	5	02	1	1	02	718	5	06	2	3	02	771	6	01	1	3	08
666	5	02	1	1	[illegible]	719	5	06	2	4	03	772	6	01	1	3	09
667	5	02	1	3	01	720	5	06	2	4	04	773	6	01	1	4	01
668	5	02	1	3	02	721	5	06	2	4	05	774	6	01	1	4	05
669	5	02	1	3	03	722	5	06	2	4	09	775	6	01	1	4	07
670	5	02	1	3	04	723	5	06	2	4	12	776	6	01	1	4	08
671	5	02	1	3	05	724	5	06	3	3	02	777	6	01	1	4	10
672	5	02	1	3	13	725	5	06	3	3	03	778	6	01	1	4	11
673	5	02	1	4	01	726	5	07	1	3	02	779	6	01	1	4	12
674	5	02	1	4	02	727	5	07	1	3	12	780	6	01	1	5	01
675	5	02	1	4	05	728	5	07	1	4	12	781	6	01	1	5	07
676	5	02	1	4	07	729	5	08	1	2	[illegible]	782	6	01	1	5	08
677	5	02	1	5	11	730	5	08	1	2	12	783	6	01	1	5	10
678	5	02	2	4	02	731	5	08	1	3	01	784	6	01	1	5	11
679	5	02	2	4	05	732	5	08	1	3	02	785	6	01	2	1	08
680	5	02	2	4	07	733	5	08	1	3	06	786	6	01	2	3	02
681	5	02	2	4	09	734	5	08	1	3	07	787	6	01	2	4	05
682	5	02	2	4	10	735	5	08	1	3	09	788	6	01	2	4	07
683	5	03	1	3	05	736	5	08	1	3	12	789	6	01	2	4	09
684	5	03	1	4	04	737	5	08	1	4	01	790	6	01	2	4	10
685	5	03	1	4	05	738	5	08	1	4	02	791	6	01	2	5	08
686	5	03	1	4	10	739	5	08	1	4	05	792	6	01	2	5	09
687	5	03	2	4	05	740	5	08	1	4	07	793	6	01	2	5	11
688	5	03	2	4	07	741	5	08	1	4	09	794	6	01	3	4	07
689	5	05	1	4	10	742	5	08	1	4	12	795	6	02	1	1	01

(Continued)

Table 21 (Continued)

Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation
796	6	02	1	1	02	849	6	04	2	1	08	902	[illegible]	[illegible]	2	2	05
797	6	02	1	1	05	850	6	04	2	3	01	903	6	06	2	2	12
798	6	02	1	1	07	851	6	05	1	3	04	904	6	06	2	3	01
799	6	02	1	1	08	852	6	05	1	3	05	905	6	06	2	3	02
800	6	02	1	1	09	853	6	05	1	3	08	906	6	06	2	3	05
801	6	02	1	2	04	854	6	05	1	3	09	907	6	06	2	3	08
802	6	02	1	3	01	855	6	05	1	3	11	908	6	06	2	3	09
803	6	02	1	3	02	856	6	05	1	4	01	909	6	06	2	3	12
804	6	02	1	3	03	857	6	05	1	4	04	910	6	06	2	4	01
805	6	02	1	3	04	858	6	05	1	4	05	911	6	06	2	4	02
806	6	02	1	3	05	859	6	05	1	4	07	912	6	06	2	4	03
807	6	02	1	3	06	860	6	05	1	4	10	913	6	06	2	4	05
808	6	02	1	3	08	861	6	05	1	4	12	914	6	06	2	4	06
809	6	02	1	3	12	862	6	05	1	5	04	915	6	06	2	4	07
810	6	02	1	4	01	863	6	05	1	5	11	916	6	06	2	4	09
811	6	02	1	4	02	864	6	05	2	4	07	917	6	06	2	4	10
812	6	02	1	4	04	865	6	05	2	5	08	918	6	06	2	4	12
813	6	02	1	4	05	866	6	06	1	1	01	919	6	06	3	2	02
814	6	02	1	4	06	867	6	06	1	1	02	920	6	06	3	2	07
815	6	02	1	4	07	868	6	06	1	1	06	921	6	06	3	2	10
816	6	02	1	4	08	869	6	06	1	1	07	922	6	06	3	2	12
817	6	02	1	4	09	870	6	06	1	1	08	923	6	06	3	3	02
818	6	02	1	4	10	871	6	06	1	1	09	924	6	06	3	3	12
819	6	02	1	4	12	872	6	06	1	2	02	925	6	06	3	4	[illegible]
820	6	02	1	5	07	873	6	06	1	2	04	926	6	07	1	3	09
821	6	02	1	5	08	874	6	06	1	2	09	927	6	07	1	4	01
822	6	02	1	5	10	875	6	06	1	2	10	928	6	07	1	4	07
823	6	02	1	5	[illegible]	876	6	06	1	2	12	929	6	07	1	4	09
824	6	02	2	1	01	877	6	06	1	3	01	930	6	07	1	4	12
825	6	02	2	1	02	878	6	06	1	3	02	931	6	07	2	4	01
826	6	02	2	1	08	879	6	06	1	3	03	932	6	08	1	2	02
827	6	02	2	3	02	880	6	06	1	3	04	933	6	08	1	2	04
828	6	02	2	3	04	881	6	06	1	3	05	934	6	08	1	2	05
829	6	02	2	3	05	882	6	06	1	3	06	935	6	08	1	3	01
830	6	02	2	4	01	883	6	06	1	3	07	936	6	08	1	3	02
831	6	02	2	4	02	884	6	06	1	3	08	937	6	08	1	3	03
832	6	02	2	4	05	885	6	06	1	3	09	938	6	08	1	3	04
833	6	02	2	4	07	886	6	06	1	3	10	939	6	08	1	3	05
834	6	02	2	4	09	887	6	06	1	3	11	940	6	08	1	3	06
835	6	02	2	4	10	888	6	06	1	3	12	941	6	08	1	3	08
836	6	02	2	4	12	889	6	06	1	4	01	942	6	08	1	3	09
837	6	02	3	2	07	890	6	06	1	4	02	943	6	08	1	3	11
838	6	C2	4	1	08	891	6	06	1	4	03	944	6	08	1	3	12
839	6	03	1	3	02	892	6	06	1	4	04	945	6	08	1	3	13
840	6	03	1	3	04	893	6	06	1	4	05	946	6	08	1	4	01
841	6	03	1	3	05	894	6	06	1	4	07	947	6	08	1	4	02
842	6	03	1	4	02	895	6	06	1	4	08	948	6	08	1	4	03
843	6	03	1	4	04	896	6	06	1	4	09	949	6	08	1	4	04
844	6	03	1	4	05	897	6	06	1	4	10	950	6	08	1	4	05
845	6	03	1	4	07	898	6	06	1	4	11	951	6	08	1	4	07
846	6	03	1	4	12	899	6	06	1	4	12	952	6	08	1	4	09
847	6	04	1	1	01	900	6	06	1	5	11	953	6	08	1	4	10
848	6	04	2	1	01	901	6	06	2	2	02	954	6	08	1	4	11

(Continued)

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Table 21 (Concluded)

Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation	Map Unit	Surface Configuration	Soils	Lithology	State of Ground	Vegetation
955	6	08	1	4	12	1008	6	13	1	4	05						
956	6	08	1	4	13	1009	6	13	2	1	08						
957	6	08	1	5	01	1010	6	13	2	3	01						
958	6	08	1	5	08	1011	6	13	2	3	02						
959	6	08	1	5	11	1012	6	13	2	3	08						
960	6	08	2	2	02	1013	6	13	2	4	02						
961	6	08	2	2	12	1014	6	13	3	2	02						
962	6	08	2	3	02	1015	6	13	3	2	12						
963	6	08	2	3	04	1016	6	14	1	3	02						
964	6	08	2	3	05	1017	6	14	1	3	04						
965	6	08	2	3	06	1018	6	14	2	3	02						
966	6	08	2	3	07	1019	6	14	2	3	04						
967	6	08	2	3	08	1020	6	15	1	1	08						
968	6	08	2	3	11	1021	6	15	1	3	01						
969	6	08	2	3	12	1022	6	15	1	3	02						
970	6	08	2	4	02	1023	6	15	1	4	02						
971	6	08	2	4	05	1024	6	15	2	1	08						
972	6	08	2	4	08	1025	6	15	2	3	02						
973	6	08	2	4	12	1026	6	16	1	1	08						
974	6	08	3	2	02	1027	6	16	1	2	11						
975	6	08	3	2	12	1028	6	16	1	3	08						
976	6	08	3	3	02	1029	6	16	1	3	11						
977	6	08	3	4	02	1030	6	16	1	4	01						
978	6	08	3	4	12	1031	6	16	1	4	02						
979	6	09	1	1	01	1032	6	16	1	4	05						
980	6	09	1	1	08	1033	6	16	1	4	07						
981	6	09	1	2	02	1034	6	16	1	4	08						
982	6	09	1	2	03	1035	6	16	1	4	10						
983	6	09	1	3	01	1036	6	16	1	4	11						
984	6	09	1	3	08	1037	6	16	1	4	12						
985	6	09	2	1	01	1038	6	16	1	5	01						
986	6	09	2	1	08	1039	6	16	1	5	02						
987	6	09	2	3	01	1040	6	16	1	5	05						
988	6	09	2	3	08	1041	6	16	1	5	07						
989	6	10	1	2	04	1042	6	16	1	5	08						
990	6	10	1	3	01	1043	6	16	1	5	11						
991	6	10	1	3	02	1044	6	16	2	2	11						
992	6	10	1	3	03	1045	6	16	2	3	11						
993	6	10	1	3	05	1046	6	16	2	5	11						
994	6	10	1	3	08	1047	6	16	3	2	11						
995	6	10	1	3	12	1048	6	16	3	4	11						
996	6	10	2	2	05	1049	6	16	3	5	11						
997	6	10	2	3	02	1050	6	16	4	1	08						
998	6	10	2	3	03	1051	6	16	4	5	08						
999	6	10	2	4	03	1052	6	16	4	5	11						
1000	6	10	2	4	12												
1001	6	10	3	2	05												
1002		13	1	1	01												
1003	6	13	1	2	02												
1004	6	13	1	3	01												
1005	6	13	1	3	02												
1006	6	13	1	4	02												
1007	6	13	1	4	04												

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Table 22

Matrix Element Terrain De :riptors Associated With

Thematic Factors Used To Compile 'actor Complex Map of the World

Terrain Description No.	Surface Configuration 1 Plains Level	2 Plains Rolling	3 Tablelands & Plateaus	4 Plains & Hills or Mts Complex	5 Hill	6 Mountains	Soil Surface Texture (upper 15 cm) 01 Sand	02 Sand & Loam	03 Sand & Clay	04 Sand & Organic Material	05 Sand & Bare	06 Loam	07 Loam & Silt	08 Loam & Clay	09 Loam & Organic Material	10 Loam & Bare	11 Silt	12 Silt & Clay	13 Clay	14 Clay & Bare	15 Organic Material	16 Bare Area
1.10	1	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0
1.20	1	1	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
1.30	1	1	1	1	1	0	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0
1.40	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
2.10	1	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0
2.20	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
2.30	1	1	1	1	1	0	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0
2.40	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
3.10	1	1	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
3.20	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0
3.30	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
3.40	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
4.10	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
4.20	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
4.30	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
5.10	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
5.20	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0
5.30	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0

Terrain Description No.	Lithology 1 Consolidated Rock	2 Unconsolidated Rock	3 Alluvium	4 Ice Cap	State of Ground 1 Permafrost	2 High Water Table	3 Water Table Fluctuates	4 Low Water Table	5 Rock or Ice	Vegetation 01 Needleleaf Forest	02 Broadleaf Forest	03 Mixed Forest	04 Montane Forest	05 Savanna	06 Forest & Grassland	07 Woodland & Scrubland	08 Tundra & Alpine	09 Grassland	10 Desert Scrub & Desert	11 Barren	12 Com. Grain & Horticulture	13 Commercial Plantation
1.10	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1.20	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1.30	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0
1.40	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	0
2.10	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2.20	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2.30	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0
2.40	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
3.10	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
3.20	0	1	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1
3.30	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	0
3.40	0	1	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	0
4.10	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4.20	0	1	1	0	1	0	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	0
4.30	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
5.10	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
5.20	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	1	1
5.30	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1

(Continued)

Table 22 (Continued)

Terrain Description No.	Surface Configuration 1 Plains Level	2 Plains Rolling	3 Tablelands & Plateaus	4 Plains & Hills or Mts Complex	5 Hills	6 Mountains	Soil Surface Texture (upper 15 cm) 01 Sand	02 Sand & Loam	03 Sand & Clay	04 Sand & Organic Material	05 Sand & Bare	06 Loam	07 Loam & Silt	08 Loam & Clay	09 Loam & Organic Material	10 Loam & Bare	11 Silt	12 Silt & Clay	13 Clay	14 Clay & Bare	15 Organic Material	16 Bare Area
5.40	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
5.50	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
5.60	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
5.70	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
6.10	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
6.11	1	1	1	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0
6.12	1	1	1	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0
6.13	1	1	1	1	1	1	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0
6.14	1	1	1	1	1	1	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0
7.10	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
7.20	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
7.30	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
8.10	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
8.20	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
8.30	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
8.40	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
8.50	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
8.60	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0

Terrain Description No.	Lithology 1 Consolidated Rock	2 Unconsolidated Rock	3 Alluvium	4 Ice Cap	State of Ground 1 Permafrost	2 High Water Table	3 Water Table Fluctuates	4 Low Water Table	5 Rock or Ice	Vegetation 01 Needleleaf Forest	02 Broadleaf Forest	03 Mixed Forest	04 Montane Forest	05 Savanna	06 Forest & Grassland	07 Woodland & Scrubland	08 Tundra & Alpine	09 Grassland	10 Desert Scrub & Desert	11 Barren	12 Com. Grain & Horticulture	13 Commercial Plantation
5.40	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
5.50	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
5.60	1	1	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
5.70	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
6.10	1	0	0	0	0	1	0	0	1	1	1	1	0	0	1	0	0	1	0	0	1	1
6.11	0	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0
6.12	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
6.13	0	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
6.14	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7.10	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
7.20	0	1	1	0	0	1	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	0
7.30	0	1	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1
8.10	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0
8.20	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
8.30	0	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	1	1	1	0	1	1
8.40	0	1	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1
8.50	0	1	0	0	0	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1
8.60	0	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	1	1	0	0	1	1

(Continued)

Table 22 (Continued)

Terrain Description No.	Surface Configuration 1 Plains Level	2 Plains Rolling	3 Tablelands & Plateaus	4 Plains & Hills or Mts Complex	5 Hills	6 Mountains	Soil Surface Texture (upper 15 cm) 01 Sand	02 Sand & Loam	03 Sand & Clay	04 Sand & Organic Material	05 Sand & Bare	06 Loam	07 Loam & Silt	08 Loam & Clay	09 Loam & Organic Material	10 Loam & Bare	11 Silt	12 Silt & Clay	13 Clay	14 Clay & Bare	15 Organic Material	16 Bare Area
8.70	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
9.10	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
9.20	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
9.30	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
9.40	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
9.50	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
9.60	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
10.10	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
10.20	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
10.30	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
10.40	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
10.50	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
10.60	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
10.70	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
10.80	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
10.90	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
10.91	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
10.92	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
10.93	1	1	1	1	1	1	0	0	[illegible]	[illegible]	0	0	0	1	0	0	0	1	1	1	0	0
11.10	1	1	1	1	1	1	1	1	[illegible]	1	[illegible]	0	0	0	0	0	0	0	0	0	0	0
11.20	1	1	1	1	1	1	1	1	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
11.30	1	1	1	1	1	1	1	[illegible]	[illegible]	1	1	0	0	0	0	0	0	0	0	0	0	0

Terrain Description No.	Lithology 1 Consolidated Rock	2 Unconsolidated Rock	3 Alluvium	4 Ice Cap	State of Ground 1 Permafrost	2 High Water Table	3 Water Table Fluctuates	4 Low Water Table	5 Rock or Ice	Vegetation 01 Needleleaf Forest	02 Broadleaf Forest	03 Mixed Forest	04 Montane Forest	05 Savanna	06 Forest & Grassland	07 Woodland & Scrubland	08 Tundra & Alpine	09 Grassland	10 Desert Scrub & Desert	11 Barren	12 Com. Grain & Horticulture	13 Commercial Plantation
8.70	0	1	0	0	0	1	1	0	0	1	1	1	0	0	1	1	1	1	0	0	1	1
9.10	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
9.20	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
9.30	0	1	1	0	1	0	0	0	0	1	1	1	0	0	1	0	1	1	0	1	0	1
9.40	0	1	1	0	0	1	0	0	0	1	1	1	0	1	1	0	1	1	0	0	1	1
9.50	0	1	1	0	1	0	0	0	0	1	1	1	0	0	1	0	1	1	0	0	0	1
9.60	0	1	1	0	0	1	0	0	0	1	1	1	0	1	1	0	1	1	0	0	1	1
10.10	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
10.20	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
10.30	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
10.40	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
10.50	0	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
10.60	0	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
10.70	1	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
10.80	0	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
10.90	0	1	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1
10.91	0	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1
10.92	1	1	0	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1
10.93	0	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1
11.10	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
11.20	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1	1	0	0
11.30	0	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1

(Continued)

Table 22 (Continued)

Terrain Description No.	Surface Configuration 1 Plains Level	2 Plains Rolling	3 Tablelands & Plateaus	4 Plains & Hills or Mts Complex	5 Hills	6 Mountains	Soil Surface Texture (upper 15 cm) 01 Sand	02 Sand & Loam	03 Sand & Clay	04 Sand & Organic Material	05 Sand & Bare	06 Loam	07 Loam & Silt	08 Loam & Clay	09 Loam & Organic Material	10 Loam & Bare	11 Silt	12 Silt & Clay	13 Clay	14 Clay & Bare	15 Organic Material	16 Bare Area
11.40	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
11.50	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
11.60	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
12.10	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
12.20	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
12.30	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
13.10	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
13.20	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
13.30	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
14.10	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
14.20	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
14.30	1	1	1	1	0	0	1	1	1	1	1	0	[illegible]	0	0	0	0	0	0	0	0	0
14.40	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
14.50	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
14.60	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0
15.10	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
15.20	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
15.30	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0

Terrain Description No.	Lithology 1 Consolidated Rock	2 Unconsolidated Rock	3 Alluvium	4 Ice Cap	State of Ground 1 Permafrost	2 High Water Table	3 Water Table Fluctuates	4 Low Water Table	5 Rock or Ice	Vegetation 01 Needleleaf Forest	02 Broadleaf Forest	03 Mixed Forest	04 Montane Forest	05 Savanna	06 Forest & Grassland	07 Woodland & Scrubland	08 Tundra & Alpine	09 Grassland	10 Dese - Scrub & Desert	11 Barren	12 Com. Grain & Horticulture	13 Commercial Plantation
11.40	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11.50	0	1	0	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1
11.60	1	0	0	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1
12.10	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1	1	0	0
12.20	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	[illegible]	1	1
12.30	1	0	0	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1
13.10	0	1	1	0	0	1	0	0	0	1	1	1	0	1	1	0	0	1	0	0	1	1
13.20	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0
13.30	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1	1	0	0	1	1
14.10	0	1	1	0	1	0	0	0	0	1	1	1	0	0	1	0	1	1	0	0	1	1
14.20	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	0
14.30	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
14.40	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
14.50	0	1	1	0	1	0	0	0	0	1	1	1	0	0	1	0	1	1	0	0	1	1
14.60	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	1	1	0	0	1	1
15.10	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
15.20	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
15.30	1	1	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1

(Continued)

Table 22 (Continued)

	Surface Configuration						Soil Surface Texture (upper 15 cm)																Lithology				State of Ground					Vegetation												
	1	2	3	4	5	6	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	1	2	3	4	1	2	3	4	5	01	02	03	04	05	06	07	08	09	10	11	12	13
Terrain Description No.	Plains Level	Plains Rolling	Tablelands & Plateaus	Plains & Hills or Mts Complex	Hills	Mountains	Sand	Sand & Loam	Sand & Clay	Sand & Organic Material	Sand & Bare	Loam	Loam & Silt	Loam & Clay	Loam & Organic Material	Loam & Bare	Silt	Silt & Clay	Clay	Clay & Bare	Organic Material	Bare Area	Consolidated Rock	Unconsolidated Rock	Alluvium	Ice Cap	Permafrost	High Water Table	Water Table Fluctuates	Low Water Table	Rock or Ice	Needleleaf Forest	Broadleaf Forest	Mixed Forest	Montane Forest	Savanna	Forest & Grassland	Woodland & Scrubland	Tundra & Alpine	Grassland	Desert Scrub & Desert	Barren	Com. Grain & Horticulture	Commercial Plantation
15.40	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	1
15.50	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0
15.60	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0
15.70	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0		1	1	0	1	1	0	0
15.80	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0
15.90	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	0	0	0	1	1	0	1	1	1	1	0	1	1	1	1	1	0	1	1
15.91	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	0	0	0	1	1	0	1	1	1	1	0	1	1	1	1	1	0	1	1
15.92	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	1	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1	1	1	0	1	1
15.93	1		1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	0	1	1	1	1	0	1	1	1	1	1	0	1	1
16.10	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	1	1	0	0	1	0	1	1	0	0	1	1
16.20	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0
16.30	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1
17.10	1	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	1	1	0	0	1	0	1	1	0	1	0	0
17.20	1	1	1	1	0	0	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	1	1	1	0	1	0	0	1	1
18.10	1	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	1	0	0	1	0	1	1	0	1	0	0
18.20	1	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	1	1	0	1	0	0
18.30	1	1	1	1	0	0	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	1	1
19.10	1	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	1	1	0	1	0	0

(Continued)

Table 22 (Continued)

Terrain Description No.	Surface Configuration 1 Plains Level	2 Plains Rolling	3 Tablelands & Plateaus	4 Plains & Hills or Mts Complex	5 Hills	6 Mountains	Soil Surface Texture (upper 15 cm) 01 Sand	02 Sand & Loam	03 Sand & Clay	04 Sand & Organic Material	05 Sand & Bare	06 Loam	07 Loam & Silt	08 Loam & Clay	09 Loam & Organic Material	10 Loam & Bare	11 Silt	12 Silt & Clay	13 Clay	14 Clay & Bare	15 Organic Material	16 Bare Area	Lithology 1 Consolidated Rock	2 Unconsolidated Rock	3 Alluvium	4 Ice Cap	State of Ground 1 Permafrost	2 High Water Table	3 Water Table Fluctuates	4 Low Water Table	5 Rock or Ice	Vegetation 01 Needleleaf Forest	02 Broadleaf Forest	03 Mixed Forest	04 Montane Forest	05 Savanna	06 Forest & Grassland	07 Woodland & Scrubland	08 Tundra & Alpine	09 Grassland	10 Desert Scrub & Desert	11 Barren	12 Com. Grain & Horticulture	13 Commercial Plantation
19.20	1	1	1	1	0	0	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	1	1	1	0	1	0	0	1	1
20.10	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
20.20	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	0	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0
20.30	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	0	1	[illegible]	1	1	1	1	1	1	1	1	1	0	1
20.40	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
21.10	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1
21.20	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	1	0	1	0	1	0	1
21.30	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
21.40	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	1	1	1	1	1	0	1	0	1
21.50	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	0	1	0	0	0	0	1	1	1	0	0	1	0	1	1	0	1	0	1
21.60	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	0	0	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	1
22.10	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	1	0	0
22.20	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	1	0	0
22.30	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	1	0	1	1	1	1	1	0	1
22.40	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	1	0	1	1	0	0
23.10	1	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0
23.20	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0
23.30	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	0	1	1	0	0
23.40	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0
24.00	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0

(Continued)

Table 22 (Concluded)

Terrain Description No.	Surface Configuration 1 Plains Level	2 Plains Rolling	3 Tablelands & Plateaus	4 Plains & Hills or Mts Complex	5 Hills	6 Mountains	Soil Surface Texture (upper 15 cm) 01 Sand	02 Sand & Loam	03 Sand & Clay	04 Sand & Organic Material	05 Sand & Bare	06 Loam	07 Loam & Silt	08 Loam & Clay	09 Loam & Organic Material	10 Loam & Bare	11 Silt	12 Silt & Clay	13 Clay	14 Clay & Bare	15 Organic Material	16 Bare Area	Lithology 1 Consolidated Rock	2 Unconsolidated Rock	3 Alluvium	4 Ice Cap	State of Ground 1 Permafrost	2 High Water Table	3 Water Table Fluctuates	4 Low Water Table	5 Rock or Ice	Vegetation 01 Needleleaf Forest	02 Broadleaf Forest	03 Mixed Forest	04 Montane Forest	05 Savanna	06 Forest & Grassland	07 Woodland & Scrubland	08 Tundra & Alpine	09 Grassland	10 Desert Scrub & Desert	11 Barren	12 Com. Grain & Horticulture	13 Commercial Plantation
25.00	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
26.10	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
26.20	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	1	1	1	1	0	0	0	0	[illegible]	0	0	0	0	0	1	0	0

(Sheet 7 of 7)

Table 23

<u>Printout of Thematic Map Legend and Corresponding Terrain Matrix Elements</u>

MAP UNIT	SURFACE CONFIGU-RATION	SOILS	LITHOLOGY	STATE OF GROUND	VEGETATION	TERRAIN DESCRIPTORS
1	1	1	1	3	5	10.70 12.20
2	1	1	1	4	7	5.30 10.30 10.70 11.20 11.40 12.10 12.20 22.10 22.20
3	1	1	1	4	4	5.30 10.70 11.40 12.20
4	1	1	1	4	10	5.30 10.30 10.70 11.20 11.40 12.10 12.20 22.10 22.20
5	1	1	1	4	12	5.30 10.70 11.40 12.20
6	1	1	2	1	8	9.10 9.30 14.10 14.30 21.10 21.30
7	1	1	2	2	2	3.20 8.30 8.40 9.40 13.10 14.20 15.10 15.20 15.30 15.40 17.20 21.20 21.40
8	1	1	2	3	2	3.20 8.30 8.40 8.50 10.50 10.60 10.70 10.80 11.30 20.20
9	1	1	2	3	5	3.20 8.30 8.40 10.50 10.60 10.70 10.80 11.30 20.20
10	1	1	2	4	5	10.50 10.60 10.70 10.80 11.30 20.20
11	1	1	2	4	7	1.30 2.30 5.20 5.30 7.10 7.20 8.20 8.50 10.10 10.20 10.30 10.40 10.50 10.60 10.70 10.80 11.10 11.30 20.10 20.20 23.20 23.30
12	1	1	2	4	9	5.30 7.20 8.50 10.50 10.60 10.70 10.80 11.30 20.20
13	1	1	2	4	10	1.30 2.30 5.20 5.30 7.10 7.20 8.20 8.50 10.10 10.20 10.30 10.40 10.50 10.60 10.70 10.80 11.10 11.30 20.10 20.20 23.30
14	1	1	3	3	2	3.20 8.30 8.40 10.50 10.60 10.80
15	1	1	3	4	10	1.30 2.30 5.20 7.10 7.20 10.10 10.20 10.40 10.50 10.60 10.80 20.10
16	1	1	3	4	12	5.20 7.20 10.50 10.60 10.80
17	1	2	1	3	1	6.14 10.70 12.20 16.10
18	1	2	1	4	2	6.14 10.70 11.40 12.20
19	1	2	1	4	5	6.14 10.70 11.40 12.20
20	1	2	1	4	9	5.30 6.14 10.70 11.40 12.20
21	1	2	2	3	1	9.30 14.10 17.10 18.10
22	1	2	2	1	2	9.30 14.10 17.10 18.10
23	1	2	2	1	6	9.30 14.10 17.10 18.10
24	1	2	2	1	8	9.10 9.30 14.10 14.30 17.10 18.10 21.10 21.30
25	1	2	2	2	1	3.20 6.13 8.30 8.40 9.40 13.10 14.20 15.10 15.20 15.30 15.40 17.20 21.20 21.40
26	1	2	2	2	2	3.20 6.13 8.30 8.40 9.40 13.10 14.20 15.10 15.20 15.30 15.40 17.20 21.20 21.40
27	1	2	2	2	5	3.20 6.13 8.30 8.40 9.40 13.10 17.20 21.40
28	1	2	2	3	1	3.20 6.13 8.30 8.40 8.50 10.50 10.60 10.70 10.80 11.30 20.20
29	1	2	2	3	2	3.20 6.13 8.30 8.40 8.50 10.50 10.60 10.70 10.80 11.30 20.20
30	1	2	2	3	6	3.20 6.13 8.30 8.40 8.50 10.50 10.60 10.70 10.80 11.30 20.20
31	1	2	2	3	8	3.20 5.20 5.30 6.13 7.20 8.10 8.20 8.30 8.40 8.50 10.10 10.20 10.30 10.50 10.60 10.70 10.80 11.10 11.30 13.70 15.60 15.70 15.80 20.10 20.20
32	1	2	2	4	2	6.13 8.50 10.50 10.60 10.70 10.80 11.30 20.20
33	1	2	2	4	4	6.13 7.20 10.50 10.60 10.70 10.80 11.30 20.20 23.30
34	1	2	2	4	5	6.13 10.50 10.60 10.70 10.80 11.30 20.20
35	1	2	2	4	7	1.30 2.30 5.20 5.30 6.13 7.10 7.20 8.20 8.50 10.10 10.20 10.30 10.40 10.50 10.60 10.70 10.80 11.10 11.30 20.10 20.20 23.20 23.30
36	1	2	2	4	9	5.30 6.13 7.20 8.50 10.50 10.60 10.70 10.80 11.30 20.20
37	1	2	3	2	2	3.20 6.13 8.30 8.40 9.40 13.10 14.20 15.10 15.20 15.40 17.20 21.20 21.40
38	1	2	3	2	3	3.20 6.13 8.30 8.40 9.40 13.10 14.20 15.10 15.20 15.40 17.20 21.20

Table 24

Seismic Response Ranking of the Terrain Matrix Elements

Terrain Descriptor Number	Predicted Seismic Response - Class 14
1.10-1.20-1.30-1.40-2.10-2.20-2.30-2.40 3.10-3.20-3.30-3.40-4.10-4.20-4.30-5.10 5.20-5.30-5.40-5.50-5.60-5.70-6.10-6.11 6.12	1
12.10-12.20-12.30	2
6.13-6.14-8.10-8.20-8.30-8.40-8.50-8.60 8.70-9.10-9.20-9.30-9.40-9.50-9.60-10.10 10.20-10.30-10.40-10.50-10.60-10.70-10.80-10.10 10.91-10.92-10.93-11.10-11.20-11.30-11.40-11.50 11.60	3
7.10-7.20-7.30-14.10-14.20-14.30-14.40-14.50 14.60	4
21.10-21.20-21.30-21.40-21.50-21.60	5
15.10-15.20-15.30-15.40-15.50-15.60-15.70-15.80 15.90-15.91-15.92-15.93-16.10-16.20-16.30-19.10 19.20	6
13.10-13.20-13.30-17.10-17.20-18.10-18.20-18.30 20.10-20.20-20.30-20.40-22.10-22.20-22.30-22.40 23.10-23.20-23.30-23.40-24.00-25.00-26.10-26.20	7

Table 25

Cultural and Natural Background Noise Sources

Cultural		Natural	
1.	Urban areas	1N.	Rain
2.	Railroads	2N.	Sleet
3.	Airports	3N.	Hail
4.	Marine traffic	4N.	Wind
5.	Interstate highways	5N.	Stream
6.	Principal highways	6N.	Rivers and wave action
7.	Secondary roads	7N.	Thunder and lightning
8.	Mines (underground and open pit)	8N.	Earth tremors
9.	Factories	9N.	Rock cracking
10.	Generating stations	10N.	Animal noise
11.	Agriculture operations	11N.	Dust storms and/or sand stroms
12.	Construction operations		
13.	High-voltage transmission lines		
14.	Pipe lines		
15.	Lock or dam		
16.	Campsite		
17.	Wells		
18.	Windmills		
19.	Drawbridges		
20.	Impact areas		
21.	Cantonement areas		
22.	Schools and institutions		
23.	Logging activities		
24.	Pumping stations		

Table 26

Military Grid Coordinates of Sampling Points

Map: Fulda

Series: M 745 No. L5524

Scale: 1:50,000

Sample No.	Military Grid x	Military Grid y
1	4889	9466
2	6488	8715
3	6285	9669
4	4982	9266
5	6290	9380
6	5654	9698
7	6415	0355
8	5536	0545
9	5538	9114
10	5631	9834
11	5601	0189
12	5384	9770
13	4935	9103
14	6539	9597
15	6992	9527
16	4845	9895
17	4985	0432
18	5486	0045
19	5683	9820
20	6888	0080

Table 27

Background Noise Sources, Number of Occurrences, and Distances from Sampling Points

Sampling Point	Distance from Sampling Point, km: 0 - 0.5 Type	Number	0.5 - 1.0 Type	Number	1.0 - 2.0 Type	Number
1	1	2	6	2	1	2
	2	1	7	14	2	1
	6	2	16	1	7	31
	7	5	15	1	13	1
	11	1	11	1	18	1
	5N	5			16	1
	6N	1			24	1
	15	1			11	1
					22	1
2	1	1	1	1	1	3
	7	5	6	1	7	28
	11	1	7	6	8	1
	5N	1	8	1	11	1
			11	1		
3	6	1	7	3	1	1
	7	6	11	2	7	23
	11	1	5N	1	11	1
	5	1			13	1
					17	1
					18	1
					5N	2
4	7	4	2	1	1	3
	11	1	5	1	6	1
	5N	2	6	2	7	29
	15	1	13	1	16	1
			15	4	18	1
			6N	1	5N	5
			11	1	6N	1
			7	7	15	1
					8	1
					11	1

(Continued)

Table 27 (Continued)

	Distance from Sampling Point, km					
	0 - 0.5		0.5 - 1.0		1.0 - 2.0	
Sampling Point	Type	Number	Type	Number	Type	Number
5	7	5	1	2	1	2
	11	1	7	12	6	1
	5N	1	16	1	7	43
			13	1	11	1
			15	1		
			11	1		
6	7	6	7	11	1	2
	11	1	11	1	7	38
	15	1	13	1	11	1
			5N	1	15	1
					17	1
7	7	5	7	11	1	4
	11	1	11	1	2	1
	5N	1	17	1	7	39
					16	1
					11	1
8	1	1	7	10	1	2
	7	7	11	1	2	1
	11	1	5N	1	7	21
	5N	1			6N	1
					18	1
					11	1
9	7	6	1	1	1	3
	11	1	2	1	7	45
			6	1	15	26
			7	16	24	1
			11	1	5N	7
			5N	2	6N	2
					11	1
					16	1

(Continued)

Table 27 (Continued)

Sampling Point	Distance from Sampling Point, km: 0 - 0.5 Type	Number	0.5 - 1.0 Type	Number	1.0 - 2.0 Type	Number
10	7	8	1	2	6	1
	11	1	7	17	7	47
					11	1
	5N	2	11	1	13	1
			5N	3	17	1
					5N	4
					6N	1
11	1	1	7	11	1	2
	7	9	11	1	2	1
	11	1	15	1	7	38
	5N	1	8	1	16	1
	15	1			8	1
					11	1
					17	1
					5N	3
					6N	2
12	1	1	7	12	1	4
	7	6	11	1	5	1
	11	1	13	1	7	38
	5N	2	5N	1	8	1
					13	1
					11	1
					17	1
					5N	8
13	1	1	6	1	1	2
	7	6	7	14	7	54
					11	1
	5N	1	16	1	15	3
	6N	1	11	1	16	2
	18	1			13	1
	11	1				

(Continued)

Table 27 (Continued)

Sampling Point	Distance from Sampling Point, km: 0 - 0.5 Type	0 - 0.5 Number	0.5 - 1.0 Type	0.5 - 1.0 Number	1.0 - 2.0 Type	1.0 - 2.0 Number
14	1	1	6	1	1	2
	7	6	7	14	7	54
	5N	1	16	1	15	3
					11	1
	6N	1	11	1	16	2
	18	1			13	1
	11	1				
15	7	5	6	1	1	1
	11	1	7	15	6	1
			11	1		
	5N	1	17	1	7	29
			8	1	11	1
			5N	2	17	1
					15	1
					5N	6
16	1	1	7	10	6	2
	2	1	16	2	9	1
	6	1	5N	2	11	1
	7	6	6N	2	15	1
	16	1	9	1	17	1
			11	1	16	3
					5N	5
					7	40
17	5	1	2	1	1	4
	6	1	7	15	2	1
	7	7	11	1	7	32
	5N	1	5N	1	11	1
	11	1			13	1
					5N	2
					9	1

(Continued)

Table 27 (Concluded)

	Distance from Sampling Point, km					
	0 - 0.5		0.5 - 1.0		1.0 - 2.0	
Sampling Point	Type	Number	Type	Number	Type	Number
18	7	6	7	13	1	7
	17	2	6	1	7	36
	11	1	11	1	11	1
	5N	1			17	1
	6N	1			15	2
					8	1
					5N	5
					6N	1
					13	1
19	7	8	7	8	1	3
	11	1	11	1	6	1
			17	1	7	35
			5N	2	13	1
					11	1
					17	1
					5N	6
20	7	7	7	12	1	1
	11	1	11	1	6	1
	5N	1	5N	2	7	40
					2	1
					11	1
					17	2
					5N	5

Table 28

Summary of the Single Target Test Program

Engineering Development (ED) Tests

Target Class	Terrain Site* Condition Code	Priority	Target Travel Mode	No. of Iterations	Total Number of Test Runs Priority 1	2	3	Remarks
Variation Within a Target Type								
Wheeled vehicle type M35A1, three vehicles	3,8,13**		10/km/hr and convoy speed on roads 7.5 and 30.0 km/hr for cross-country 5.0 and 12.0 km/hr for obstacle	2	108	-	-	Three vehicles are specified. One vehicle can be the same as used to determine signature variation with a target class (see above).
Tracked vehicle type M113 three vehicles	3,8,13**		10 km/hr and convoy speed on roads 7.5 and 30.0 km/hr for cross-country 5.0 and 12.0 km/hr for obstacle	2	108	-	-	Smooth road, cross-country, and obstacle course is required at all locations for these tests.

(Continued)

* Terrain site condition codes correspond to conditions identified in paragraph 31.

** Tests to be run on cross-country, smooth road, and obstacle course.

Table 28 (Concluded)

Target Class	Terrain Site Condition Code	Priority	Target Travel Mode	No. of Iterations	Total Number of Test Runs, Priority 1	2	3	Remarks
Variation Within a Target Class								
Wheeled vehicle type								
M170	2,5,8,14	1	10 km/hr and convoy speed for road sites.					Priority based on site conditions.
M175	1,3,4,6,7,9,12,13	2	7.5 and 30.0 km/hr for cross-country sites	2	128	256	64	
M35A1	10,11	3						
XM381								
M622								
M813								
M125								
VIOU								
Tracked vehicle type								
M113	2,5,8,14	1	Same as for wheeled vehicles.	2	48	96	24	Priority based on site conditions.
M60	1,3,4,6,7,9,12,13	2						
M551	10,11	3						
Rotary-wing aircraft								
CH46F			Altitude: 150 and 750 m; speeds: 0.5 and 1.0 cruising speed horizontal flight; decending and ascending.	2	180	-	-	
UHIN								
TH57A	8,13,14							
CH3B								
HH IK								
Fixed-wing aircraft								
Three types; to be determined.	8,13,14		Altitude 500 and 1500 m; speeds: 0.5 and 1.0 cruising speed horizontal flight only.	2	72	-	-	
Walking-man targets								
One man	2,5,8,14	1	Route and march step 5- and 15-m CPA walk paths	2	96	192	48	Priority based on site conditions.
Three men	1,3,4,6,7,9,12,13	2						
Seven men	10,11	3						

Table 29

Target Types and Target Combination Codes for Multiple-Target Signature Acquisition

Secondary Targets	Primary Targets: Wheeled Vehicles 3 Types	Tracked Vehicles 3 Types	Rotary-Wing Aircraft 3 Types	Fixed-Wing Aircraft 3 Types	Walking Man 1 Man
Wheeled vehicles (3 types)	1*	2	3	4	5
Tracked vehicles (3 types)		6	7	8	9
Rotary-wing aircraft (3 types)			10	11	12
Fixed-wing aircraft (3 types)				13	14

Target Types

Wheeled Vehicles	Tracked Vehicles	Rotary-Wing Aircraft	Fixed-Wing Aircraft
M170	M113	UH IN	
M35A1	M551	TH57A	To be determined
M125	M60A1	HH1K	

* Numbers refer to target combination codes used in Table 30.

Table 30

Summary of the Multiple-Signature Acquisition Test Program

Advanced Development (AD) Tests

Targets (Coded from Matrix in Table 29)	Terrain Site Conditions Code*	Target Travel Modes	Target** Combinations	Iterations	Total Test Runs	Remarks
1	5, 8, 13	Cross-country at 7.5 and 30 km/hr or Road at 10 km/hr and convoy speed	9	2	108	Site surface can be cross-country or smooth road
2	5, 8, 13	Cross-country at 7.5 and 30 km/hr or Road at 10 km/hr and convoy speed	9	2	108	Site surface can be cross-country or smooth road
3	5, 8, 13	Wheeled vehicles: Cross-country at 7.5 and 30 km/hr or Smooth road at 10 km/hr and convoy speed				Site surface can be cross-country or smooth road
		Rotary-wing aircraft: Altitudes of 150, 750 m; speeds of 0.5 and 1.0 cruising speed, horizontal flight	9	2	432	
4	5, 8, 13	Wheeled vehicles: Cross-country at 7.5 and 30 km/hr or Smooth road at 10 km/hr and convoy speed				Site surface can be cross-country or smooth road

(Continued)

* Terrain site condition codes correspond to conditions identified in paragraph 31.
** From Table 29.

Table 30 (Continued)

Targets (Coded from Matrix in Table 29)	Terrain Site Conditions Code	Target Travel Modes	Target Combinations	Iterations	Total Test Runs	Remarks
		Fixed-wing aircraft: Altitudes of 500 and 1500 m; speeds of 0.5 and 1.0 cruising speed, horizontal flight	9	2	432	
5	5, 8, 13	Wheeled vehicles: Cross-country at 7.5 and 30 km/hr or Smooth road at 10 km/hr and convoy speed				Site surface can be cross-country or smooth road
		Walking-man: One man, normal walk, march step; two walk paths (near, far)	3	2	144	
6	5, 8, 13	Cross-country at 7.5 and 30 km/hr or Road at 10 km/hr and convoy speed	9	2	108	Site surface can be cross-country or smooth road
7	5, 8, 13	Tracked vehicle: Cross-country at 7.5 and 30 km/hr or Road at 10 km/hr and convoy speed				Site surface can be cross-country or smooth road

(Continued)

Table 30 (Continued)

Targets (Coded from Matrix in Table 29)	Terrain Site Conditions Code	Target Travel Modes	Target Combinations	Iterations	Total Test Runs	Remarks
7	5, 8, 13	Rotary-wing aircraft: Altitudes of 150, 750 m; speeds of 0.5, and 1.0 cruising speed, horizontal flight	9	2	432	
8	5, 8, 13	Tracked vehicles: Same as 6 Fixed-wing aircraft: Altitudes of 500, 1500 m; speeds of 0.5, and 1.0 cruising speed, horizontal flight	9	2	432	
9	5, 8, 13	Tracked vehicles: Same as 6 Walking-man: One man, normal route walk, one walk path (far)	3	2	36	
10	5	Rotary-wing aircraft: Altitudes of 150, 750 m; speeds of 0.5 and 1.0 cruising speed, horizontal flight	9	2	144	

(Continued)

Table 30 (Concluded)

Targets (Coded from Matrix in Table 29)	Terrain Site Conditions Code	Target Travel Modes	Target Combinations	Iterations	Total Test Runs	Remarks
11	5	Rotary-wing aircraft: Same as 10 Fixed-wing aircraft: Altitudes of 500, 1500 m; speeds of 0.5 and 1.0 cruising speed, horizontal flight	9	2	288	
12	5, 8, 13	Rotary-wing aircraft: Same as 10 Walking-man: One man, normal route walk, one walk path (far)	3	2	72	
13	5	Fixed-wing aircraft: Altitudes of 500, 1500 m; speeds of 0.5 and 1.0 cruising speed, horizontal flight	9	2	144	
14	5, 8, 13	Fixed-wing aircraft: Same as 13 Walking-man: One man, normal route walk, one walk path (far)	3	2	72	
				Total	2952	

(Sheet 4 of 4)

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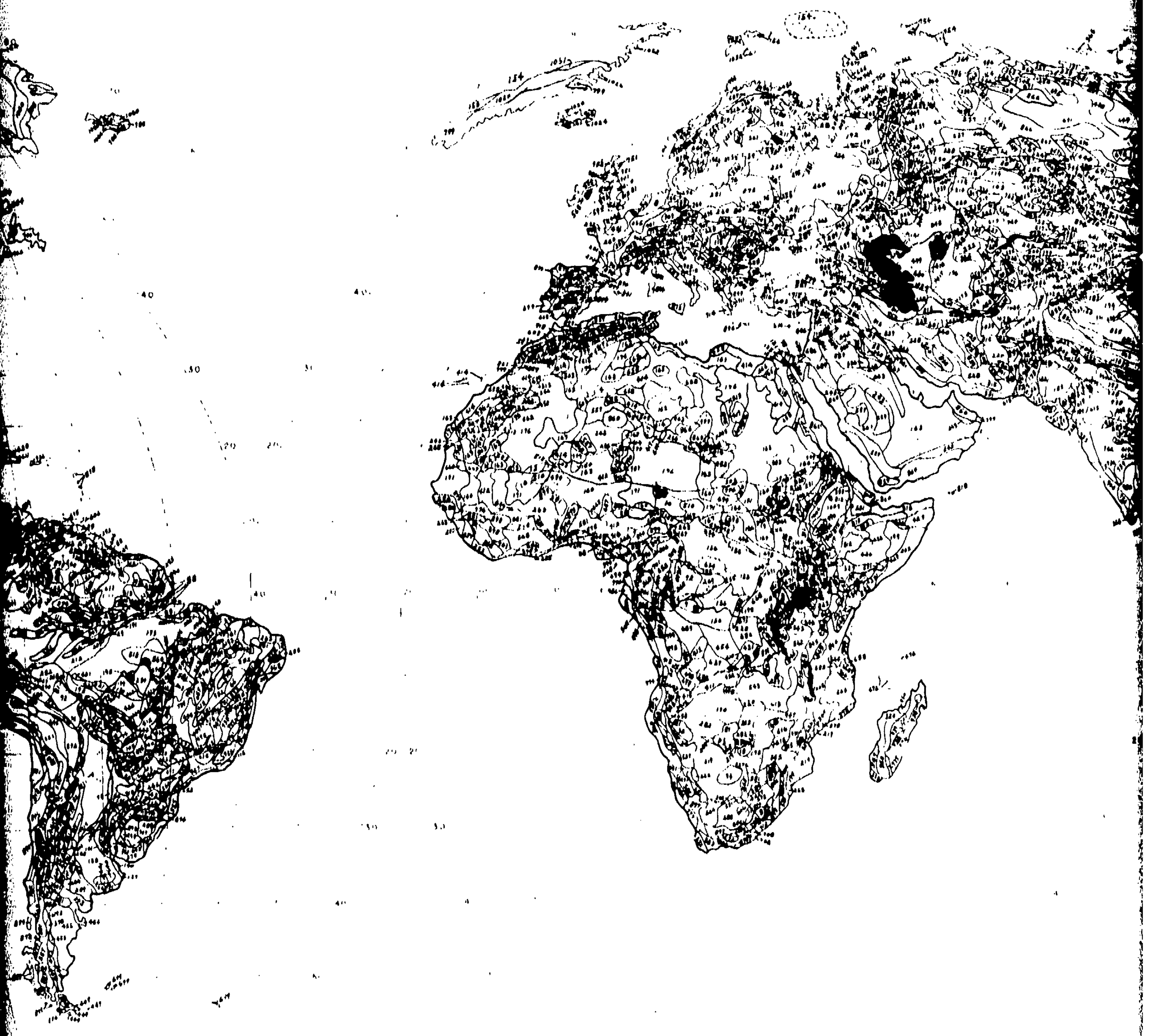
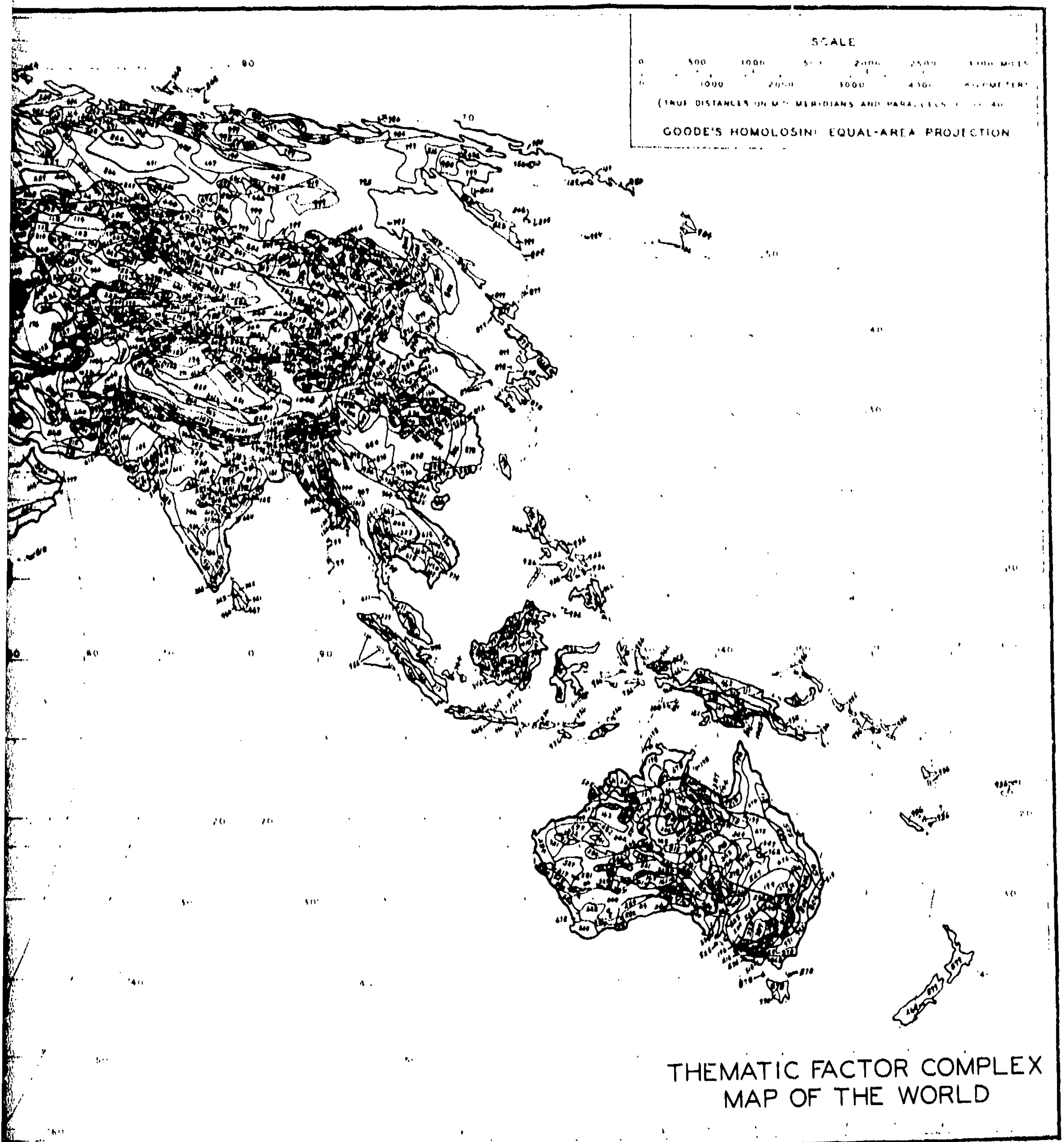
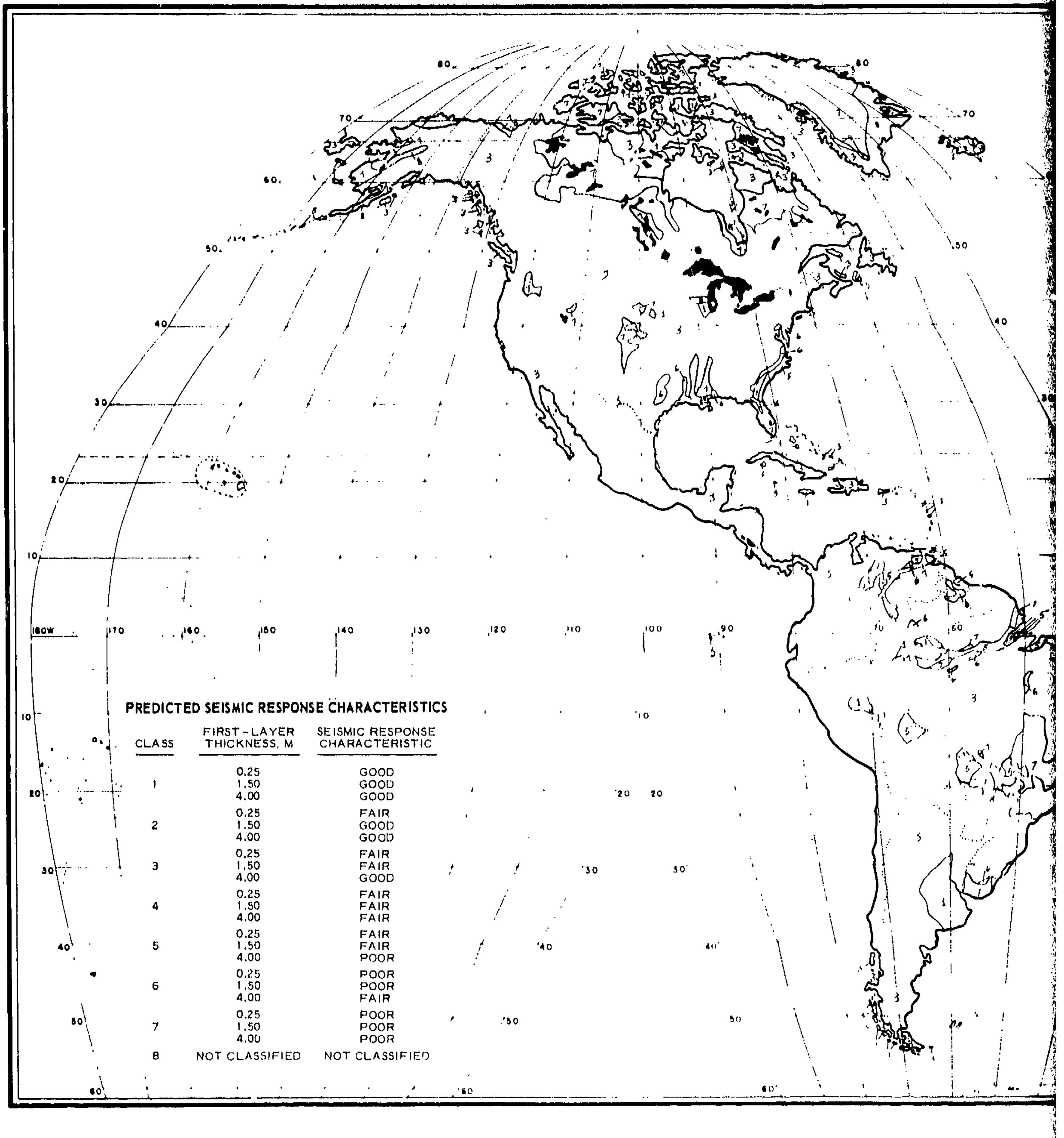
2





THEMATIC FACTOR COMPLEX
MAP OF THE WORLD

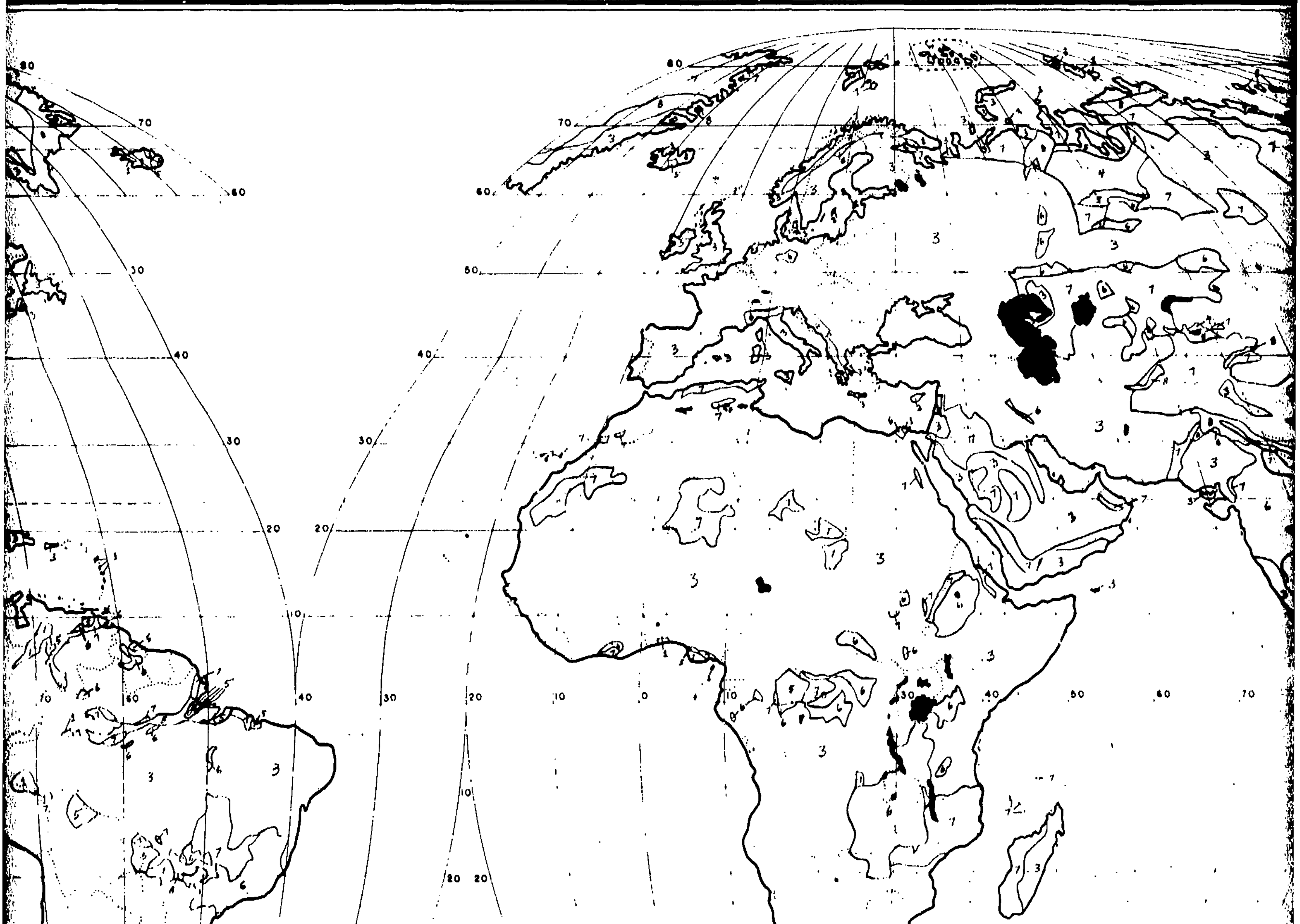
PLATE 1



PREDICTED SEISMIC RESPONSE CHARACTERISTICS

CLASS	FIRST-LAYER THICKNESS, M	SEISMIC RESPONSE CHARACTERISTIC
1	0.25 1.50 4.00	GOOD GOOD GOOD
2	0.25 1.50 4.00	FAIR GOOD GOOD
3	0.25 1.50 4.00	FAIR FAIR GOOD
4	0.25 1.50 4.00	FAIR FAIR FAIR
5	0.25 1.50 4.00	FAIR FAIR POOR
6	0.25 1.50 4.00	POOR POOR FAIR
7	0.25 1.50 4.00	POOR POOR POOR
8	NOT CLASSIFIED	NOT CLASSIFIED

2



3

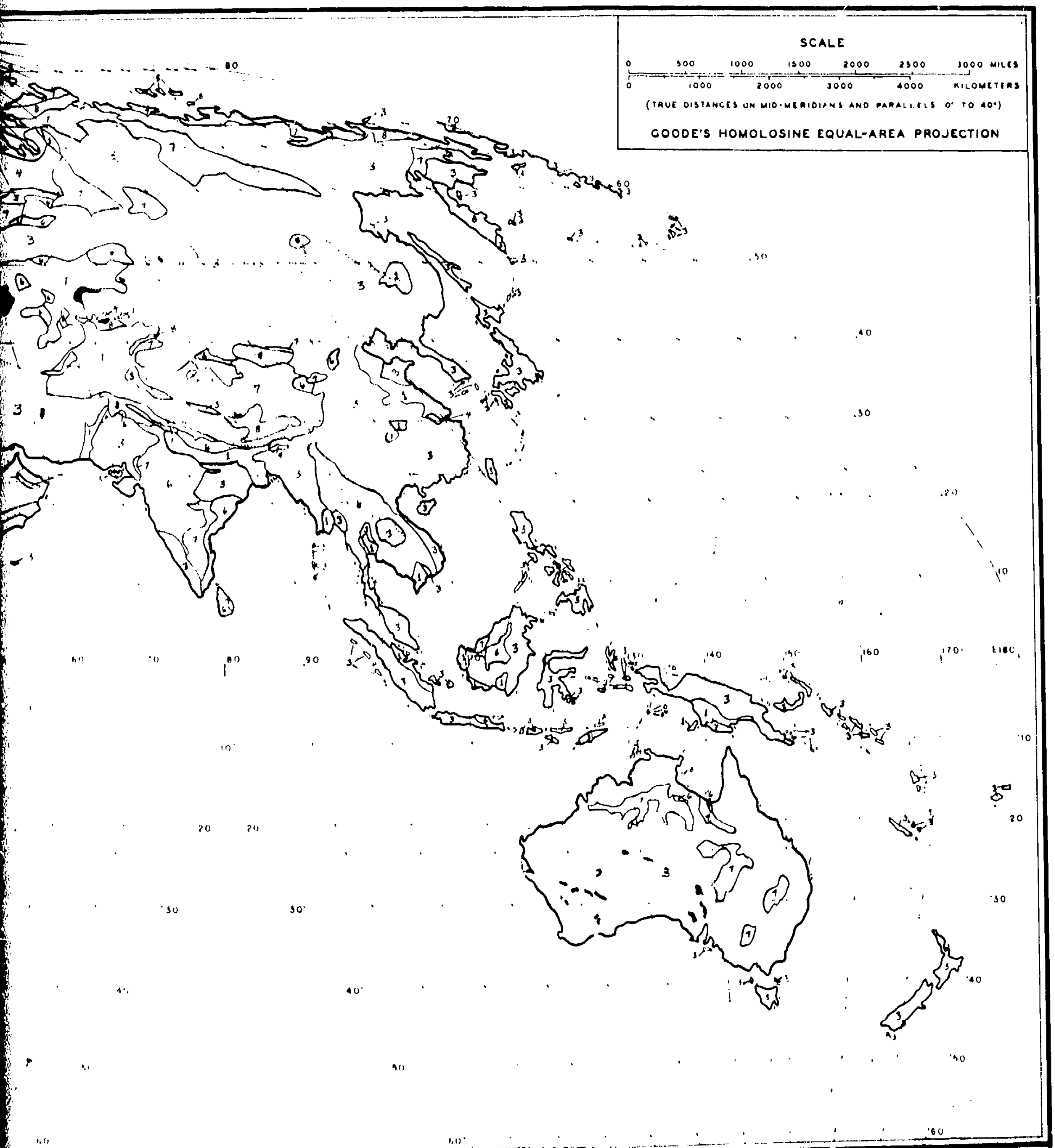

SCALE
0 500 1000 1500 2000 2500 3000 MILES
0 1000 2000 3000 4000 KILOMETERS
(TRUE DISTANCES ON MID-MERIDIANS AND PARALLELS 0° TO 40°)
GOODE'S HOMOLOSINE EQUAL-AREA PROJECTION

PLATE 2

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Benn, Bob O
Rationale and plan for field data acquisition required for the rational design and evaluation of seismic and acoustic classifying sensors, by Bob O. Benn. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1975.
1 v. (various pagings) illus. 27 cm. (U. S. Waterways Experiment Station. Miscellaneous paper M-75-10)
Prepared for Project Manager, Remotely Monitored Battlefield Sensor System, AMC, Fort Monmouth, New Jersey, under Project 1X764723DL73.
Includes bibliography.

1. Acoustic waves. 2. Remote sensing. 3. Remotely monitored battlefield surveillance system. 4. Seismic waves. 5. Sensors. 6. Target classification. I. U. S. Army Materiel Command. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Miscellaneous paper M-75-10)
TA7.W34m no.M-75-10