PROJECT OTTER
(OVERLAND TRAIN TERRAIN EVALUATION RESEARCH)

PRETEST REPORT

TECHNICAL REPORT NO. 3-588

Report 1

December 1961

U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
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PREFACE

Project OTTER (Overland Train Terrain Evaluation Research) is part of Research and Development Subproject No. 8S70-05-001-06, "Military Evaluation of Geographic Areas," which has been assigned to the U. S. Army Engineer Waterways Experiment Station, and is being performed for Office, Chief of Research and Development, Department of the Army. The subproject is directed by the Area Evaluation Section of the Soils Division, Waterways Experiment Station.

This report was written by Messrs. John H. Shamburger and Charles R. Kolb. Field work was accomplished and the plates in this report were prepared by Messrs. Shamburger and Harry K. Woods, Geology Branch, Waterways Experiment Station. Special thanks are due Major Kenneth B. Hartung, former Commanding Officer, M/Sgt. William G. Cox, and all the personnel of the Engineer Test Activity, Yuma, Arizona, for their excellent support and cooperation during the field work. Some of the initial work on the project was done by Dr. J. R. Van Lopik, formerly with the Geology Branch, Waterways Experiment Station. Technical assistance was rendered by Messrs. Warren E. Grabau, Chief, Area Evaluation Section, and Joseph R. Compton, Chief, Embankment and Foundation Branch, Waterways Experiment Station. All phases of the study were under the direct supervision of Mr. Kolb, Chief, Geology Branch, and the general supervision of Messrs. W. J. Turnbull and W. G. Shockley, Chief and Assistant Chief, respectively, of the Soils Division, Waterways Experiment Station.

Directors of the Waterways Experiment Station during the conduct of this study and preparation of this report were Col. Edmund H. Lang, CE, and Col. Alex G. Sutton, Jr., CE. Technical Director was Mr. J. B. Tiffany.

CONTENTS

SUMMARY

Performance in desert areas of the Overland Train, a logistical cargo carrier, is to be tested in 1962 at the Yuma Test Station by the U. S. Army Transportation Research Command (TRECOM). To realistically evaluate test results, TRECOM needs to know the representativeness of the terrain over which the Overland Train is tested compared with world desert terrain conditions. Projects concerned with terrain analysis and evaluation have been conducted at WES for several years, and a classification system, based on plan-profile, slope occurrence, slope, relief, soil type, soil consistency, rock type, and vegetation, and a technique for mapping terrain factors have been developed. Many world deserts, including the desert at Yuma, have been mapped.

Fourteen test courses were tentatively selected at the Yuma Test Station after a comprehensive office study of the terrain factor maps of the area. Routes were selected which will provide a reasonably severe test of the mobility of the Overland Train in terrain which is similar to much of that of world deserts. A major field investigation was conducted of the test courses at Yuma which included: (a) surveying and delimiting test courses, (b) gathering terrain factor data along the courses, and (c) obtaining aerial imagery of the courses. Terrain types classified along nine of the test courses according to the Waterways Experiment Station mapping system are tentatively compared to the terrain of world deserts.

Actual testing of the various courses exhibiting different terrain types at Yuma should result in conclusions regarding the effects of these terrain types on movement of the Overland Train. Additional reports are planned to summarize the observations, results, and conclusions derived from these tests as they pertain to the Overland Train project as well as to the over-all evaluation of desert areas for military purposes.

PROJECT OTTER (OVERLAND TRAIN TERRAIN EVALUATION RESEARCH)

PRETEST REPORT

PART I: INTRODUCTION

Background

1. Performance of the Overland Train, a logistical cargo carrier, in a desert environment is scheduled for testing at the U. S. Army's Yuma Test Station, Yuma, Arizona, in 1962 by the U. S. Army Transportation Research Command (TRECOM). TRECOM is interested in knowing the representativeness of the terrain within which the Overland Train is tested as compared with world desert terrain conditions. For example: Are the terrain types over which the Overland Train will operate at Yuma similar to those in other world deserts? Are these similar terrain types widely distributed? Are the capabilities of the vehicle to be tested over courses that contain terrain that is areally significant in other world deserts?

2. The determination of areal significance presupposes a knowledge of the terrain conditions found in other deserts of the world and a method of so cataloging these terrain features that objective comparisons can be made. Projects concerned with terrain analysis and evaluation have been conducted at the U. S. Army Engineer Waterways Experiment Station (WES) for more than seven years. Under the R&D project "Military Evaluation of Geographic Areas (MEGA)," quantitative or semiquantitative classification systems have been developed for describing the various terrain factors, and reasonably objective techniques have been evolved for mapping them. In the process of developing these classifications and techniques, a large portion of the deserts of the Northern Hemisphere has been mapped. Thus, both the procedures and the basic data are available for the purpose of making objective comparisons between areas. Such comparisons are called "terrain analogs."

3. It was logical that the techniques for making terrain analogs, and the large fund of basic data on world deserts accumulated as a result

of the MEGA project should be exploited for the purpose of selecting and classifying the test courses for the Overland Train at the Yuma Test Station.

4. In this study several considerations recommend the use of the technique developed: (a) the most important factors comprising desert terrain have been selected for comparison; (b) the factors have been classified either in quantitative terms or in rigidly defined qualitative terms; (c) the factors have been mapped as objectively as possible in world deserts and at Yuma; and (d) terrain maps using this standard classification have been completed for the deserts of Northwest Africa, Northeast Africa, the Middle East, South Central Asia, and the Southwest United States.

5. An important feature of the world desert maps developed by WES is that terrain types are distinguished or cataloged strictly on the basis of terrain factors and not in terms of terrain effects. The implications of this statement require some explanation and will be discussed more fully later in this report. Basically, eight factors are considered in the preparation of desert terrain analogs: plan-profile, slope occurrence, slope, relief, soil, soil consistency, rock type, and vegetation. Each of these factors is divided into a number of quantitative or qualitative subdivisions. Different terrain types can thus be designated by an array of digits, each of which represents a particular range or subdivision within a given factor. It is obvious that using such a system results in a vast number of different types of terrain, some of which may, but others of which may not, have any effect on the performance of the Overland Train.

6. The purpose of the WES maps was to broadly survey all aspects of desert terrain that affect not just vehicle mobility, but military considerations in general. Thus, certain terrain factors and, particularly, certain ranges of terrain factors chosen for mapping in world deserts will eventually prove to be of no consequence from the standpoint of the mobility of the Overland Train. However, the elimination of such terrain factors, or certain ranges of terrain factors from consideration should not be based on judgment. Elimination of factors or factor ranges, or the grouping or subdividing of ranges, can be done objectively only by critically appraising the performance of the Overland Train along actual test courses.

7. An ultimate goal of the WES project "Military Evaluation of Geographic Areas," is to develop methods of interpreting the physical characteristics of an area in terms of their effects on individual military activities, such as vehicle movement. Procedures used in the past to select test courses, to measure terrain characteristics, and to test observations of terrain conditions have been subjective, qualitative, and incomplete. Hence there has been no valid basis for translating operational experience in one area to other areas of the world. The recognition by TRECOM that it is highly advisable to carefully select and definitively describe the courses over which the Overland Train will be tested offers an excellent opportunity for the WES to test its techniques of terrain description and comparison, and to obtain much-needed data on the ranges of terrain factor values which are significant in Overland Train mobility. The investigation set up for this purpose is known as Project OTTER, OTTER being an acronym for "Overland Train Terrain Evaluation Research."

Test Course Criteria

8. Preliminary to selection of Overland Train test courses in the field, a comprehensive office study was made of the terrain factor maps which had been prepared of the deserts of Northeast Africa, Northwest Africa, the Middle East, and South Central Asia. The areas occupied by individual Yuma terrain types in these four world deserts were computed to determine areally significant types. With this as a basis, courses were selected with the following criteria in mind:

- a. Terrain types that are areally significant in world deserts should be selected.
- b. Courses should cross as many terrain types as possible, within the limits imposed by item a above.
- c. Courses should not cross terrain that obviously will exceed the capabilities of the Overland Train.
- d. Courses should be kept to a minimum over terrain which will obviously have little or no adverse effect on performance.
- e. Impact areas and other areas at Yuma Test Station preempted for other testing programs should be avoided, if possible.
- f. Courses should be at least 4 miles in length, and wide

enough to allow several traverses without tracking. A course width of 200 ft was arbitrarily selected.

g. Each terrain type along any one course should cover a minimum length of 2000 ft.

9. Based on these criteria, 12 courses were located in the Yuma Test Station area and two in the Yuma Sand Hills (plate 1). It is believed that the routes selected at Yuma will provide a reasonably severe test of the mobility of the Overland Train in terrain which is similar to much of that of world deserts.

Purpose and Scope of This Report

10. The purposes of this report are to: (a) provide detailed maps of the courses which have been selected for testing, (b) briefly describe the WES system of terrain classification, (c) carefully evaluate each test course in terms of the WES system, (d) elaborate on the meaning of the notations accompanying each of the maps, and (e) outline the steps that are planned to synthesize test data in terms that are meaningful to Overland Train mobility.

PART II: FIELD INVESTIGATIONS

11. As indicated in paragraph 8, test courses were tentatively selected in the office study prior to field investigations. During the period 28 January-3 February 1961, a preliminary field survey of the Yuma area was made. At this time, a low-altitude aerial reconnaissance of a large part of the Yuma Test Station and Sand Hills area was conducted in an L-20 aircraft. During the flight, courses selected in the office study were closely observed; later all or parts of the routes were traversed in jeeps. The Yuma Sand Hills and the Transportation Corps Indian Wash Test Course (not shown in plate 1) were also examined in the field.

12. Major field investigations were conducted at Yuma during March and April 1961 by WES personnel, contractors, cooperating agencies, and consultants. This work involved (a) surveying and delimiting test courses, (b) gathering terrain factor data along the courses, and (c) obtaining aerial imagery of the courses. Additional microrelief data were obtained by WES contractors during 17-21 May 1961.

Ground Studies

13. The center lines of courses 1 through 6, 8, 9, and 12 (plate 1) were surveyed and soils, vegetation, and microrelief data collected. Selected ground photographs that illustrate terrain conditions along the test courses are included in this report as photographs 1-18. Center-line stakes were driven at varying intervals along each course. Every 300 to 800 ft, markers were erected 100 ft on each side of the center line to identify course limits. The lengths of the courses vary from 4 to 6 miles with the end points of the courses marked by 40-ft X's outlined in lime (see photograph 11).

14. Course 7 was not surveyed because, after field examination, it was concluded that passageways through the rough terrain were not adequate to permit operation of the Overland Train. Courses 10 and 11 are located partially outside the limits of the Yuma Test Station and permission must be obtained for their use. Most of the land in question is owned by agencies of either the State or Federal Government and easements could

undoubtedly be obtained. Although reconnaissance ground surveys were made along these courses, they have not been surveyed or delimited. Similarly, courses 13 and 14, located within the Yuma Sand Hills, have not been marked in the field. There is some question concerning the possibility of transporting the Overland Train to the Sand Hills area.

15. Although courses 10, 11, 13, and 14 have not been surveyed or delimited, terrain types occur along their lengths that are not found along other courses. Consequently, these courses will not be eliminated from the testing program until the difficulties involved in their utilization can be weighed against the benefits to be derived from their use.

16. Along all surveyed courses, the soil was sampled wherever a change in surface soil occurred. Shallow borings, 18 to 24 in. deep, were made and samples taken at each stratum change for laboratory analysis. A trafficability reconnaissance of several test courses was also conducted. Cone penetrometer readings indicated that strength or bearing capacity of the soils should not be an important factor in immobilization. However, additional data should be collected during testing at points where movement difficulties are encountered. Several miles of microrelief profiles, depicting relief differences between 3 in. and 10 ft were surveyed both parallel and transverse to test course center lines. Vegetation assemblages were mapped in selected areas and correlated with maps of the same areas based on examination of aerial photographs. However, it soon became apparent that photographic mapping of vegetative types was both rapid and accurate, and little further field mapping was necessary to delineate vegetative types along each course.

Aerial Photography

17. It was concluded during the office studies that accurate and objective mapping of geometry, ground, and vegetation factors along the test courses would require topographic maps of these courses at a fairly small contour interval. Since maps with 5-ft contour intervals can be prepared using photogrammetric techniques, at a reasonable cost and within a reasonable period of time, photographic coverage at the required scale was flown for the 14 tentative test courses. These black-and-white

photographs at a scale of 1:12,000 were used in preparing 1:5000-scale topographic strip maps of the surveyed test courses. These strip maps include a zone 1000 ft on either side of the course center line. Photo mosaics of all courses were also prepared. Obviously, these maps and photographs are excellent for classifying the various geometry terrain factors along each course. They also proved valuable for mapping vegetation and ground factors.

Infrared, Color, and Radar Imagery

18. Although it was not a specific project objective, the desirability of concurrently conducting terrain sensing or imaging studies is obvious. Much detailed terrain information was obtained for the test courses which should make them ideal flight paths for studies aimed at evaluating terrain sensors and establishing correlations between image properties and terrain factors. Data obtained by interpretation and photogrammetric techniques from black-and-white aerial photographs can be supplemented by examination of images or returns obtained utilizing other portions of the electromagnetic spectrum. This multiband or multiwavelength concept is one of the most promising approaches to terrain sensing and analysis. Consequently, in addition to the 1:12,000, black-and-white, photographic coverage, the Photo Interpretation Research Division of the Cold Regions Research and Engineering Laboratories (CRREL), in cooperation with the University of Michigan, made infrared and color imagery of several courses. Data concerning soils, geology, and vegetation, as well as temperature and radiation, were collected in the field by CRREL personnel. The Army Electronic Proving Ground (AEPG) at Fort Huachuca, Arizona, has been approached concerning the possibility of obtaining radar imagery of the test courses. These and other data will be summarized in future reports (see paragraph 34).

PART III: TERRAIN CLASSIFICATION AND ANALOG DEVELOPMENT

WES System of Terrain Classification

19. The terrain classification described in WES Technical Report No. 3-506* is being utilized for Project OTTER. Only a few definitions and comments concerning the system will be included in this report.

20. For purposes of the WES system, terrain is considered to be the sum of the various physical attributes of the land that describe an area. A terrain factor is an attribute of terrain that can be described in either qualitative or quantitative terms. A mapping unit is a definable subdivision within a terrain factor; it may be defined quantitatively as a specific range of values, or qualitatively in terms of mapping units within each of the eight terrain factors mentioned in paragraph 5. An area described in this way is called a terrain type; it is identified by an array of numbers (or number-letter symbols), each representing a mapping unit of one of the terrain factors considered in the descriptive system. Terrain factors can be conveniently grouped into three categories: geometry, ground, and vegetation.

Geometry factors

21. Geometry factors considered are plan-profile, occurrence of steep slopes, characteristic slope, and characteristic relief. Plan-profile indicates (a) whether the topographic highs are flat-topped or peaked, (b) the areal occupancy of the highs, (c) the degree of elongation or planar shape of the highs, and (d) the orientation or degree of alignment exhibited by the highs. Ranges of these four subfactors have been combined in such a way that they identify 25 basic types of surface configuration (fig. 1). Occurrence of steep slopes, i.e. slopes greater than 50 per cent, indicates the modal maximum number of such slopes encountered along several traverses in an area (fig. 2). The characteristic slope

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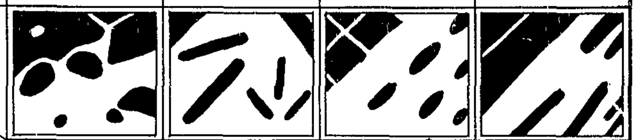
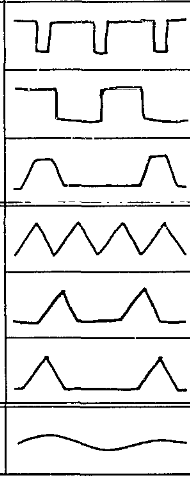
* U. S. Army Engineer Waterways Experiment Station, CE, Handbook; A Technique for Preparing Desert Terrain Analogs, by J. R. Van Lopik and C. R. Kolb, Technical Report No. 3-506 (Vicksburg, Mississippi, May 1959).





Highs* occupy:	Highs are → (↓)	Schematic Plan / Schematic Profile	Nonlinear and Random	Linear and Random	Nonlinear and Parallel	Linear and Parallel
			Units	Units	Units	Units
> 60% of area	Flat-topped		1	1L	1//	1L//
40-60% of area	Flat-topped		2	2L	2//	2L//
< 40% of area	Flat-topped		3	3L	3//	3L//
> 60% of area	Crested or Peaked		4	4L	4//	4L//
40-60% of area	Crested or Peaked		5	5L	5//	5L//
< 40% of area	Crested or Peaked		6	6L	6//	6L//
No pronounced highs or lows			7			

* Highs are considered to be (1) peaked or crested prominences which exhibit characteristic slopes greater than 6 degrees or (2) flat-topped prominences which exhibit summit areas with characteristic slopes < 6 degrees and side slopes > 6 degrees

Fig. 1. Characteristic plan-profile mapping units

indicates the modal slope class or range found in the area (fig. 3), and characteristic relief indicates the modal relief (fig. 4). A landscape (or landscape type) is identified by an array of four number (or number-letter) symbols, each representing a mapping unit within one of the four geometry factors. Surface features not defined by a 10-ft contour interval

Units	Number of Steep Slopes Per 10 Miles
1	Lacking
2	1-5
3	5-20
4	20-100
5	100-200
6	More than 200

Fig. 2. Mapping units for occurrence of slopes greater than 50 per cent

Units	Descriptive Term	Ranges of Degrees	Slope Values Per Cent
1a	Flat	0 to 1/2	0 to 1
1b	Flat	1/2 to 2	1 to 3-1/2
2	Gentle	2 to 6	3-1/2 to 10
3	Moderate	6 to 14	10 to 25
4	Declivitous	14 to 26-1/2	25 to 50
5	Steep	26-1/2 to 45	50 to 100
6	Precipitous	>45	>100

Fig. 3. Characteristic slope mapping units

Relief	Units	Ranges of Relief Values
Type I*	1	0 to 10 ft
	2	10 to 50 ft
	3	>50 ft
Type II†	4	0 to 100 ft
	5	100 to 400 ft
	6	400 to 1000 ft
	7	>1000 ft

* Relief in areas where the characteristic slope is less than 6 degrees (approximately 10 per cent)

† Relief in areas where the characteristic slope is greater than 6 degrees (approximately 10 per cent)

Fig. 4. Characteristic relief mapping units

(i.e. features having less than 10 ft of relief) are ignored in the geometry factors. Consequently, a landscape is defined in terms of the plan-profile, slope occurrence, characteristic slope, and characteristic relief, as those factors generated by a 10-ft contour interval. Microrelief (or surface roughness) is concerned with those features of terrain geometry having relief of less than 10 ft. A microrelief classification is presently being developed.

Ground factors

22. Ground factors include soil type, soil consistency, and surface rock. Soil-type mapping units have been divided into two groups on the basis of percentage of area occupied by bare rock and stony soils. A soil-rock association is mapped if more than 20 per cent of the area is covered by bare rock and stony soil whereas if less than 20 per cent is so covered, a soil association is mapped. As shown in fig. 5, the soil-rock units

		Units	Description
Soil-Rock Associations		1	Bare rock and stony soils* cover 90% of mapped area
		2	Bare rock and stony soils cover from 50 to 90% of mapped area
		3	Bare rock and stony soils cover from 20 to 50% of mapped area
Soil Associations	Coarse-Grained Soils†	4	Gravel: 90% of a typical sample consists of gravel
		5	Sand: 90% of a typical sample consists of sand
		6	Sand-gravel with fines: 50% of a typical sample consists of sand and/or gravel
	Fine-Grained Soils‡	7	Silt and clay with coarse-grained soils: 50% of a typical sample consists of silt and/or clay
		8	Silt: 75% of a typical sample consists of silt
		9	Clay: 75% of a typical sample consists of clay
		10	Saline: 25% of a typical sample consists of salt

* Stony soils: 75% of a typical sample consists of material coarser than gravel (3 in.)

† Coarse-grained soils: 50% of a typical sample consists of sand and/or gravel

‡ Fine-grained soils: 50% of a typical sample consists of silt and/or clay

Fig. 5. Soil type

indicate 20 to 50, 50 to 90, and greater than 90 per cent bare rock and stony soil coverage. Subdivision of the soil association category is based on grain-size percentages of random samples (fig. 5). A soil consistency factor is utilized in describing regions of soil associations. The primary stratification of soil consistency is based on homogeneity or lack of homogeneity (layered consistency) in the uppermost 12 in. of soil (see fig. 6). The homogeneous group is divided into noncohesive and cohesive

		Units	Descriptive Term
Homogeneous Consistencies*	Non-Cohesive Material	1	Loose: The ratio of voids to constituent grains is close to a naturally occurring maximum, i.e., the grains are loosely packed
		2	Dense: The ratio of voids to constituent particles is close to a naturally occurring minimum, i.e., the grains are closely packed
	Cohesive Material	3	Soft (usually perennially wet): Little or no bearing capacity
		4	Firm: Moderate bearing capacity
		5	Hard: High bearing capacity
Layered Consistencies†	Crusted Surface	6	Hard thin crust over soft material
		7	Hard thin crust over noncohesive material
		8	Thin zones of firm material over noncohesive material
		9	Surface of pebbles or gravel over noncohesive material
	Noncohesive Surface Layer <12 in. Thick	10	Dense layer within 12 in. of the surface
		11	Hard layer within 12 in. of the surface

* Soil of essentially uniform consistency to depths of 12 in.

† Soil posessing two or more relatively discrete layers within 12 in. of the surface

Fig. 6. Soil consistency

categories. The noncohesive category is further subdivided into two mapping units (loose and dense), while the cohesive category is subdivided into three mapping units (soft, firm, and hard). The nonhomogeneous or layered consistency units identify various combinations of the consistencies which occur within the uppermost 12 in. of soil, e.g. hard crust over soft material, firm over noncohesive, etc.

23. Regions of soil-rock associations are described in terms of

surface rock factor. Accepted geologic rock nomenclature has been employed in the surface rock classification and the classification of this factor as used in WES desert terrain studies is shown in fig. 7. Since the nature of

Units	Descriptive Term
1	IGNEOUS (Undiff.)
2	Intrusive
3	Extrusive
3a	True Extrusive
3b	Cemented Volcanic Ejecta
4	METAMORPHIC (Undiff.)
5	SEDIMENTARY (Undiff.)
6	Sandstone
7	Limestone
8	Shale
9	Evaporites

Fig. 7. Surface rock

the rock at Yuma is of little consequence in the performance of the Overland Train, the various rock types occurring along the selected courses at Yuma have not been classified, and rock type will not be considered in determining terrain types along the test courses analogous to those of mapped world deserts.

Vegetation factor

24. In WES Technical Report 3-506 the vegetation factor is subdivided on the basis of naturally occurring desert vegetation assemblages and their structure (fig. 8). Structural aspects considered are ground cover, canopy cover, spacing, height, trunk diameter, and crown diameter. A more universal and comprehensive structural system for classifying vegetation has been developed by WES; however, for Project OTTER it was necessary to employ the same system (WES) used earlier to map the world deserts

Units	Descriptive Term	Ground Cover Per Cent
1	Barren	1
2	Sparse shrub and grass	1-5
3	Scattered shrub and grass	5-25
4	Scattered shrub and/or scrubby trees	50-90
4a	With scattered 3rd story* trees	50-90
5	Dense shrub and/or scrubby trees	80-100
5a	With scattered 3rd story trees	80-100
5b	With grain-herb cultivation	90-100
6	Palms with or without grain-herb cultivation	75-100
7	Steppe	50-100
8	Steppe-savanna	90-100
9	Grain-herb cultivation	90-100
10	Marsh	80-100

* Vegetation stories are distinguished on the basis of height: 1st story vegetation ranges from 0 to 6 ft in height; 2nd story, from 6 to 25 ft; 3rd story, from 25 to 70 ft.

Fig. 8. Vegetation

in order that a valid comparison could be made between vegetative types traversed along the Overland Train test courses and those which occur in the mapped world deserts.

Terrain Types Along Overland Train Test Courses

25. Terrain types were classified along test courses 1 through 6, 8, 9, and 12. The technique employed in mapping world desert areas was applied within the 200-ft-wide strips, thus restricting the classification to terrain types that would be encountered by the Overland Train within the

test courses. Terrain types traversed along an essentially linear course by the Overland Train are compared with area maps of terrain types prepared for world deserts by WES. By using this technique the value or range of each factor was determined and assigned a symbol corresponding to a mapping unit. Each terrain type was identified by an array of seven (or occasionally more) symbols indicating various combinations of mapping units of plan-profile, slope occurrence, slope, relief, soil type, soil consistency, and vegetation--always designated in that order. Forty-two individual terrain types were found to occur along the nine test courses for which topographic strip maps have been prepared.

26. Plates 2-40 include aerial mosaics of all 14 tentative test courses at a scale of 1:15,000 and topographic strip maps of nine of these courses at a scale of 1:5000. To illustrate the format and content of these plates, consider Test Course 5. Plate 18 is an aerial mosaic of the terrain along this course, and it shows the limits of the topographic maps which follow, i.e. plates 19, 20, and 21. The topographic maps show the center lines of the courses and the locations of center-line stakes used for sampling control. The stakes are spaced at varying distances, usually between 500 and 1000 ft apart. In order to expedite laying out each test course, stake 1 was arbitrarily located in the field at some point easily identifiable on air photos. Stakes were then numbered consecutively first to the left of stake 1 (toward the nearer end of the course), then the numbering system was continued to the right of stake 1 (toward the opposite end). Thus, in plate 19, stake 1 occurs about 4000 ft from the start of the test run and stakes are numbered toward the left to stake 7. Stakes 8, 9, 10, etc., are numbered consecutively to the right of stake 1. The limits of the test course (200 ft in width) are shown on either side of the center line. For a valid test and a valid terrain comparison with mapped world deserts, the Overland Train may maneuver or deviate from a straight-line path only within the limits of this test course.

27. The limits of various terrain factor types are shown along the parallel lines above and below each topographic strip. Thus in plate 19 the area from the beginning of the test course to the vicinity of stake 1 is classified as landscape type 7,1,1a,1; from stake 1 to stake 14 as landscape type 7,1,1b,1; and so on. The ground factors do not change until

the vicinity of stake 21 in plate 20. The vegetation type changes at about stake 14 in plate 19. The terrain type, since it changes whenever any of the factor values change, changes in the vicinity of stake 1 in plate 19. The range of values and the meanings of each of the digits used to classify the terrain types along Course 5 are indicated in the table on the back of plate 18, and also listed in figs. 1-8.

28. A final point that should be considered in examining these plates is the use in many instances of a complex or dual classification for the ground and vegetation factors. This symbolization indicates the occurrence of two distinct mapping units within the area so mapped. It is shown by listing the two mapping units on either side of a diagonal line. The predominant unit of the complex is to the left of the diagonal and the subordinate unit to the right of the diagonal. Thus, in plate 19, the vegetation type 2/4, which has been delineated from the beginning of the course to the vicinity of stake 14, indicates a predominance of sparse shrubs and grasses with intervening smaller areas of scattered shrubs and/or scrubby trees. The complex classification is also used for the ground factors. Note the classification of the ground factors between stakes 22 and 34 in plates 20 and 21. The designation 6,9/6,10 for the ground factors along this segment of Course 5 indicates that a unit 6 (sand and gravel with fines) soil type, with a unit 9 soil consistency (surface of pebbles or gravel over noncohesive materials) is the predominant ground factor type; and a unit 6 soil type with a unit 10 consistency (loose surface layer with a dense layer within 12 in. of the surface) is subordinate.

Analog Development

29. The determination of analogous terrain types in two noncontiguous areas is made by comparing the seven-digit terrain type classified in one area with that of another. This is a direct comparison of terrain factor units such as is done in WES reports developing degrees of analogy between Yuma terrain and various world deserts. Maps showing the representativeness of terrain along the routes selected for the Overland Train are special forms of analog maps. The analogies between "test course terrains"

and the terrains of other world desert areas are based on only those ranges of factors which are assumed to have an adverse effect of some kind on the cross-country performance of the Overland Train. Determination of the actual effect of the presently chosen ranges of terrain factors on Overland Train mobility must await actual testing of the train, and will be discussed in detail in the supplemental and summary reports which will be prepared at the conclusion of the tests.

30. The test program should result in conclusions regarding the effects of various types of terrain on the cross-country performance of the Overland Train. However, it is unlikely that each terrain type will impose a unique effect or combination of effects; as a result, it is probable that several different terrain types will be found to produce the same total effect on the Overland Train. It is therefore anticipated that grouping certain of the mapping units within selected terrain factors will be required to account for performance data. On the other hand, it may also be found that performance variations will occur in response to conditions within a single mapping unit. For example, it may be found that a critical slope value is achieved for the Overland Train which lies within one of the slope mapping units; in this event, it may be necessary to subdivide the existing mapping units in order to adequately describe the effects of terrain on performance. Ultimately, these data will be employed to construct what might be called "terrain effects" maps, in which ranges of effects on the Overland Train will be used as mapping units. If the test program is completely successful in establishing the connection between terrain types and effects on Overland Train mobility, it will be a simple matter to convert the terrain analog maps as presented in this study into a series of terrain effects maps. At this point it will be possible to illustrate the representativeness of the terrain tested at Yuma to world desert terrains in terms of the effects on the test vehicle.

31. As presently conceived, the terrain effects maps which will be developed for the OTTER project will resemble figs. 9-12. However, the final product will almost certainly be more definitive, in that measured values can be substituted for the qualitative statements of relative difficulty that are used on the existing maps. The delineations of analogous areas will also be more accurate, because test data will be available to

replace the assumptions on which the present maps are based. One of these assumptions was that the Overland Train would be able to negotiate all the terrain types found along the test courses. Another was that neither grouping nor subdivision of mapping units would be necessary in the completion of the final terrain effects maps. Neither assumption, of course, is entirely warranted. Judgment was the only basis for estimating which terrain types were more negotiable or less negotiable than those tested at Yuma. Actual testing at Yuma should permit a much more sophisticated assessment of these categories, as well as a choice of categories that are much more definitive.

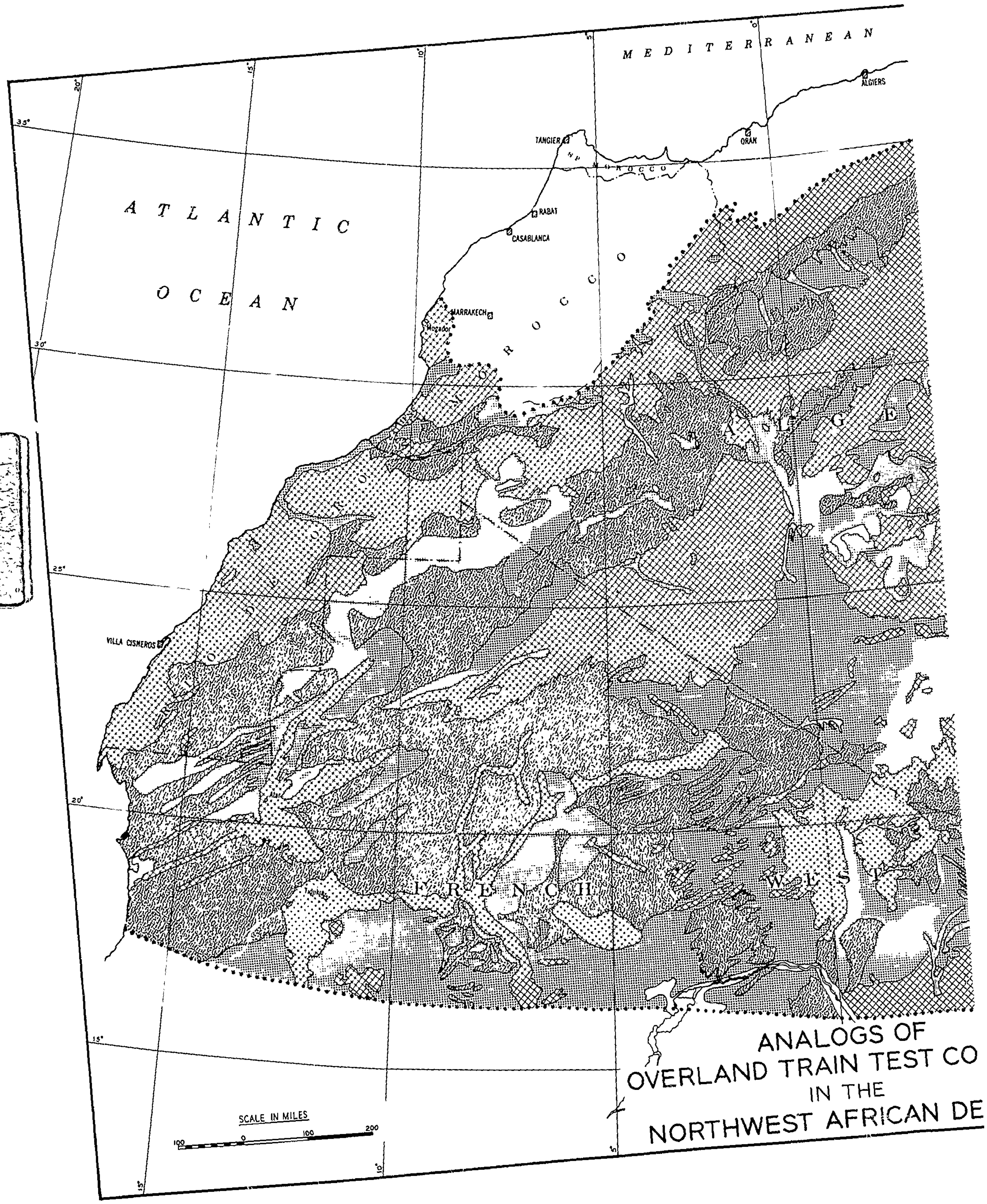
32. The preliminary effects maps (figs. 9-12) are maps of the deserts of Northwest Africa, Northeast Africa, the Middle East, and South Central Asia. They were compiled from folio reports prepared by WES for these desert areas. Terrain types occurring along the test courses were compared with those mapped in these desert areas, and the following categories involving the mobility of the Overland Train were delineated:

- a. Terrain types analogous to those along the test courses;
- b. Terrain types that are assumed to be as negotiable as, or more negotiable than those along the test courses;
- c. Terrain types which are assumed to be more difficult to negotiate than those along the test courses;
- d. Areas where circuitous routes could cross terrain types which are assumed to be as negotiable as, or more negotiable than those along the test courses; and
- e. Areas where comparison is questionable.

In many instances, WES desert terrain maps delineate complexes (i.e. areas within which two distinctive terrain types are found, one of which is subordinate to the other in areal extent). In such instances when the predominant terrain type is such that it would prohibit movement of the Overland Train, but the subordinate terrain type is easily negotiable, the area is delineated as one "where circuitous routes could cross terrain types as or more negotiable than those along the test courses." For comparative purposes, landscape types in world deserts occurring along the test courses have been shown in figs. 9-12 as a green overprint.

33. The areas in figs. 9-12 which are analogous from the standpoint of terrain types to those along the Yuma test courses are relatively small

1


MEDITERRANEAN
ALGIERS
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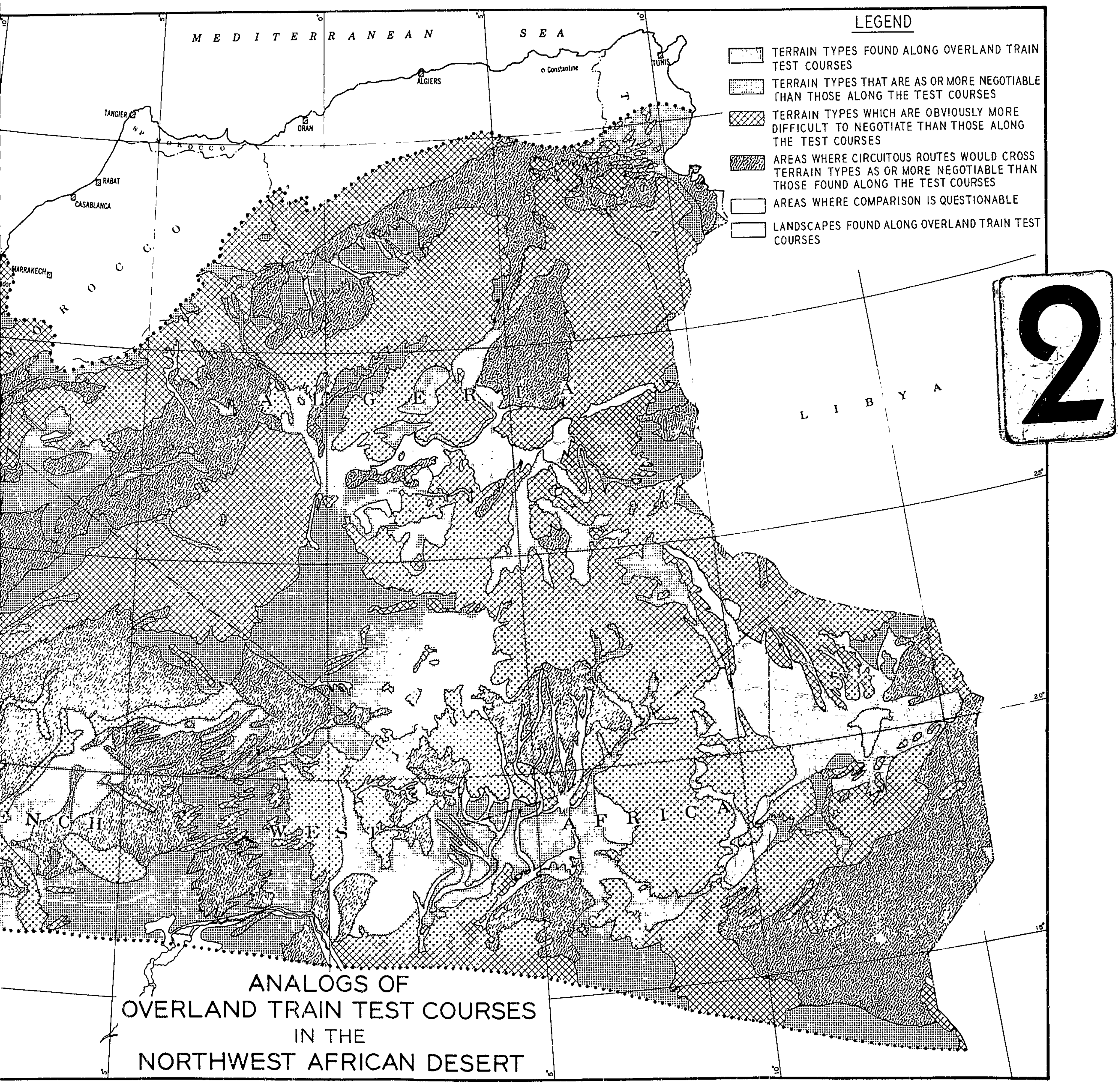
ANALOGS OF
OVERLAND TRAIN TEST CO
IN THE
NORTHWEST AFRICAN DE


LEGEND
TERRAIN TYPES FOUND ALONG OVERLAND TRAIN TEST COURSES
TERRAIN TYPES THAT ARE AS OR MORE NEGOTIABLE THAN THOSE ALONG THE TEST COURSES
TERRAIN TYPES WHICH ARE OBVIOUSLY MORE DIFFICULT TO NEGOTIATE THAN THOSE ALONG THE TEST COURSES
AREAS WHERE CIRCUITOUS ROUTES WOULD CROSS TERRAIN TYPES AS OR MORE NEGOTIABLE THAN THOSE FOUND ALONG THE TEST COURSES
AREAS WHERE COMPARISON IS QUESTIONABLE
LANDSCAPES FOUND ALONG OVERLAND TRAIN TEST COURSES
MEDITERRANEAN SEA
TANGIER
ORAN
ALGIERS
Constantine
TUNIS
RABAT
CASABLANCA
MARRAKECH
MOROCCO
ALGERIA
LIBYA
WEST AFRICA
25°
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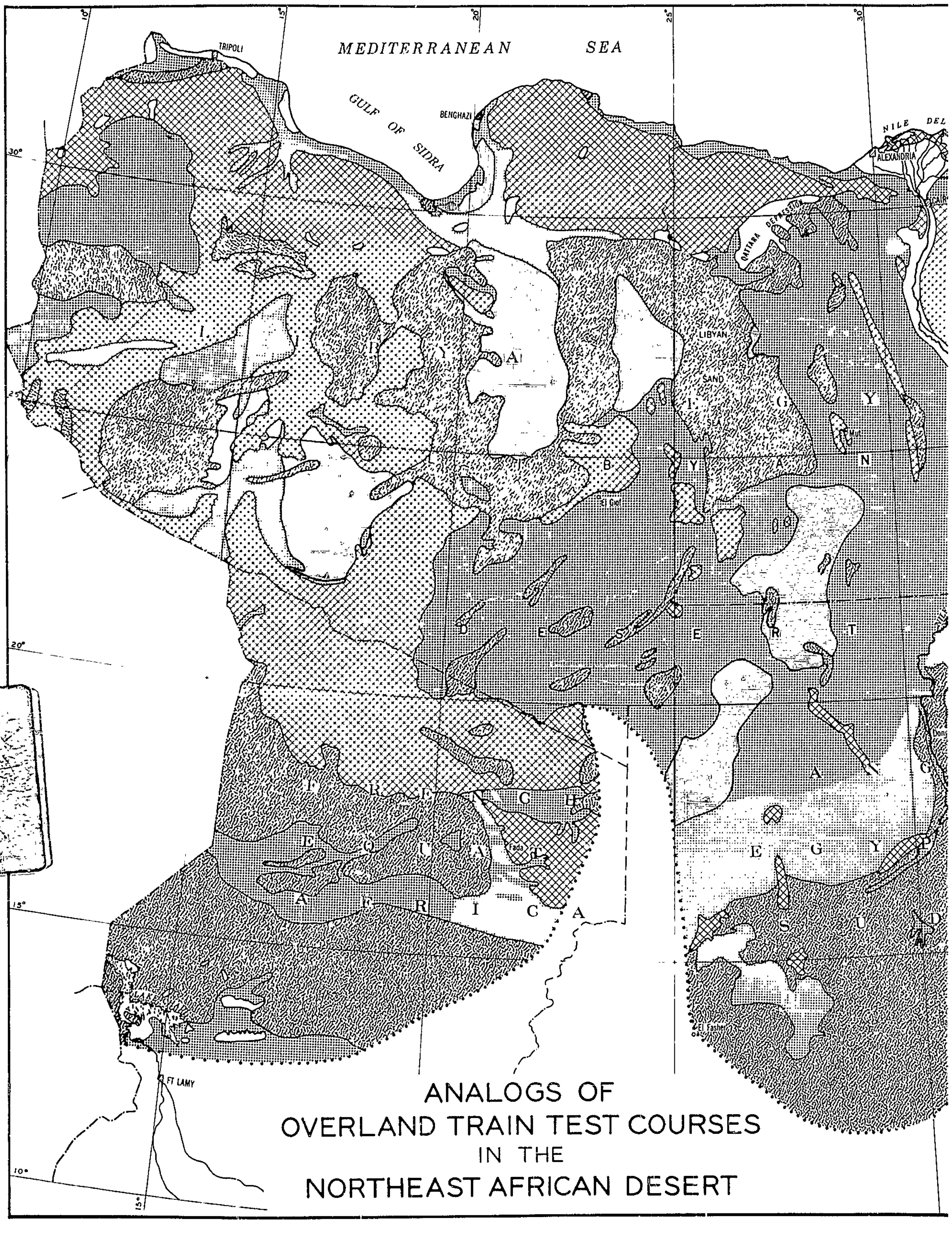
2
ANALOGS OF
OVERLAND TRAIN TEST COURSES
IN THE
NORTHWEST AFRICAN DESERT

Fig. 9

1


MEDITERRANEAN SEA
TRIPOLI
GULF OF SIDRA
BENGHAZI
ALEXANDRIA
QATTARA DEPRESSION
LIBYAN SAND SEA
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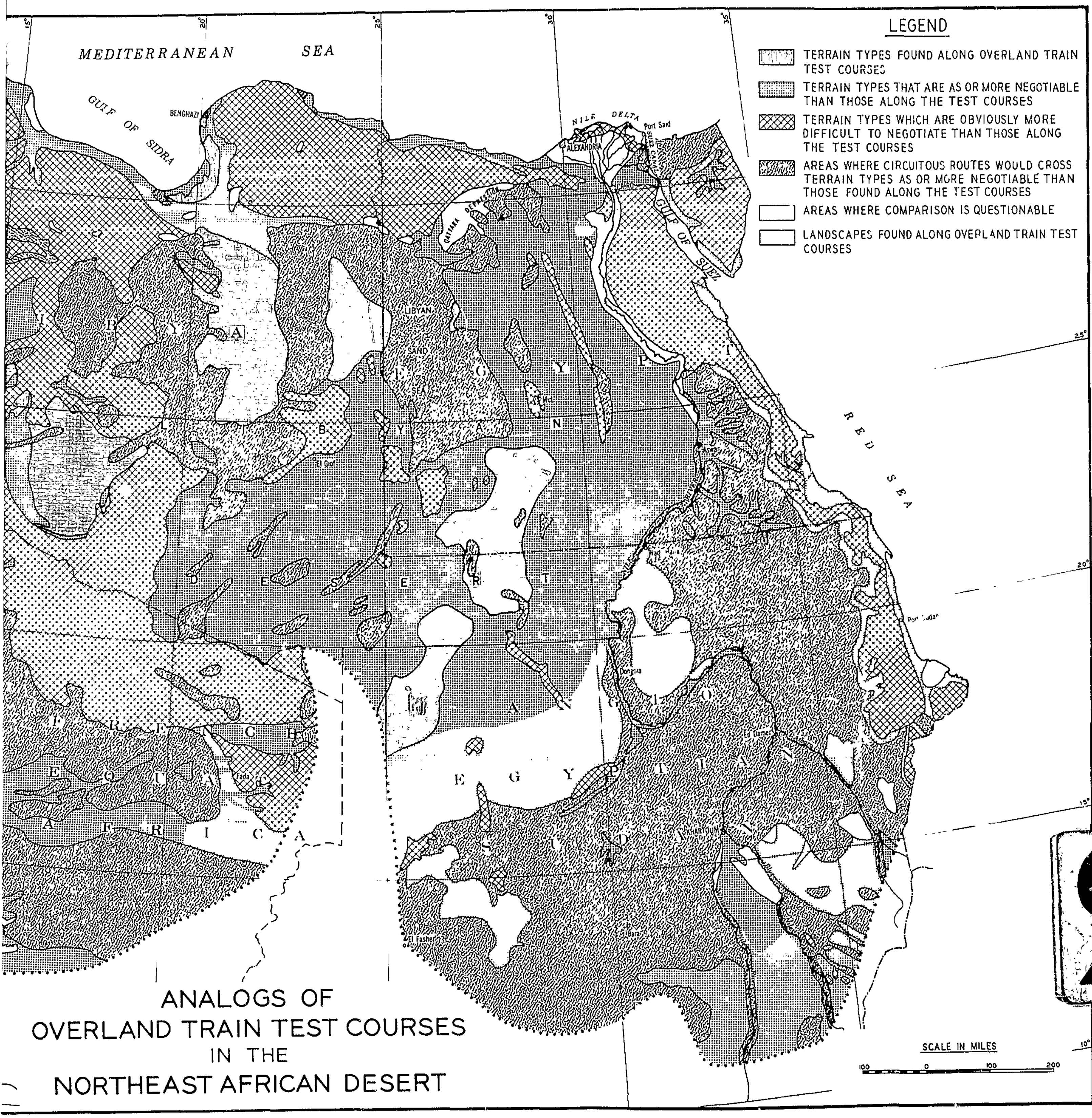
ANALOGS OF
OVERLAND TRAIN TEST COURSES
IN THE
NORTHEAST AFRICAN DESERT


MEDITERRANEAN SEA
GULF OF SIDRA
BENGHAZI
NILE DELTA
Port Said
ALEXANDRIA
CAIRO
QATTARA DEPRESSION
GULF OF SUEZ
LIBYAN SAND SEA
RED SEA
El Giof
Port Sudan
Dongola
Fada
KHARTOUM
El Fasher
LIBYA
EGYPTIAN DESERT
FRENCH EQUATORIAL AFRICA
EGYPT
ANGLO-EGYPTIAN SUDAN
LEGEND
TERRAIN TYPES FOUND ALONG OVERLAND TRAIN TEST COURSES
TERRAIN TYPES THAT ARE AS OR MORE NEGOTIABLE THAN THOSE ALONG THE TEST COURSES
TERRAIN TYPES WHICH ARE OBVIOUSLY MORE DIFFICULT TO NEGOTIATE THAN THOSE ALONG THE TEST COURSES
AREAS WHERE CIRCUITOUS ROUTES WOULD CROSS TERRAIN TYPES AS OR MORE NEGOTIABLE THAN THOSE FOUND ALONG THE TEST COURSES
AREAS WHERE COMPARISON IS QUESTIONABLE
LANDSCAPES FOUND ALONG OVEPLAND TRAIN TEST COURSES
SCALE IN MILES
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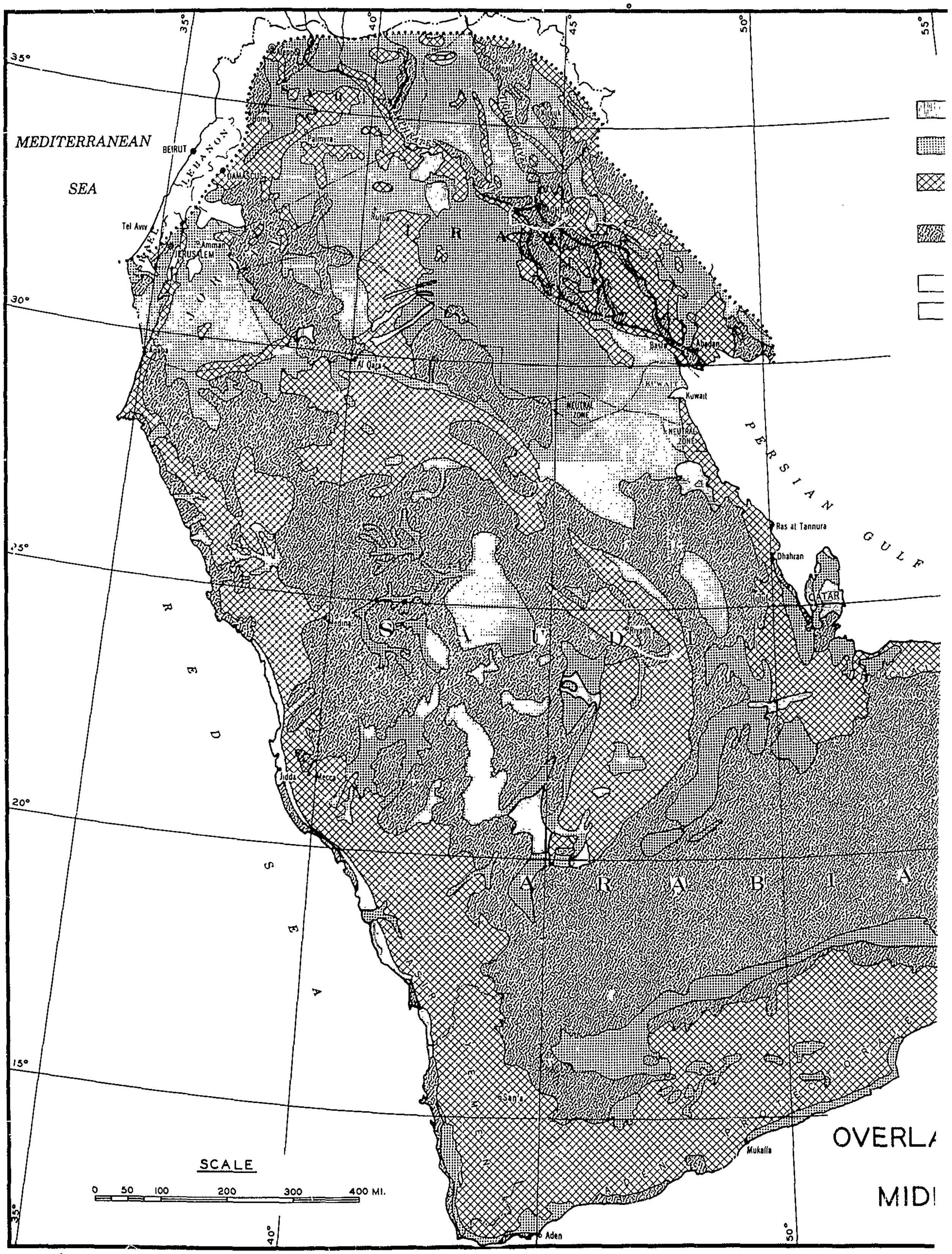
ANALOGS OF
OVERLAND TRAIN TEST COURSES
IN THE
NORTHEAST AFRICAN DESERT

Fig. 10

1



MEDITERRANEAN
SEA
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Tel Aviv
Amman
JERUSALEM
Aleppo
Homs
Palmyra
Mosul
Kirkuk
BAGHDAD
Rutba
Al Qaja
Basra
Abadan
Kuwait
NEUTRAL ZONE
NEUTRAL ZONE
P E R S I A N G U L F
Ras at Tannura
Dhahran
Medina
Jidda
Mecca
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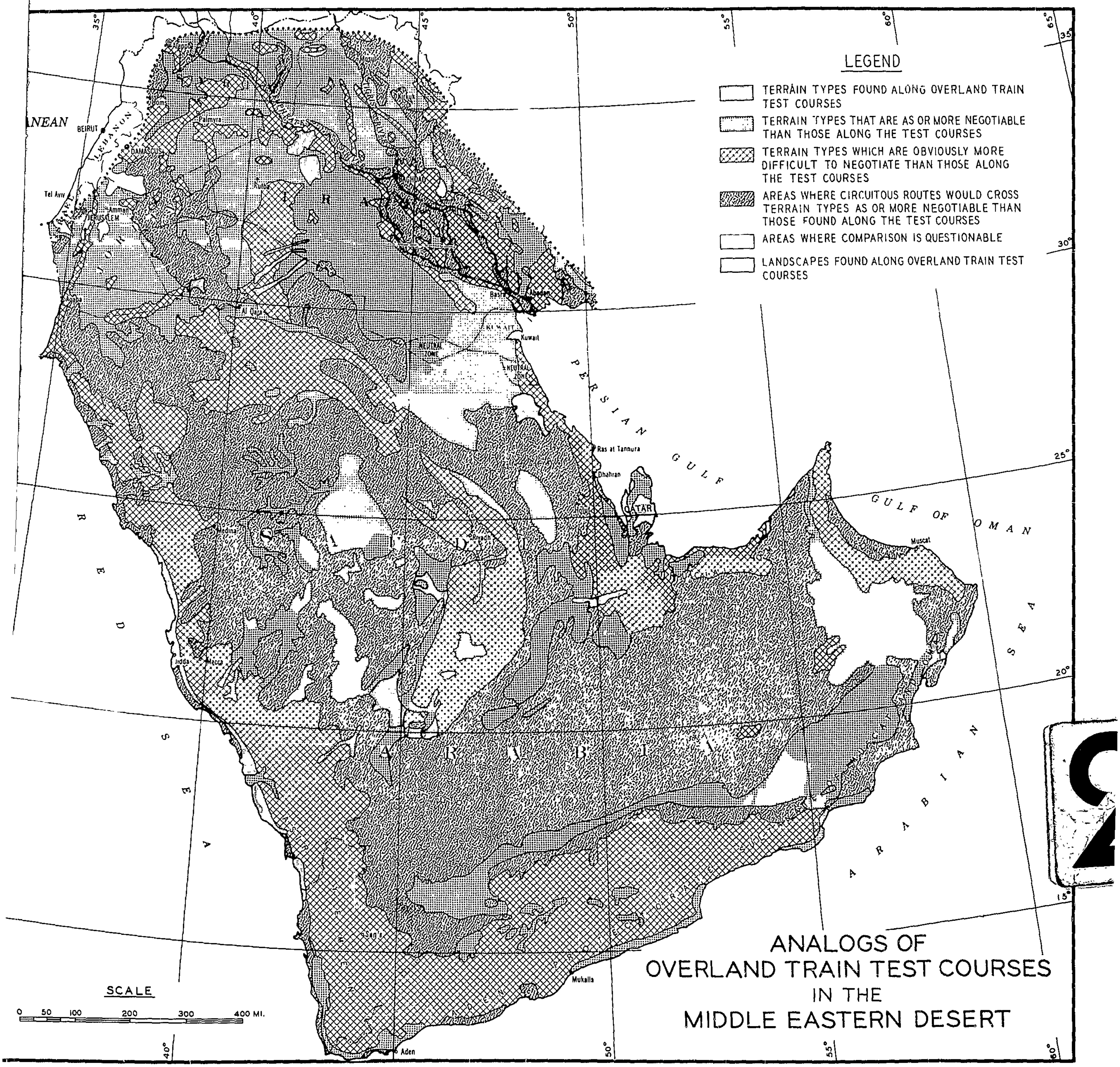
LEGEND
TERRAIN TYPES FOUND ALONG OVERLAND TRAIN TEST COURSES
TERRAIN TYPES THAT ARE AS OR MORE NEGOTIABLE THAN THOSE ALONG THE TEST COURSES
TERRAIN TYPES WHICH ARE OBVIOUSLY MORE DIFFICULT TO NEGOTIATE THAN THOSE ALONG THE TEST COURSES
AREAS WHERE CIRCUITOUS ROUTES WOULD CROSS TERRAIN TYPES AS OR MORE NEGOTIABLE THAN THOSE FOUND ALONG THE TEST COURSES
AREAS WHERE COMPARISON IS QUESTIONABLE
LANDSCAPES FOUND ALONG OVERLAND TRAIN TEST COURSES
ANALOGS OF
OVERLAND TRAIN TEST COURSES
IN THE
MIDDLE EASTERN DESERT
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PERSIAN GULF
GULF OF OMAN
ARABIAN SEA
RED SEA
ARABIA
BEIRUT
DAMASCUS
Tel Aviv
JERUSALEM
Amman
Palmyra
BAGHDAD
Basra
Abadan
KUWAIT
Kuwait
NEUTRAL ZONE
Ras at Tannura
Dhahran
QATAR
Muscat
Medina
Riyadh
Jidda
Mecca
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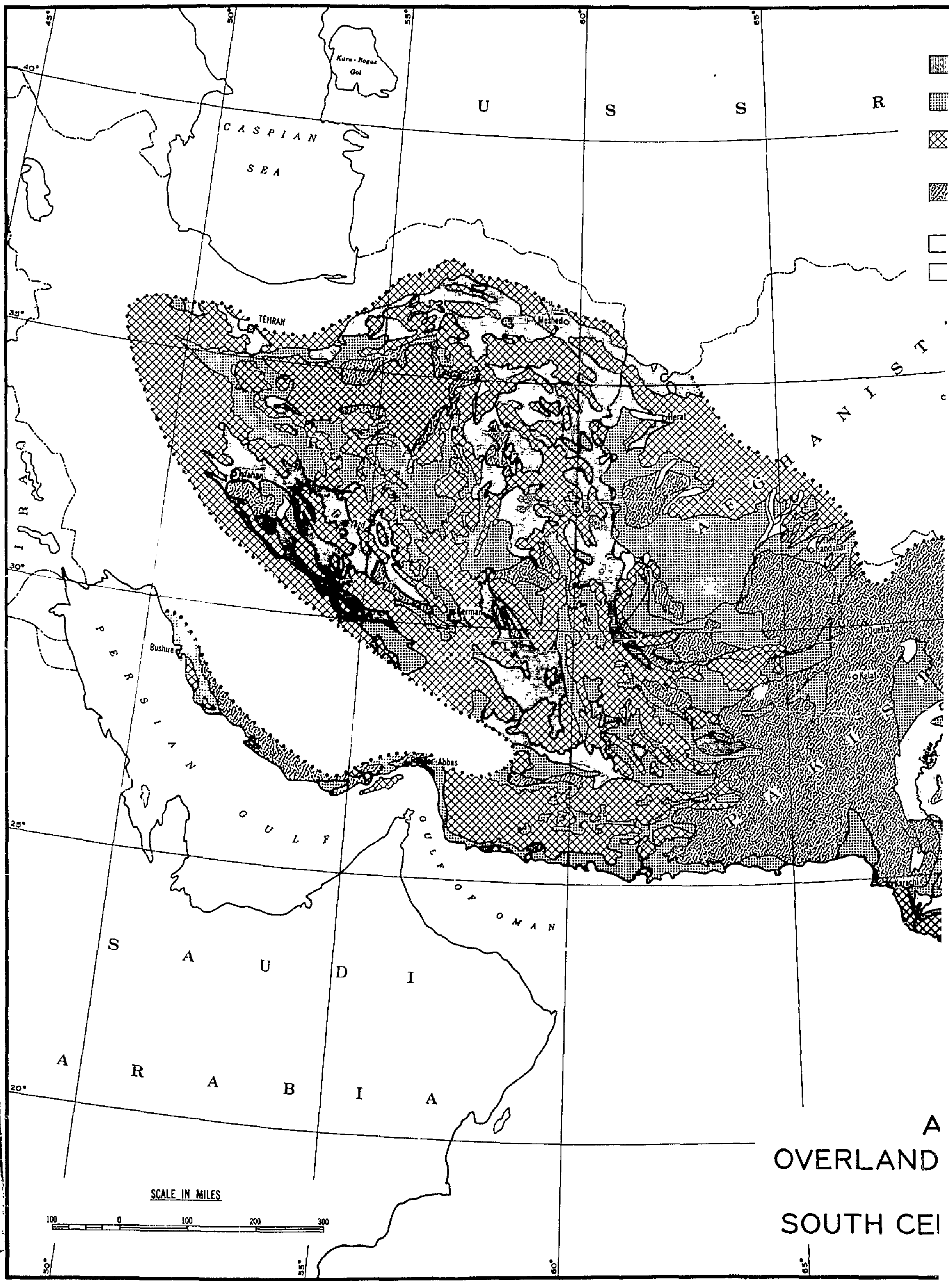
Fig. 11

1



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Kerman
IRAQ
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Bushire
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GULF OF OMAN
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SCALE IN MILES
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A
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SOUTH CE

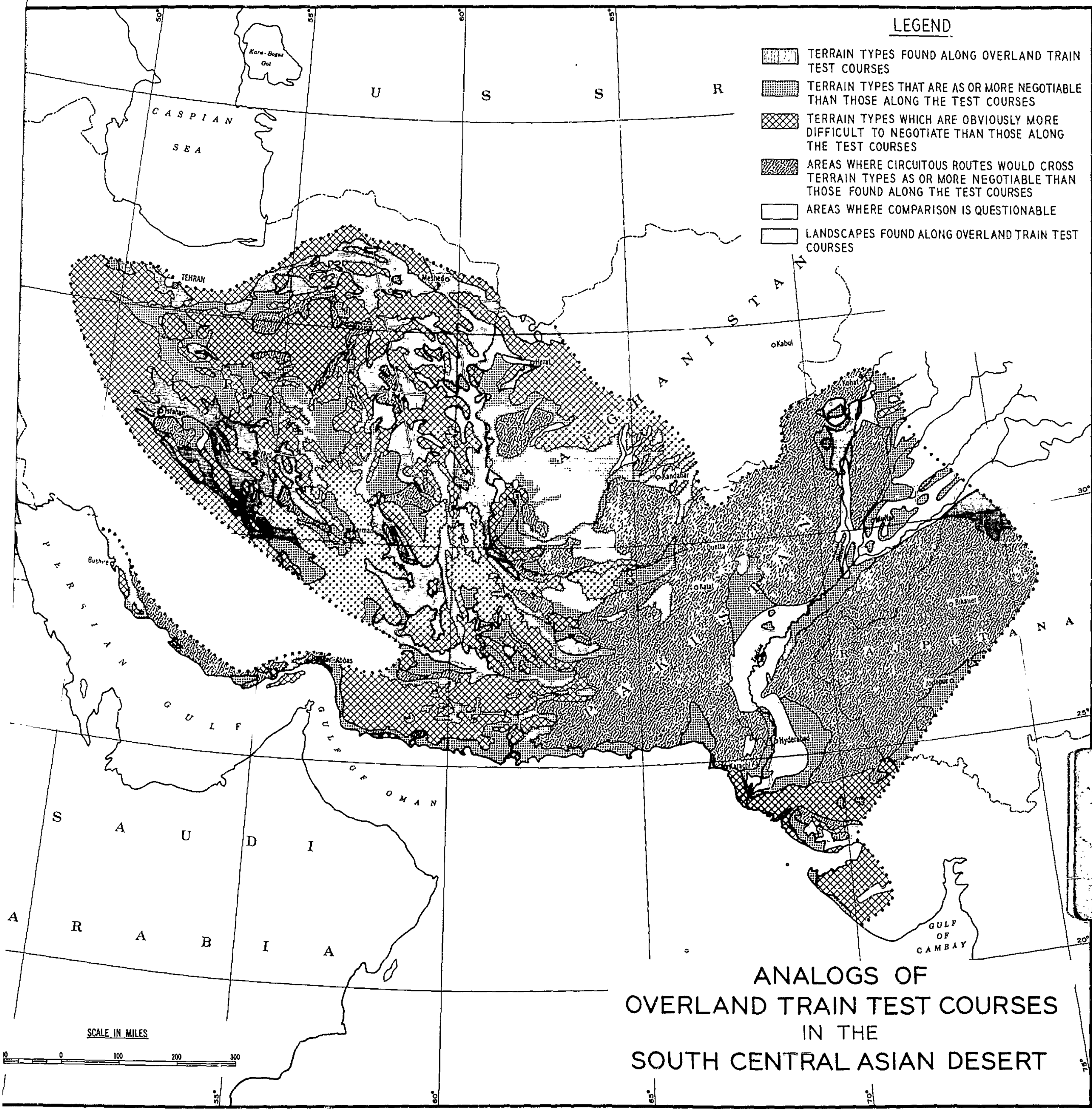

LEGEND
TERRAIN TYPES FOUND ALONG OVERLAND TRAIN TEST COURSES
TERRAIN TYPES THAT ARE AS OR MORE NEGOTIABLE THAN THOSE ALONG THE TEST COURSES
TERRAIN TYPES WHICH ARE OBVIOUSLY MORE DIFFICULT TO NEGOTIATE THAN THOSE ALONG THE TEST COURSES
AREAS WHERE CIRCUITOUS ROUTES WOULD CROSS TERRAIN TYPES AS OR MORE NEGOTIABLE THAN THOSE FOUND ALONG THE TEST COURSES
AREAS WHERE COMPARISON IS QUESTIONABLE
LANDSCAPES FOUND ALONG OVERLAND TRAIN TEST COURSES
U S S R
CASPIAN SEA
Kara-Bogaz Gol
TEHRAN
Meshed
Herat
Kabul
AFGHANISTAN
Isfahan
Kandahar
Kerman
Quetta
Kalat
Multan
Bikaner
Jodhpur
Hyderabad
Karachi
RAJPUTANA
PERSIAN GULF
GULF OF OMAN
GULF OF CAMBAY
SAUDI ARABIA
SCALE IN MILES
0 100 200 300
ANALOGS OF
OVERLAND TRAIN TEST COURSES
IN THE
SOUTH CENTRAL ASIAN DESERT

Fig. 12

in areal extent. This is to be expected. It is possible that such areas of analogy will increase considerably when the method of analog development is modified following the Overland Train tests, but this is not necessarily true. Numerous terrain types that are areally significant in world deserts do not occur at Yuma. For a more representative testing program, additional sites in the Southwest United States desert should be considered for future tests. Major types of terrain absent at Yuma are: (a) volcanic regions characterized by lava flows, cinders, cinder cones, and ash, (b) saline and fine-grained soils, particularly those with high-water tables, (c) plateau regions and regions with considerable amounts of bare rock and stony surfaces, and (d) flood plains, both with and without heavy vegetative growth.

PART IV: FUTURE WORK AND PROPOSED REPORTS

34. The following reports concerned directly or indirectly with the testing of the Overland Train will be prepared during FY 1962 and FY 1963:

a. A report concerning field testing of vehicles other than the Overland Train at Yuma. WES personnel are currently at Yuma testing the performance of a jeep and a 2-1/2-ton truck over courses that parallel and lie immediately adjacent to those prepared for testing the Overland Train. These tests should provide valuable data concerning the type of information that should be collected during the Overland Train test runs and the instrumentation that will be necessary to obtain this information. More important, they will permit a comparison of the mobility of these vehicles and the Overland Train, thus providing a broader base for estimating the effect of the terrain types along the test courses on the single military activity of cross-country movement. Upon completion of testing a report will be prepared by WES personnel.

b. A letter report, based partly on data obtained from the tests described in subparagraph a, will be prepared by WES and sent to TRECOM prior to the Overland Train tests. It will consist largely of recommendations and specifications for testing procedures and instrumentation considered necessary by WES for the Overland Train tests.

c. A supplement to the Pretest Report will be prepared by WES following the conclusion of the testing of the Overland Train. Final draft of this report should be finished approximately four months after conclusion of testing. The report will deal with those aspects of the test results that are of interest in WES area evaluation and trafficability studies. The effect of various terrain types on the operation of the Overland Train and other vehicles tested will be discussed and final terrain analog maps prepared.

d. Two reports will be prepared during FY 1962 and FY 1963 discussing subsidiary aspects of Project OTTER:

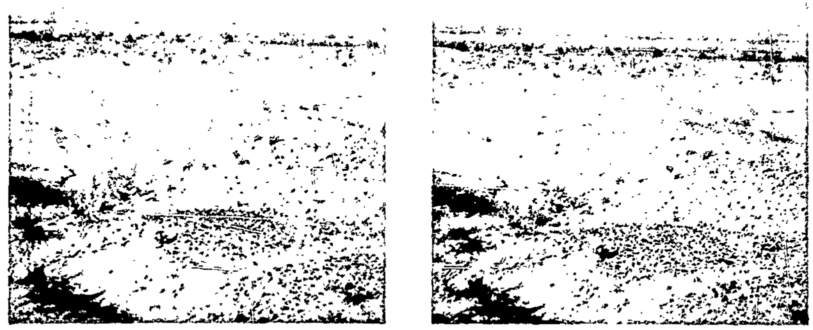
(1) A report describing the microrelief studies being conducted for the project will be prepared by a WES contractor.

(2) A report concerning aerial imagery will be prepared by CRREL and WES personnel. The report will include discussions of black-and-white, color, infrared, and radar imagery as tools for terrain analysis and of the classification of terrain in terms of the WES system.

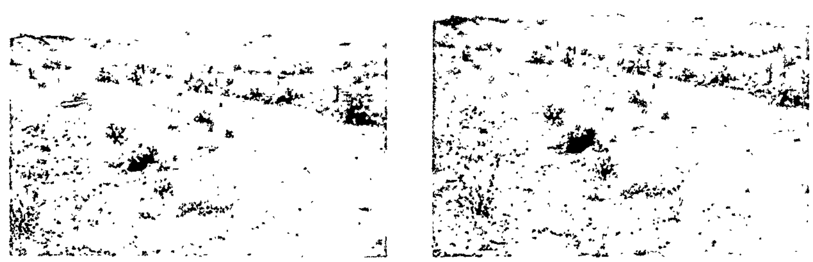
e. A summary report will be prepared by WES personnel. This report will consist of an over-all evaluation of the Project OTTER program. Data and conclusions developed as

> a result of all preceding studies will be summarized and a final appraisal made of the significance of the project in terrain evaluation and analysis.

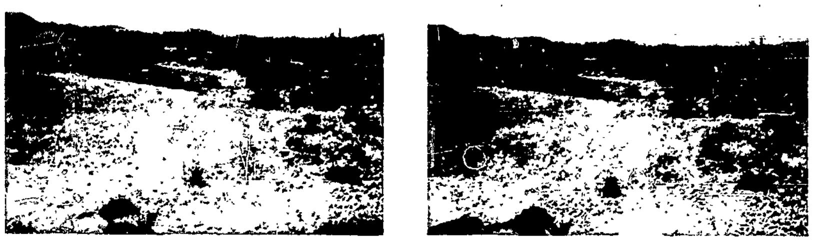
35. TRECOM is principally concerned with items b and c. The other reports, although part of the over-all project, deal primarily with aspects of terrain analysis and evaluation that pertain to WES "Military Evaluation of Geographic Areas" studies. The final summary report (item e) will, of course, be distributed to all agencies taking part in the project.



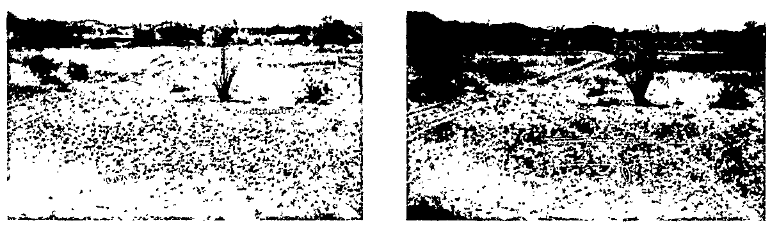
Photograph 1. Stereoscopic pair of a dissected alluvial terrace along test course 1 near center-line stake 24. Terrain type 7,1,2,1-6,10/6,1-3/2. Because the relief is less than 10 ft this is a microrelief feature



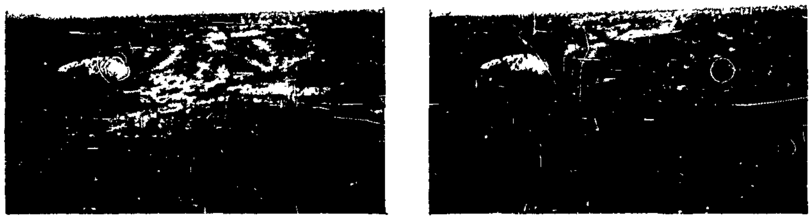
Photograph 2. Stereoscopic pair of terrain type 1,1,1b,2-6,9/6,10-2/4 along test course 1 near center-line stake 41 looking northwest. Note the vegetation in the dry washes



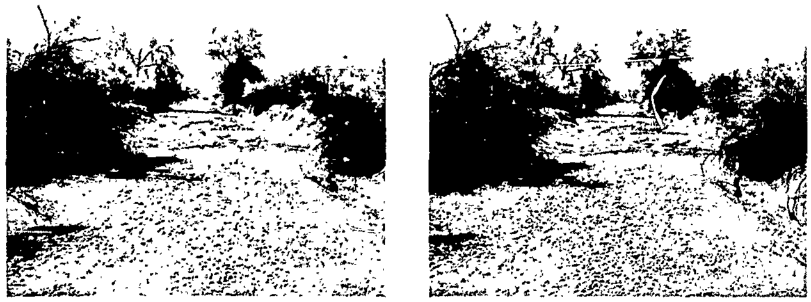
Photograph 3. Stereoscopic pair of the bouldery surface of an alluvial apron along test course 5 looking southwest from center-line stake 29. Terrain type 1,1,1b,2-6,9/6,10-2/4



Photograph 4. Stereoscopic pair of an alluvial apron, terrain type 7,1,1b,1-6,9/6,10-2/4, at center-line stake 28 on test course 5. Note the almost vertical bank of dry stream in background



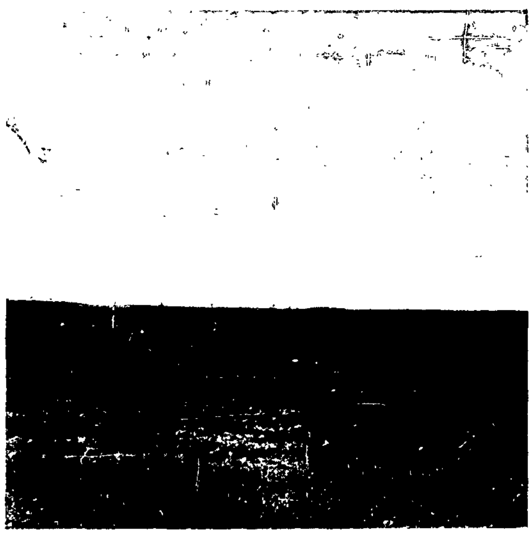
Photograph 5. Stereoscopic pair of a highly dissected alluvial apron resulting in a 4,4,3,4-6,10/6,9-1/4 terrain type along test course 5 near center-line stake 37



Photograph 6. Stereoscopic pair of a shallow wash running perpendicular to test course 9 near center-line stake 27. Note dense vegetation adjacent to the steep banks. The wash bed consists of loose sandy gravel

Photograph 7. Low sand mounds capped with vegetation along test course 1 near center-line stake 13. Terrain type 7,1,2,1-5,1-3

Photograph 8. Low, dissected, unconsolidated hills along test course 2 near center-line stake 30. Terrain type 6,1,1b,2-6,10-1/3



Photograph 9. Looking across a wide dry streambed along test course 2 near center-line stake 38 with the steep streambank in the background

Photograph 10. Dense vegetation in a dry streambed along test course 4 near center-line stake 17

Photograph 11. The southwest end of test course 5 marked by a limed "X." The flag stake in the foreground is a flank marker

Photograph 12. A ridge rising above a dry wash along test course 6 near center-line stake 2. Terrain type 6,3,1b,1-6,9/6,10-1/3

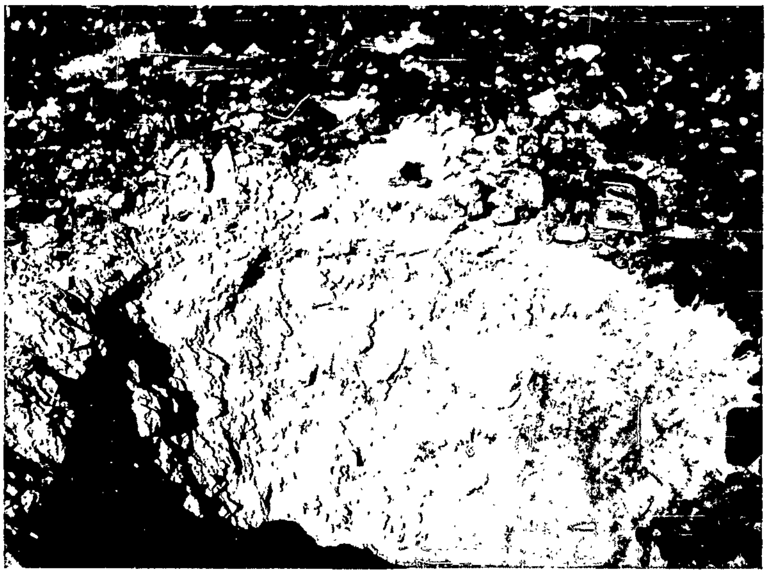
Photograph 13. Looking across test course 6. Terrain type 1,3,1b,2-6,9/6,10-2/4. The vegetation outlines the drainageways and the dark tone indicates the top of the alluvial apron, which is characterized by desert pavement (see photograph 17)

Photograph 14. An alluvial apron crossed by test course 8 near center-line stake 3. Terrain type 1,1,1b,2-6,9-2/4. Palomas Mountains in background

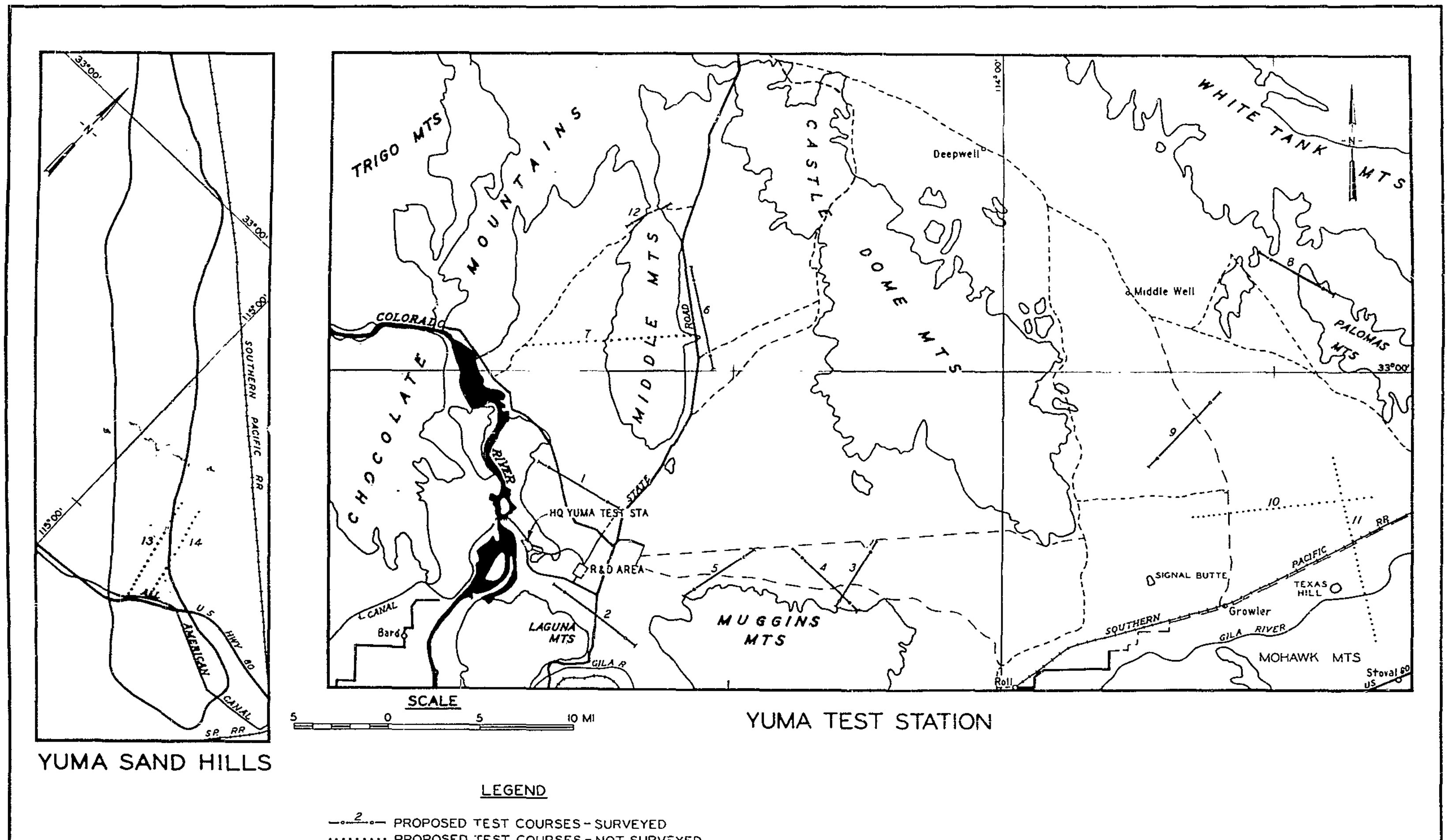
Photograph 15. Looking southeast across the Palomas Mountains along test course 8 at center-line stake 21A. Terrain type 4,3,3,5-2,2/6,9-2

Photograph 16. Creosote bushes separated by small drainageways along test course 9 near center-line stake 10. Terrain type 7,1,1a,1-6,10-3/4

Photograph 17. Surface of an alluvial apron characterized by closely fitted gravels coated with a stain or crust of manganese or iron oxide--commonly referred to as "desert pavement"



Photograph 18. Silty gravel coated with caliche (a deposit of calcium carbonate) underlying the desert pavement of an alluvial apron

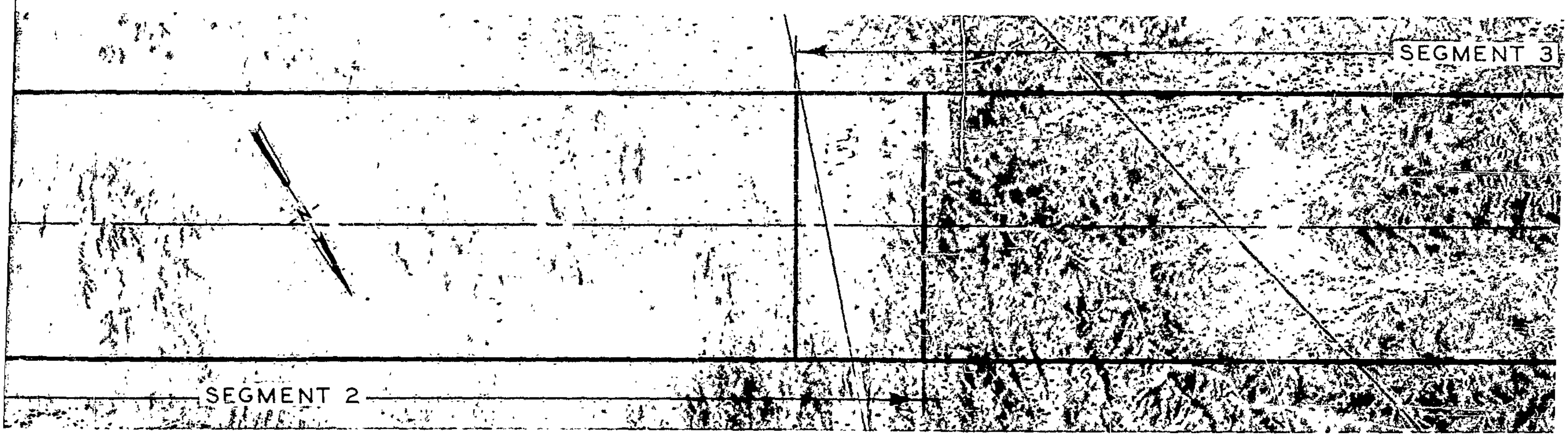


YUMA TEST STATION AND YUMA SAND HILLS

PLATE I

1

2



3

4

AERIAL MOSAIC

TEST COURSE NO. 1

SCALE IN FEET

1000 0 1000 2000

PLATE 2

TERRAIN

TEST CO

LANDSCAPE															GROU			
PLAN-PROFILE				SLOPE OCCURRENCE PER 10 MILES			CHARACTERISTIC SLOPE				CHARACTERISTIC RELIEF				SOIL TYPE			
HIGHS ARE	% AREA OCCUPIED BY HIGHS										TYPE I		TYPE II		SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	S
	>60	40-60	<40	<1	5-20	20-100	0°-1/2°	1/2°-2°	2°-6°	6°-14°	0-10	10-50	0-100	100-400				
FLAT-TOPPED	X			X				X				X					X	
PEAKED OR CRESTED																		
NO PRONOUNCED HIGHS OR LOWS		X		X				X			X						X	
		X		X				X			X						X	
		X		X				X			X						X	
		X		X					X		X				X			
		X		X					X		X						X	

* EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPIN(TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE TE THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR COMP

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO AREAL PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES TH

1

TERRAIN TYPES

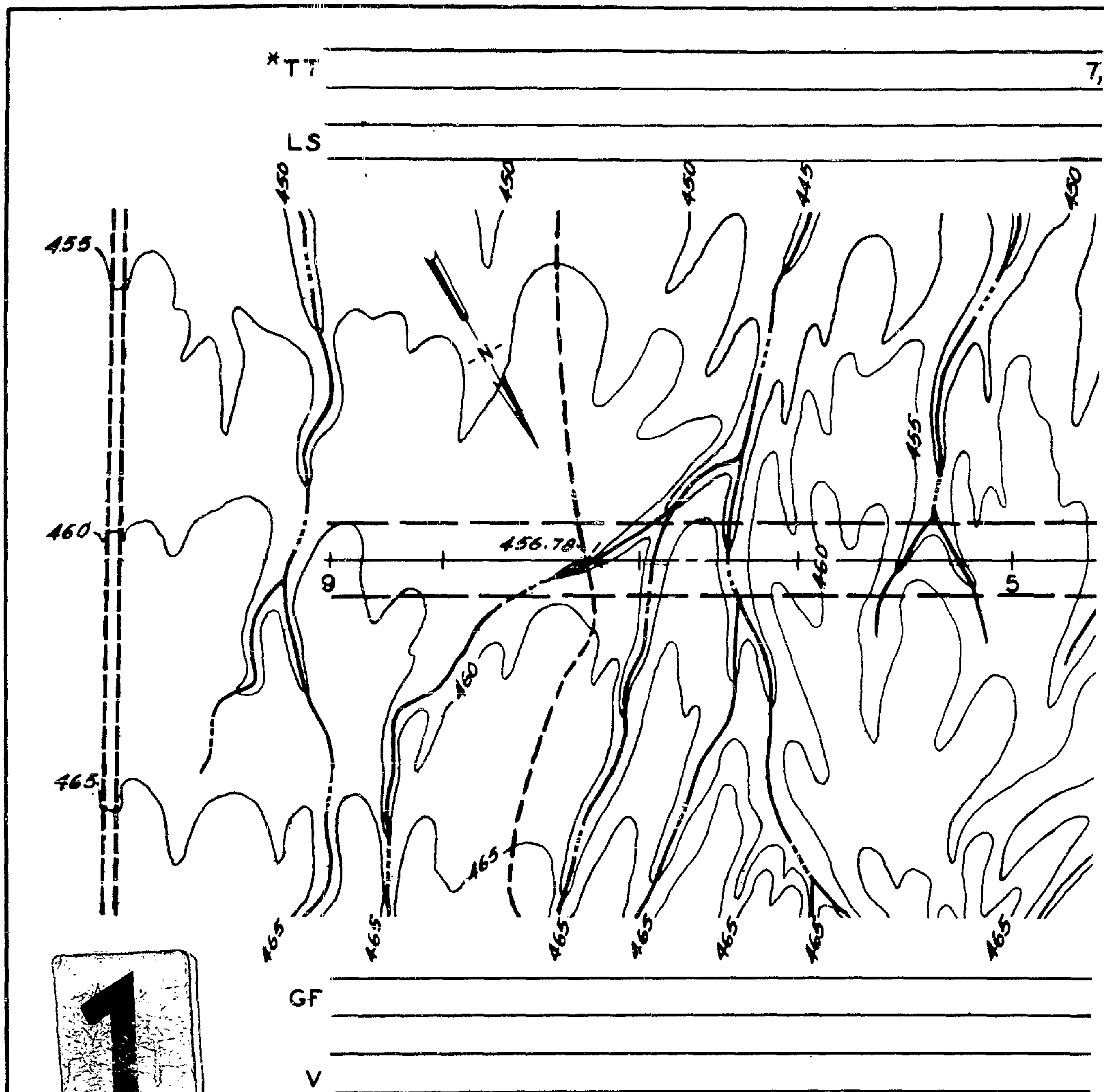
TEST COURSE 1

GROUND FACTORS							VEGETATION				TERRAIN TYPE*						
SOIL TYPE				SOIL CONSISTENCY			BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	LANDSCAPE				GROUND† FACTORS		VEGETATION†
SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT AND/OR CLAY WITH COARSE MATERIAL	LOOSE >12" BELOW SURFACE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE					PP	SO	CS	CR	ST	SC	
		X			X/	/X		X/		/X	1	1	1b	2	6	9/10	2/4
		X			X/	/X		X			7	1	1b	1	6	9/10	2
		X			X/	/X		X/		/X	7	1	1b	1	6	9/10	2/4
		X		/X		X/			X		7	1	1b	1	6	10/1	3
X				X					X		7	1	2	1	5	1	3
		X		/X		X/		/X	X/		7	1	2	1	6	10/1	3/2

IF SEVEN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL AT ORDER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY EEN INDICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

VEGETATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS. IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE ATOR IN THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2



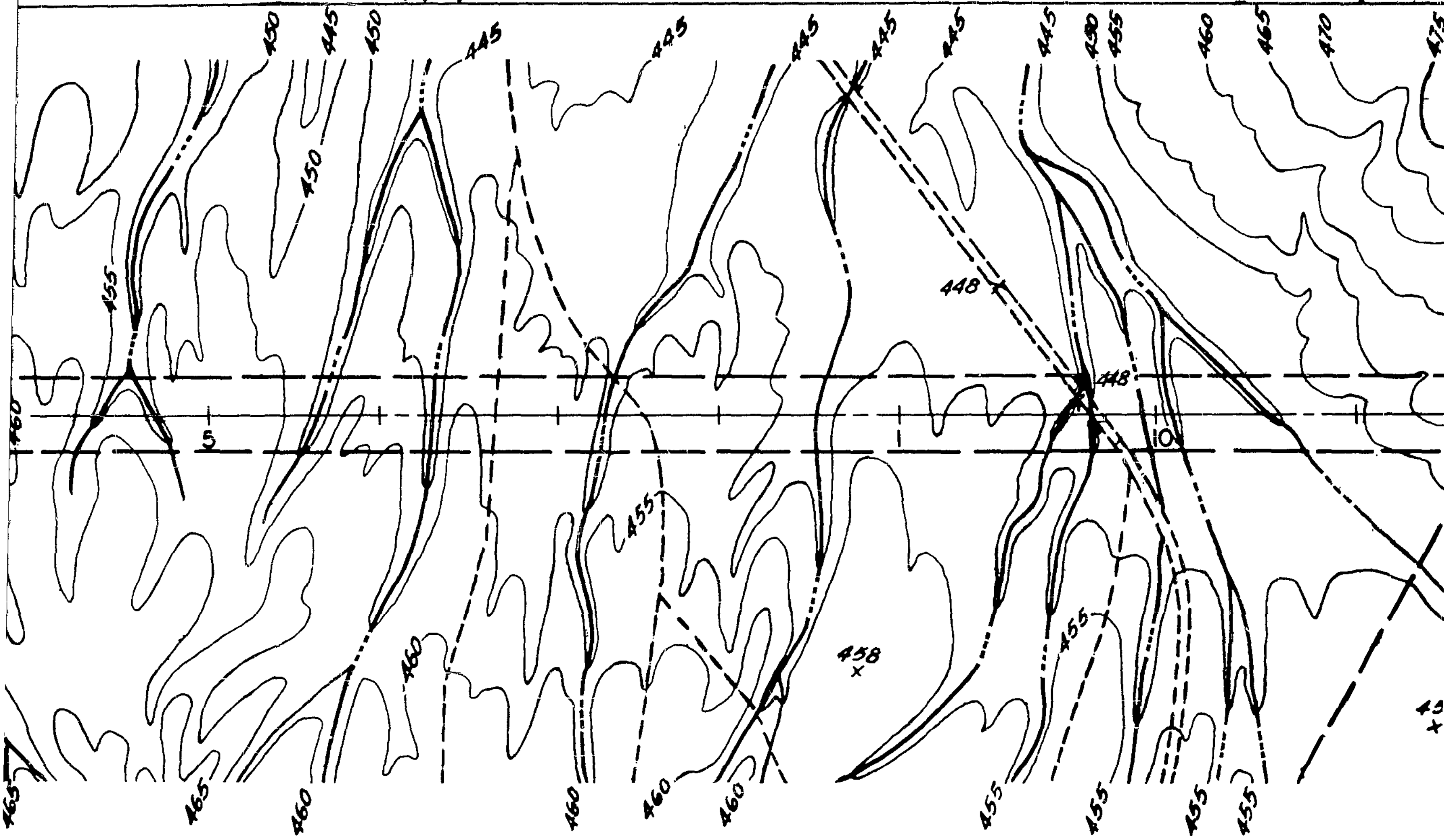
LEGEND

——— ———	LIMITS OF TEST COURSE	*TT	TERRAIN TYPE
———+——— 6	CENTER-LINE STAKE	LS	LANDSCAPE
		GF	GROUND FACTOR
———-·-·———	DRAINAGE	V	VEGETATION
═══ ═══	IMPROVED ROADS		
—— —— ——	UNIMPROVED ROADS OR TRAILS		

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

7,1,1b,1 - 6,9/6,10 - 2/4

7,1,1b,1



6,9/6,10

2/4

TYPE
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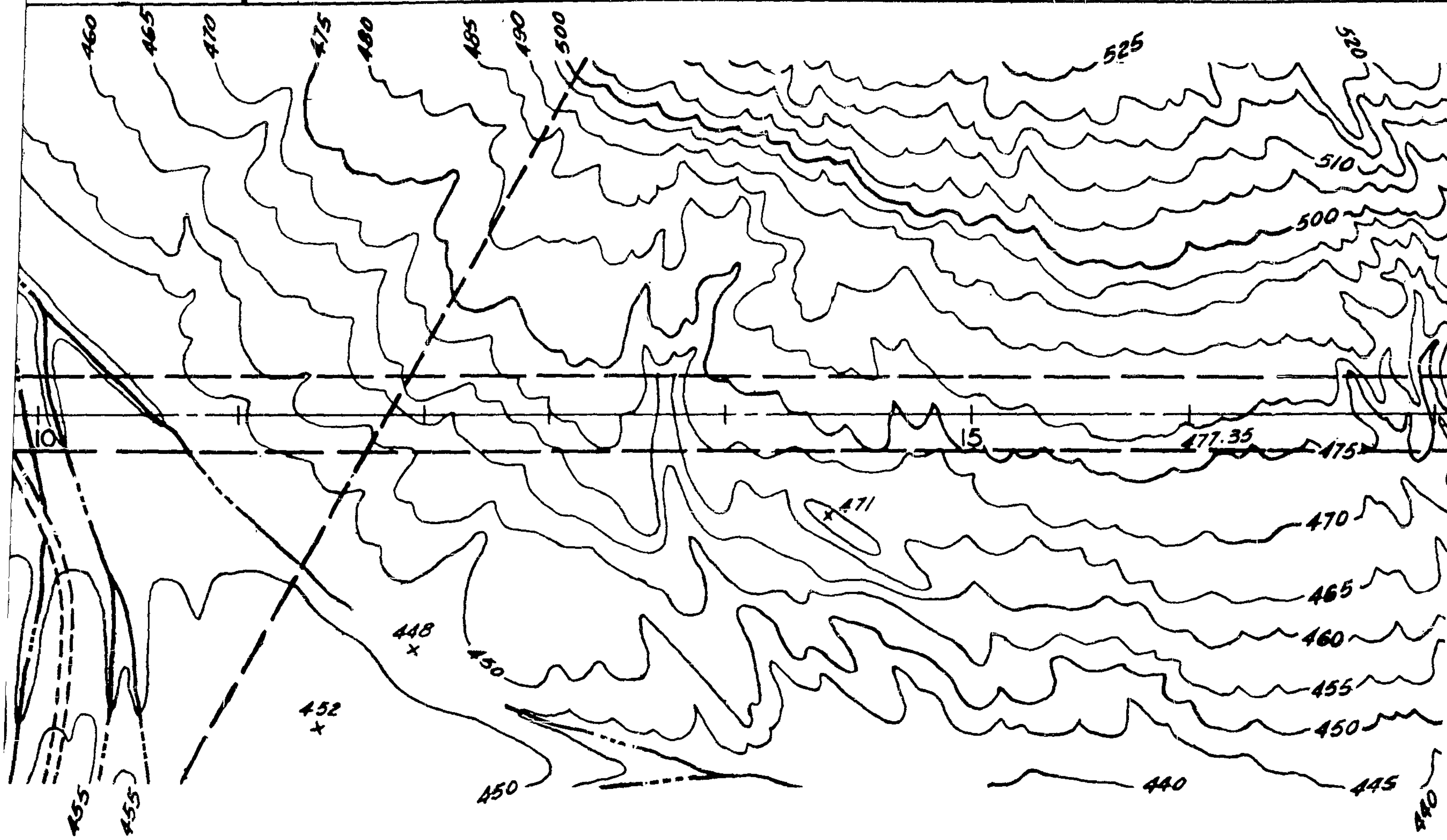
2

7,1,2,1 - 5,1 - 3

7,1,2,1



5,1

3

3

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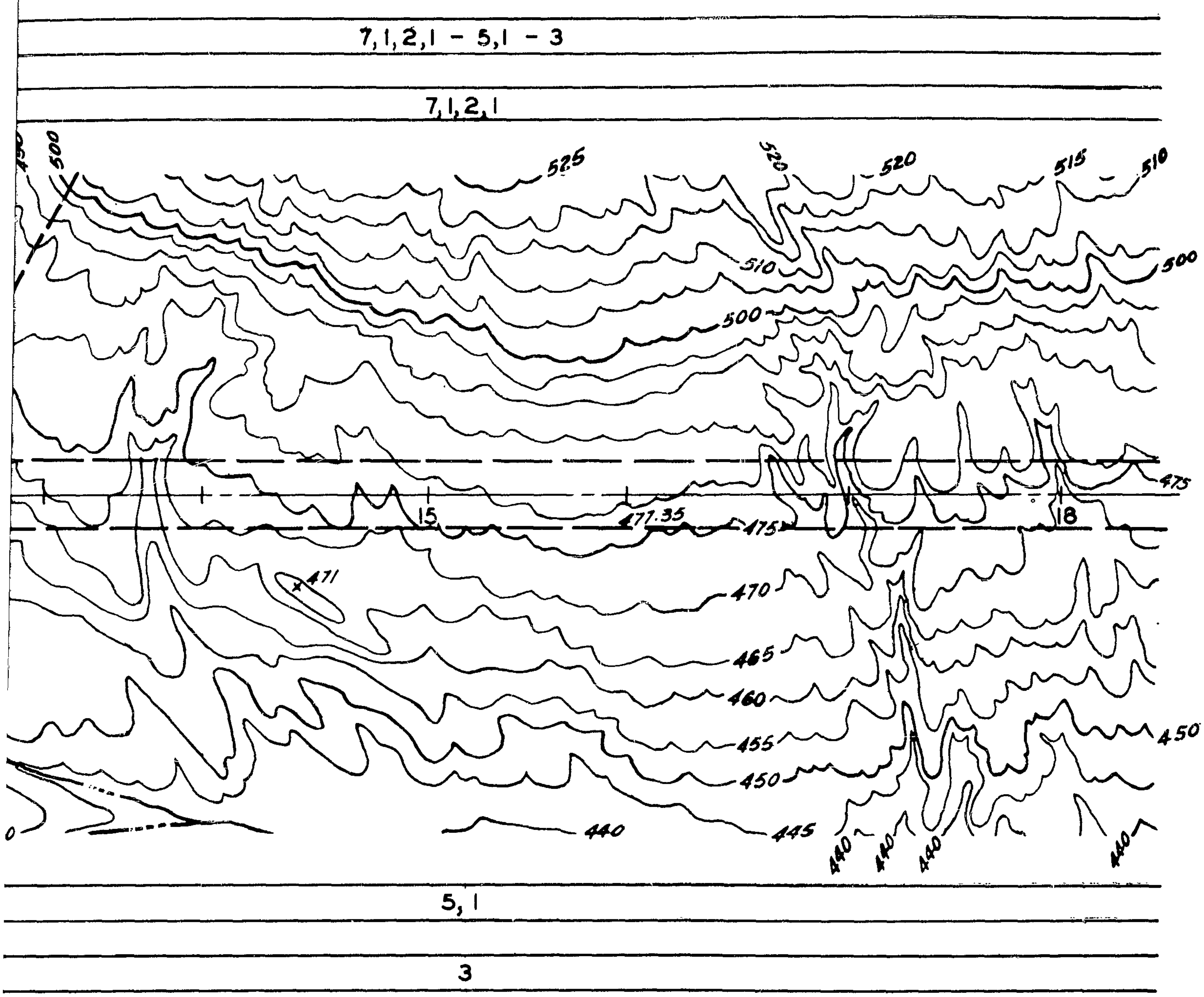
500 0

CONTOUR



TOPOGRAPHIC MAP
TEST COURSE NO. 1
SEGMENT 1

SCALE IN FEET

500 0 500 1000

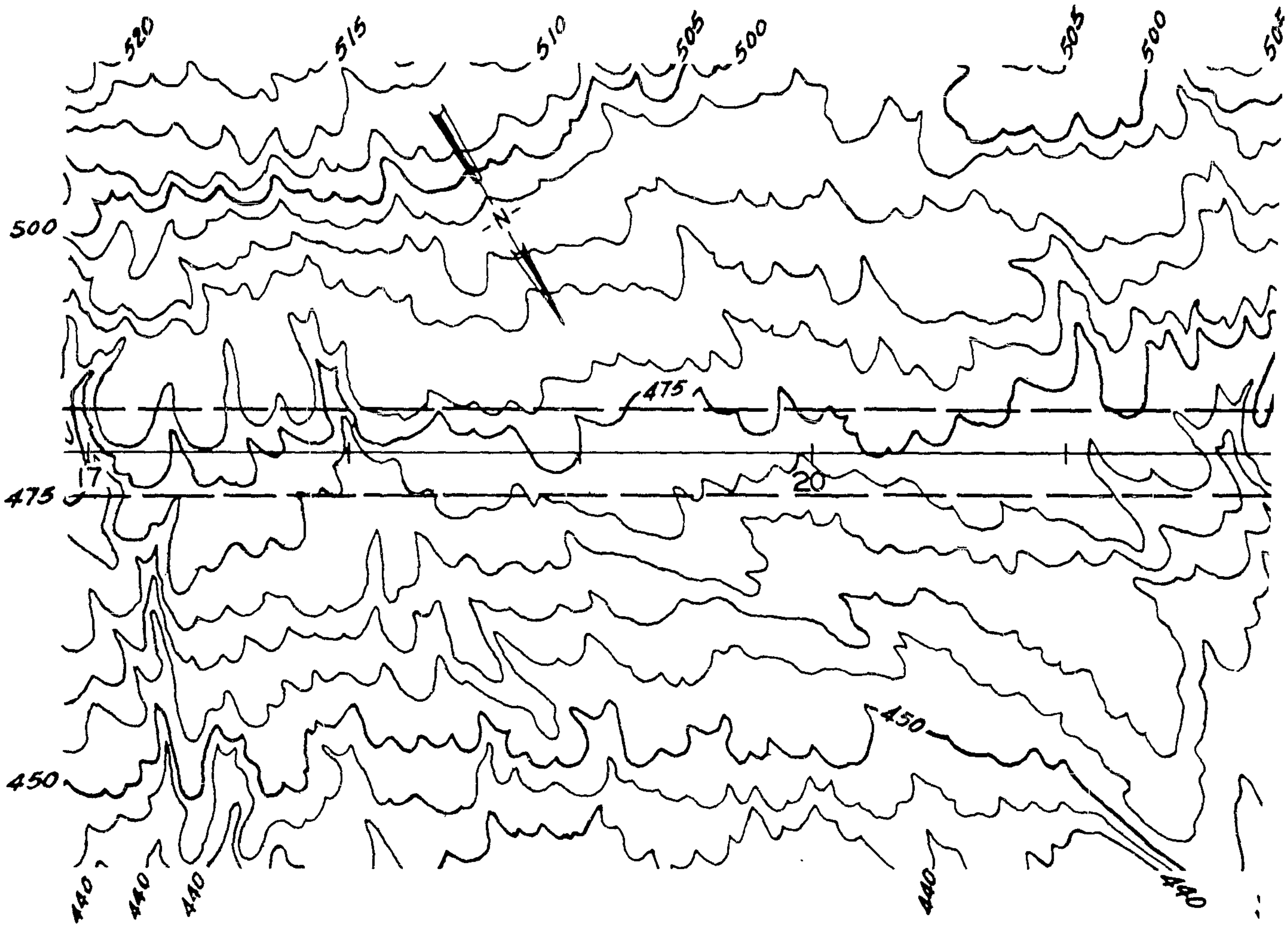
CONTOUR INTERVAL = 5 FT

4

PLATE 3

*TT 7,1,2,1 - 5,1 - 3

LS



GF 5,1

V 3

LEGEND

LIMITS OF TEST COURSE

CENTER-LINE STAKE 6

DRAINAGE

IMPROVED ROADS

UNIMPROVED ROADS OR TRAILS

*TT TERRAIN TYPE

LS LANDSCAPE

GF GROUND FACTOR

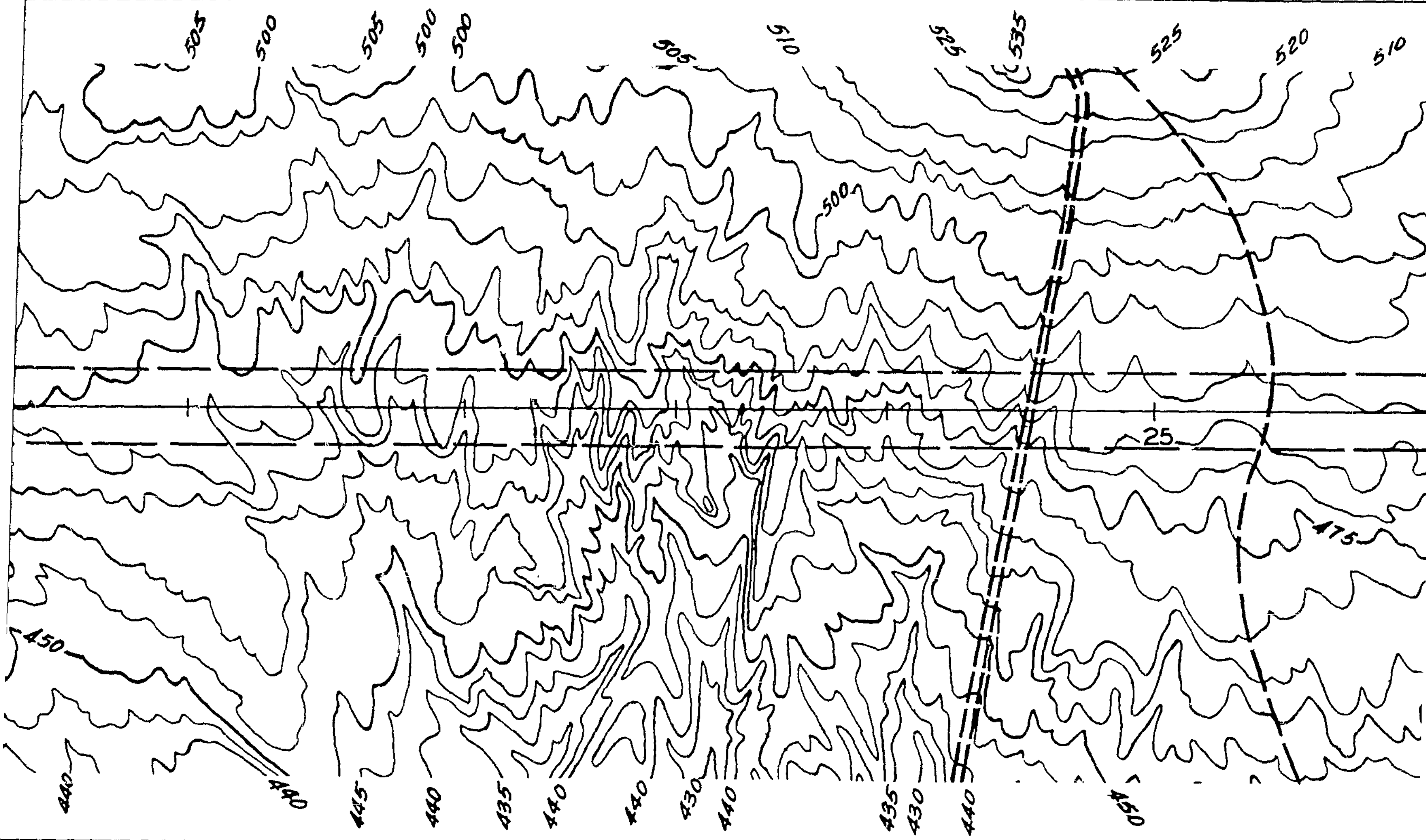
V VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

7,1,2,1 - 6,10/6,1 - 3/2

7,1,2,1



3/2

ꟷ TYPE
ꟷPE
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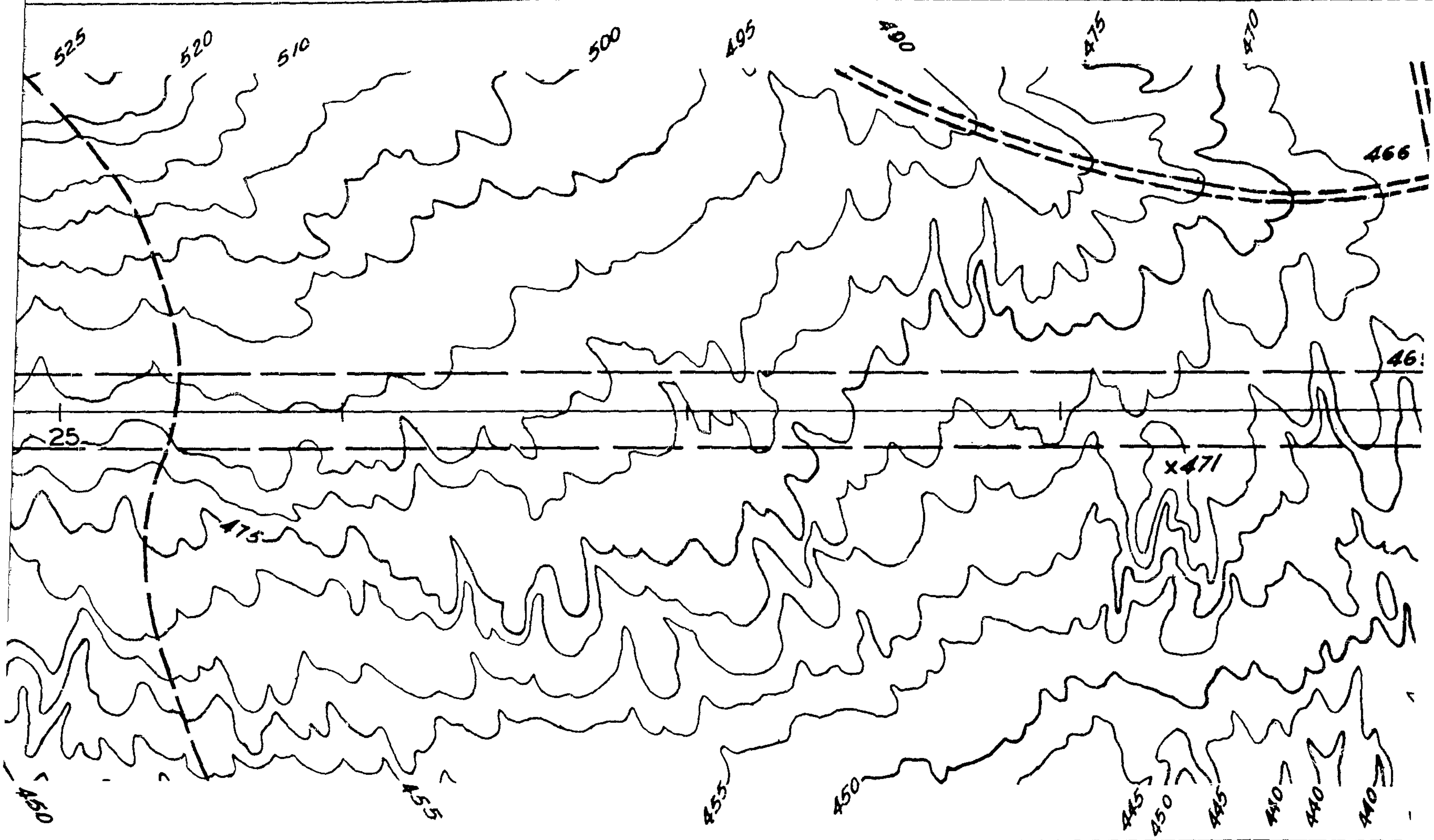
REVERSE

2

7,1,1b,1 - 6,10/6,1 - 3

7,1,1b,1



6,10/6,1

3

TOPOG

TEST

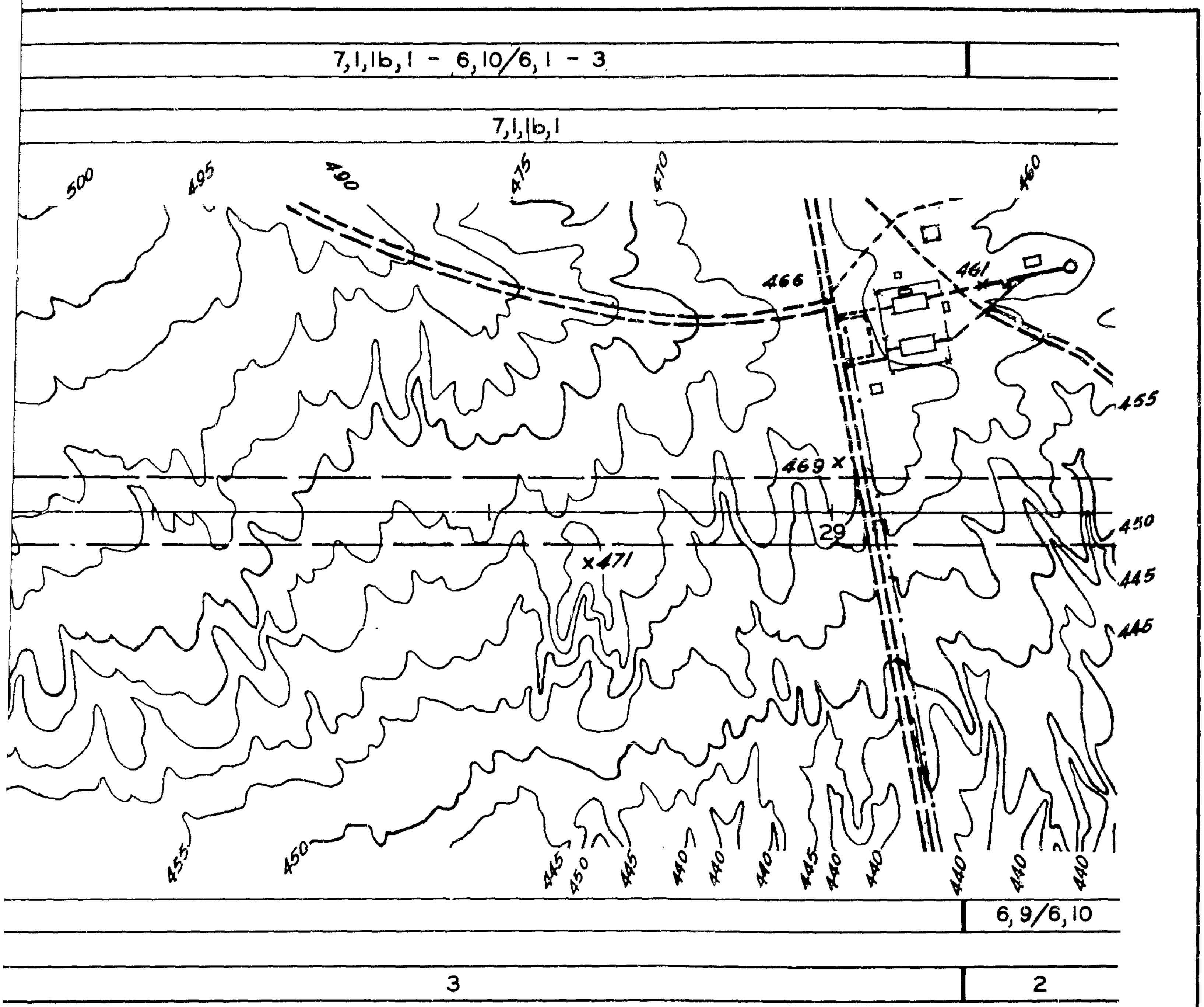
S

SCA

500 0

CONTOUR

3



TOPOGRAPHIC MAP

TEST COURSE NO. 1
SEGMENT 2

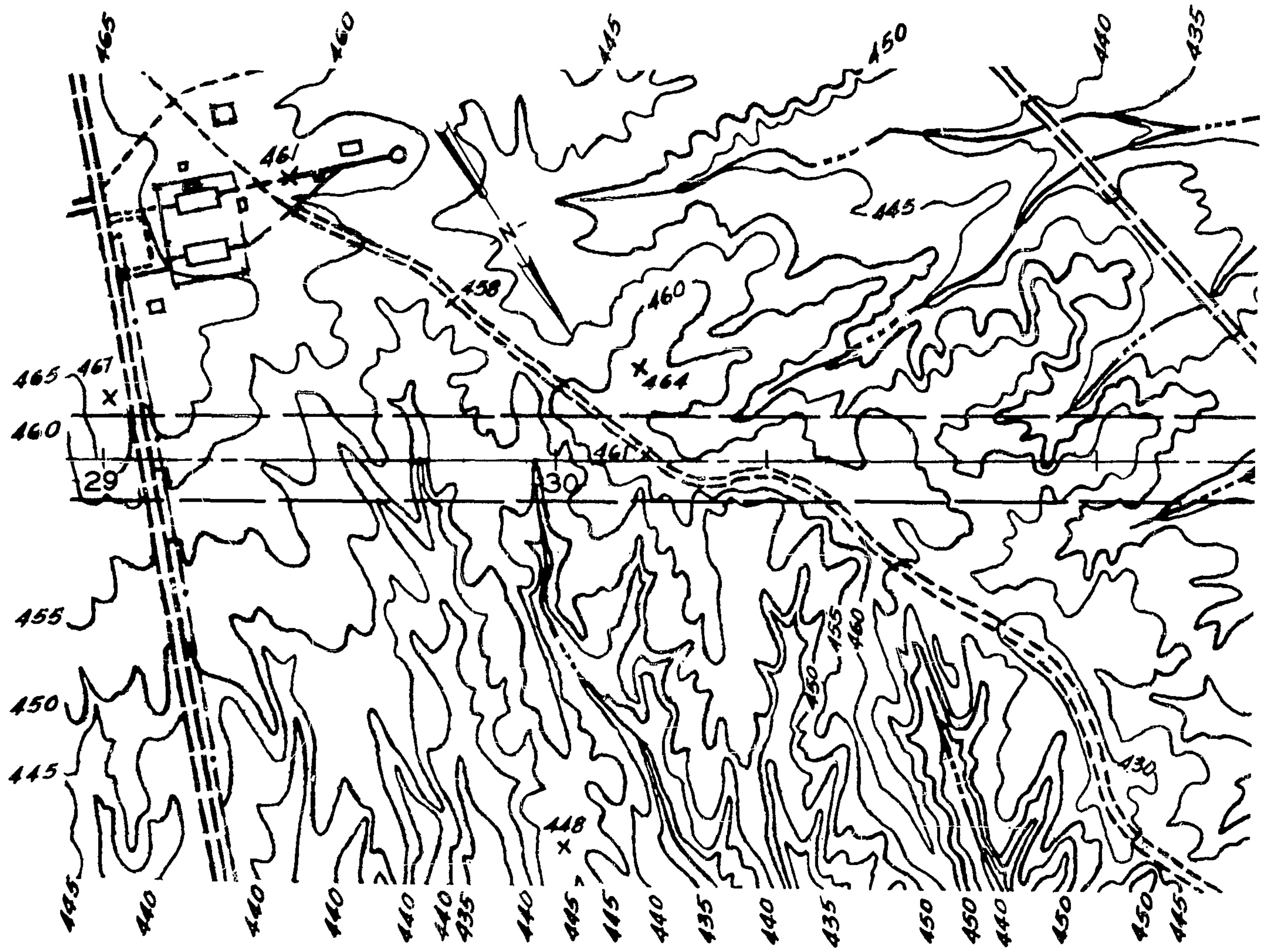
SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT	7,1,1b,1 - 6,9/6,10 - 2
LS	7,1,1b,1



GF 6,10/6,1	
V 3/2	2

LEGEND

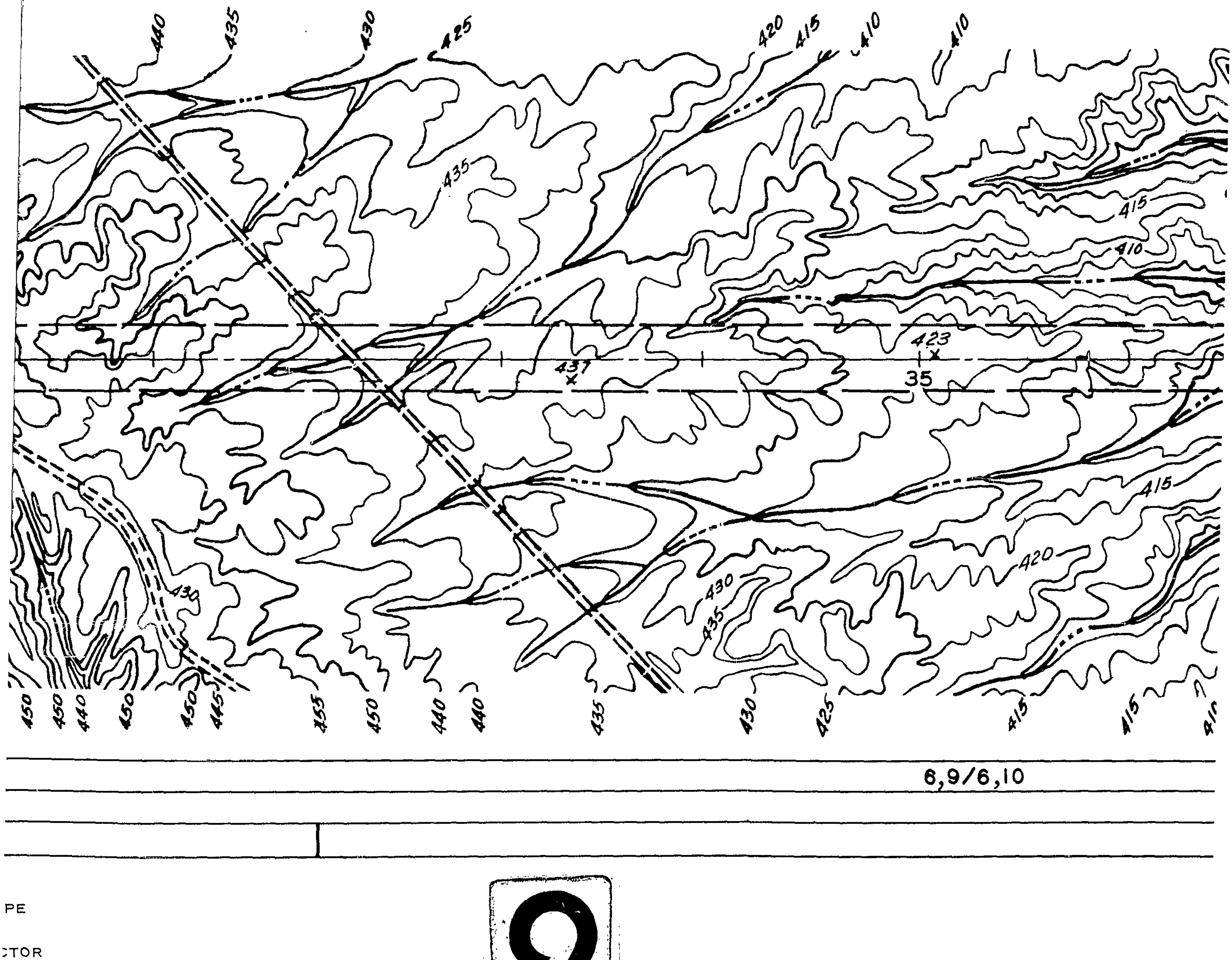
LIMITS OF TEST COURSE	*TT TERRAIN TYPE
CENTER-LINE STAKE 6	LS LANDSCAPE
DRAINAGE	GF GROUND FACTOR
IMPROVED ROADS	V VEGETATION
UNIMPROVED ROADS OR TRAILS	

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

1,1,1b,2 - 6,9

1,1,1b



6,9/6,10

PE

CTOR
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2

1,1,1b,2-6,9/6,10-2/4

1,1,1b,2

6,9/6,10

2/4

TOPOG

TEST

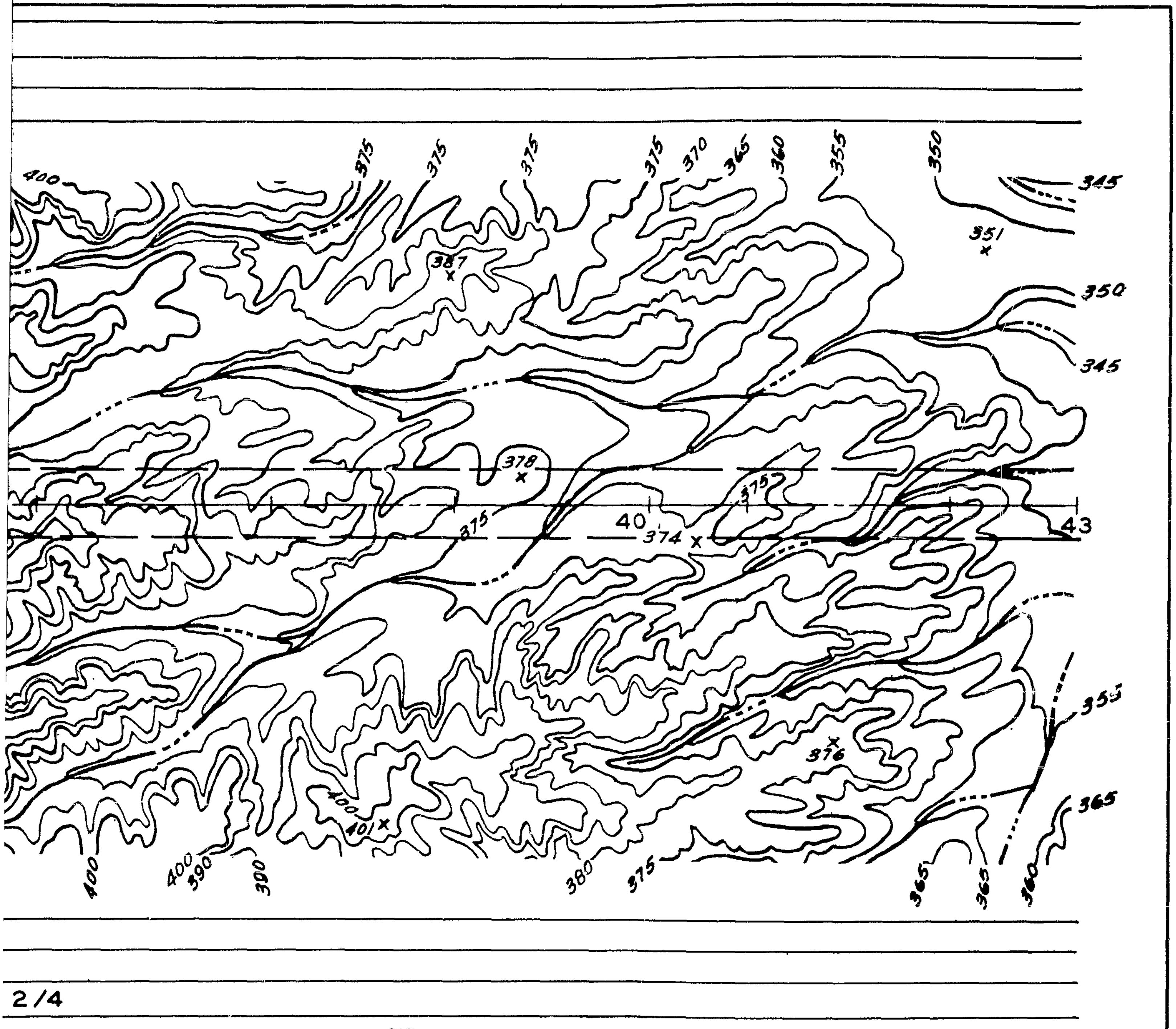
SI

SCAL

500 0

CONTOUR

3



4

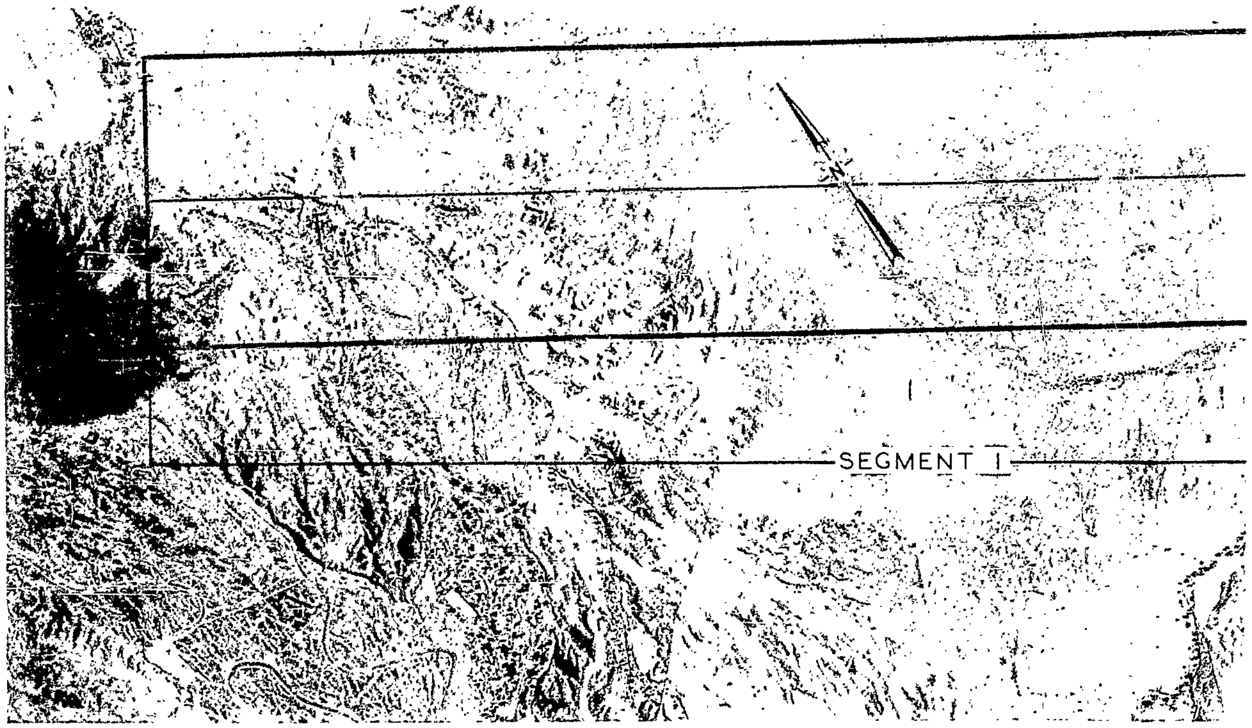
TOPOGRAPHIC MAP

TEST COURSE NO. I
SEGMENT 3

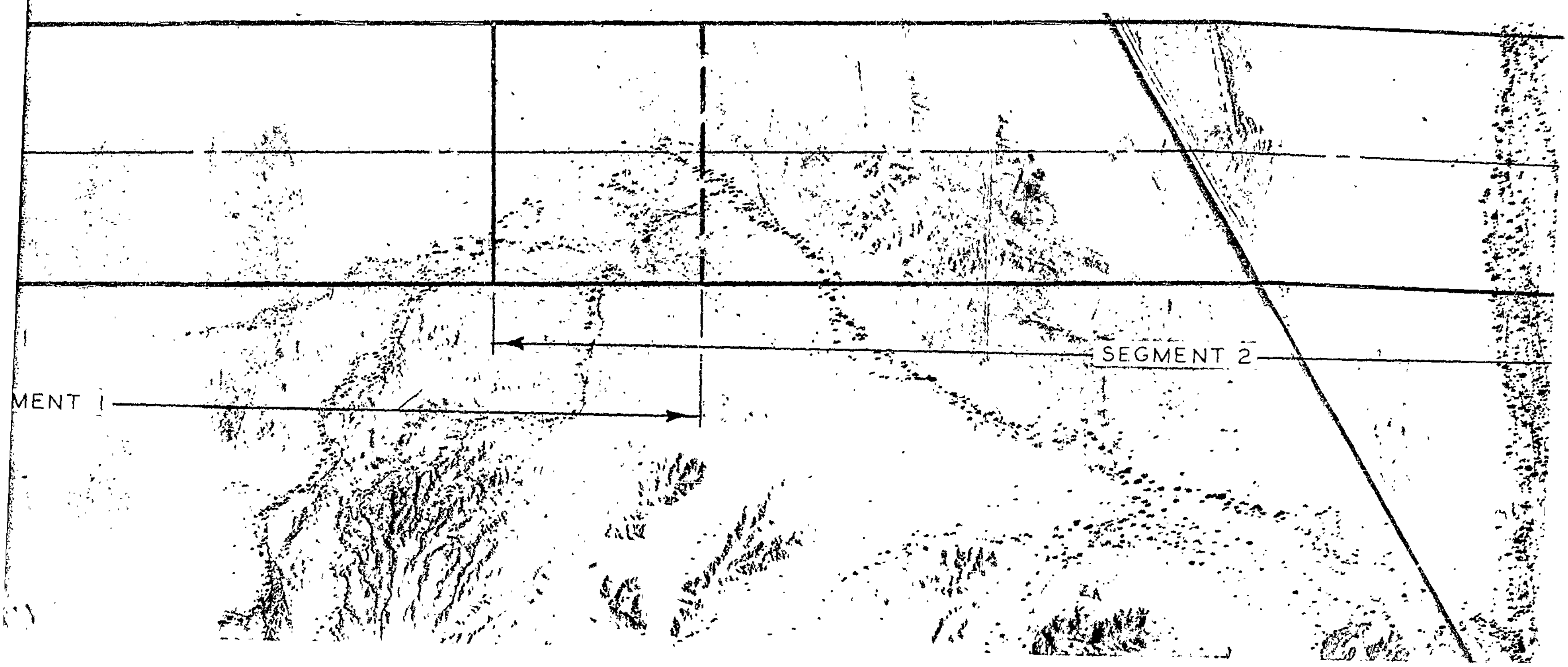
SCALE IN FEET

500 0 500 1000

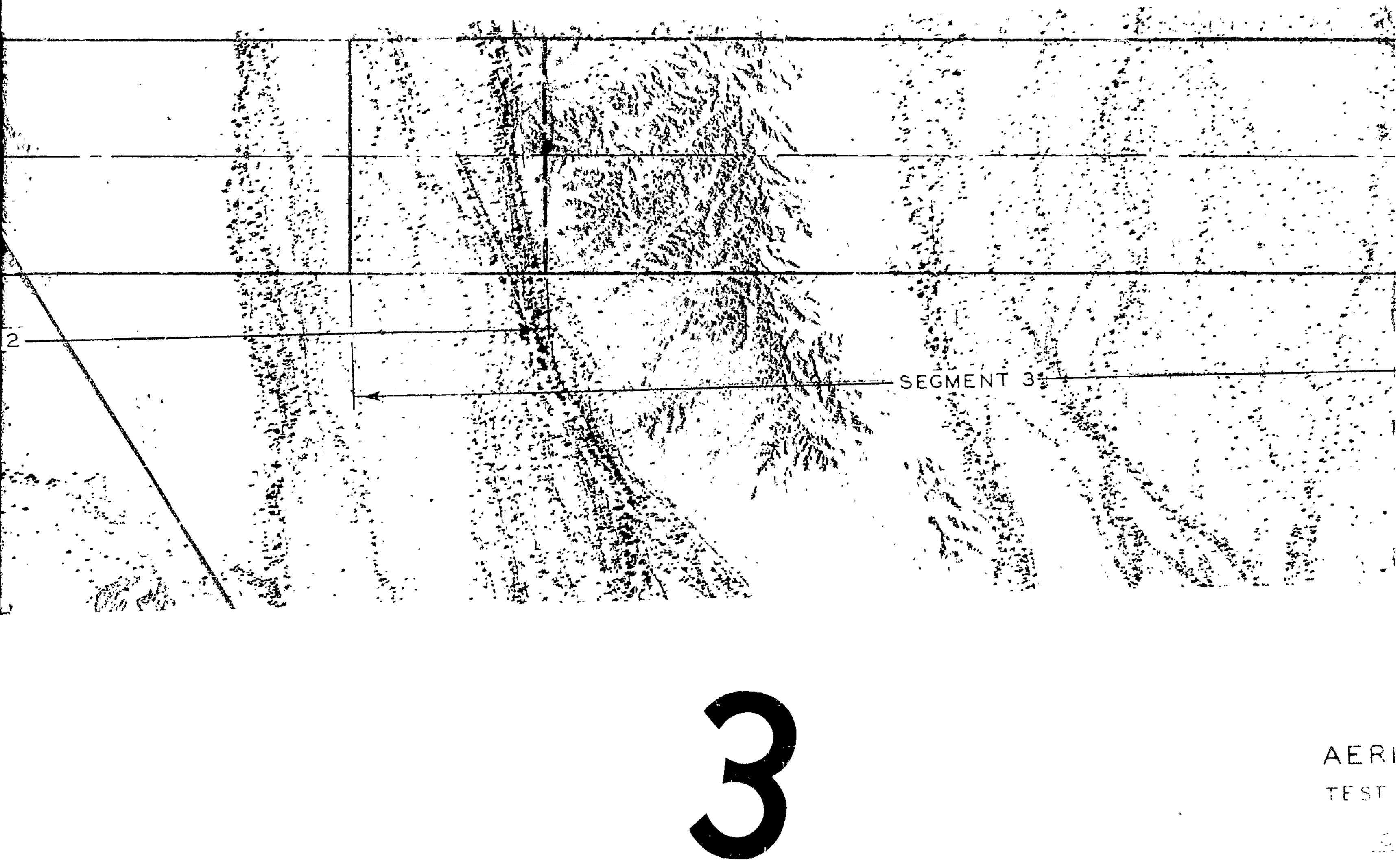
CONTOUR INTERVAL = 5 FT



1



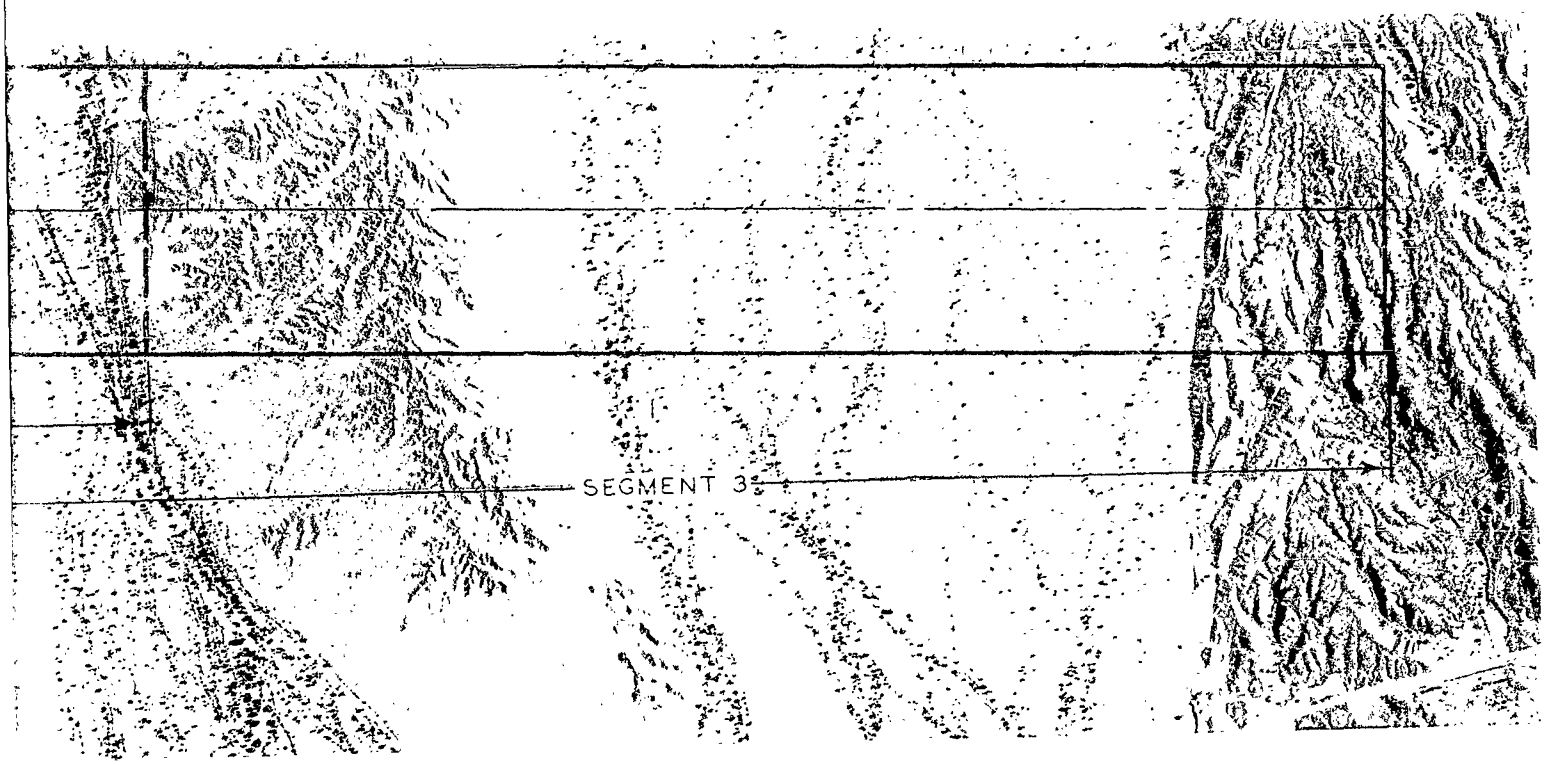
2



3

AERI

TEST



4

AERIAL MOSAIC

TEST COURSE NO 2

SCALE IN FEET

PLATE 6

TERR

TEST

LANDSCAPE																		
PLAN-PROFILE				SLOPE OCCURRENCE PER 10 MILES			CHARACTERISTIC SLOPE				CHARACTERISTIC RELIEF				SOIL TYPE			
HIGHS ARE	% AREA OCCUPIED BY HIGHS										TYPE I		TYPE II		SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	
	>60	40-60	<40	<1	5-20	20-100	0°-1/2°	1/2°-2°	2°-6°	6°-14°	0-10	10-50	0-100	100-400				
FLAT-TOPPED	X					X		X				X					X	
			X		X			X				X			X/		/X	
PEAKED OR CRESTED			X	X				X				X					X	
NO PRONOUNCED HIGHS OR LOWS		X		X			X				X				X/		/X	
		X		X			X				X						X/	
		X		X				X			X						X	
		X		X				X			X				X/		/X	
		X		X				X			X						X/	
		X		X					X		X				X			

* EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPINC
TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE TE
THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR COMP

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO AREAL
PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES TH

TERRAIN TYPES

TEST COURSE 2

GROUND FACTORS								VEGETATION				TERRAIN TYPE*						
SOIL TYPE				SOIL CONSISTENCY				BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	LANDSCAPE				GROUND† FACTORS		VEGETATION†
SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT AND/OR CLAY WITH COARSE MATERIAL	LOOSE >12" BELOW SURFACE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE	HARD LAYER WITHIN 12" OF SURFACE					PP	SO	CS	CR	ST	SC	
		X			X/	/X		X/		/X		1	4	1b	2	6	9/10	1/3
X/		/X		X/		/X		/X		X/		3	3	1b	2	5/6	1/10	3/1
		X				X		X/		/X		6	1	1b	2	6	10	1/3
X/		/X		X/		/X		/X		X/		7	1	1a	1	5/6	1/10	3/1
		X/	/X			X/	/X		X/		/X	7	1	1a	1	6/7	10/11	2/4
		X				X			X/		/X	7	1	1b	1	6	10	2/4
X/		/X		/X		/X		/X		X/		7	1	1b	1	5/6	1/10	3/1
		X/	/X			X/	/X					7	1	1b	1	6/7	10/11	2/4
X				X						X		7	1	2	1	5	1	3

)F SEVEN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL
AT ORDER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY
EEN INDICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

) VEGETATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS. IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE
IATOR IN THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2

VEGETATION			TERRAIN TYPE*						
			LANDSCAPE				GROUND† FACTORS		VEGETATION†
SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	PP	SO	CS	CR	ST	SC	
	/X		1	4	1b	2	6	9/10	1/3
	X/		3	3	1b	2	5/6	1/10	3/1
	/X		6	1	1b	2	6	10	1/3
	X/		7	1	1a	1	5/6	1/10	3/1
X/		/X	7	1	1a	1	6/7	10/11	2/4
X/		/X	7	1	1b	1	6	10	2/4
	X/		7	1	1b	1	5/6	1/10	3/1
			7	1	1b	1	6/7	10/11	2/4
	X		7	1	2	1	5	1	3

E (CS), CHARACTERISTIC RELIEF (CR), SOIL
SPONDING TO THE TERRAIN FACTOR. ONLY

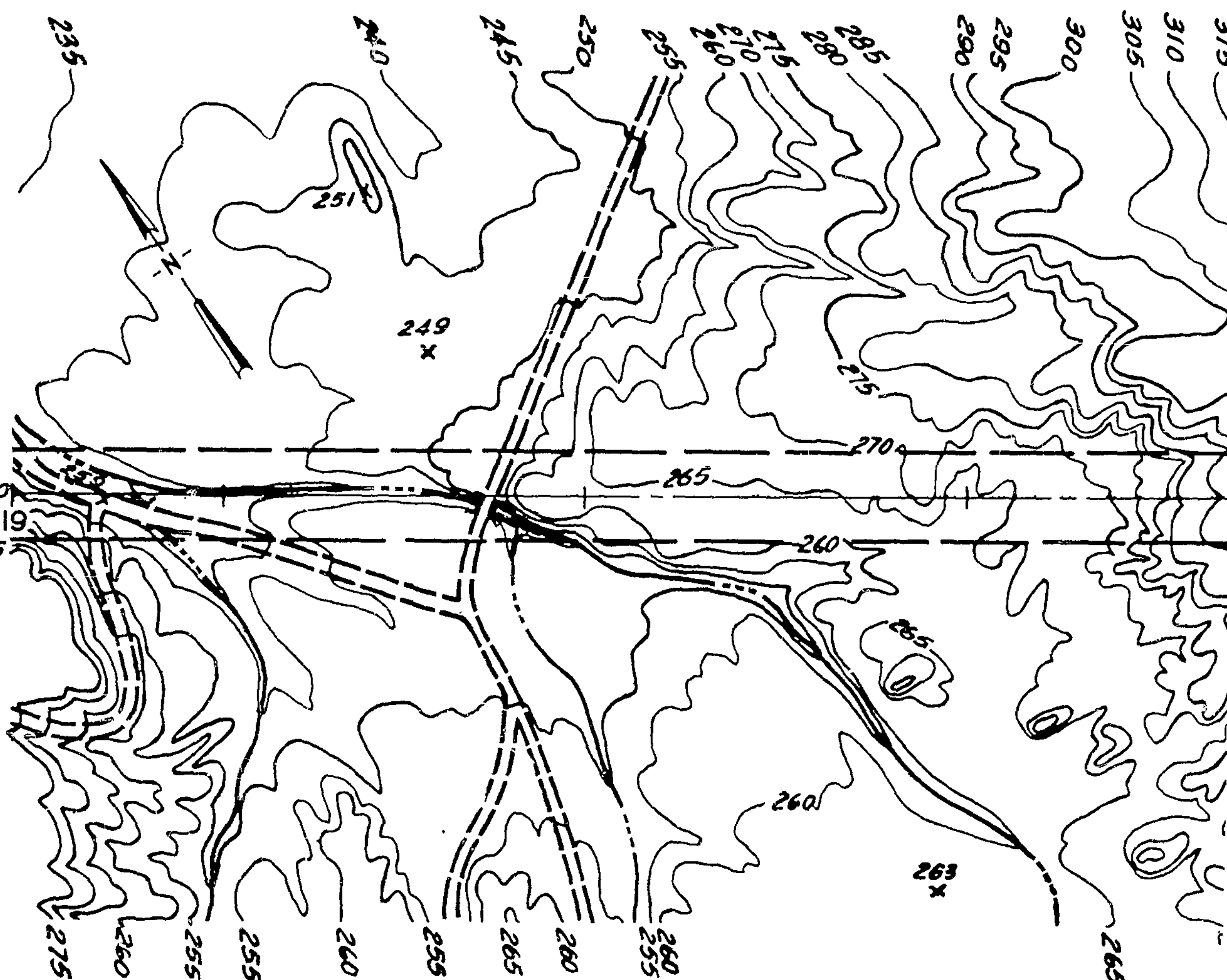
OCCURRING TYPES ARE MAPPED; THE

3

1

*TT 7,1,Ib,1 - 6,10 - 2/4

LS



GF 6,10

V 2/4

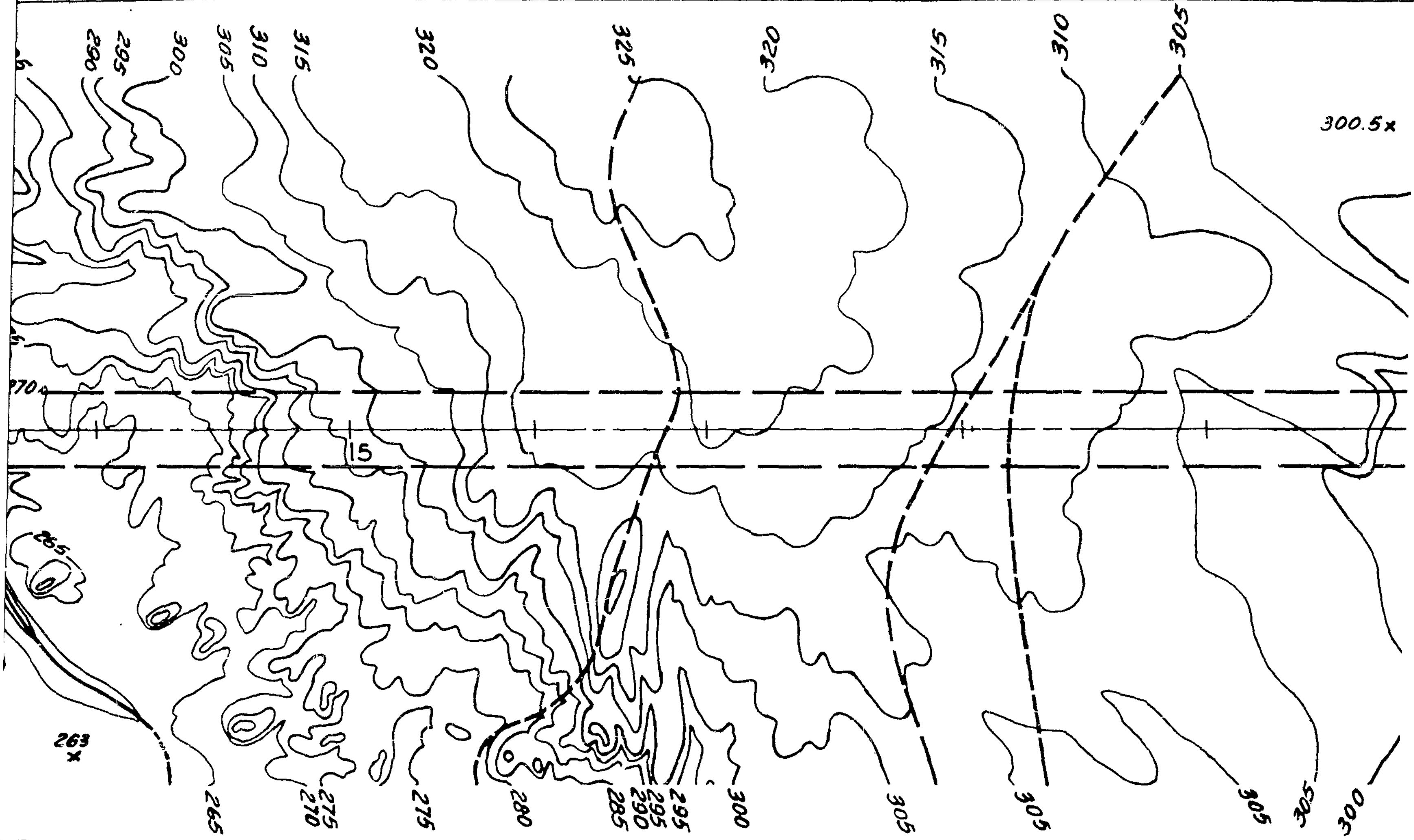
LEGEND

	LIMITS OF TEST COURSE	*TT	TERRAIN TYPE
6	CENTER-LINE STAKE	LS	LANDSCAPE
	DRAINAGE	GF	GROUND FACTOR
	IMPROVED ROADS	V	VEGETATION
	UNIMPROVED ROADS OR TRAILS		

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

7,1,Ib,1 - 5,1/6,10 - 3/1

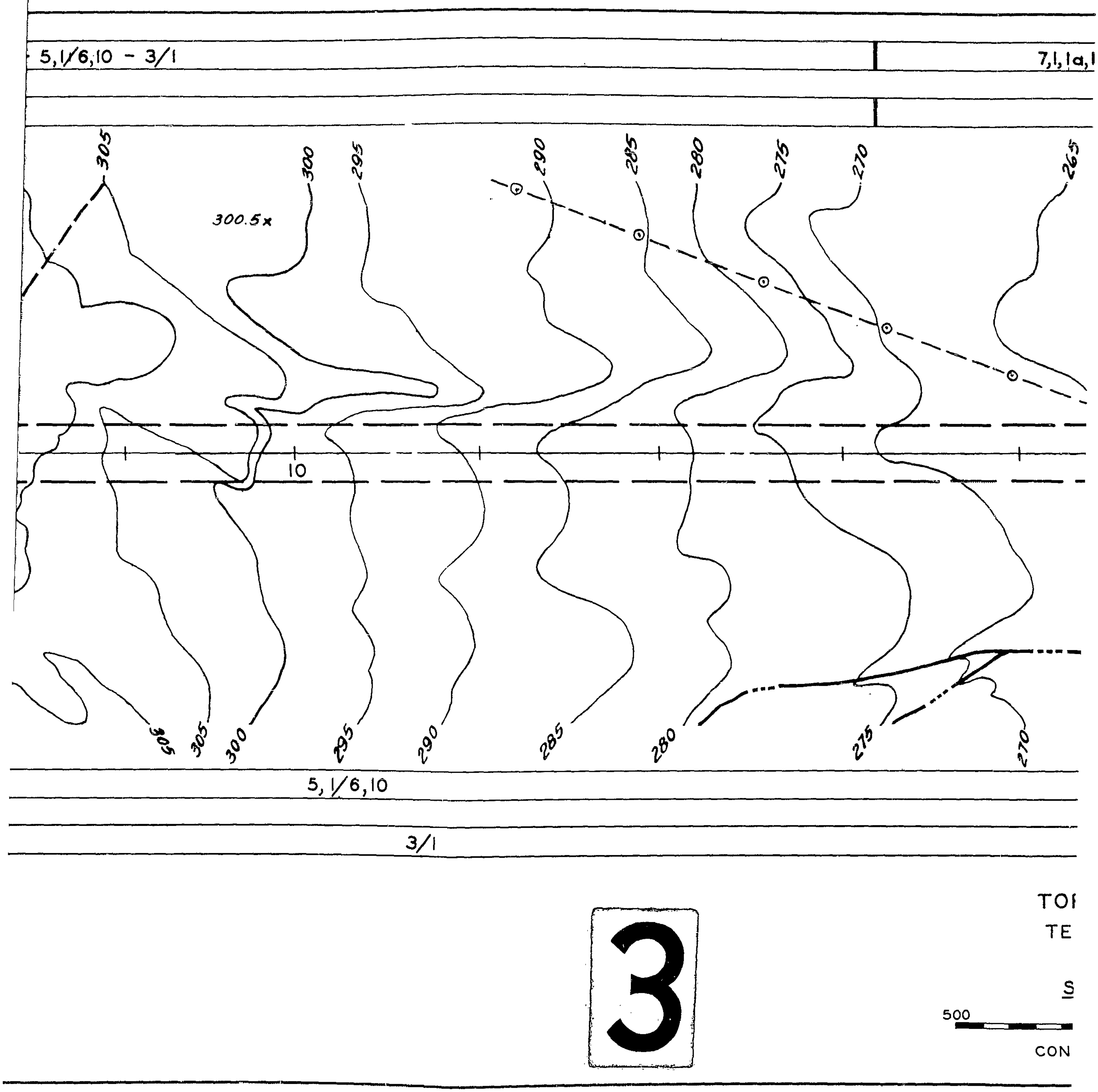
7,1,Ib,1



:AIN TYPE
›SCAPE
IND FACTOR
ETATION

ON REVERSE

2


5,1/6,10 - 3/1
7,1,1a,1
305
300.5x
300
295
290
285
280
275
270
265
10
305
305
300
295
290
285
280
275
270
5,1/6,10
3/1
3
TO
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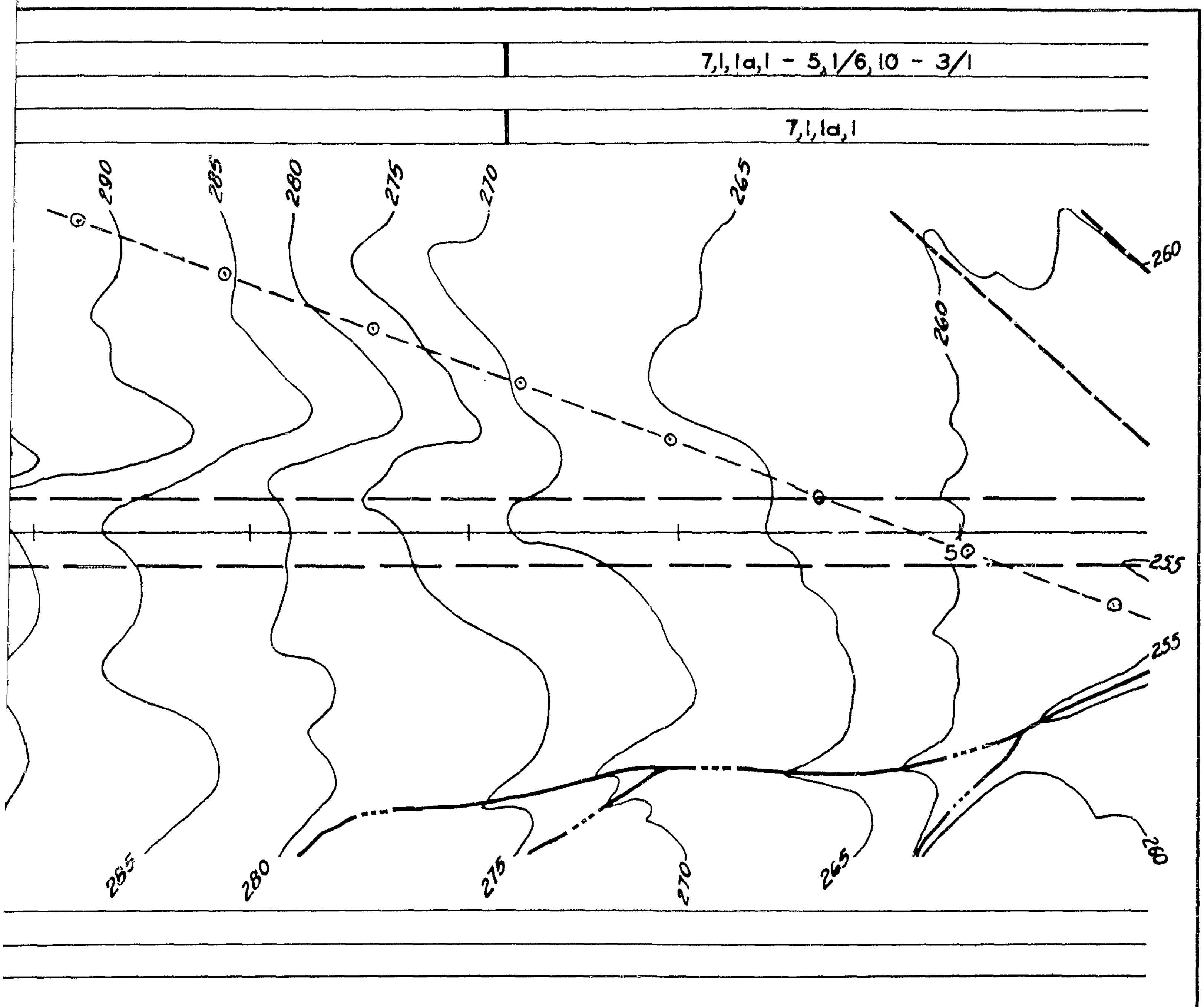
CON



TOPOGRAPHIC MAP
TEST COURSE NO. 2
SEGMENT I

SCALE IN FEET

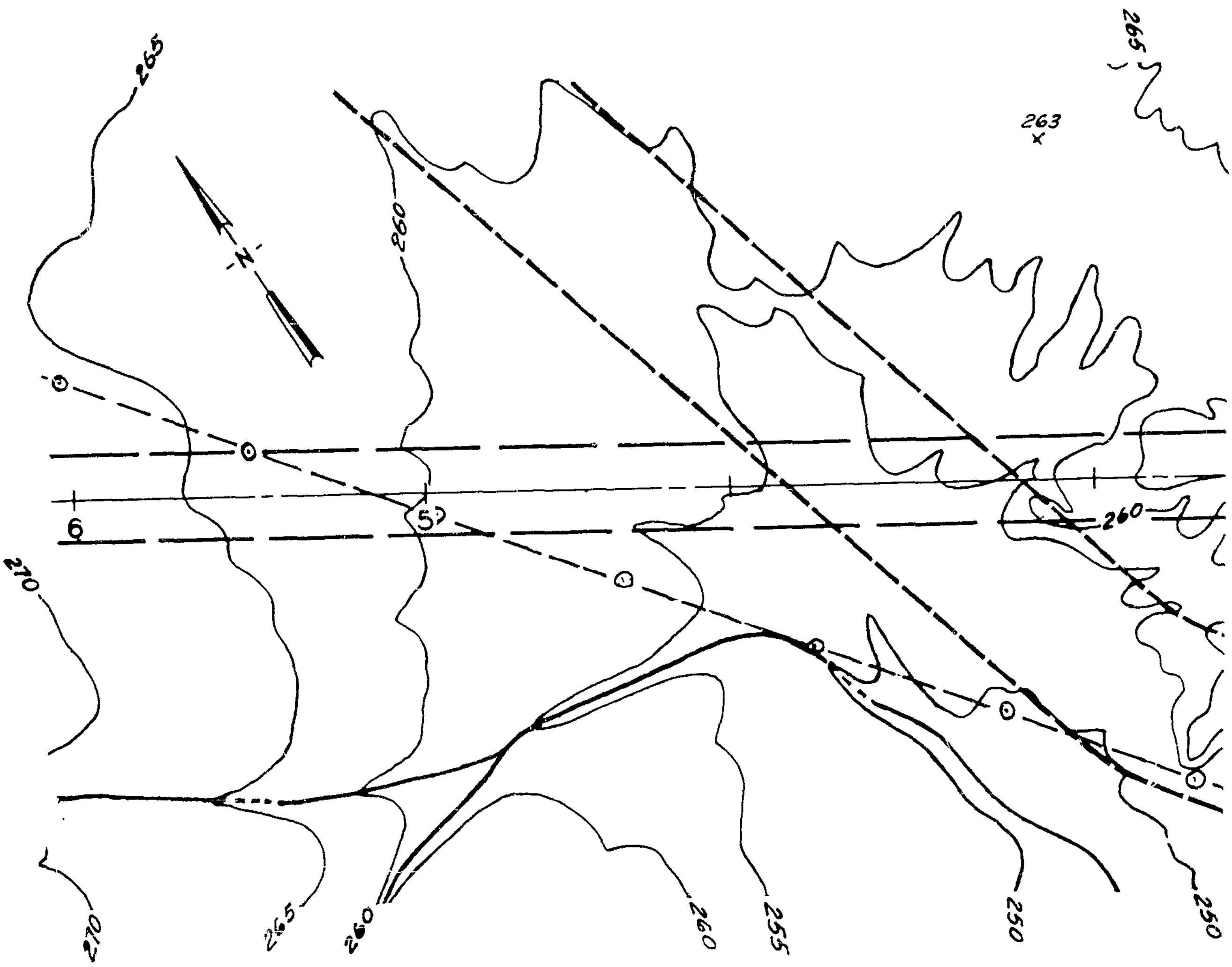
500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

PLATE 7

*TT	7,1,1a,1 - 5,1/6,10 - 3/1	
LS	7,1,1a,1	



GF	5,1/6,10
V	3/1

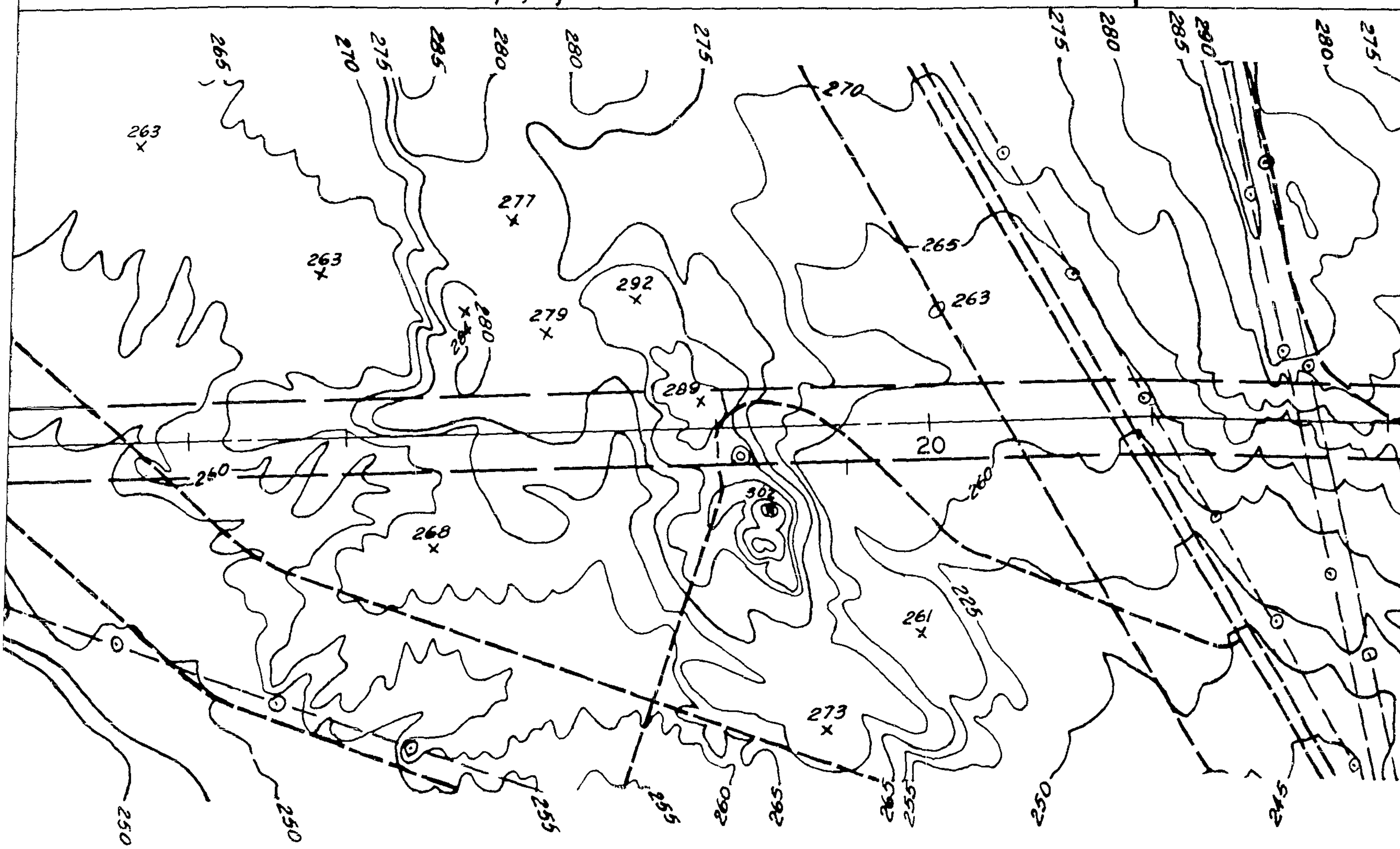
LEGEND

— —	LIMITS OF TEST COURSE	*TT	TERRAIN TYPE
6	CENTER-LINE STAKE	LS	LANDSCAPE
— - - —	DRAINAGE	GF	GROUND FACTOR
= = =	IMPROVED ROADS	V	VEGETATION
— — —	UNIMPROVED ROADS OR TRAILS		

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

3, 3, Ib, 2 - 3, 1/6, 10 - 3/1 | 7,

3, 3, Ib, 2



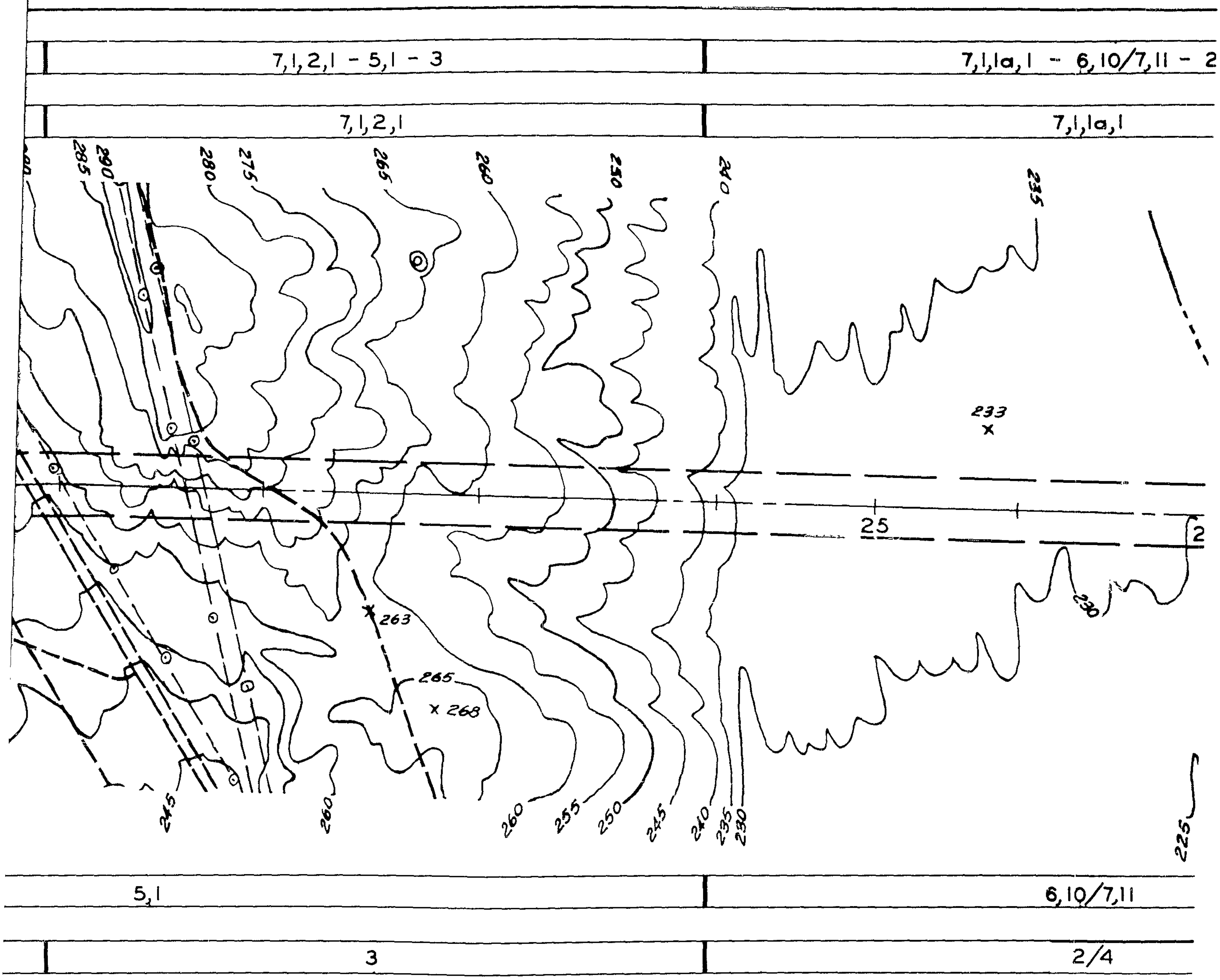
) | 5, 1

3/1

AIN TYPE
SCAPE
ND FACTOR
TATION

N REVERSE

2



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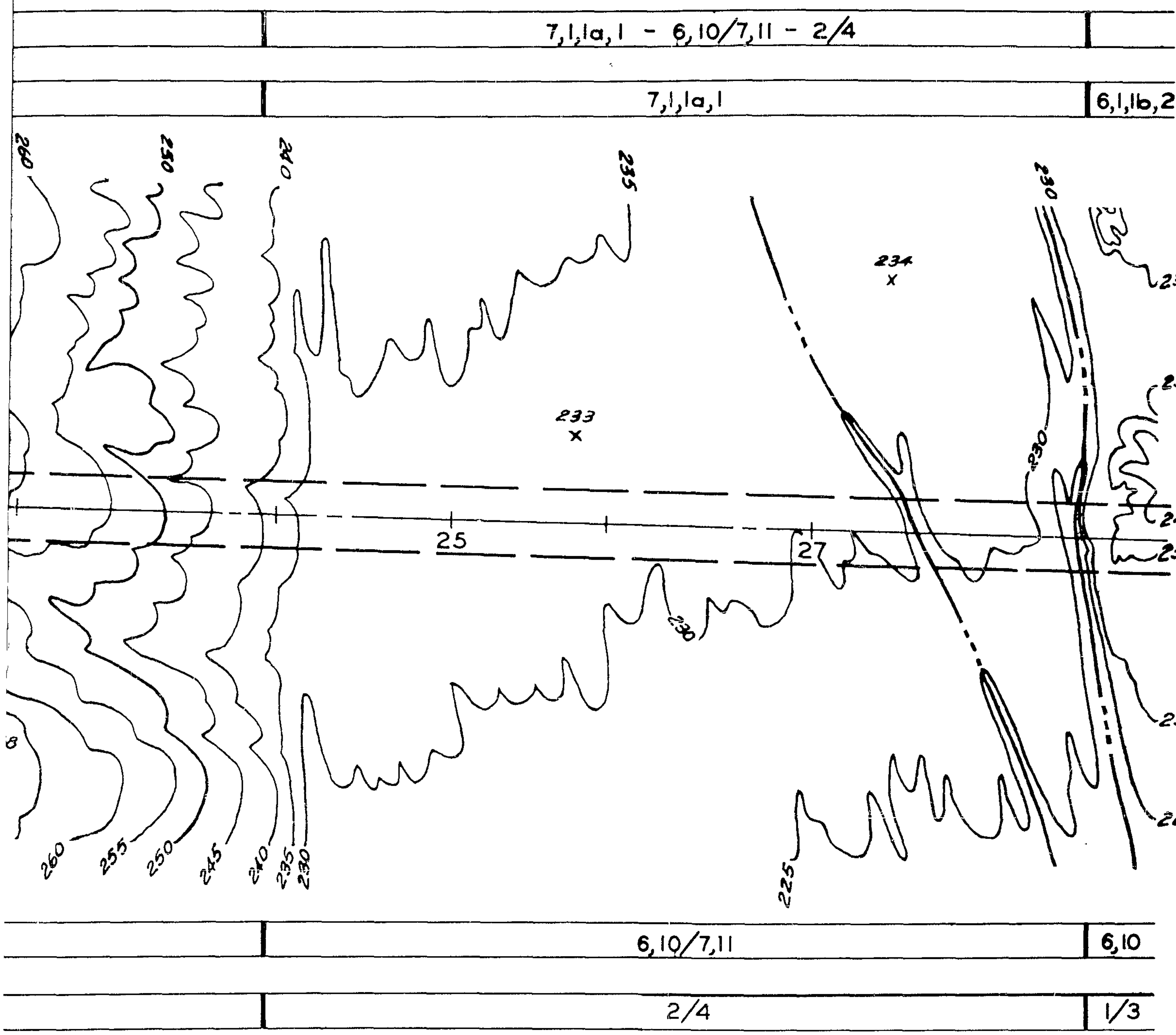
TEST

S

SCA

500 0

CONTOU



4

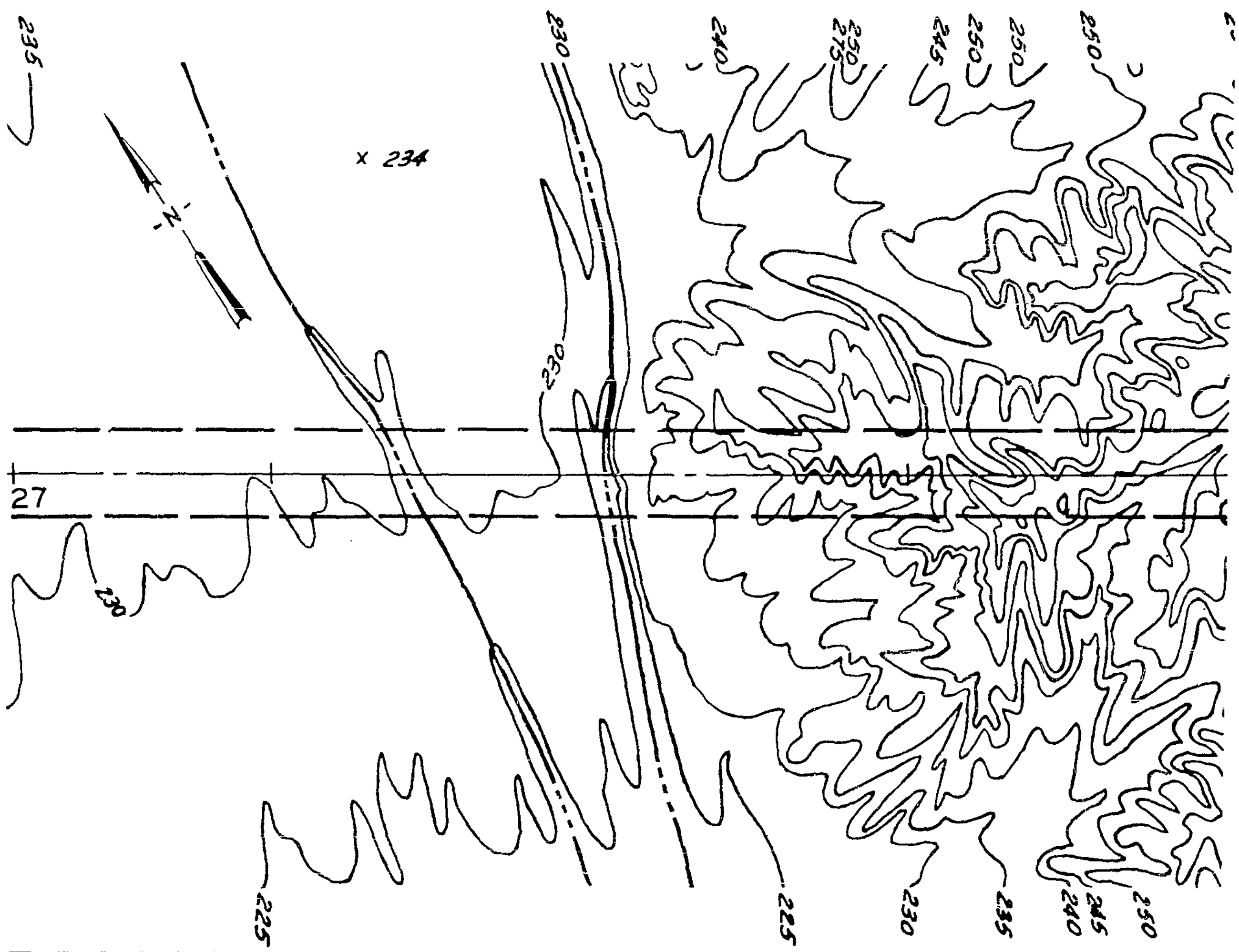
TOPOGRAPHIC MAP
TEST COURSE NO. 2
SEGMENT 2

SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

*TT	7,1,1a,1 - 6,10/7,11 - 2/4	6,1,1b
LS	7,1,1a,1	



GF	6,10/7,11	
V	2/4	

LEGEND

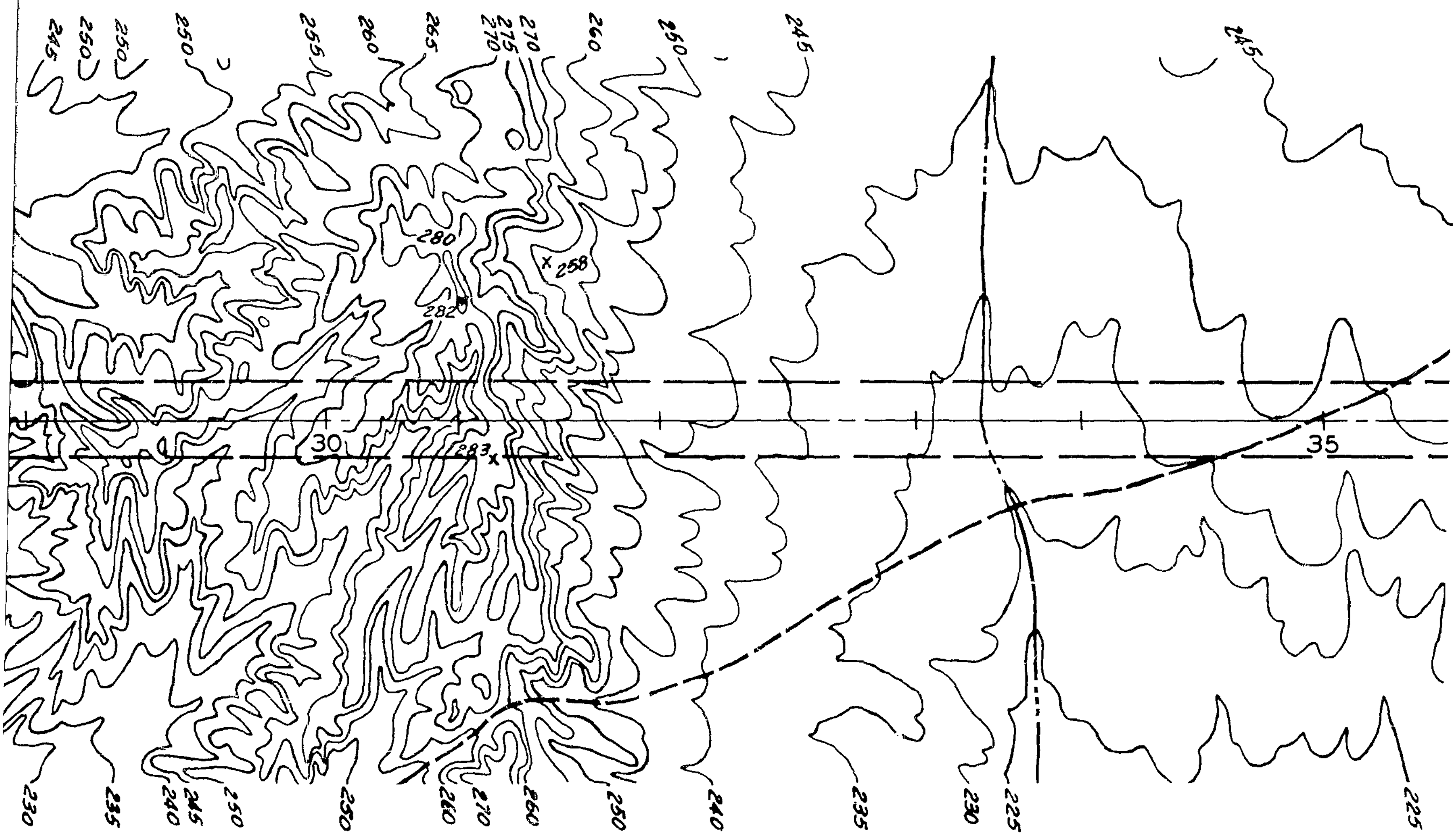
- LIMITS OF TEST COURSE
- CENTER-LINE STAKE (6)
- DRAINAGE
- IMPROVED ROADS
- UNIMPROVED ROADS OR TRAILS

- *TT TERRAIN TYPE
- LS LANDSCAPE
- GF GROUND FACTOR
- V VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

6,1,1b,2 - 6,10 - 1/3

6,1,1b,2



6,10

1/3

IN TYPE
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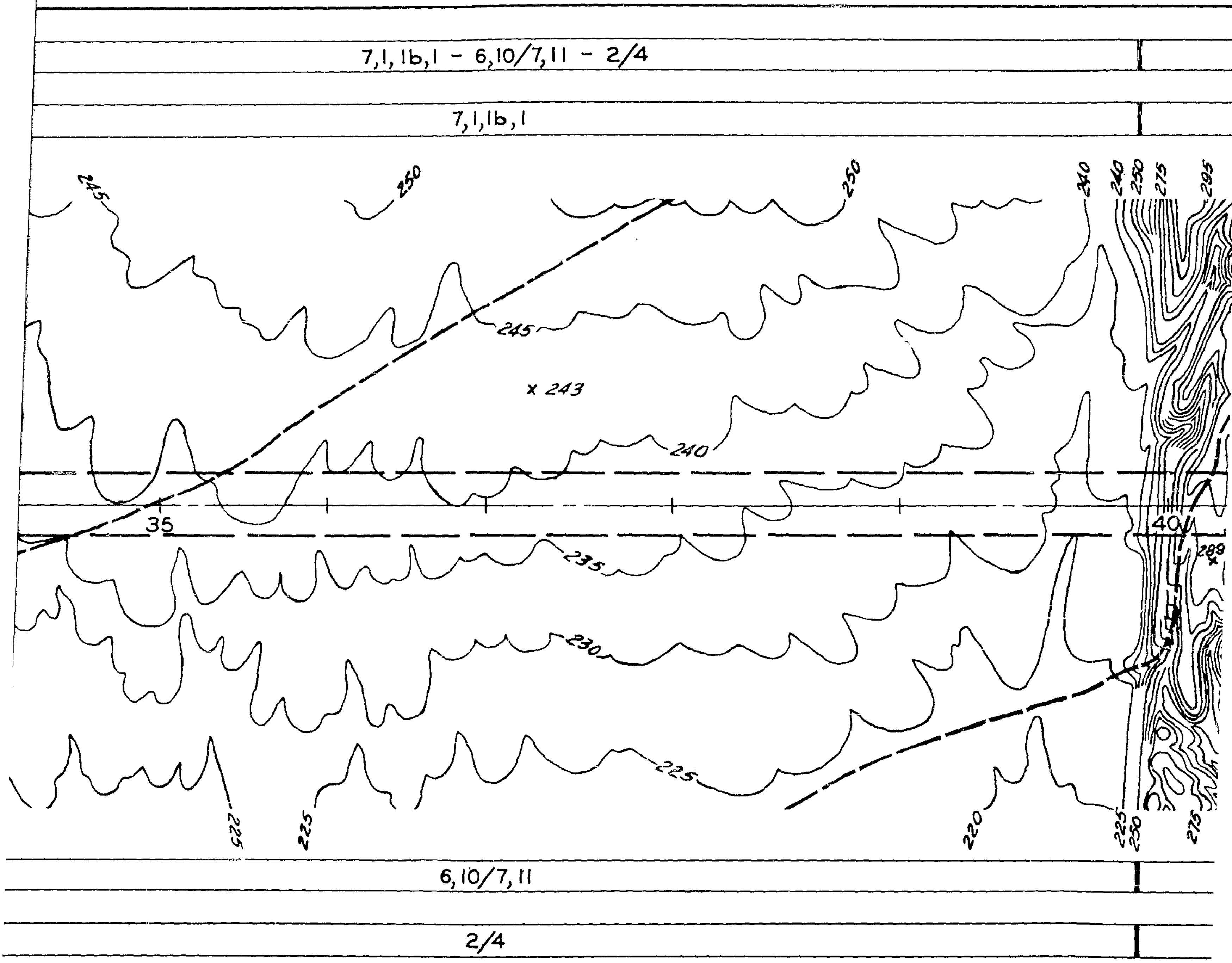
D FACTOR
ATION

REVERSE

2



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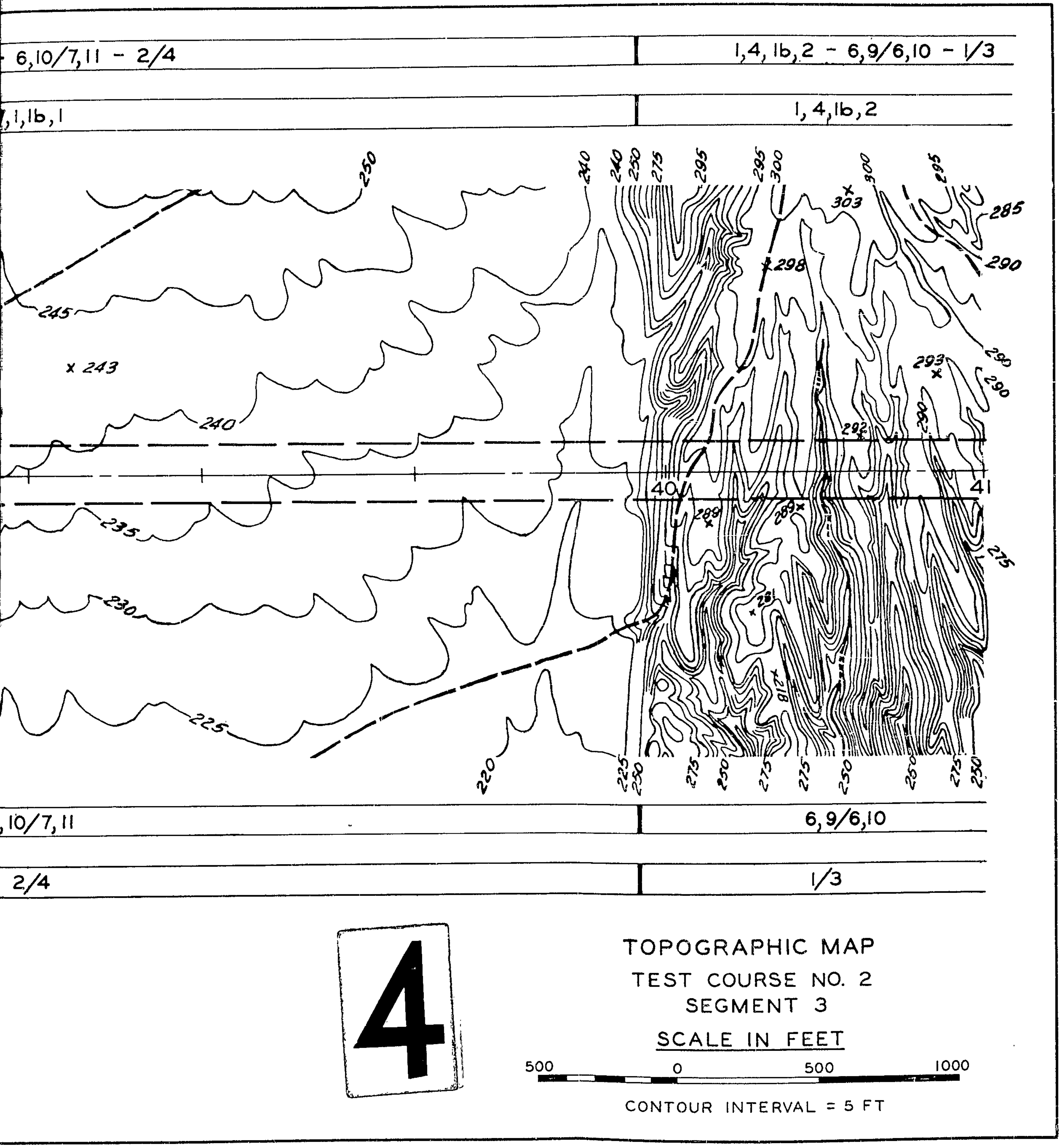
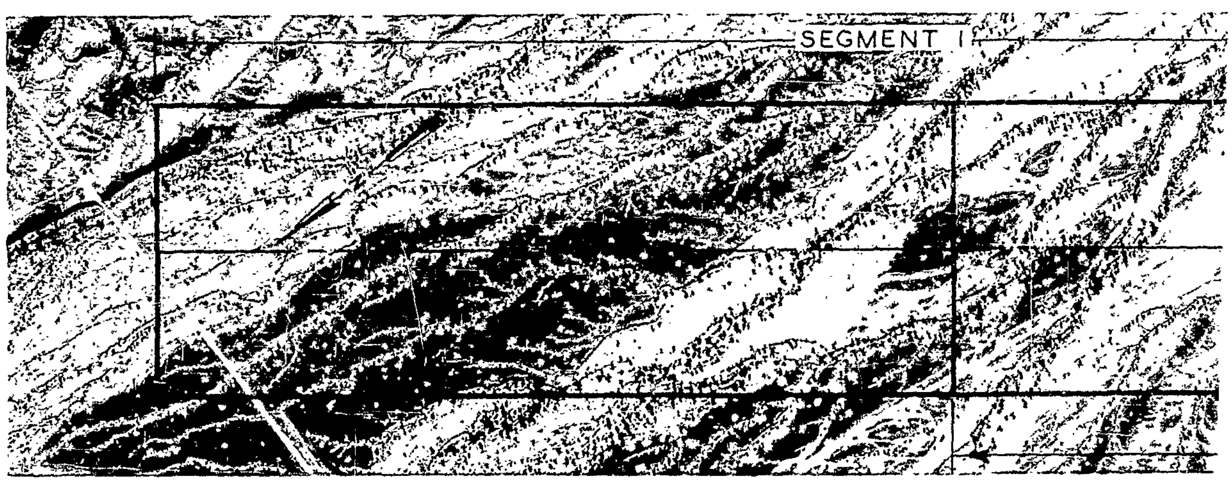
TEST
SE
SCA
500 0
CONTOU

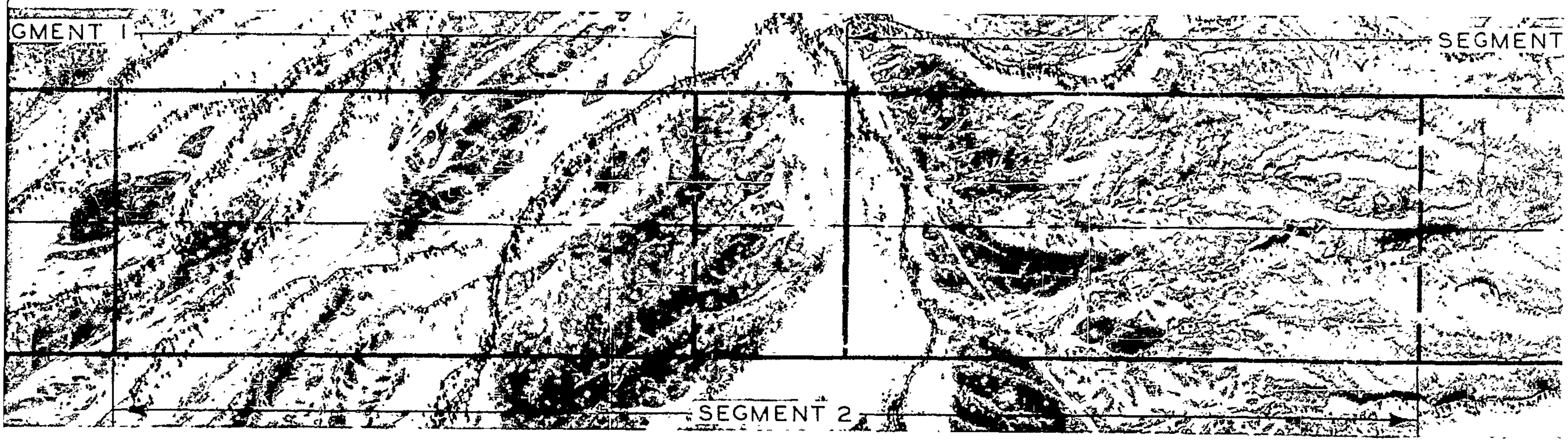
3



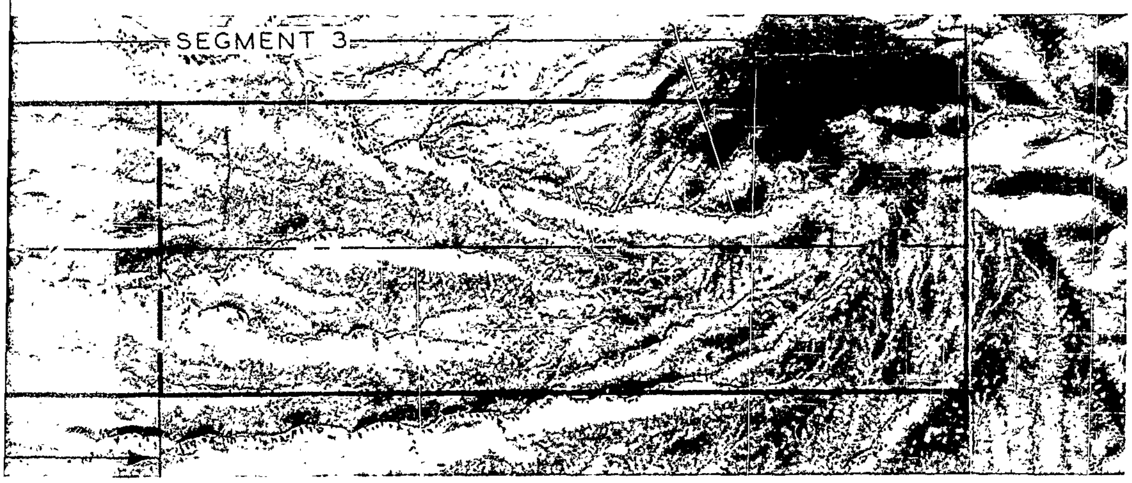
6,10/7,11 - 2/4
1,4,1b,2 - 6,9/6,10 - 1/3
,1,1b,1
1,4,1b,2
40
41
6,10/7,11
6,9/6,10
2/4
1/3
4
TOPOGRAPHIC MAP
TEST COURSE NO. 2
SEGMENT 3
SCALE IN FEET
500 0 500 1000
CONTOUR INTERVAL = 5 FT



1



2



3

AERIAL MOSAIC

TEST COURSE NO. 3

SCALE IN FEET

1000 0 1000 2000

TERRAIN

TEST CO

HIGHS ARE	LANDSCAPE: PLAN-PROFILE: % AREA OCCUPIED BY HIGHS: >60	40-60	<40	SLOPE OCCURRENCE PER 10 MILES: <1	5-20	20-100	CHARACTERISTIC SLOPE: 0°-1/2°	1/2°-2°	2°-6°	6°-14°	CHARACTERISTIC RELIEF: TYPE I: 0-10	10-50	TYPE II: 0-100	100-400	GROU: SOIL TYPE: SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES
FLAT-TOPPED & LINEAR	X				X				X			X					X
PEAKED OR CRESTED	X				X					X			X				X
NO PRONOUNCED HIGHS OR LOWS		X		X				X			X						X
		X		X				X			X						X

* EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPIN TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE T THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR COMI

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO AREAI PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES TI

TERRAIN TYPES

TEST COURSE 3

GROUND FACTORS							VEGETATION				TERRAIN TYPE*						
SOIL TYPE				SOIL CONSISTENCY							LANDSCAPE				GROUND† FACTORS		VEGETATION†
SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT AND/OR CLAY WITH COARSE MATERIAL	LOOSE >12" BELOW SURFACE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE	BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	PP	SO	CS	CR	ST	SC	
		X			X/	/X		X			1L	3	2	2	6	9/10	2
		X			X/	/X		X			4	3	3	4	6	9/10	2
		X			X/	/X		X/	/X		7	1	1b	1	6	9/10	2/3
		X			/X	X/		X/		/X	7	1	1b	1	6	10/9	2/4

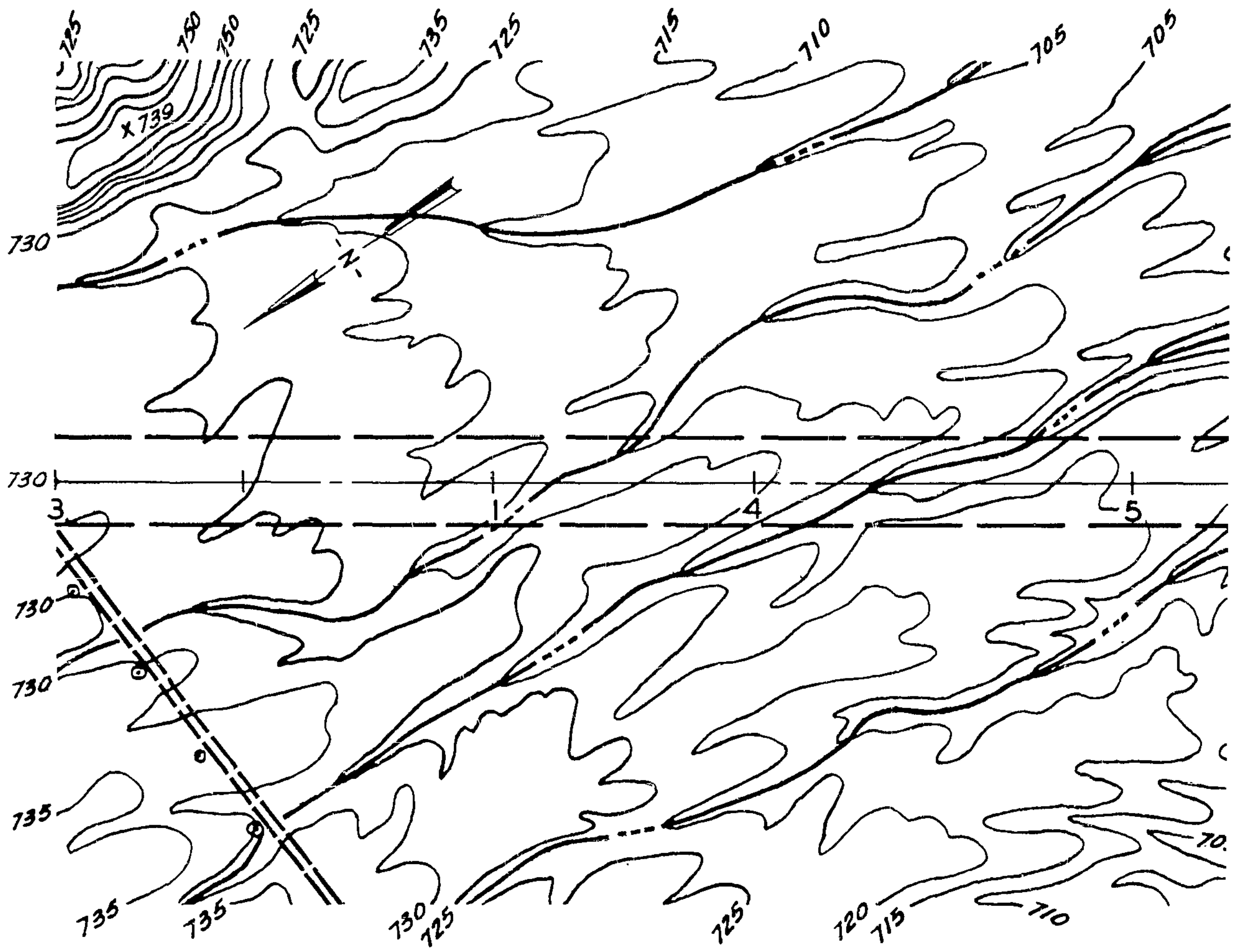
F SEVEN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL
ıT ORDER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY
:EN INDICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

VEGETATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE
ıTOR IN THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2

*TT 7,1,1b,1 - 6, 9/6,10 - 2/3

LS



GF 6,10 | 6,9

V 3 | 2/4

LEGEND

- LIMITS OF TEST COURSE
- CENTER-LINE STAKE (6)
- DRAINAGE
- IMPROVED ROADS
- UNIMPROVED ROADS OR TRAILS

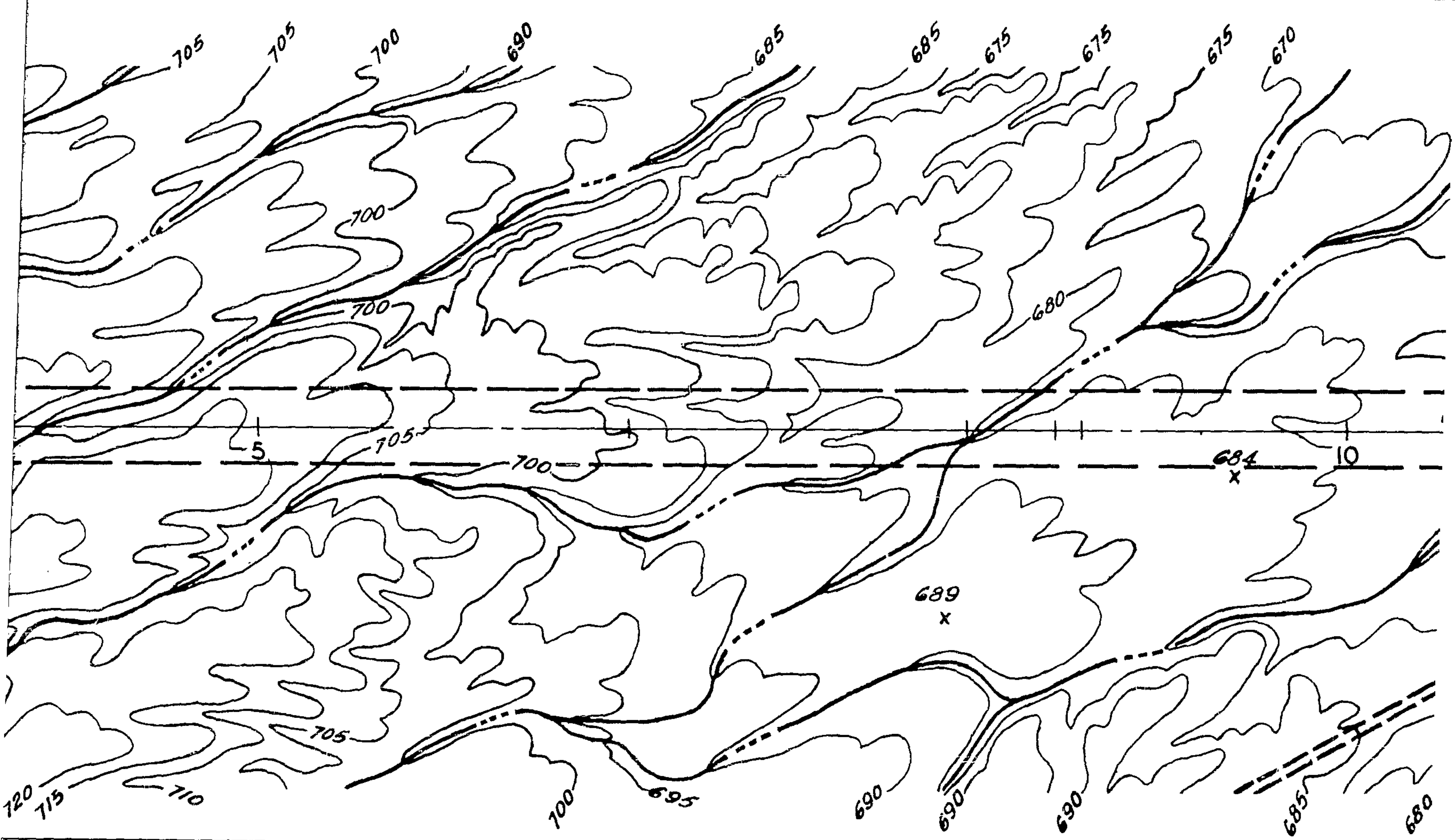
*TT TERRAIN TYPE
LS LANDSCAPE
GF GROUND FACTOR
V VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

6, 9/6,10 - 2/3	7,1,1b,1 -

7,1,1b,1



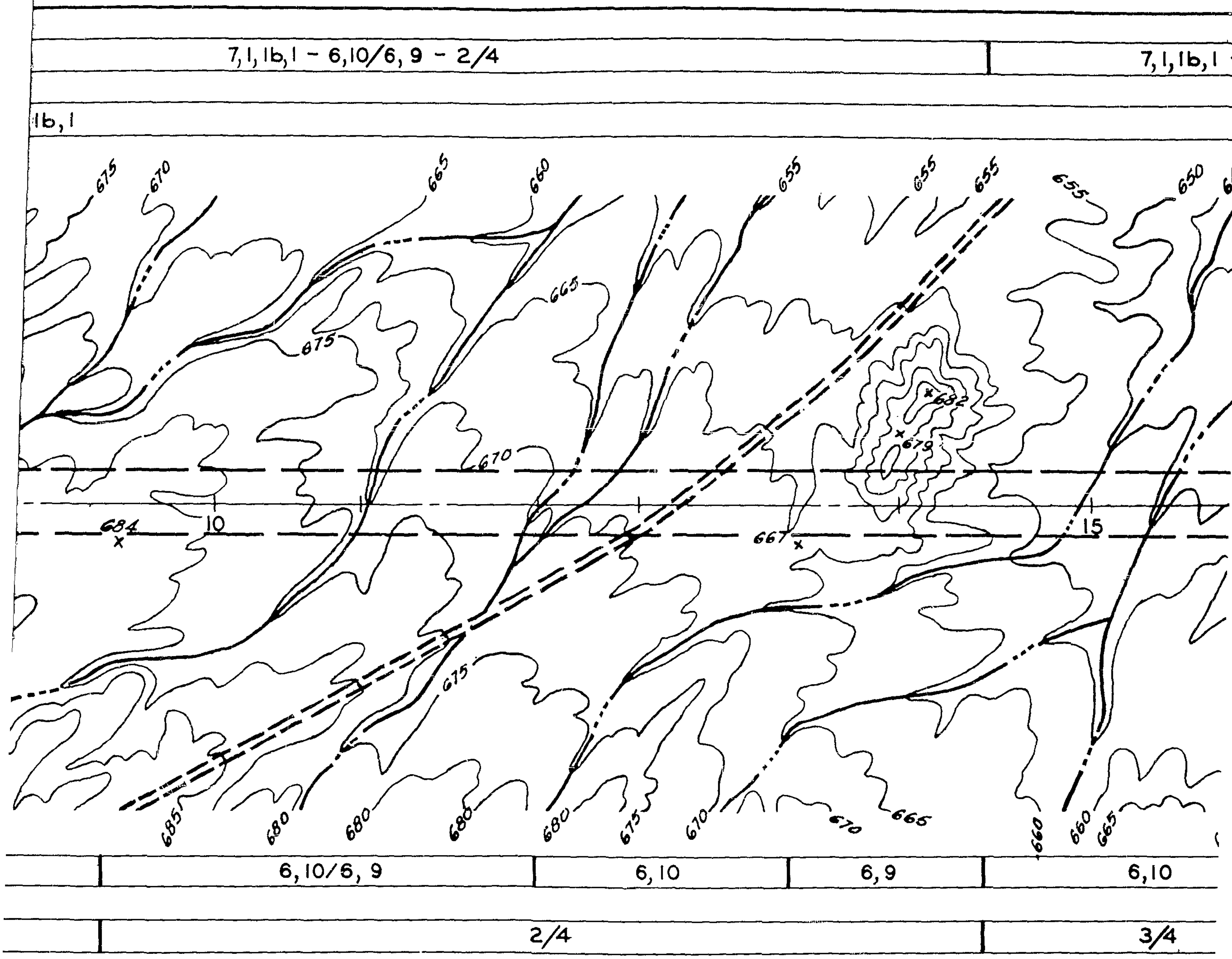
6,9	6,10	6

2/4	3/4	

RAIN TYPE
DSCAPE
UND FACTOR
GETATION

ON REVERSE

2

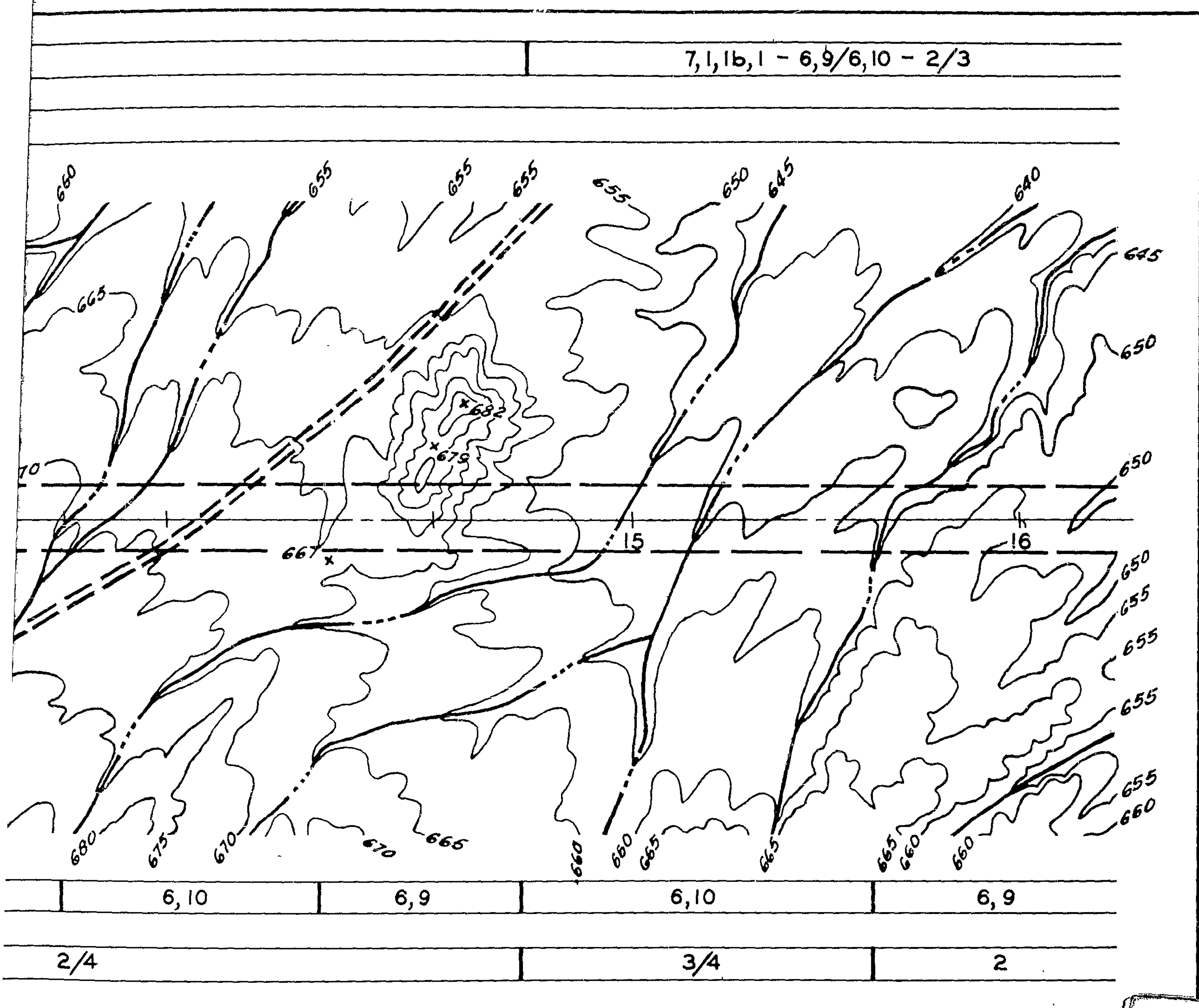


3

TOF
TE

500

CON



TOPOGRAPHIC MAP
TEST COURSE NO. 3
SEGMENT I

SCALE IN FEET

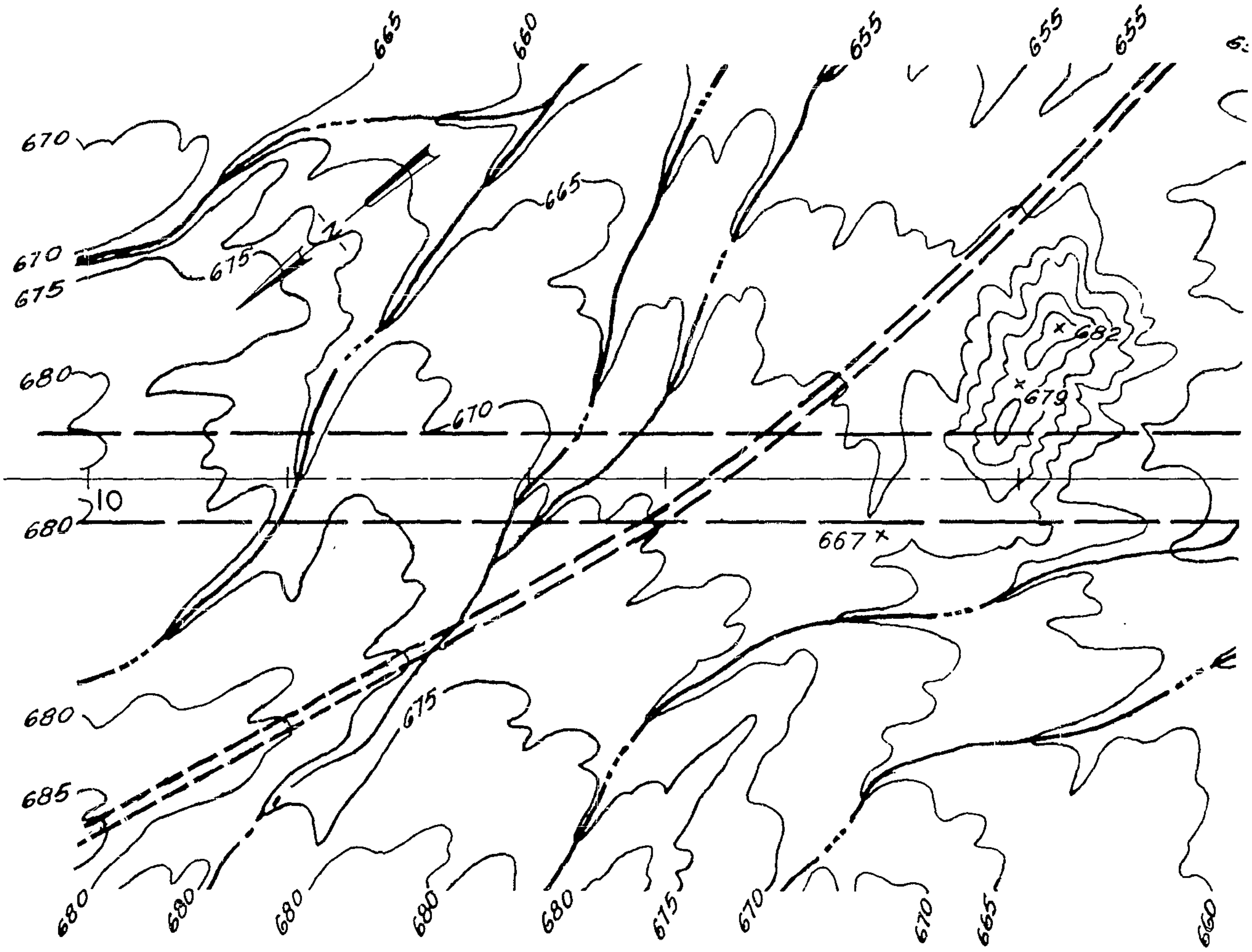
500 0 500 1000

CONTOUR INTERVAL = 5FT

4

PLATE II

*TT	7,1,1b,1-6,10/6,9-2/4	
LS		



GF	6,9/6,10	6,10	6,9	
V	2/4			

LEGEND

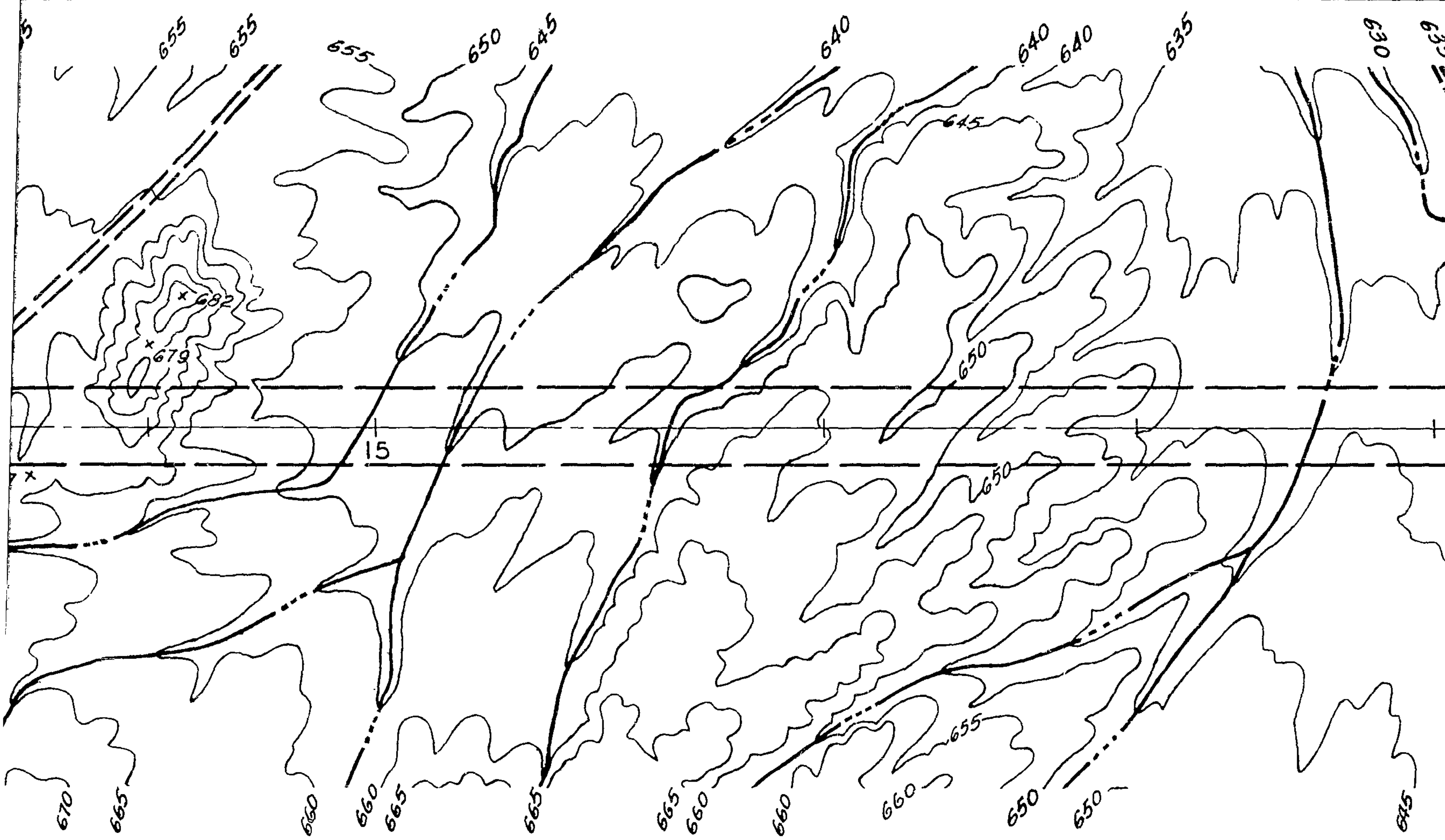
——— ———	LIMITS OF TEST COURSE	*TT	TERRAIN TYPE
———┼——— 6	CENTER-LINE STAKE	LS	LANDSCAPE
———-·-·-———	DRAINAGE	GF	GROUND FACTOR
══ ══ ══	IMPROVED ROADS	V	VEGETATION
— — — —	UNIMPROVED ROADS OR TRAILS		

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

7,1,1b,1-6,9/6,10-2/3

7,1,1b,1



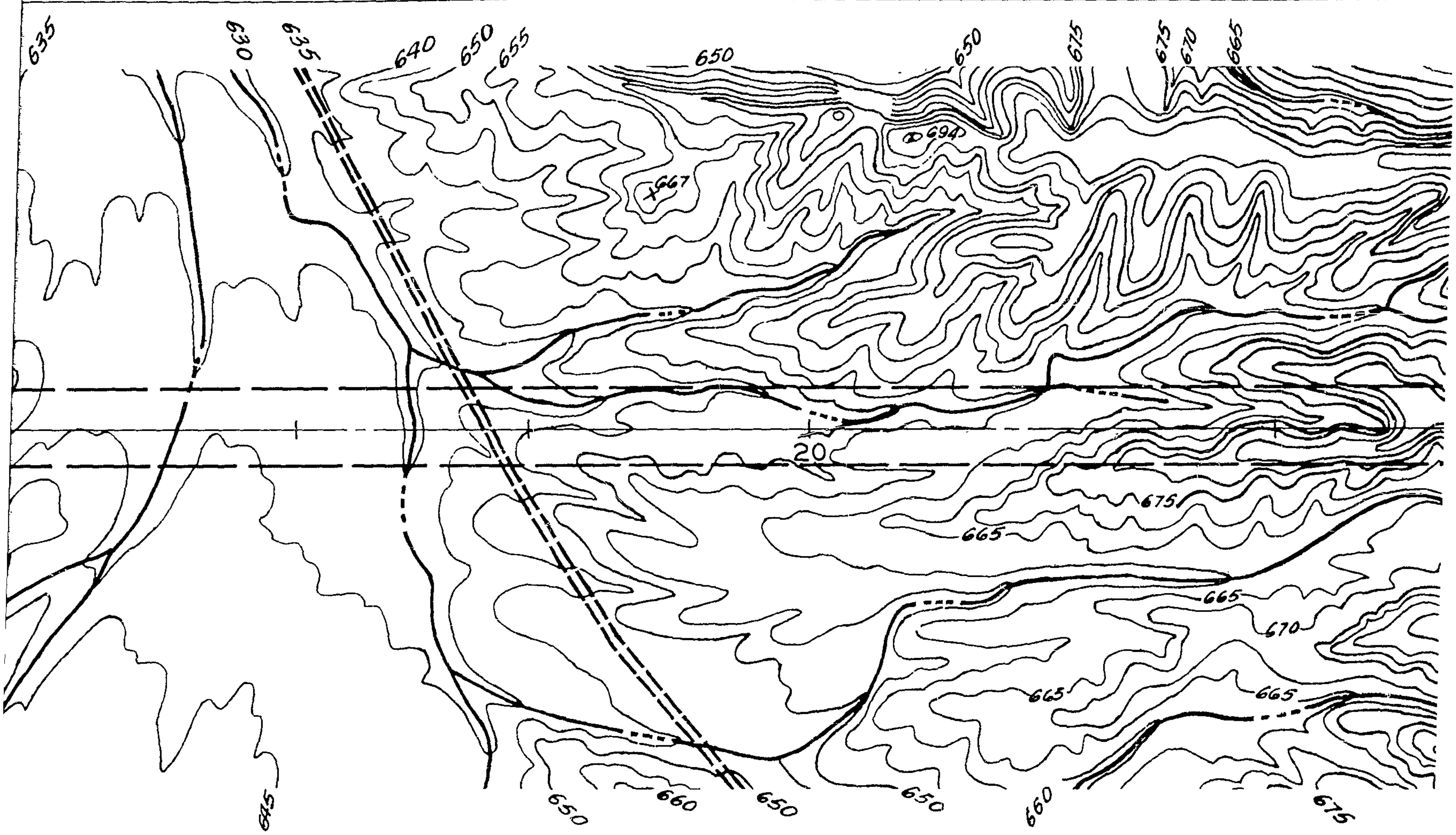
6,9	6,10	6,9	6,10
	3/4	2	3/4

AIN TYPE
SCAPE
IND FACTOR
ETATION

ON REVERSE

2

/6,10-2/3	4,3,3,4-6
	4,.



6,10	6,9/6,10
3/4	2

3

TOPO(

TEST

SC

500 0

CONTOU

4,3,3,4 - 6,9/6,10 - 2

4,3,3,4

6,9/6,10

2

TOPOGRAPHIC MAP

TEST COURSE NO. 3
SEGMENT 2

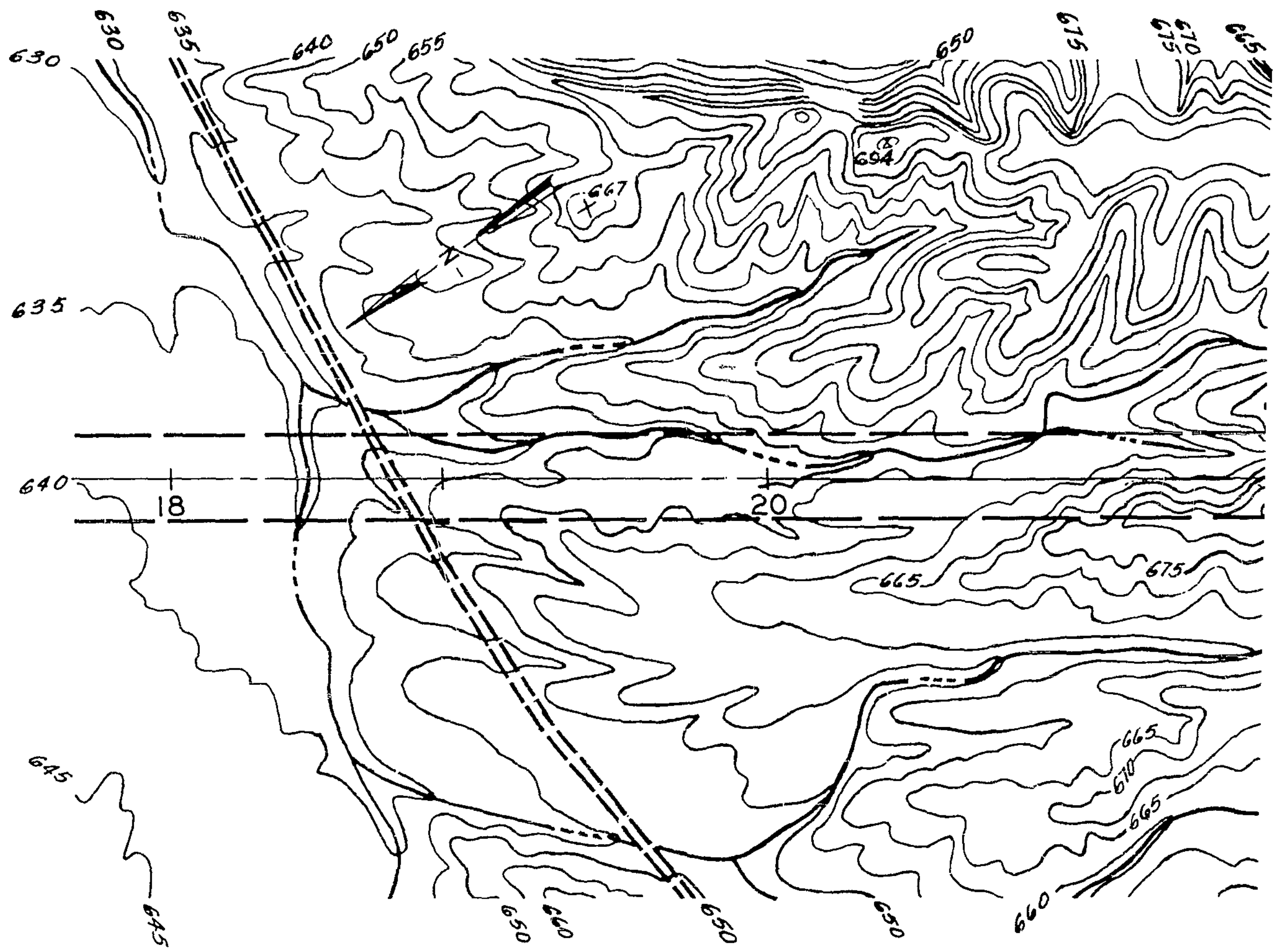
SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT	7,1,1b,1 - 6, 9/6,10 - 2/3	
LS		



GF	6/10	
V	3/4	

LEGEND

LIMITS OF TEST COURSE

CENTER-LINE STAKE (6)

DRAINAGE

IMPROVED ROADS

UNIMPROVED ROADS OR TRAILS

*TT TERRAIN TYPE

LS LANDSCAPE

GF GROUND FACTOR

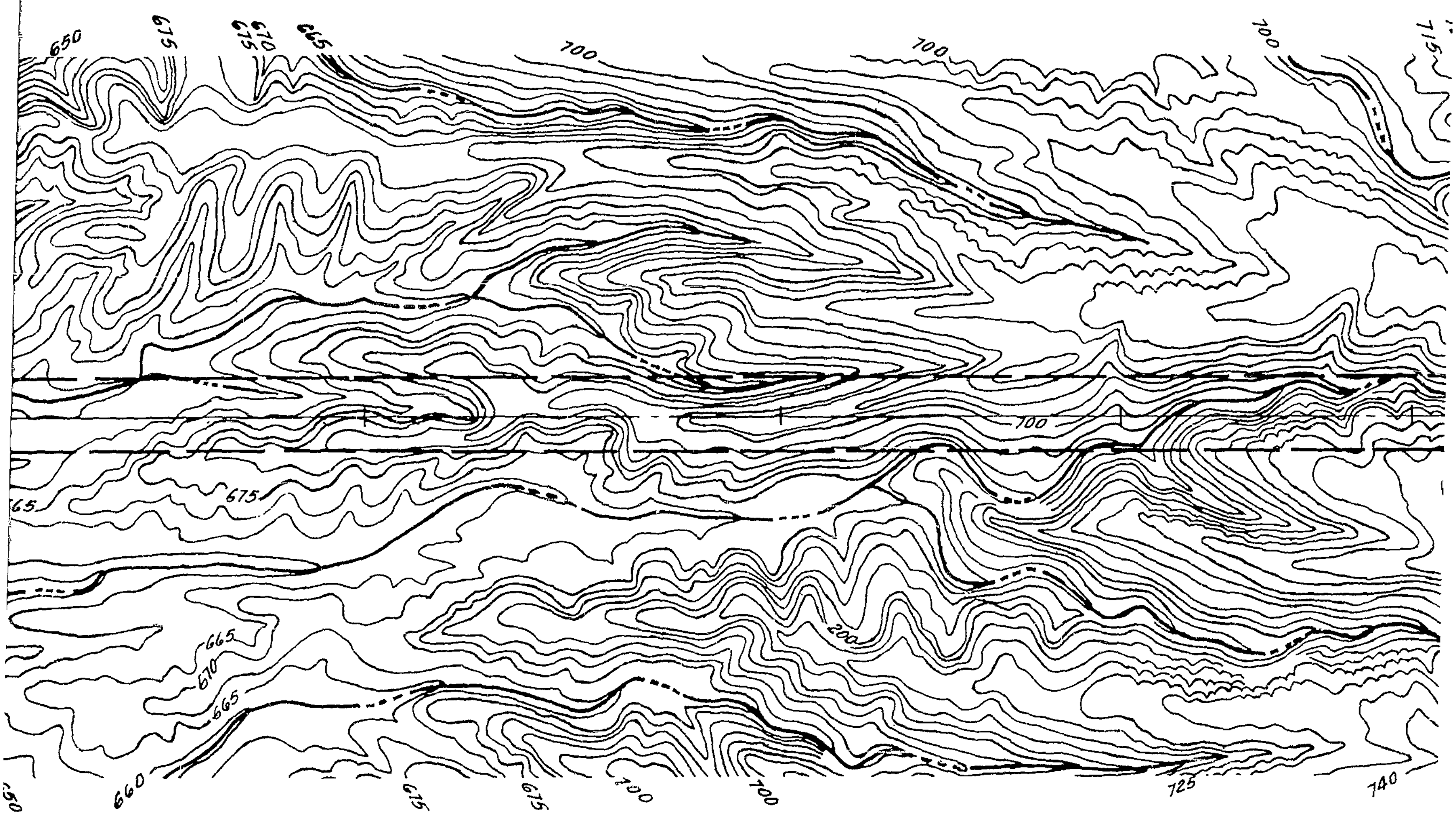
V VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

4, 3, 3, 4 - 6, 9/6, 10 - 2

4, 3, 3, 4



6, 9/6, 10

2

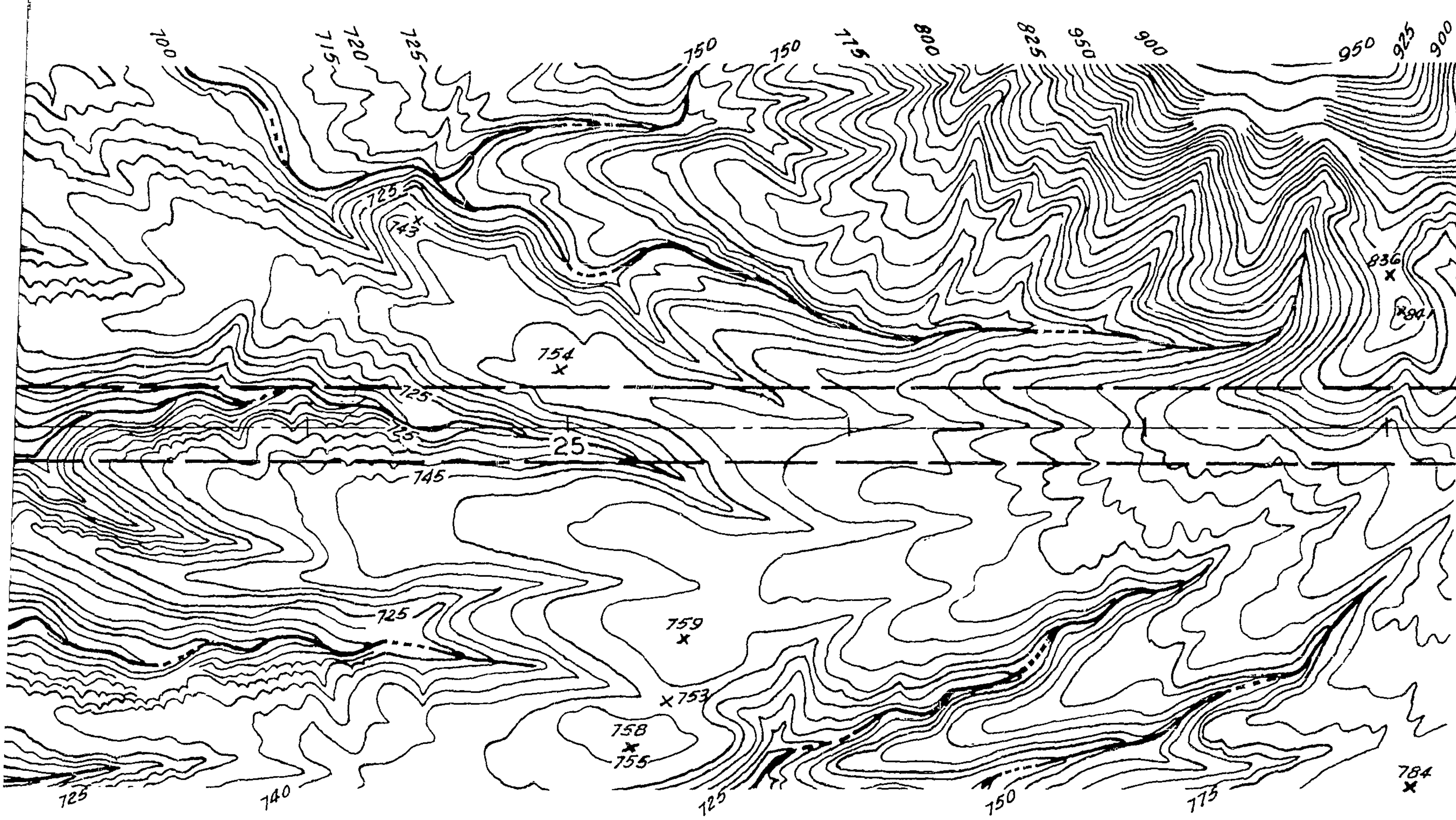
IN TYPE
:APE
D FACTOR
ATION

REVERSE

2

IL, 3, 2, 2 - 6, 9/6, 10 - 2

IL, 3, 2, 2



6, 9/6, 10

2

TOPOG

TEST

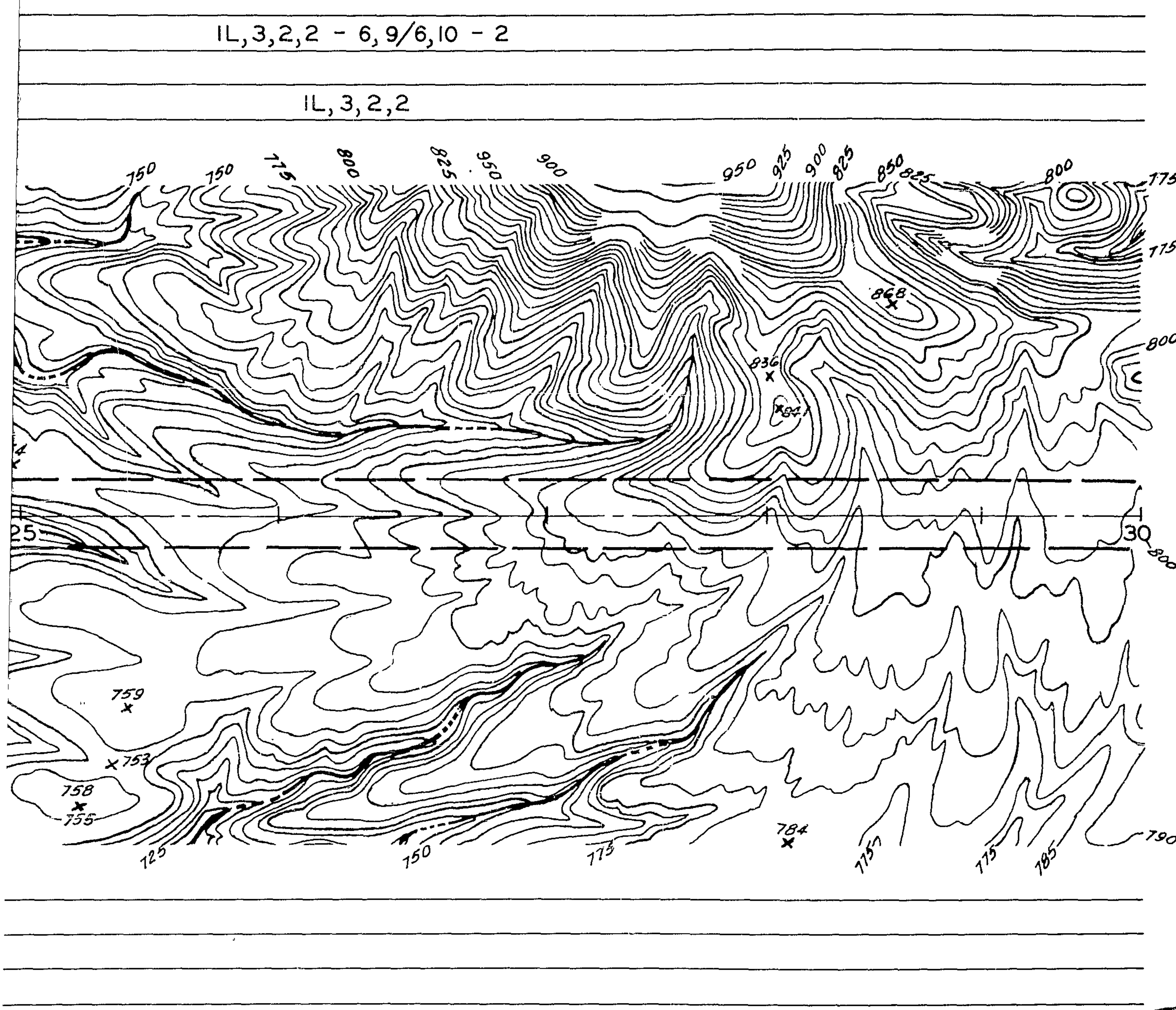
S

SCA

500 0

CONTOU

3



TOPOGRAPHIC MAP

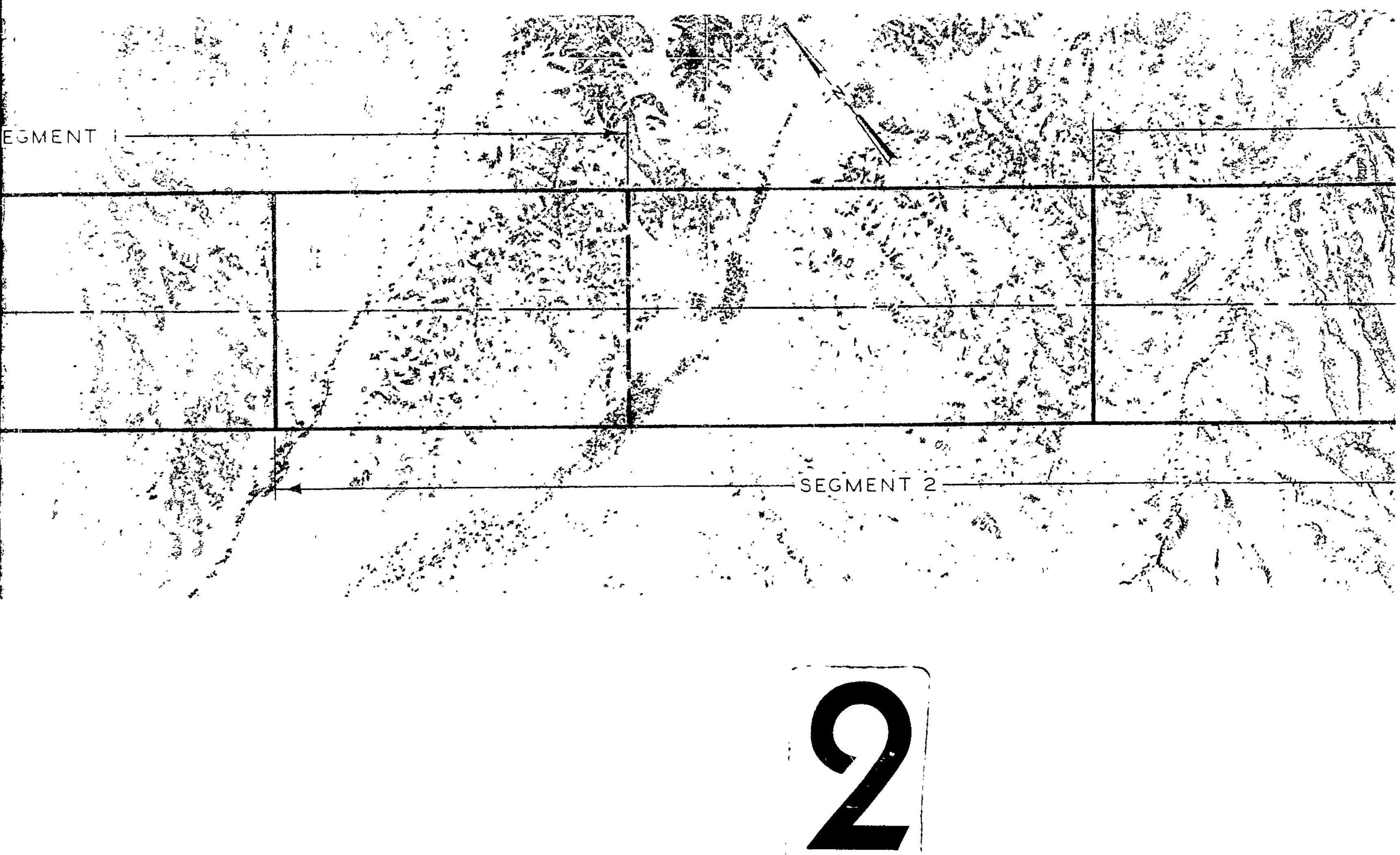
TEST COURSE NO. 3
SEGMENT 3

SCALE IN FEET

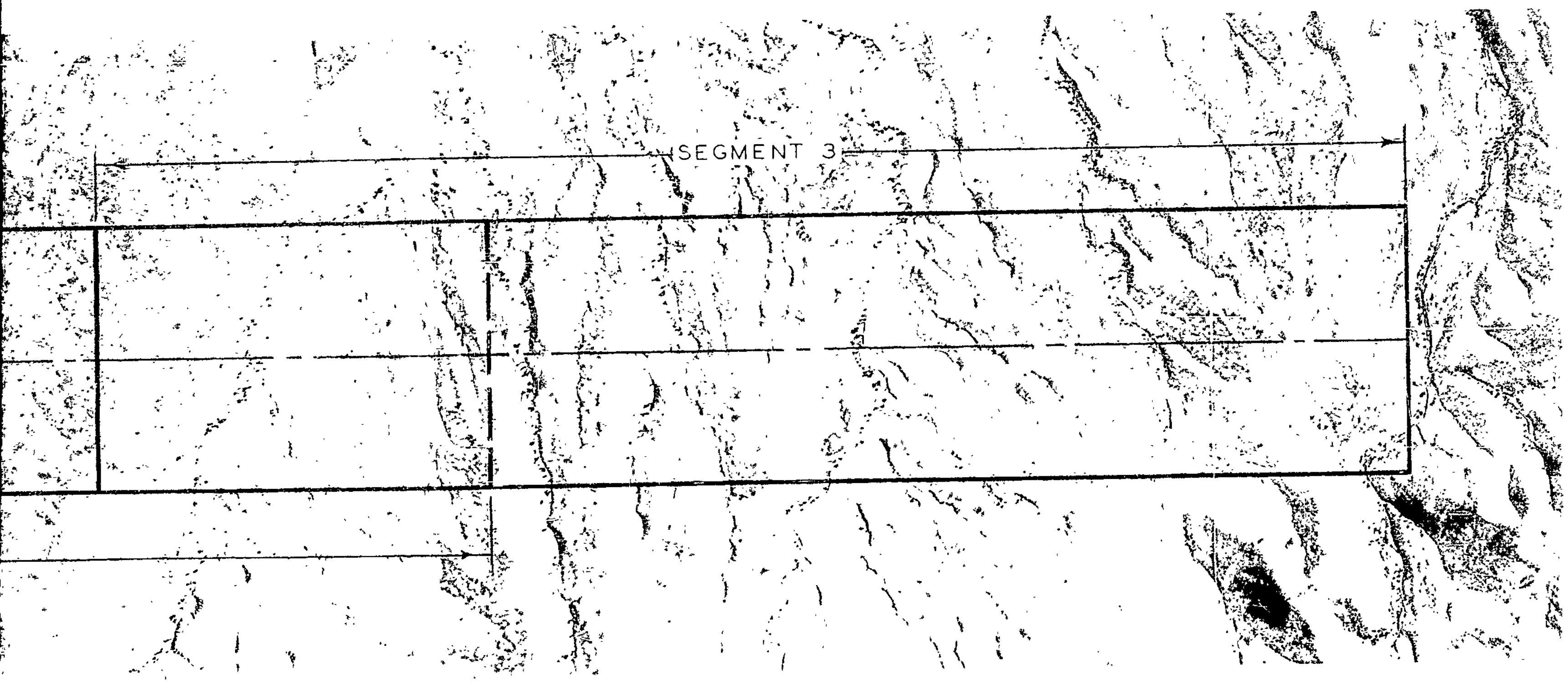
500 0 500 1000

CONTOUR INTERVAL = 5 FT

1



2



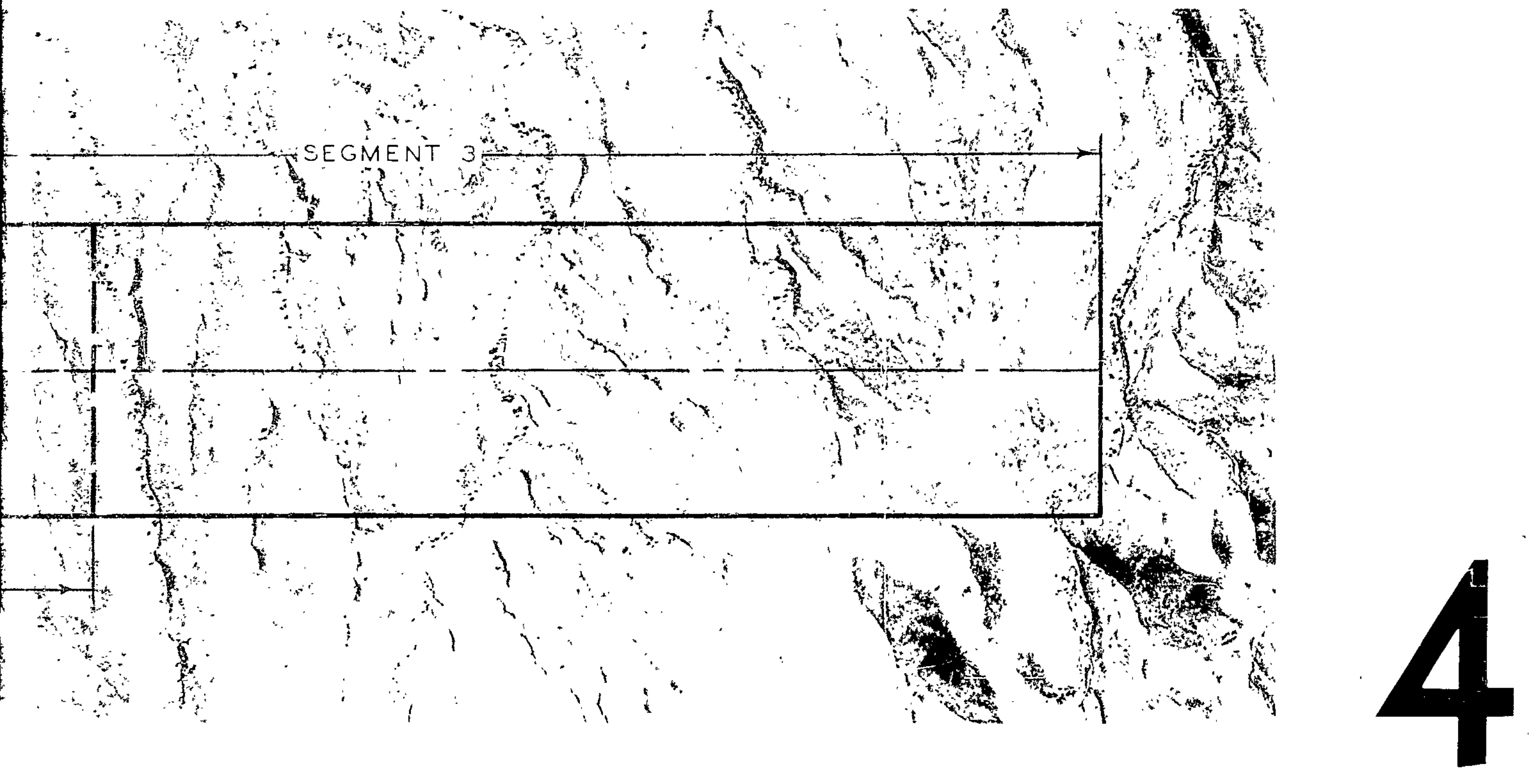
3

AERIAL M

TEST COURS

SCALE IN

1000 0



AERIAL MOSAIC

TEST COURSE NO. 4

SCALE IN FEET

1000 0 1000 2000

TERRA

TEST (

LANDSCAPE															GR		
PLAN-PROFILE				SLOPE OCCURRENCE PER 10 MILES			CHARACTERISTIC SLOPE				CHARACTERISTIC RELIEF				SOIL TYPE		
HIGHS ARE	% AREA OCCUPIED BY HIGHS										TYPE I		TYPE II		SAND	GRAVEL	SAND AND/OI GRAVEL W/FINES
	>60	40-60	<40	<1	5-20	20-100	0°-1/2°	1/2°-2°	2°-6°	6°-14°	0-10	10-50	0-100	100-400			
FLAT-TOPPED	X			X				X				X					X
	X			X				X				X					X
	X					X		X				X					X
		X		X				X				X					X
PEAKED OR CRESTED & LINEAR	X					X				X			X				X
NO PRONOUNCED HIGHS OR LOWS		X		X				X			X						X
		X		X				X			X						X
		X		X				X				X					X

* EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPF TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR CC

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO ARE PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES

TERRAIN TYPES

TEST COURSE 4

	GROUND FACTORS							VEGETATION				TERRAIN TYPE*						
	SOIL TYPE				SOIL CONSISTENCY							LANDSCAPE				GROUND† FACTORS		VEGETATION†
oo	SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILTY AND/OR CLAY WITH COARSE MATERIAL	LOOSE >12" BELOW SURFACE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE	BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	PP	SO	CS	CR	ST	SC	
			X			X			X/		/X	1	1	1b	2	6	9	2/4
			X			X/	/X		X/		/X	1	1	1b	2	6	9/10	2/4
			X			X			X/		/X	1	4	1b	2	6	9	2/4
			X			X/	/X		X/		/X	2	1	1b	2	6	9/10	2/4
			X			X			X/		/X	4L	4	3	4	6	9	2/4
			X			X		X/			/X	7	1	1b	1	6	9	1/4
			X			X/	/X		X/		/X	7	1	1b	1	6	9/10	2/4
			X			X/	/X		X/		/X	7	1	1b	2	6	9/10	2/4

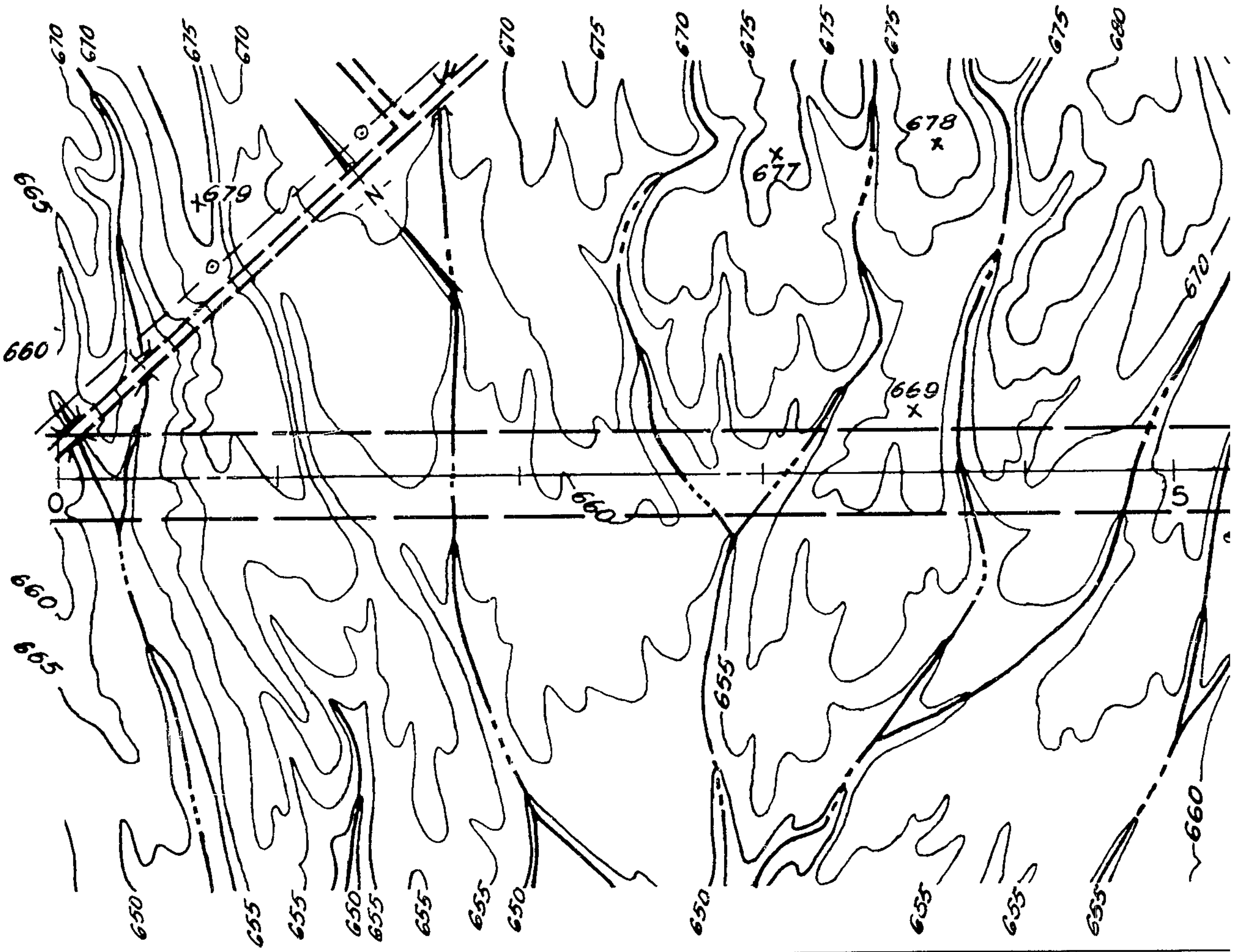
Y OF SEVEN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL THAT ORDER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY BEEN INDICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

ND VEGETATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS. IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE MINATOR IN THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2

*TT 7,1,1b,1 - 6,9/6,10 - 2/4

LS



GF | 6,9 | 6,10 | 6,9 | 6,

V 2/4

LEGEND

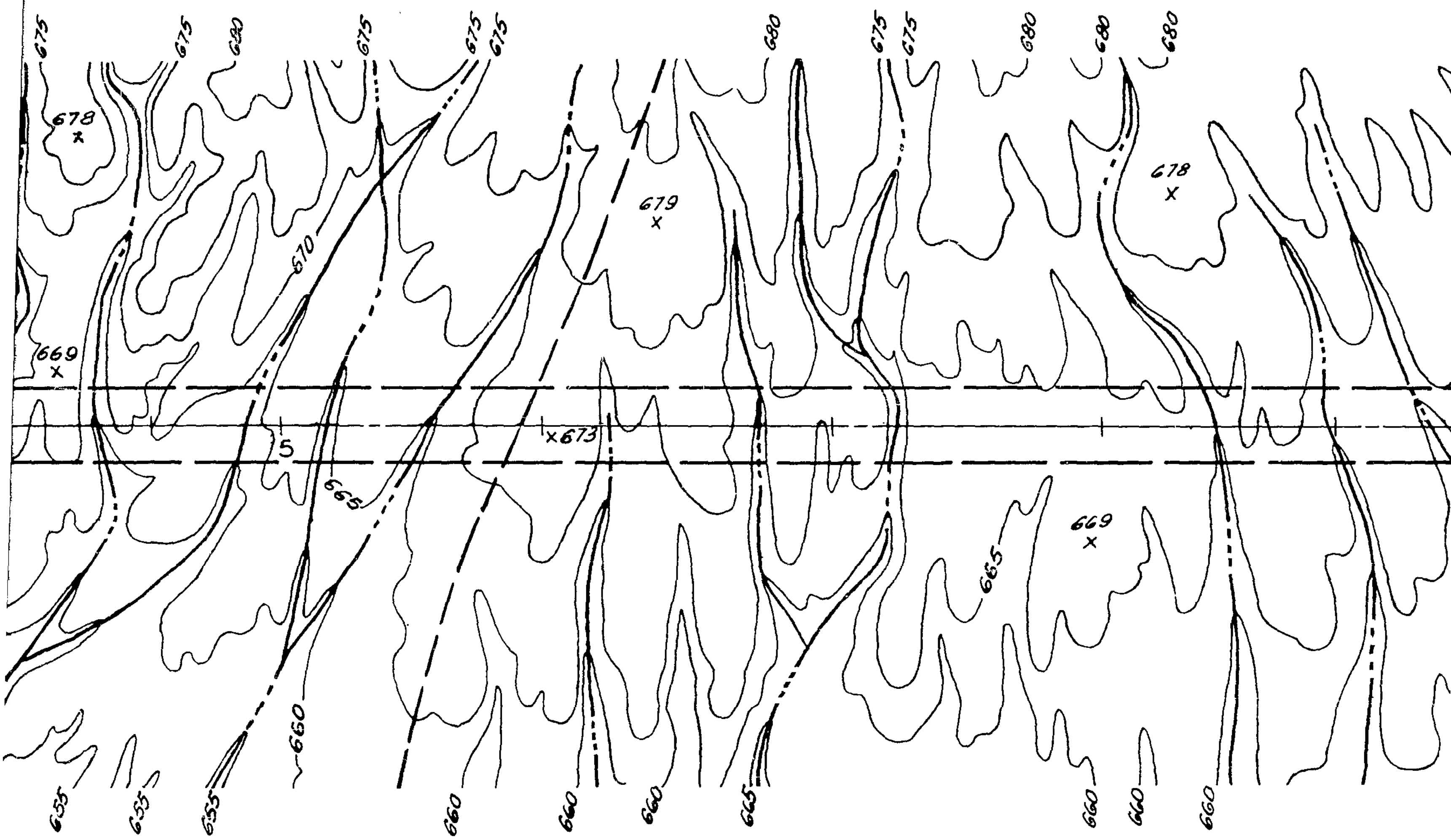
— —	LIMITS OF TEST COURSE	*TT	TERRAIN TYPE
——┼—— 6	CENTER-LINE STAKE	LS	LANDSCAPE
—·—·—	DRAINAGE	GF	GROUND FACTOR
═ ═ ═	IMPROVED ROADS	V	VEGETATION
— — — —	UNIMPROVED ROADS OR TRAILS		

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

	7,1,1b,1-6,9-1/4

7,1,1b,1



	6,10	6,9

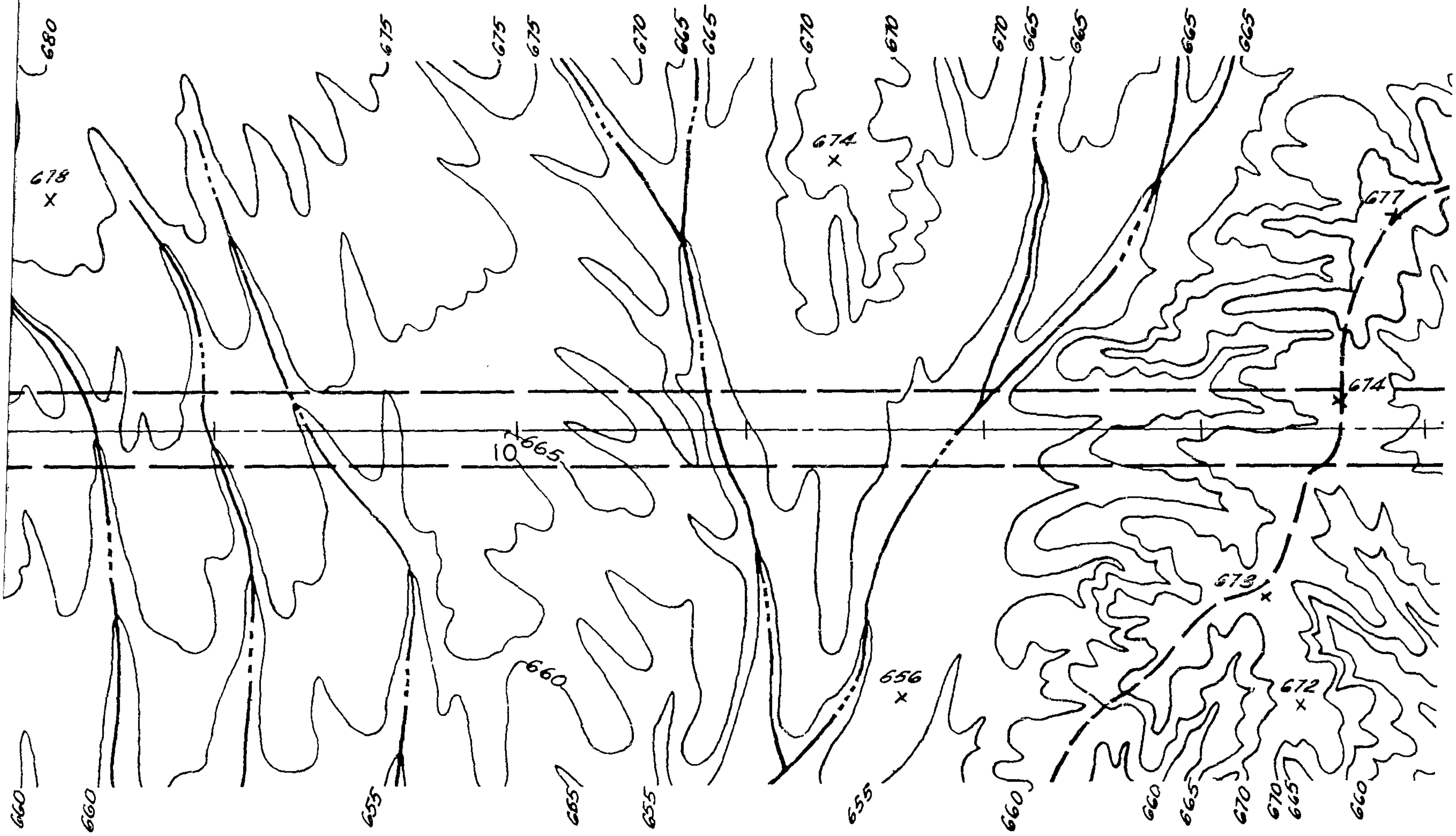
	1/4

:AIN TYPE
)SCAPE
IND FACTOR
ETATION

)N REVERSE

2

	7,1,1b,2 - 6,9/6,10 - 2/4
	7,1,1b,2



6,9	6,10/6,9	6,
1/4		2/4

3

TOPO

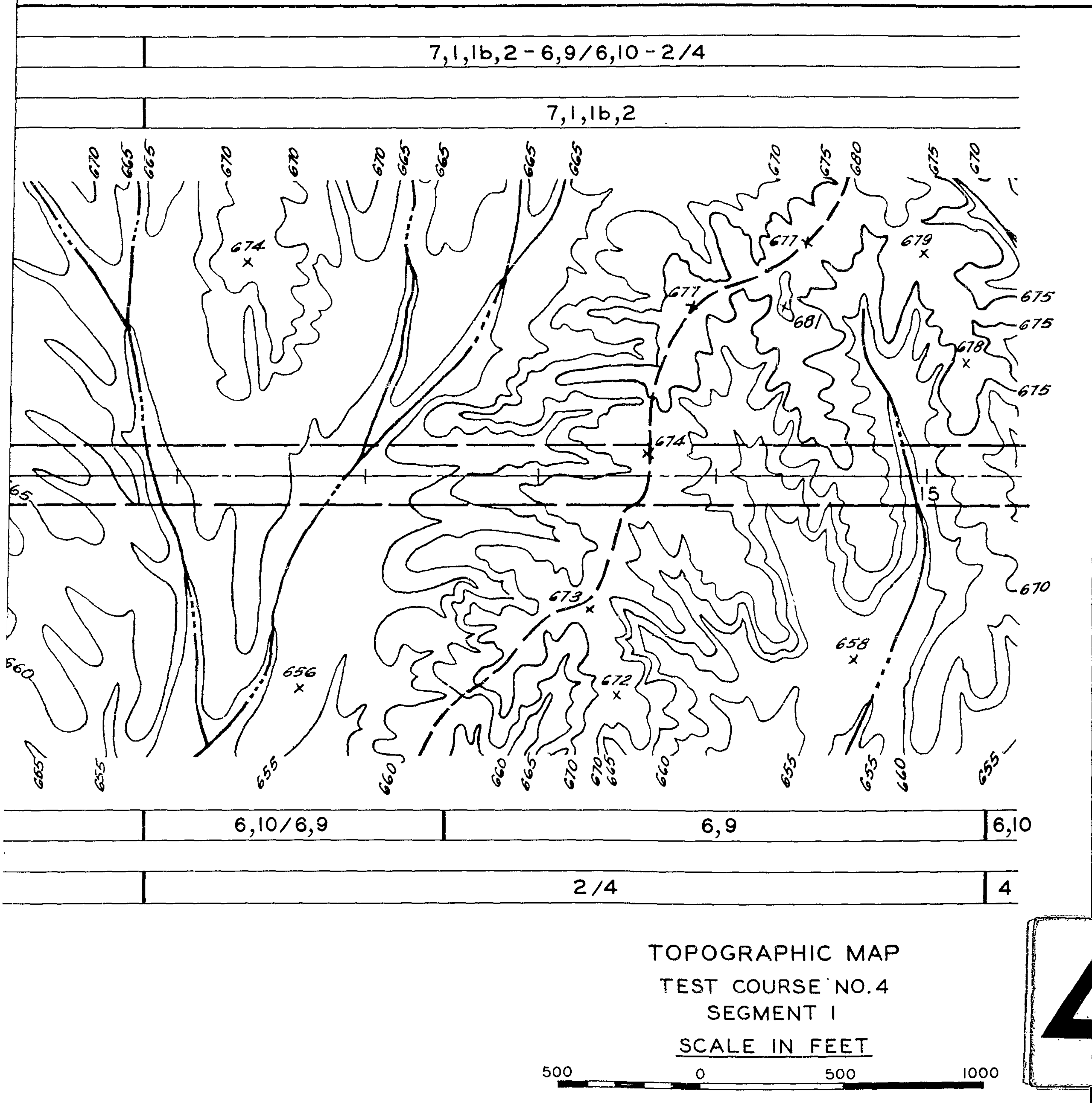
TEST

S

SCA

500 0

CONTOU



TOPOGRAPHIC MAP
TEST COURSE NO. 4
SEGMENT I

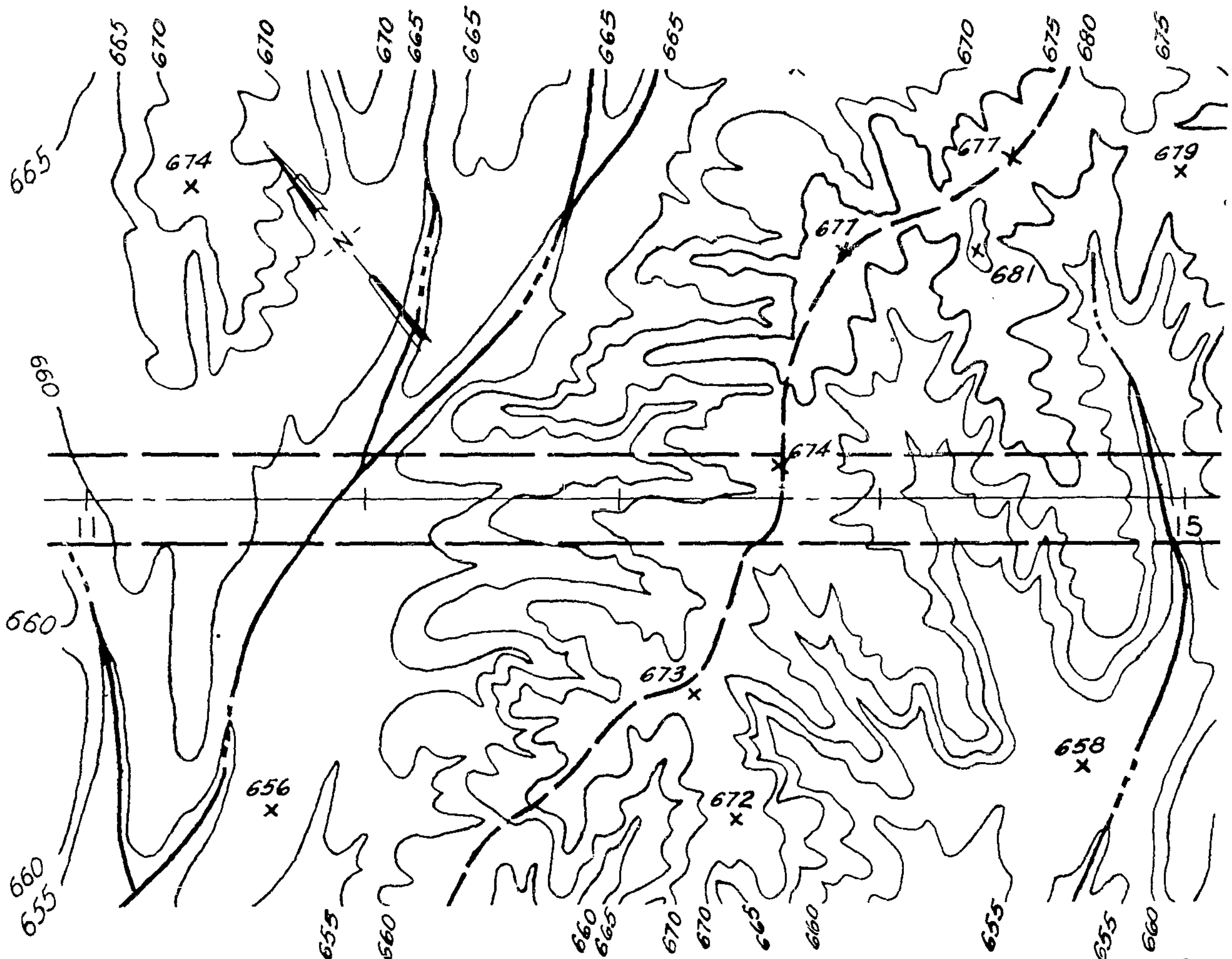
SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT	7,1,1b,2-6,9/6,10-2/4
LS	7,1,1b,2



GF	6,10/6,9	6,9
V	2/4	

LEGEND

LIMITS OF TEST COURSE

CENTER-LINE STAKE (6)

DRAINAGE

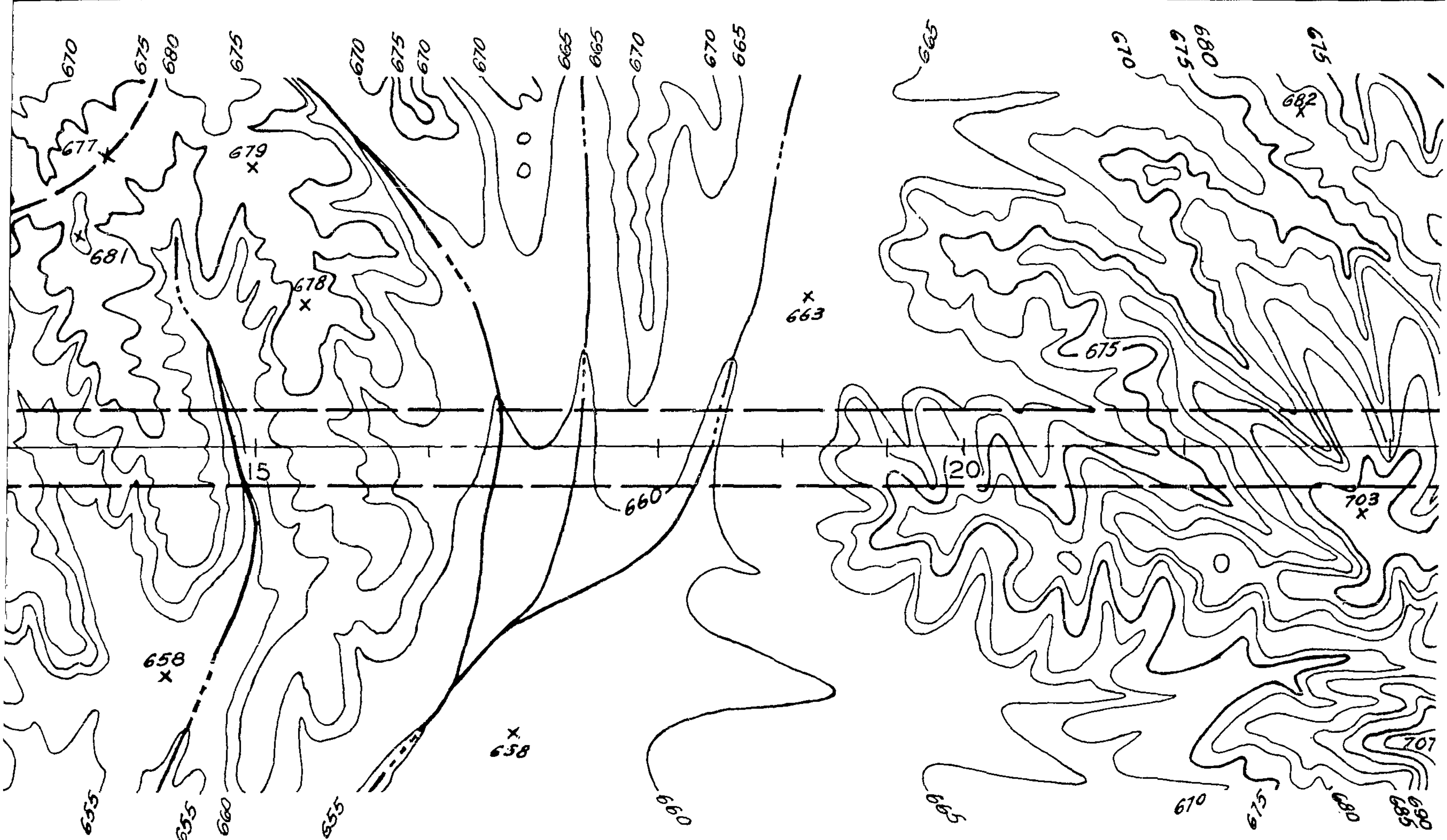
IMPROVED ROADS

UNIMPROVED ROADS OR TRAILS

*TT	TERRAIN TYPE
LS	LANDSCAPE
GF	GROUND FACTOR
V	VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

	1,1,1b,2-6,9/6,10-2/4
	1,1,1b,2

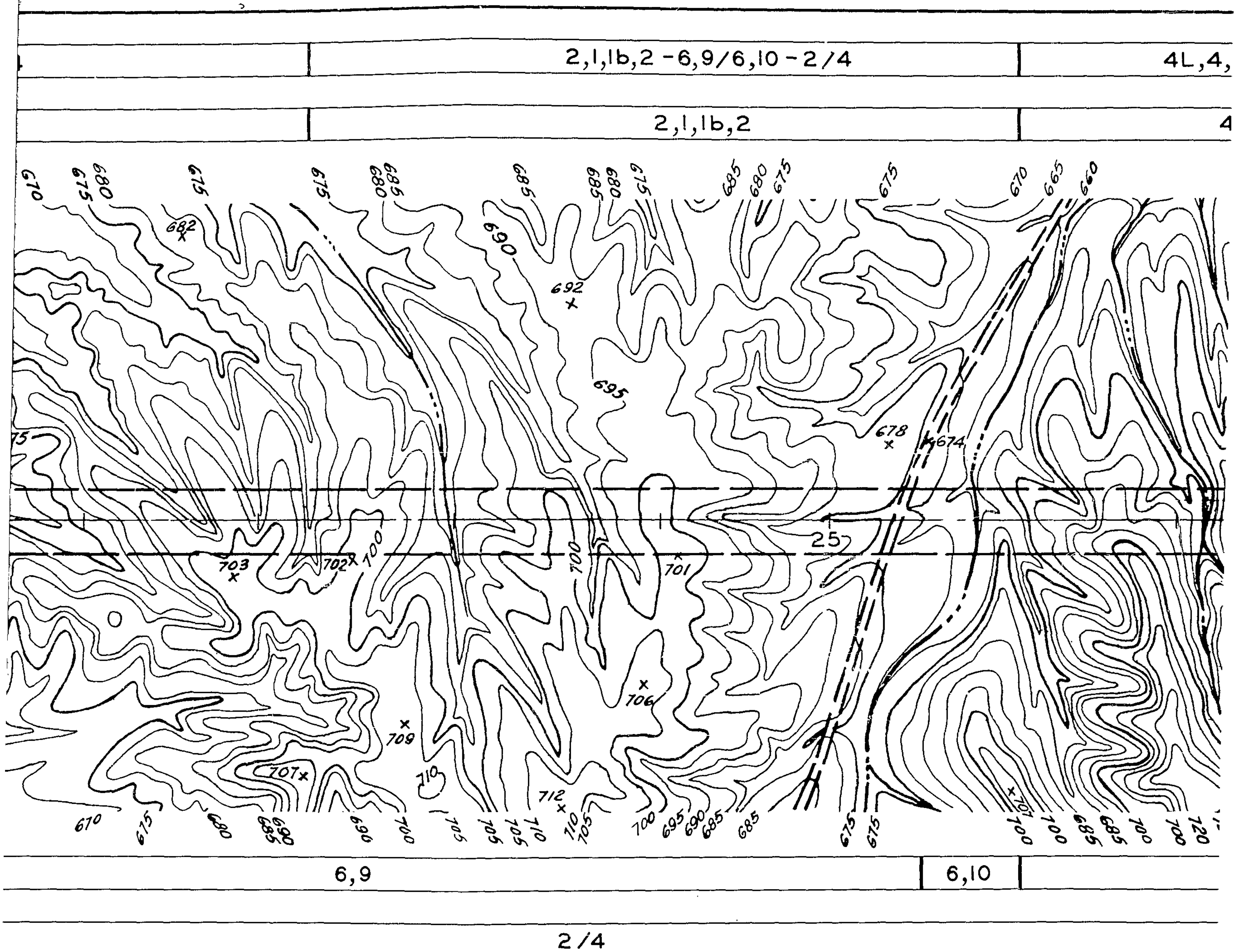


	6,10	
	4	

N TYPE
APE
FACTOR
TION

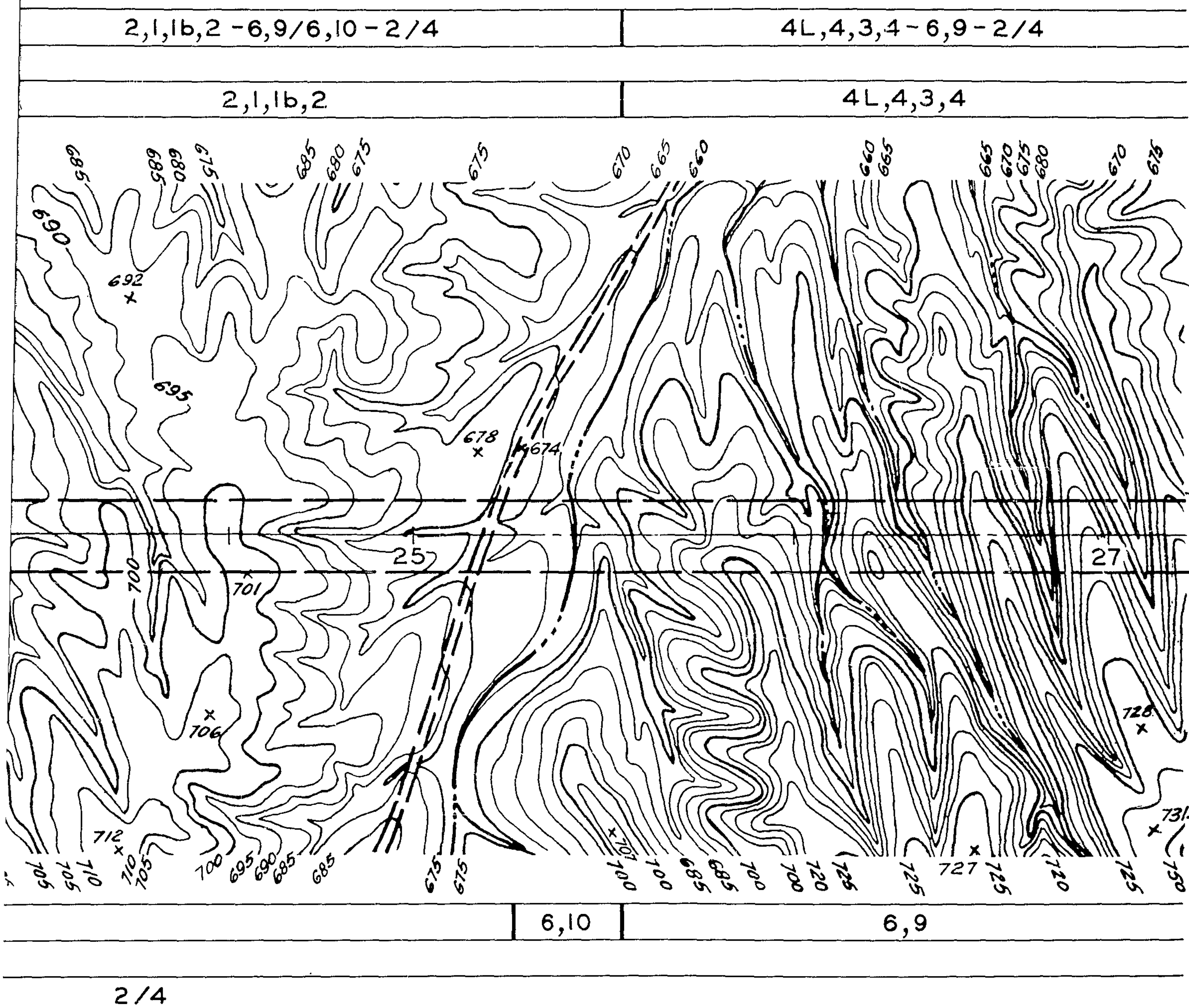
REVERSE

2



3

TOPO
TEST
S
SC
500 0
CONTOU



TOPOGRAPHIC MAP
TEST COURSE NO. 4
SEGMENT 2

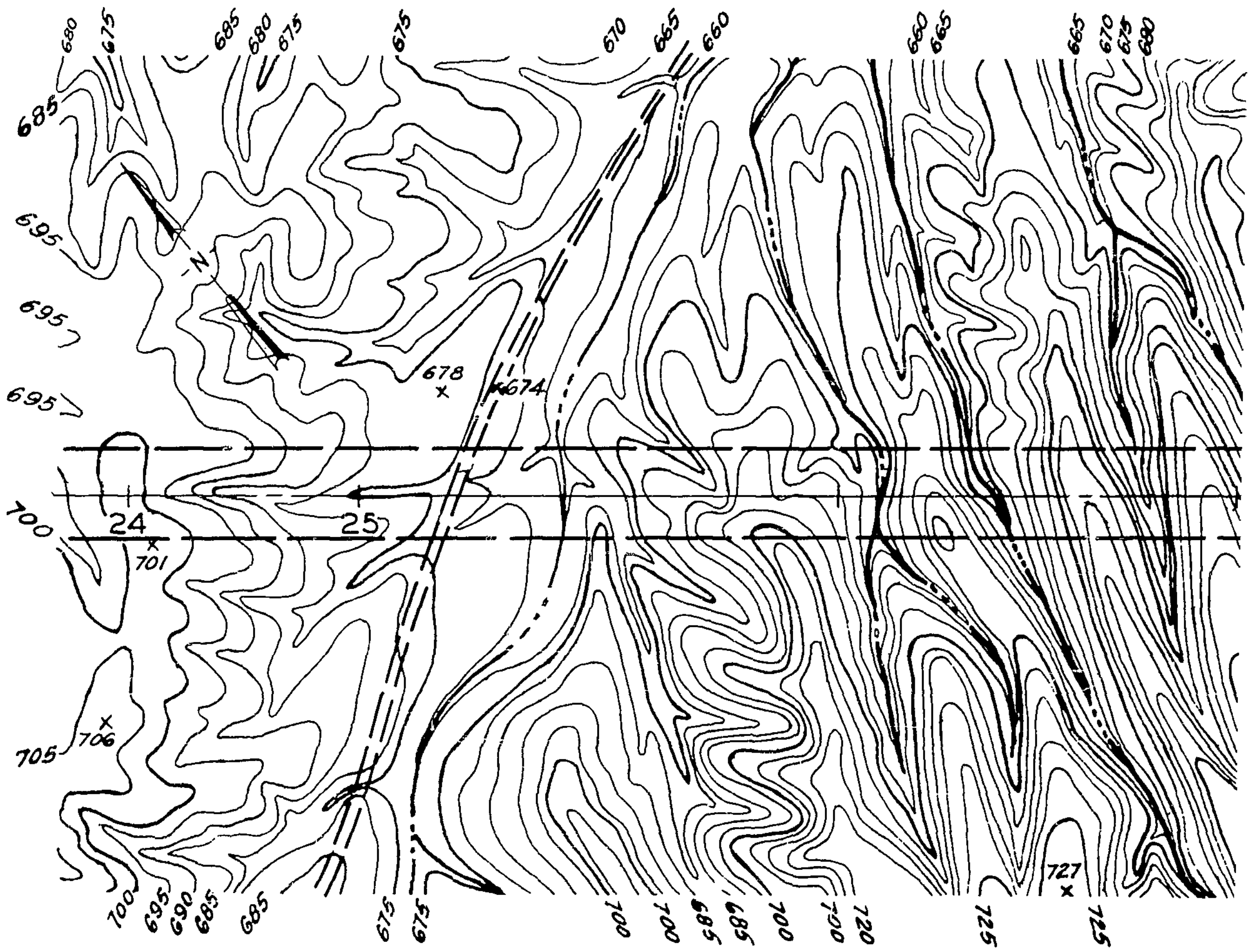
SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT	2,1,1b,2-6,9/6,10-2/4	4L,4,3,4-6,9-2/4
LS	2,1,1b,2	4L,4,3,4



GF	6,9	6,10	
V			

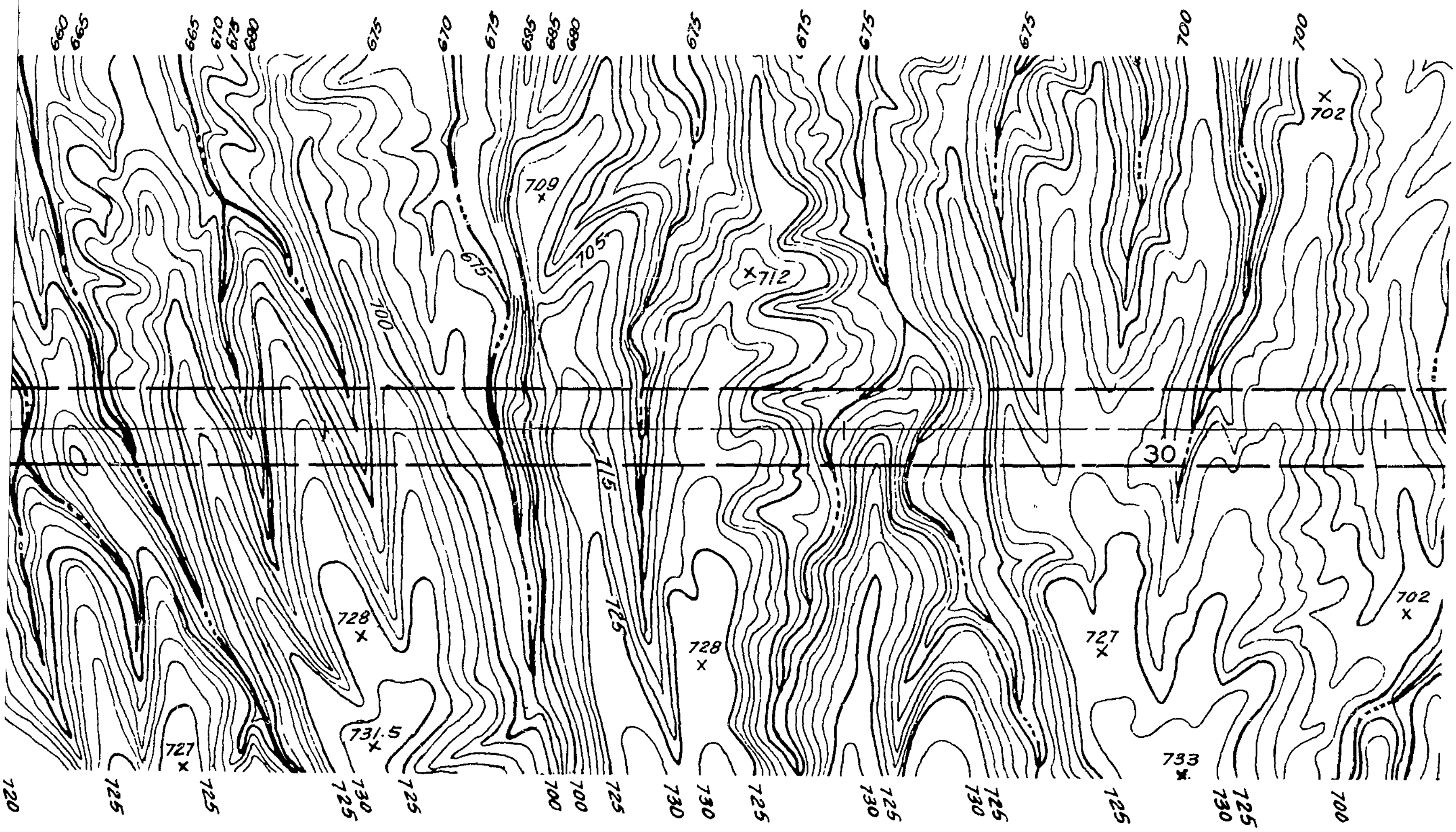
1

LEGEND

— — —	LIMITS OF TEST COURSE	*TT	TERRAIN TYPE
——┼—— 6	CENTER-LINE STAKE	LS	LANDSCAPE
—·—·—	DRAINAGE	GF	GROUND FACTOR
═ ═ ═ ═	IMPROVED ROADS	V	VEGETATION
— — — —	UNIMPROVED ROADS OR TRAILS		

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

4L,4,3,4-6,9-2/4	1,1,1b,2-6,9-2/4
4L,4,3,4	1,1,1b,2



6,9

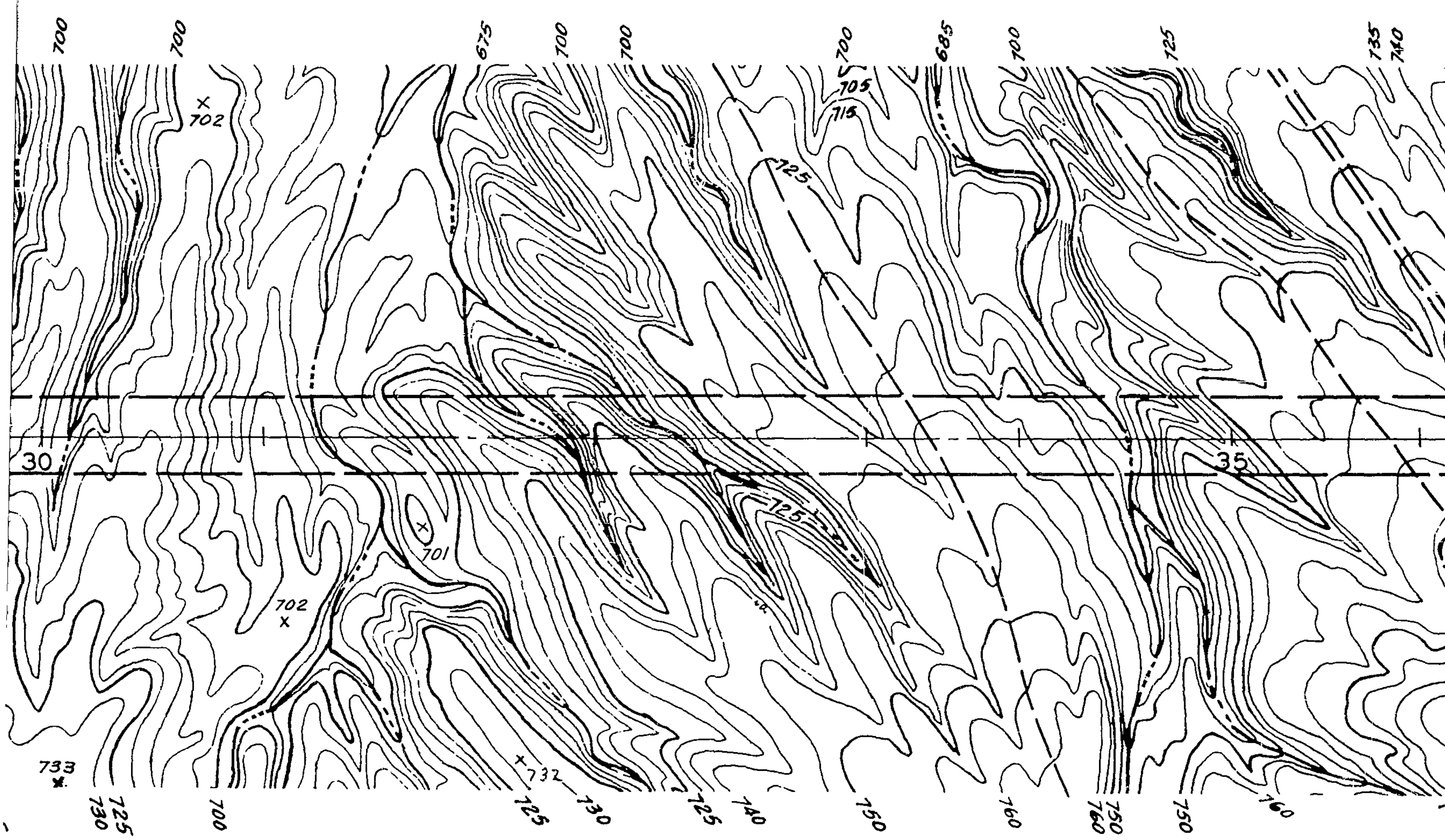
2/4

AIN TYPE
SCAPE
ND FACTOR
TATION

N REVERSE

2

-2/4	1,4,1b,2-6,9-2/4
	1,4,1b,2



6,9	
/4	

3

TOPO

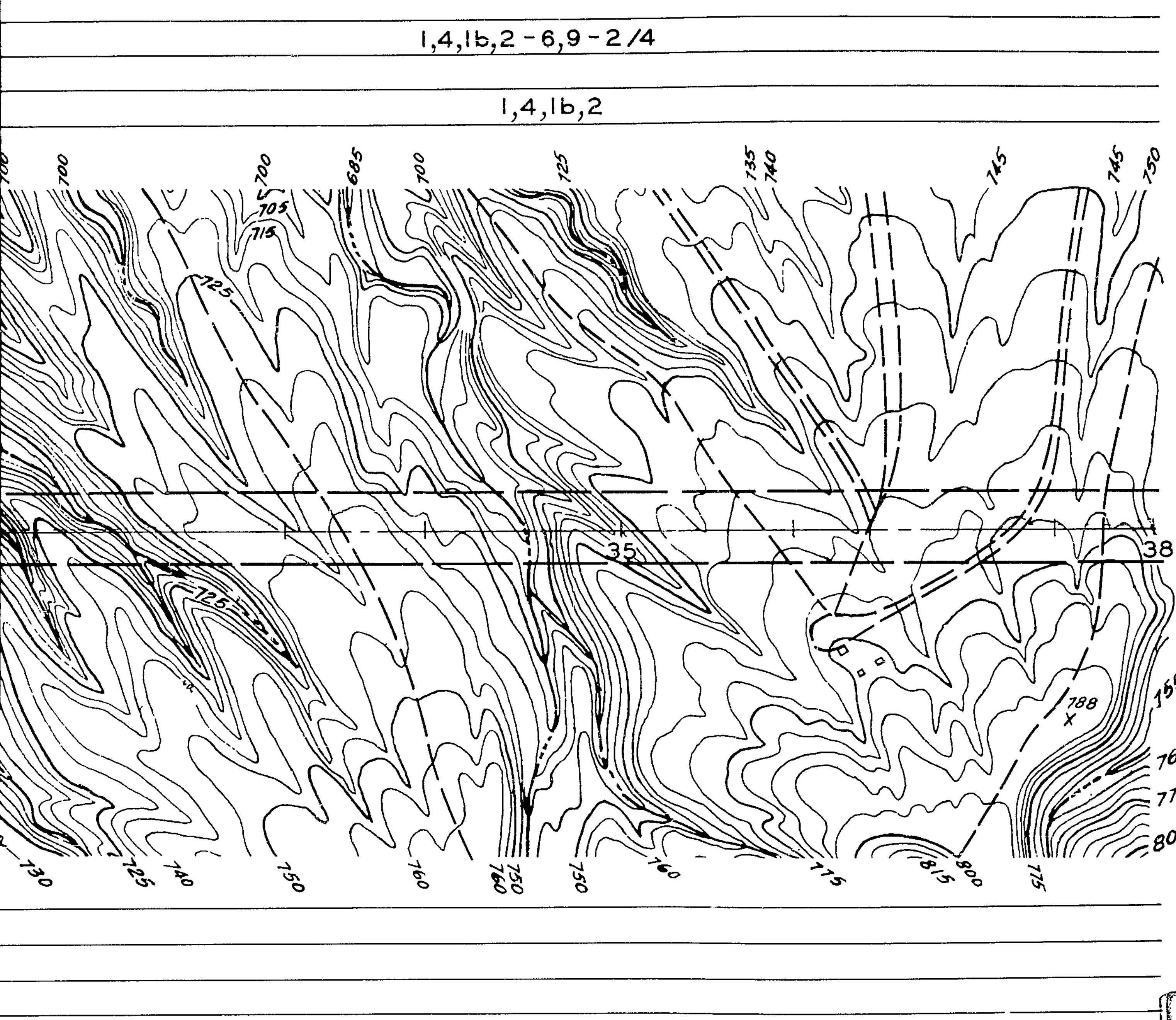
TEST

S

SCA

500 0

CONTOU

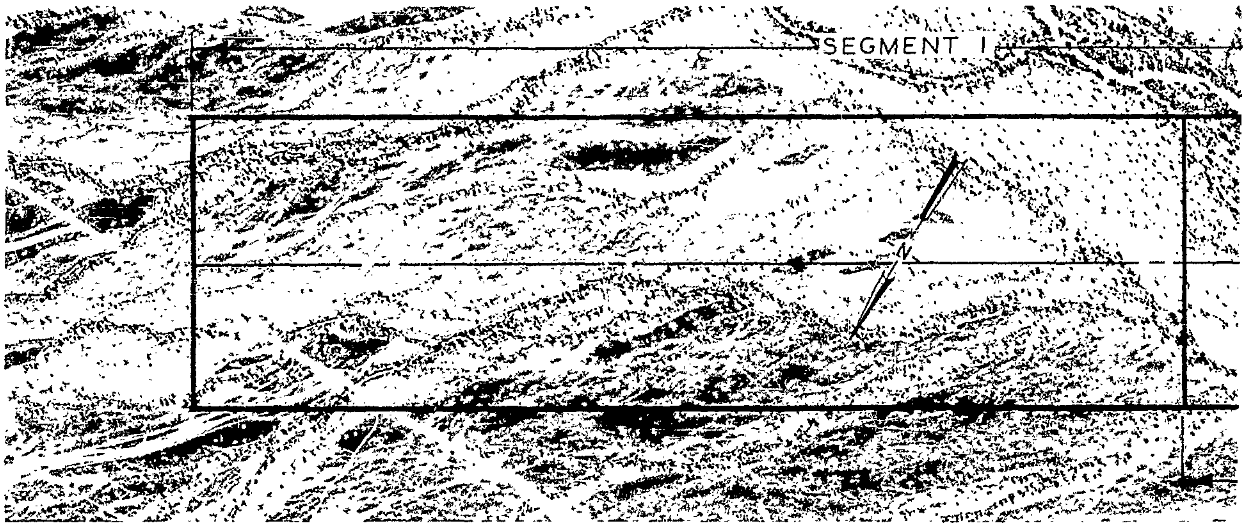


TOPOGRAPHIC MAP
TEST COURSE NO. 4
SEGMENT 3

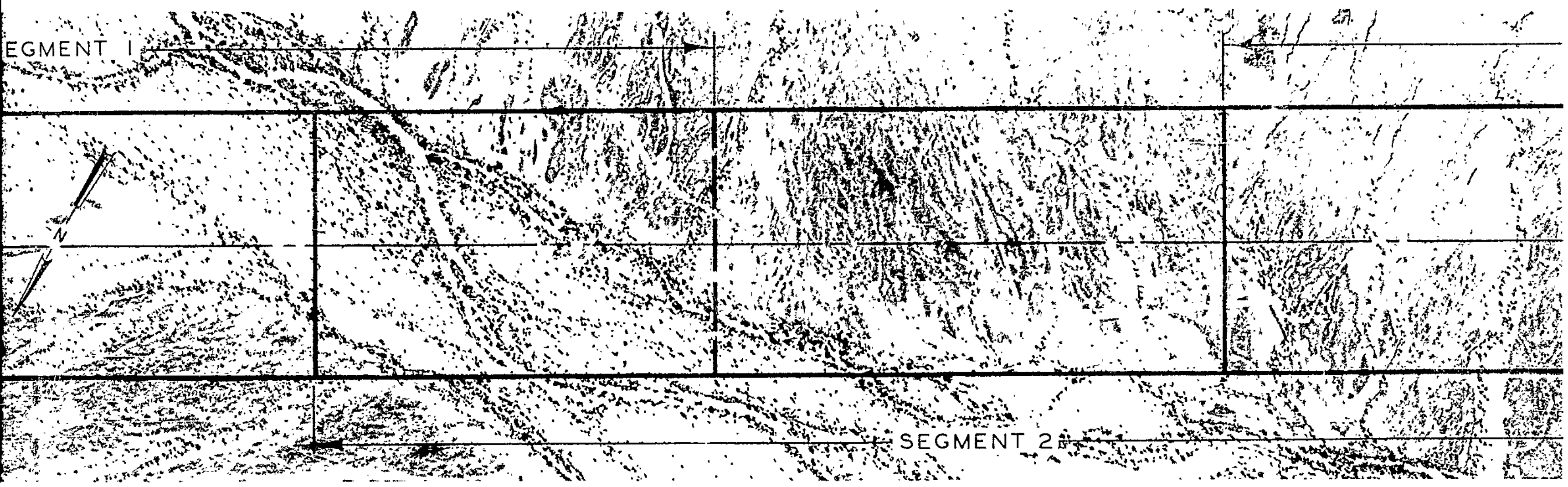
SCALE IN FEET

500 0 500 1000

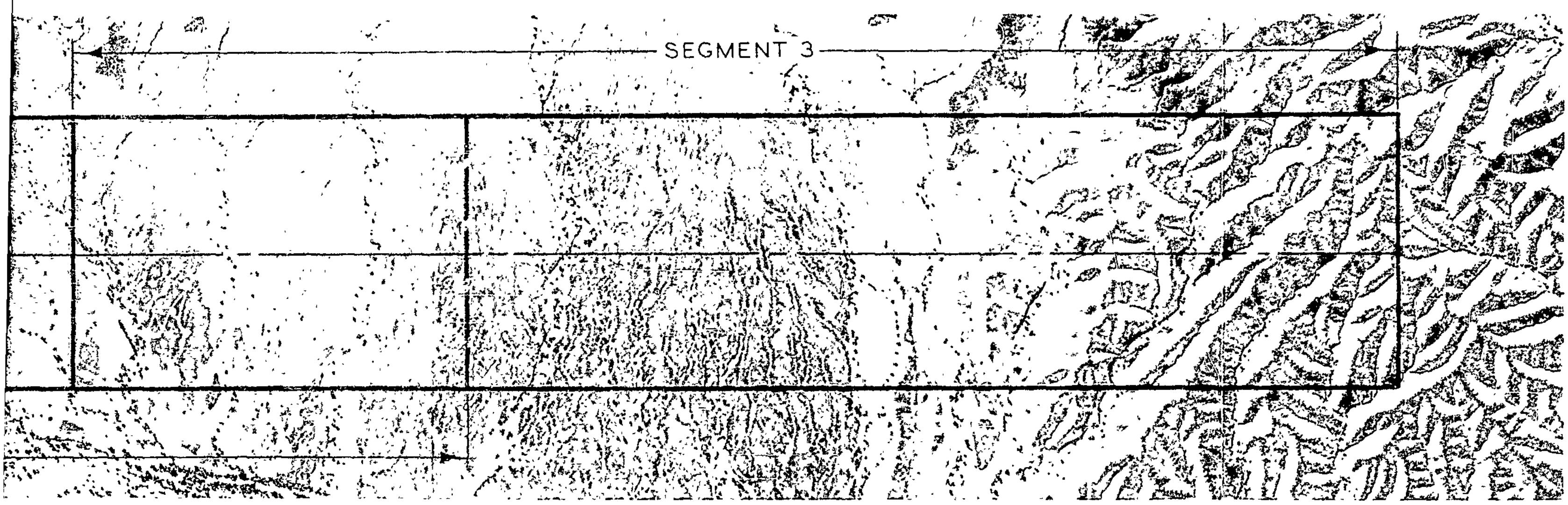
CONTOUR INTERVAL = 5 FT



1



2



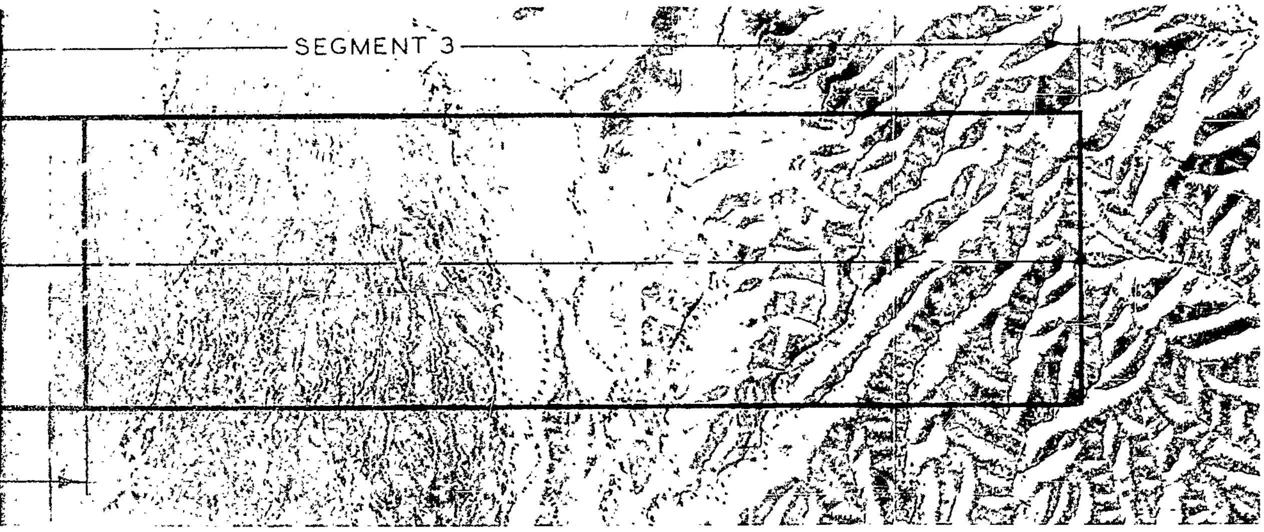
3

AERIAL MO

TEST COURSE

SCALE IN F

1000 0 1



4

AERIAL MOSAIC
TEST COURSE NO. 5

SCALE IN FEET
1000 0 1000 2000

TERRA

TEST (

HIGHS ARE	LANDSCAPE: PLAN-PROFILE: % AREA OCCUPIED BY HIGHS >60	40-60	<40	SLOPE OCCURRENCE PER 10 MILES <1	5-20	20-100	CHARACTERISTIC SLOPE 0°-1/2°	1/2°-2°	2°-6°	6°-14°	CHARACTERISTIC RELIEF TYPE I 0-10	10-50	TYPE II 0-100	100-400	GR… SOIL TYPE: SAND	GRAVEL	SAND AND/O… GRAVEL W/FINES
FLAT-TOPPED	X			X				X				X					X
PEAKED OR CRESTED	X					X				X			X				X
NO PRONOUNCED HIGHS OR LOWS		X		X			X				X						X
		X		X			X				X						X
		X		X				X			X						X
		X		X				X			X						X

* EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAP TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR C

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO AR PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES

1

TERRAIN TYPES

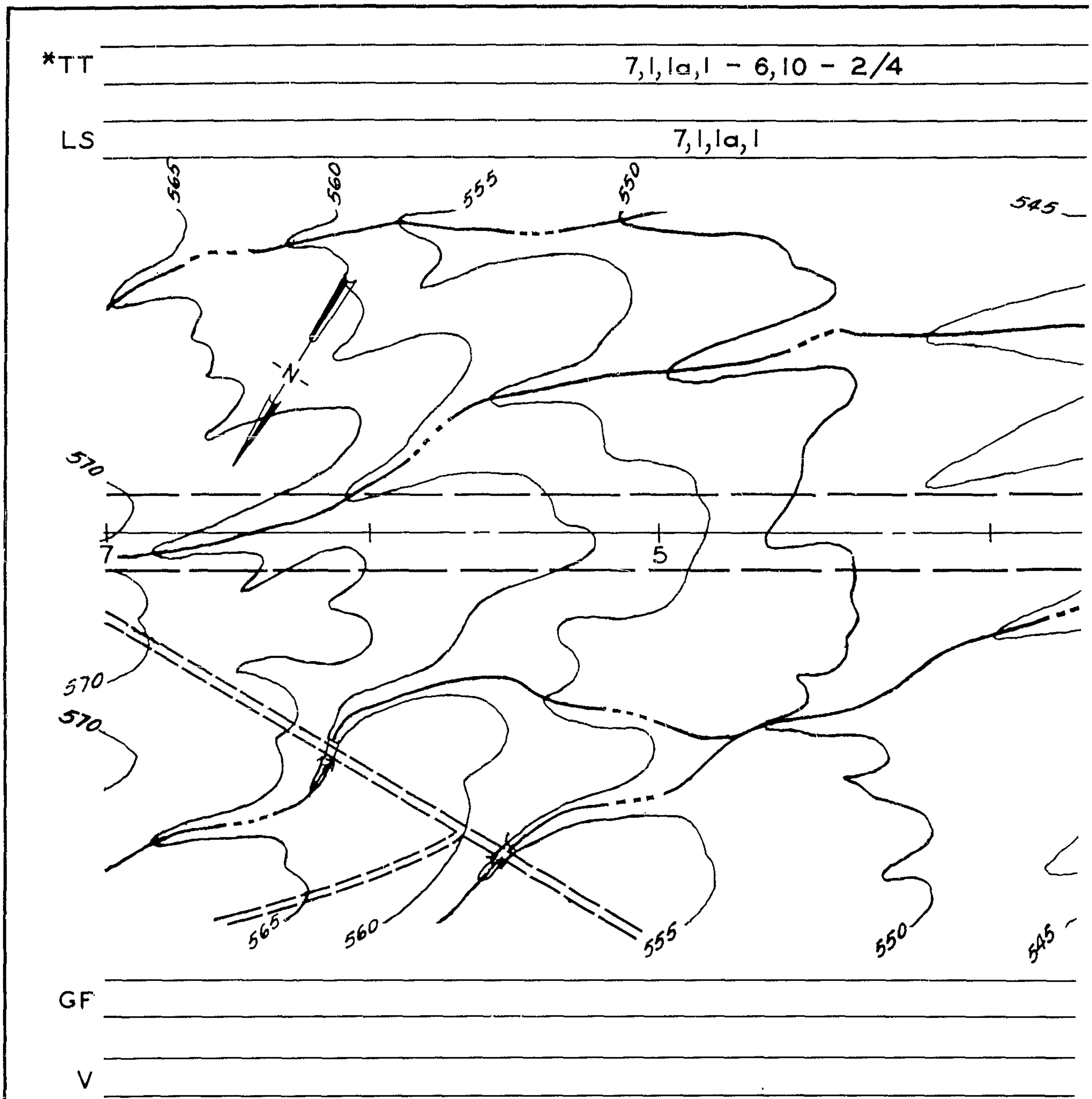
TEST COURSE 5

C		GROUND FACTORS							VEGETATION				TERRAIN TYPE*						
		SOIL TYPE				SOIL CONSISTENCY			BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	LANDSCAPE				GROUND† FACTORS		VEGETATION†
PE II		SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT AND/OR CLAY WITH COARSE MATERIAL	LOOSE >12" BELOW SURFACE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE											
	100-400												PP	SO	CS	CR	ST	SC	
				X			X/	/X		X/		/X	1	1	1b	2	6	9/10	2/4
				X			/X	X/	X/			/X	4	4	3	4	6	10/9	1/4
				X				X		X/		/X	7	1	1a	1	6	10	2/4
				X				X			X/	/X	7	1	1a	1	6	10	3/4
				X			X/	/X		X/		/X	7	1	1b	1	6	9/10	2/4
				X				X		X/		/X	7	1	1b	1	6	10	2/4

ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL
ED IN THAT ORDER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY
: HAVE BEEN INDICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

UND AND VEGETATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS. IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE
DENOMINATOR IN THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2



LEGEND

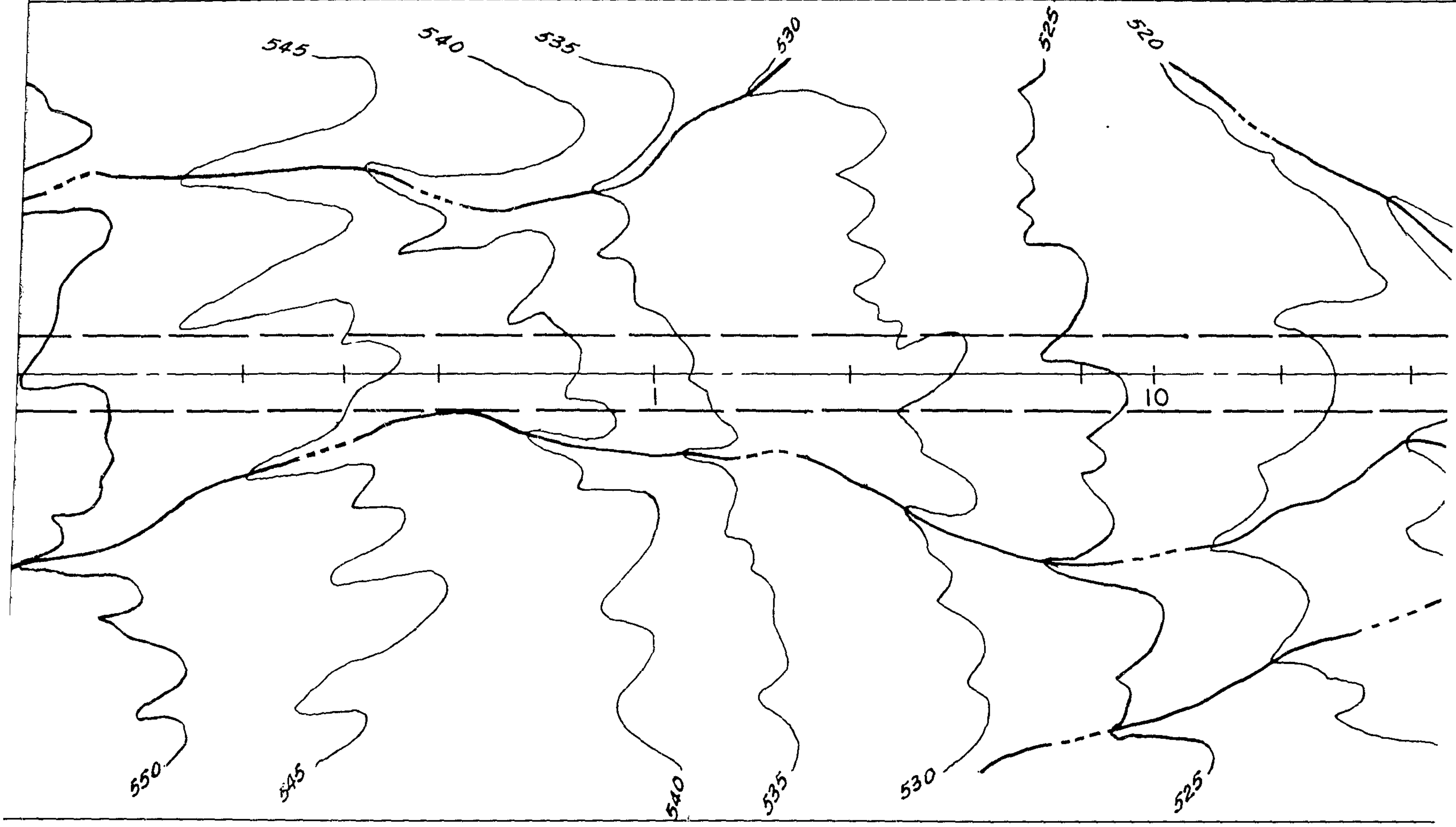
LIMITS OF TEST COURSE	*TT TERRAIN TYPE
CENTER-LINE STAKE (6)	LS LANDSCAPE
	GF GROUND FACTOR
DRAINAGE	V VEGETATION
IMPROVED ROADS	
UNIMPROVED ROADS OR TRAILS	

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

10 - 2/4

7,1,1b,1 - 6,10 - 2/4

7,1,1b,1



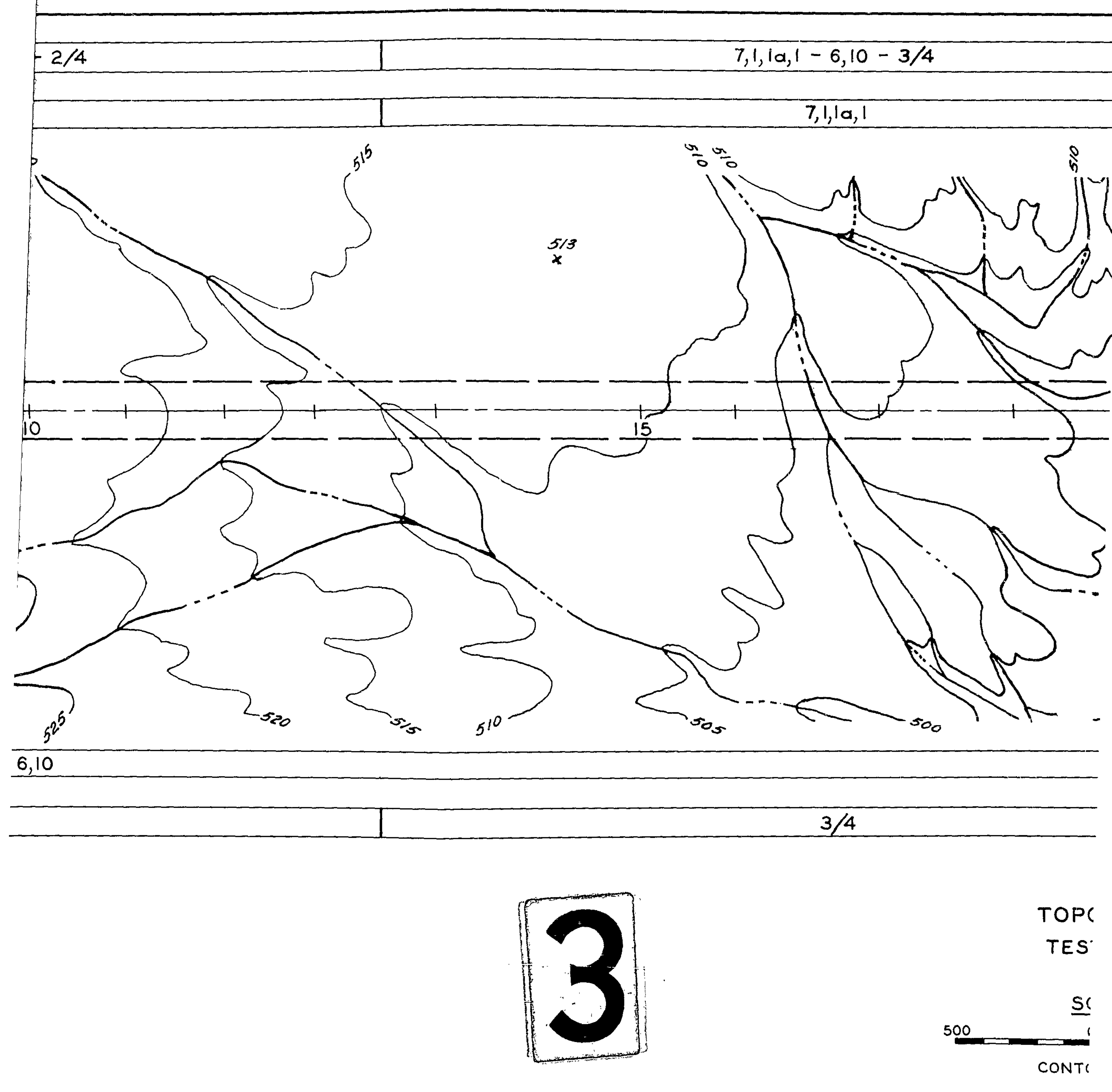
6,10

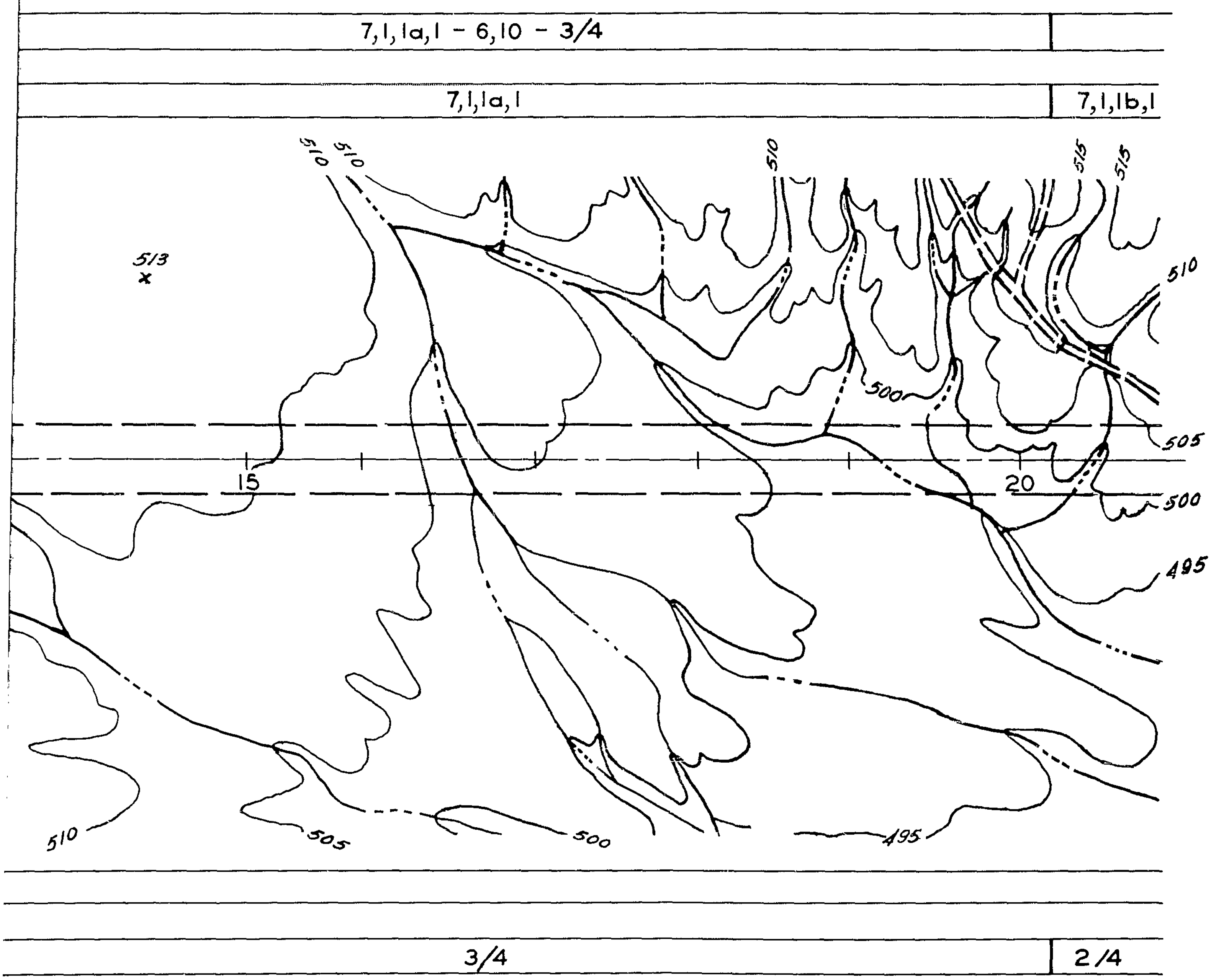
2/4

ERRAIN TYPE
ANDSCAPE
ROUND FACTOR
EGETATION

NS ON REVERSE

2


- 2/4
7,1,1a,1 - 6,10 - 3/4
7,1,1a,1
515
513
510
510
510
10
15
525
520
515
510
505
500
6,10
3/4
3
TOP
TES
500
CONT



4

TOPOGRAPHIC MAP

TEST COURSE NO. 5
SEGMENT 1

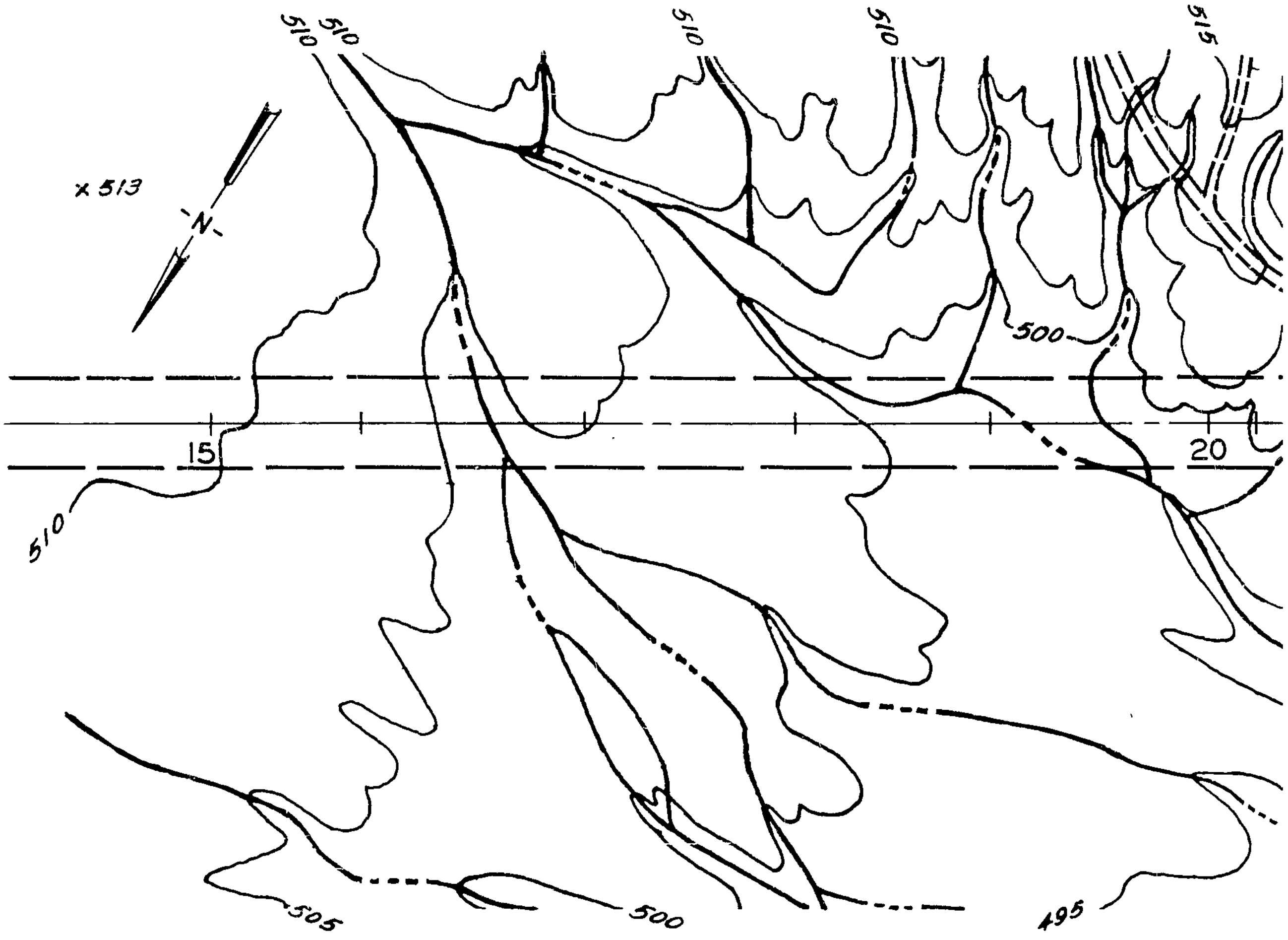
SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

*TT 7,1,1a,1 - 6,10 - 3/4

LS 7,1,1a,1



GF 6,10

V 3/4

LEGEND

LIMITS OF TEST COURSE

CENTER-LINE STAKE (6)

DRAINAGE

IMPROVED ROADS

UNIMPROVED ROADS OR TRAILS

*TT TERRAIN TYPE

LS LANDSCAPE

GF GROUND FACTOR

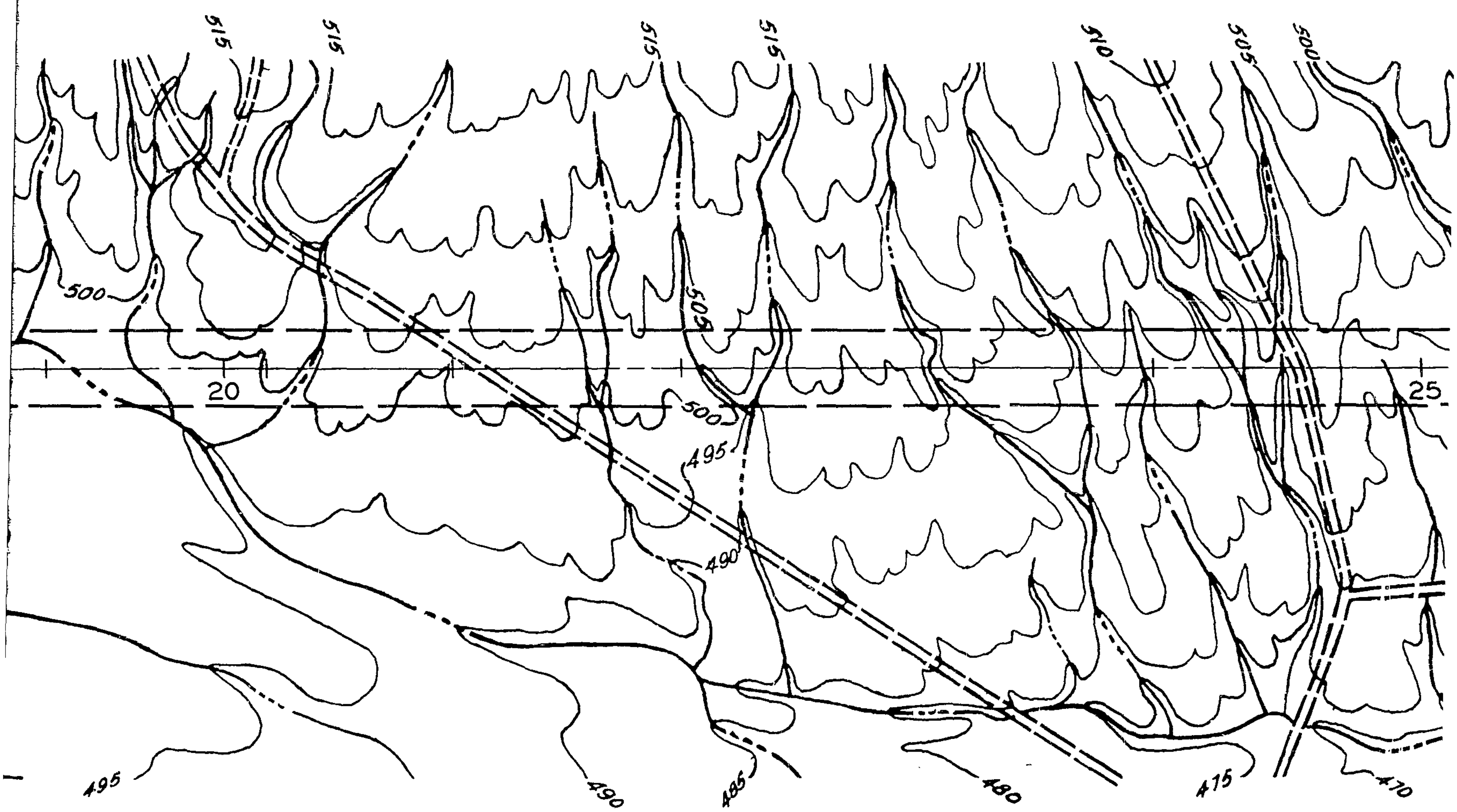
V VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

7,1,1b,1 - 6,9/6,10 - 2/4

7,1,1b,1



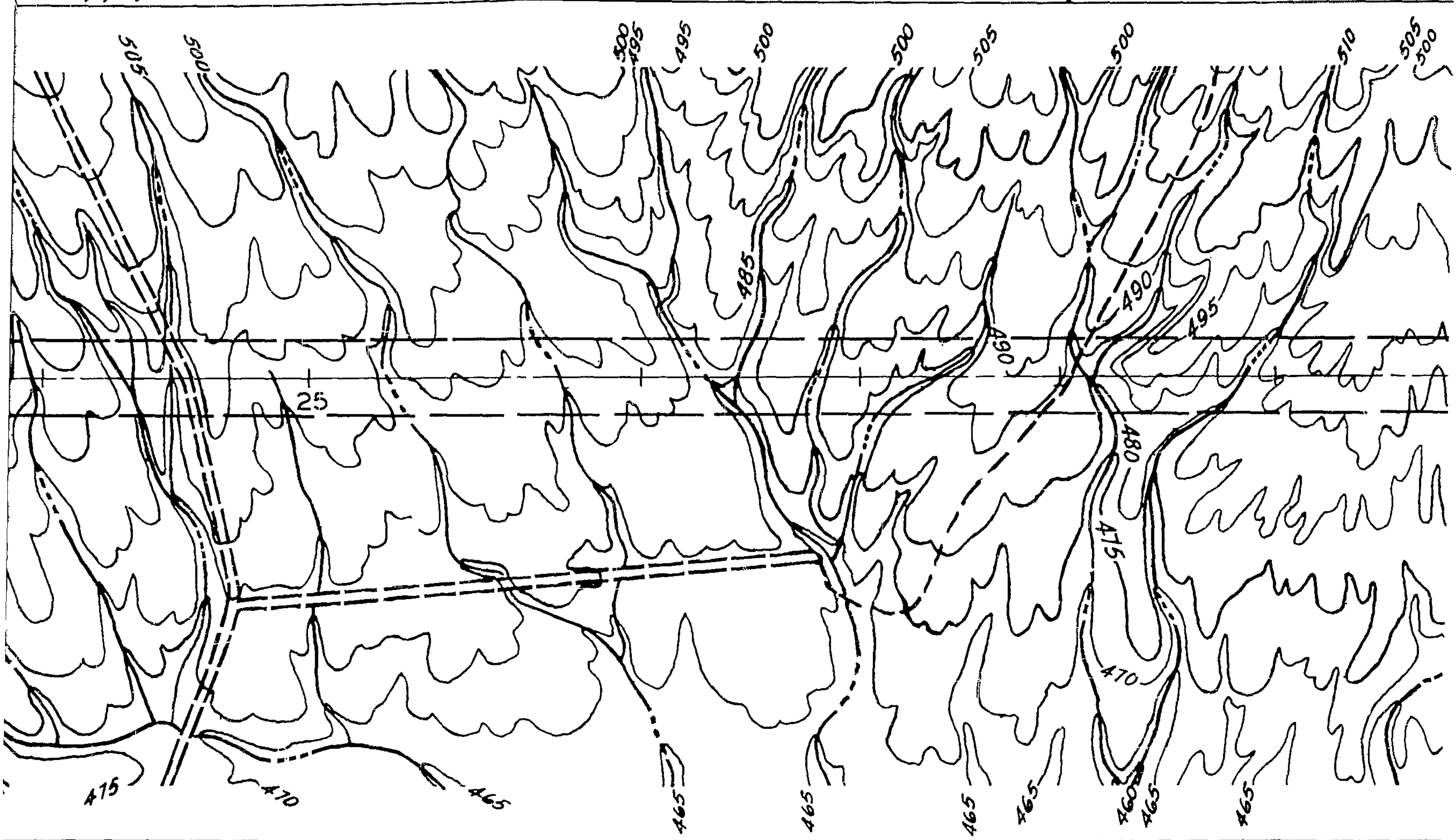
'YPE
E
ACTOR
ON

VERSE

2

,1 - 6,9/6,10 - 2/4 | 1,.1,1b,2 - 6,9/

7,1,1b,1 | 1,1,1b,



6,9/6,10

2/4

3

TOPOGR

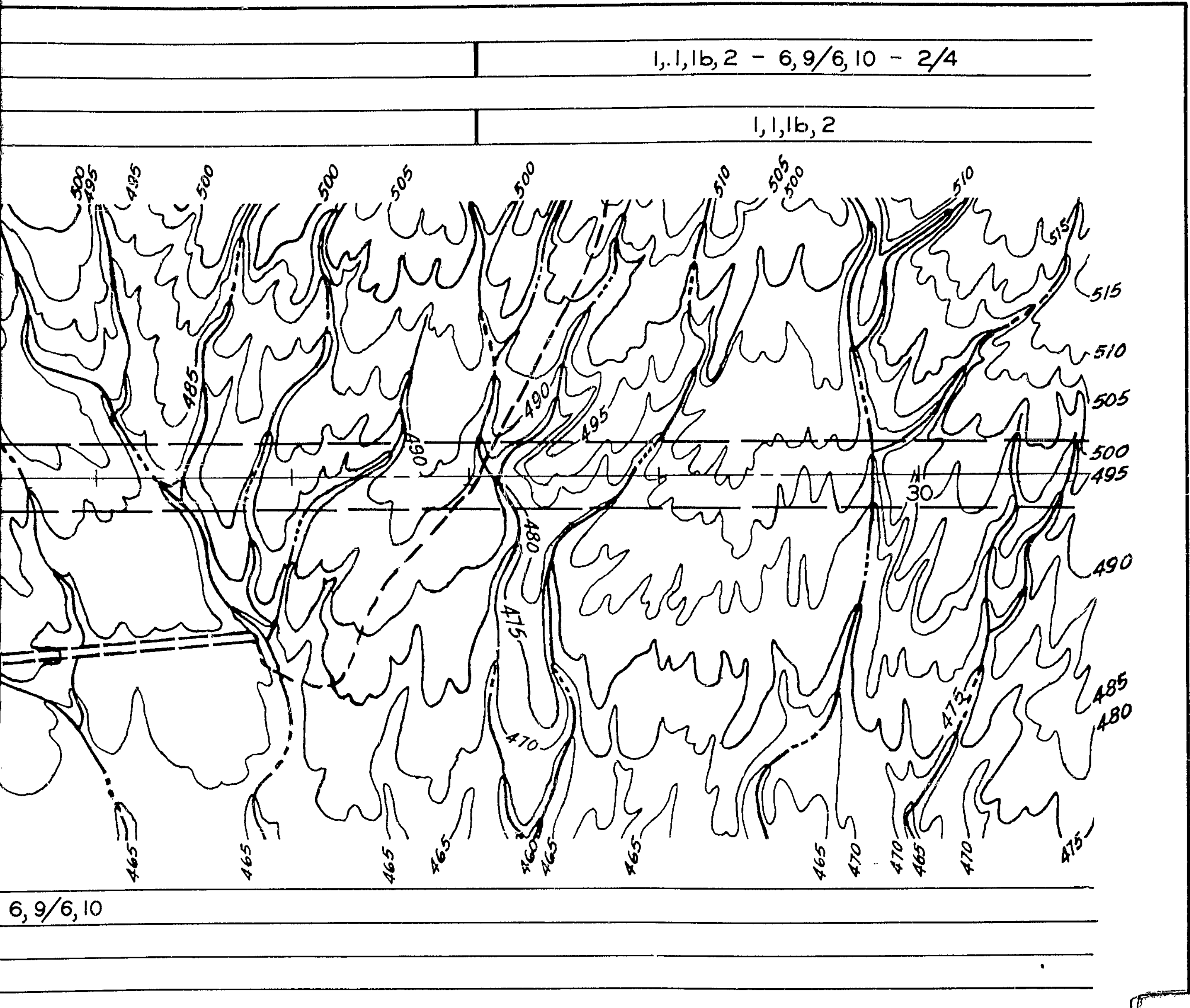
TEST CC

SEG

SCAL

500 0

CONTOUR I



TOPOGRAPHIC MAP

TEST COURSE NO. 5
SEGMENT 2

SCALE IN FEET

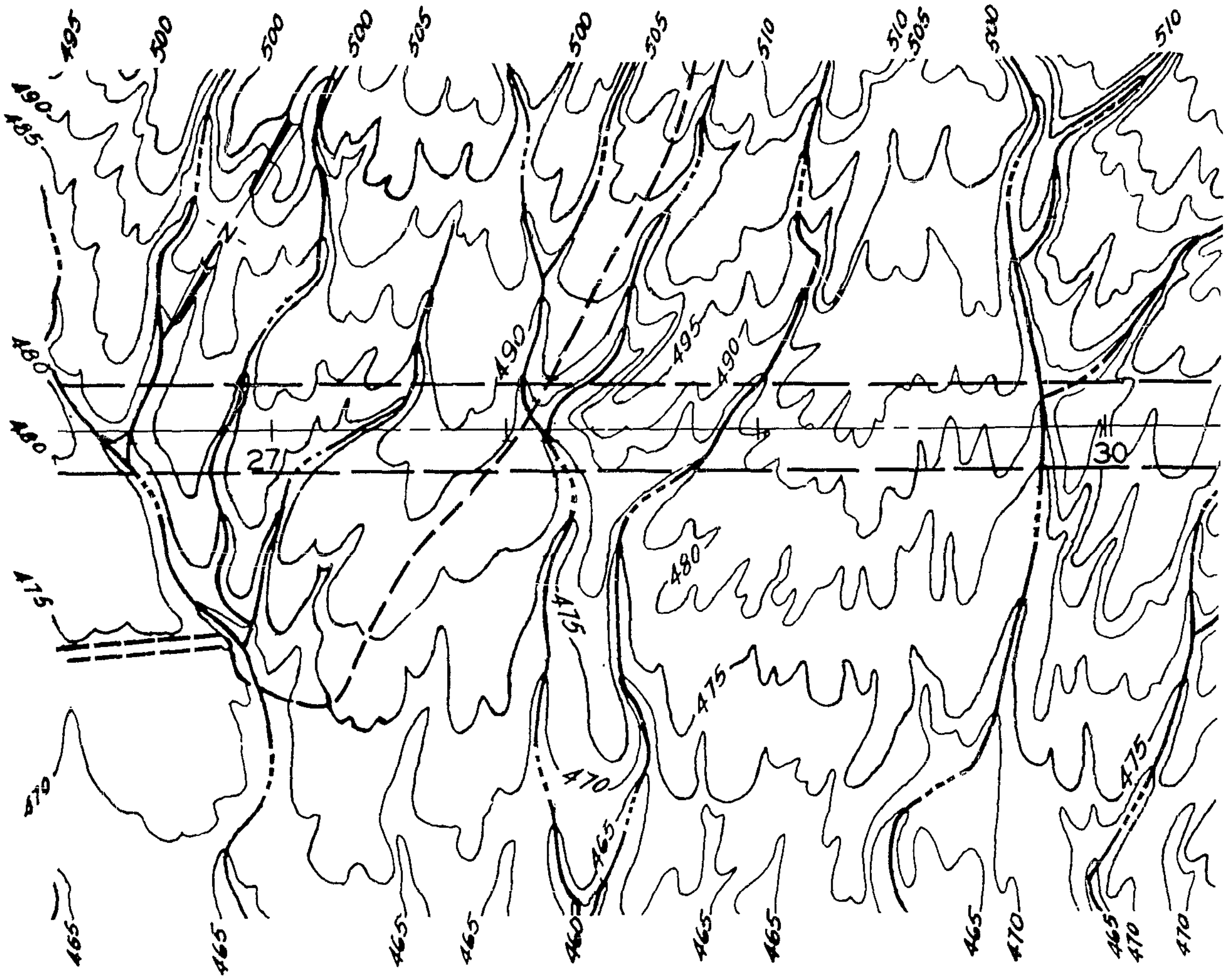
500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT 7,1,1b,1-6,9/6,10-2/4

LS 7,1,1b,1



GF

V

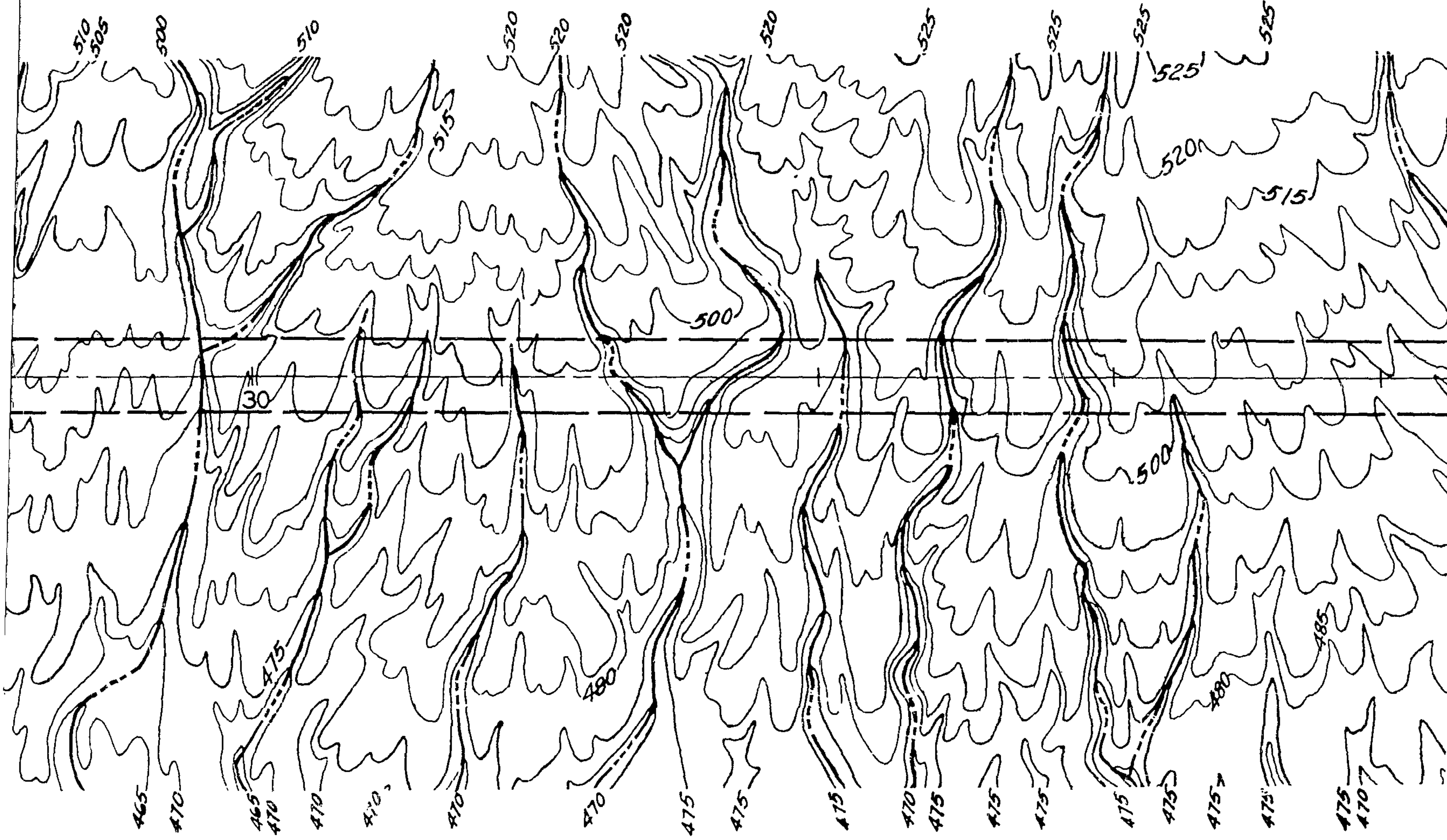
LEGEND

——— ———	LIMITS OF TEST COURSE	*TT	TERRAIN TYPE
———┼——— 6	CENTER-LINE STAKE	LS	LANDSCAPE
——-·-·——	DRAINAGE	GF	GROUND FACTOR
═ ═ ═ ═	IMPROVED ROADS	V	VEGETATION
— — — —	UNIMPROVED ROADS OR TRAILS		

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1,1,1b,2 - 6,9/6,10 - 2/4

1,1,1b,2



6,9/6,10

2/4

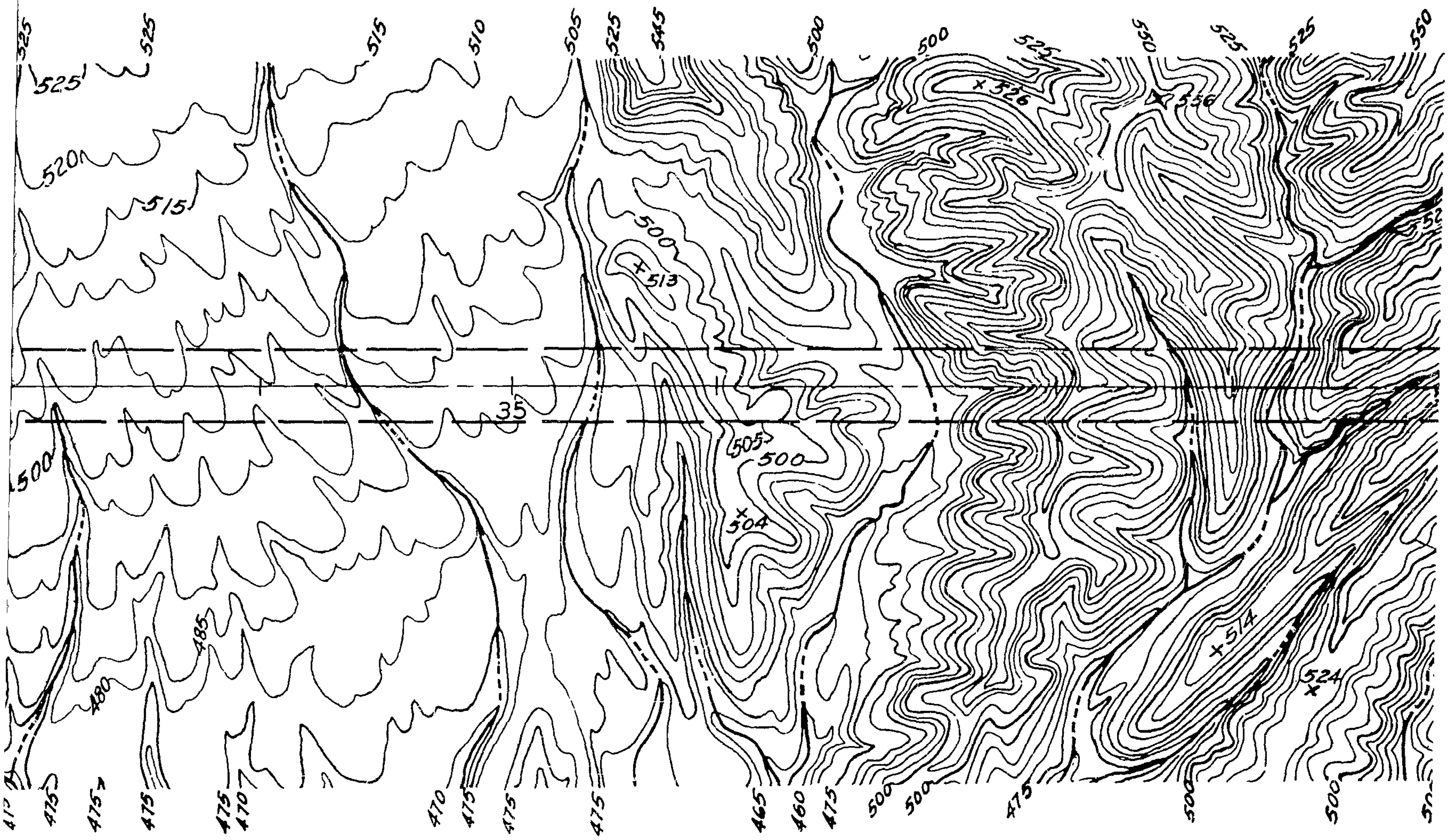
ERRAIN TYPE
ANDSCAPE
ROUND FACTOR
EGETATION

NS ON REVERSE

2

4,4,3,4 - 6,10/6,9 - 1/4

4,4,3,4



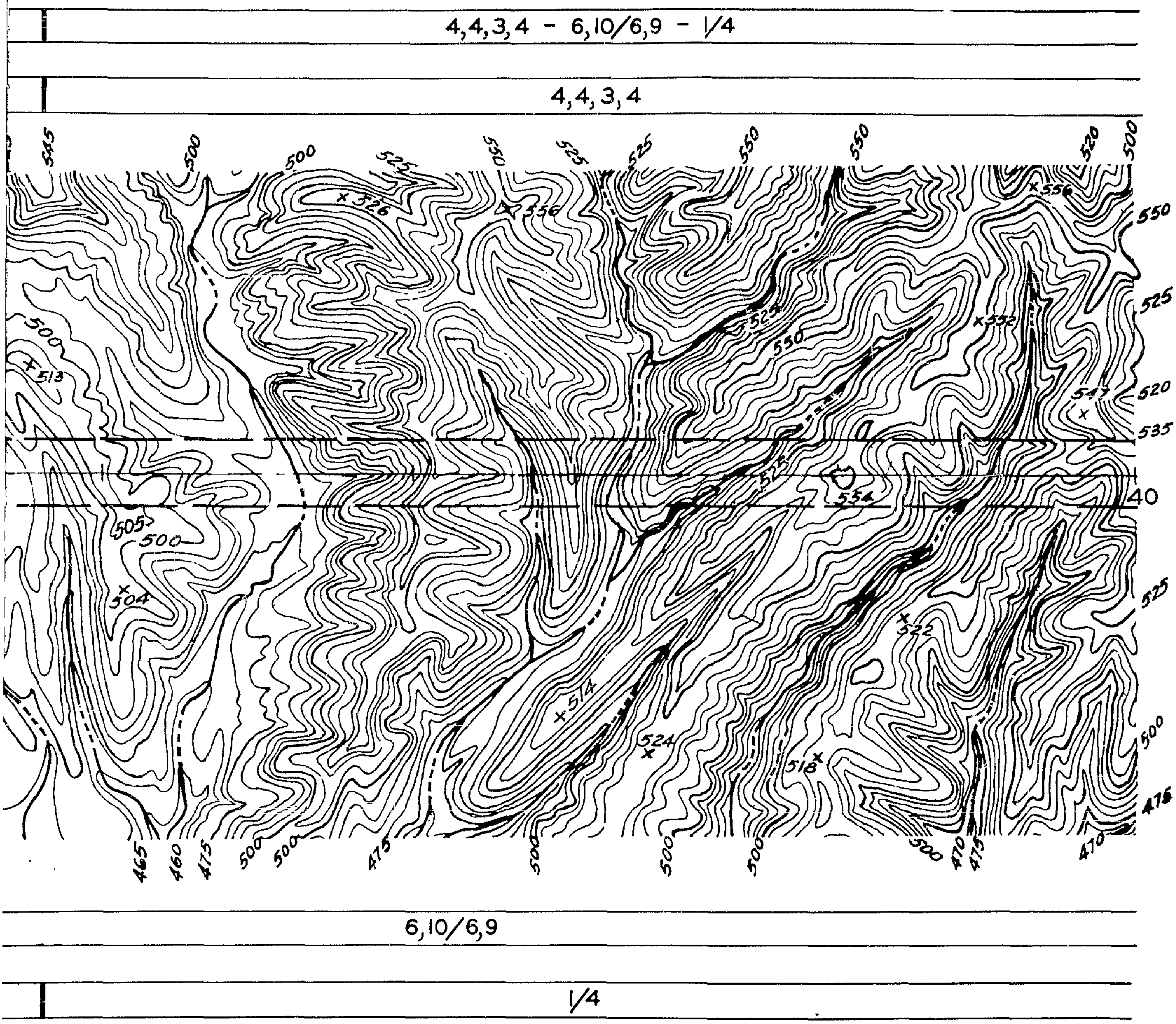
6,10/6,9

3/4

1/4

3

TOI
TE
S
500
CON



TOPOGRAPHIC MAP

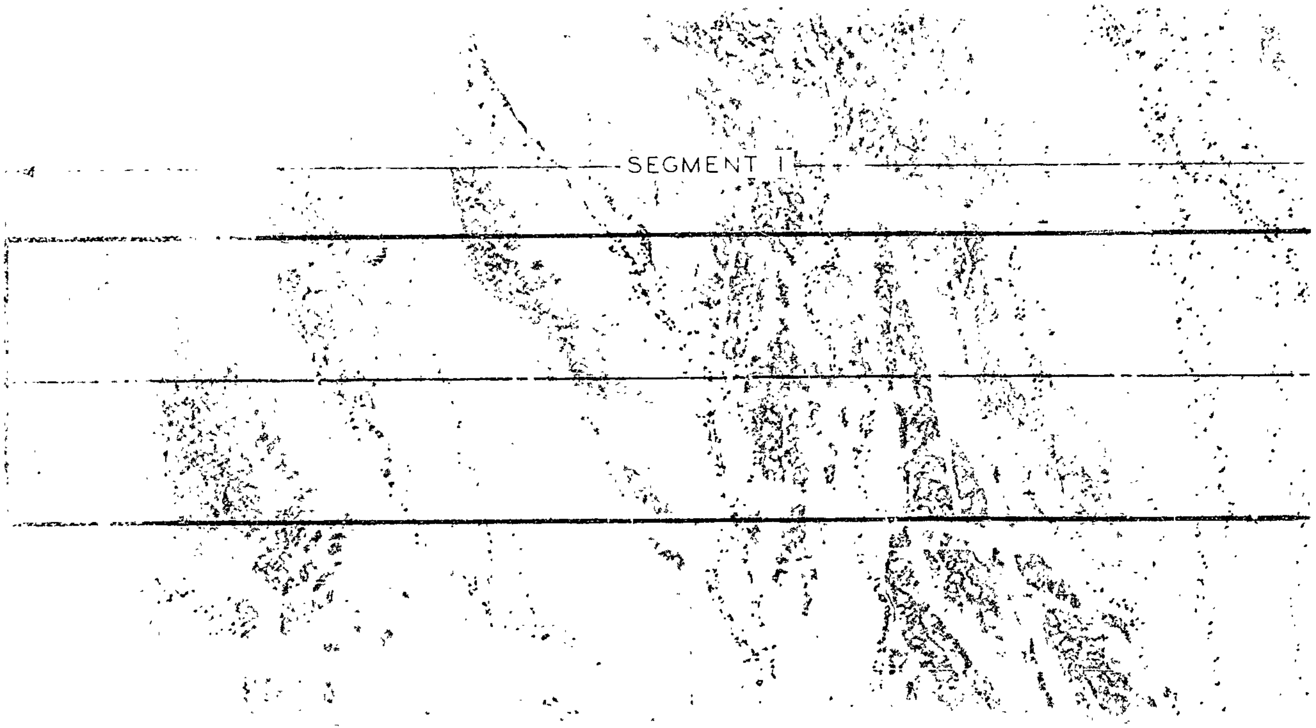
TEST COURSE NO. 5
SEGMENT 3

SCALE IN FEET

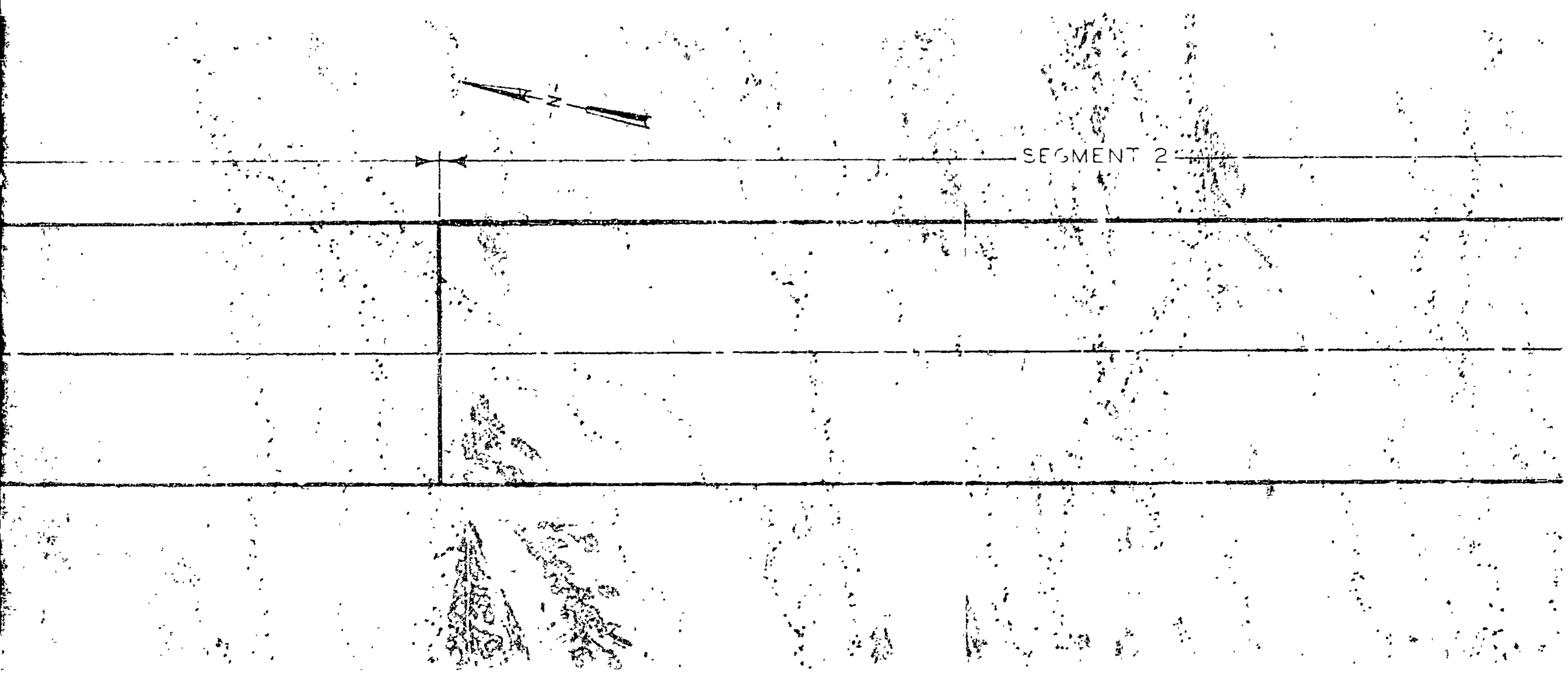
500 0 500 1000

CONTOUR INTERVAL = 5 FT

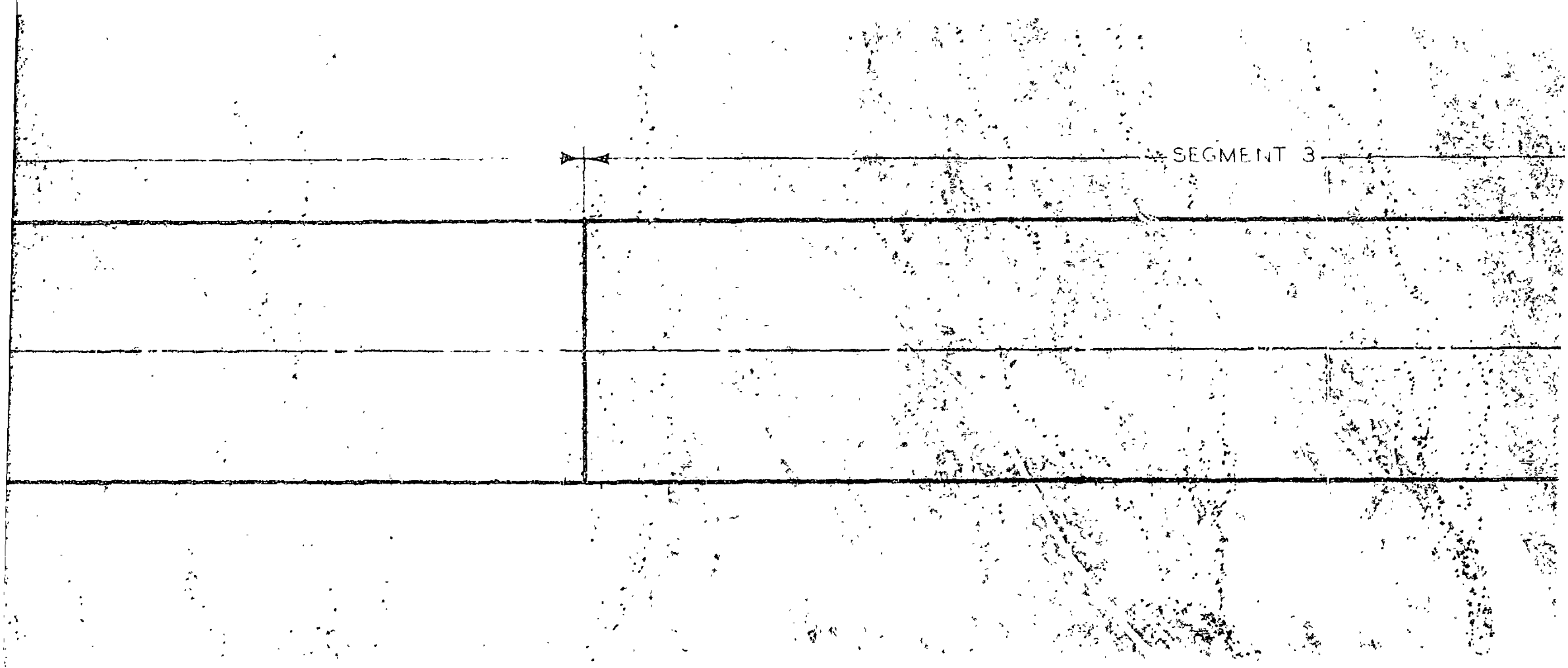
4



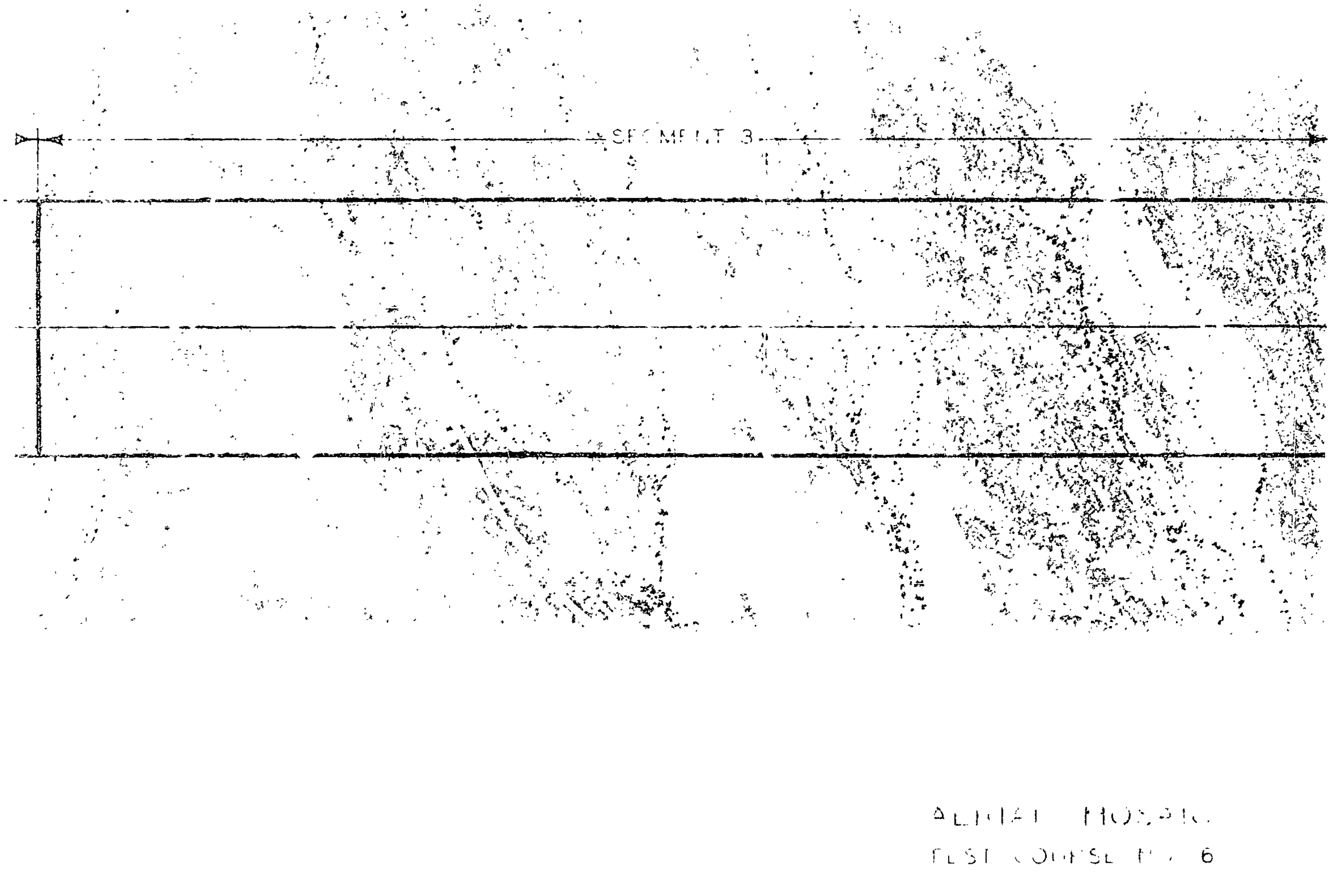
1



2



3



AERIAL MOSAIC
TEST COURSE NO. 6

SCALE IN FEET

4

TERRA

TEST

LANDSCAPE															GI		
PLAN-PROFILE				SLOPE OCCURRENCE PER 10 MILES			CHARACTERISTIC SLOPE				CHARACTERISTIC RELIEF				SOIL TYPE		
HIGHS ARE	% AREA OCCUPIED BY HIGHS										TYPE I		TYPE II		SAND	GRAVEL	SAND AND/O GRAVEL W/FINES
	>60	40-60	<40	<1	5-20	20-100	0°-1/2°	1/2°-2°	2°-6°	6°-14°	0-10	10-50	0-100	100-400			
FLAT-TOPPED	X				X			X				X					X
		X		X				X				X					X
		X		X				X				X					X
PEAKED OR CRESTED			X	X				X				X					X
			X	X				X				X					X
			X		X			X			X						X
			X		X			X			X						X
			X		X			X			X						X
NO PRONOUNCED HIGHS OR LOWS		X		X				X			X						X

• EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPF TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR CC

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO ARE PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES

1

TERRAIN TYPES

TEST COURSE 6

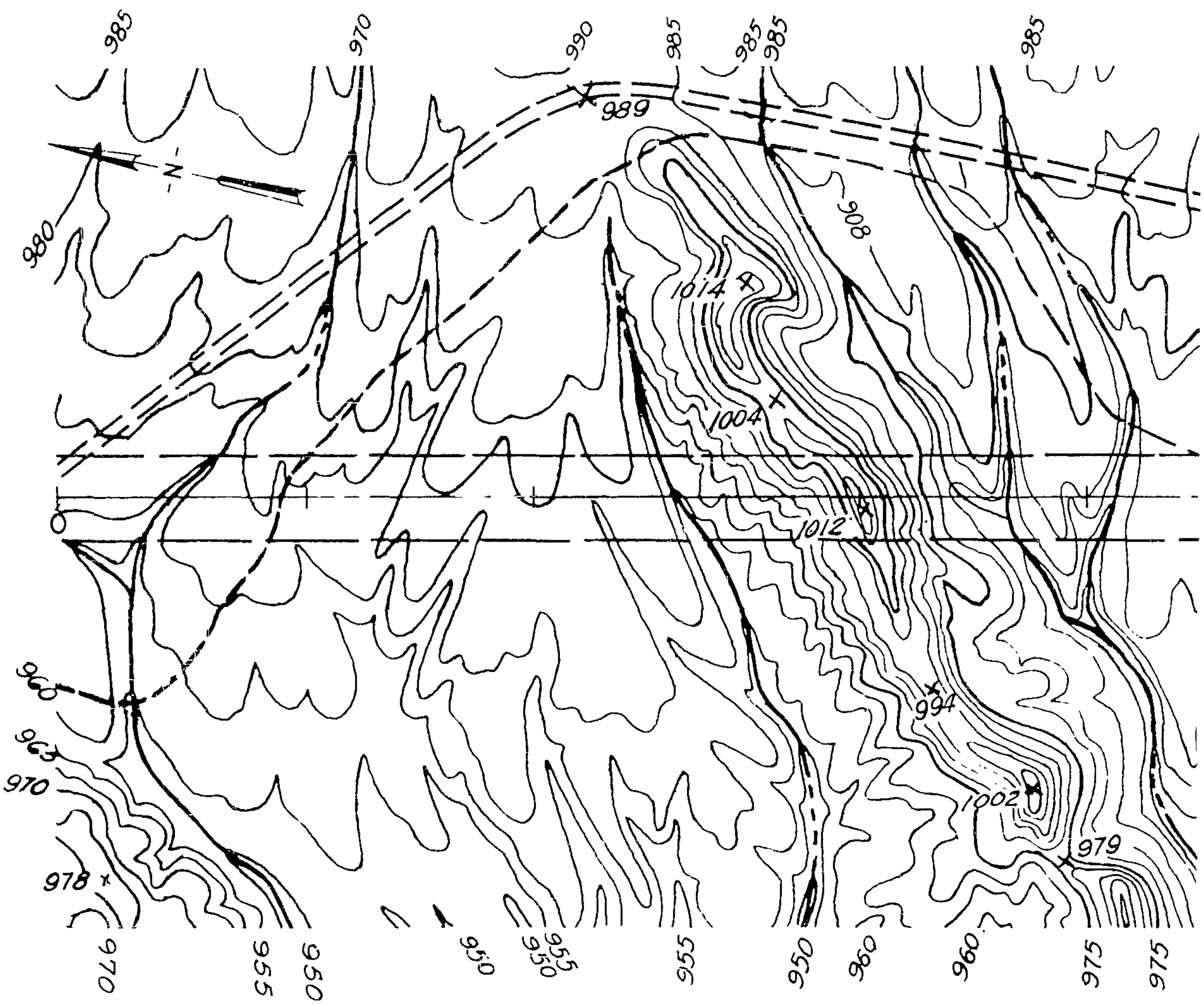
	GROUND FACTORS							VEGETATION				TERRAIN TYPE*						
	SOIL TYPE				SOIL CONSISTENCY			BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	LANDSCAPE				GROUND† FACTORS		VEGETATION†
400	SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT AND/OR CLAY WITH COARSE MATERIAL	LOOSE >12" BELOW SURFACE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE					PP	SO	CS	CR	ST	SC	
			X			X/	/X		X/		/X	1	3	1b	2	6	9/10	2/4
			X				X		/X	X/		2	1	1b	2	6	10	3/2
			X			/X	X/		X/		/X	2	1	1b	2	6	10/9	2/4
			X			X			X/		/X	6	1	1b	2	6	9	2/4
			X			/X	X/		X/		/X	6	1	1b	2	6	10/9	2/4
			X			X/	/X	X/		/X		6	3	1b	1	6	9/10	1/3
			X				X		X/		/X	6	3	1b	1	6	10	2/4
			X				X			X/	/X	6	3	1b	1	6	10	3/4
			X				X		X/		/X	7	1	1b	1	6	10	2/4

AY OF SEVEN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL
N THAT ORDER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY
/E BEEN INDICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

AND VEGETATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS. IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE
OMINATOR IN THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2

*TT	6,3,1b,1 - 6,9/6,10 - 1/3
LS	6,3,1b,1



GF	6,10	6,9	6,10	6,9
V	1/3			

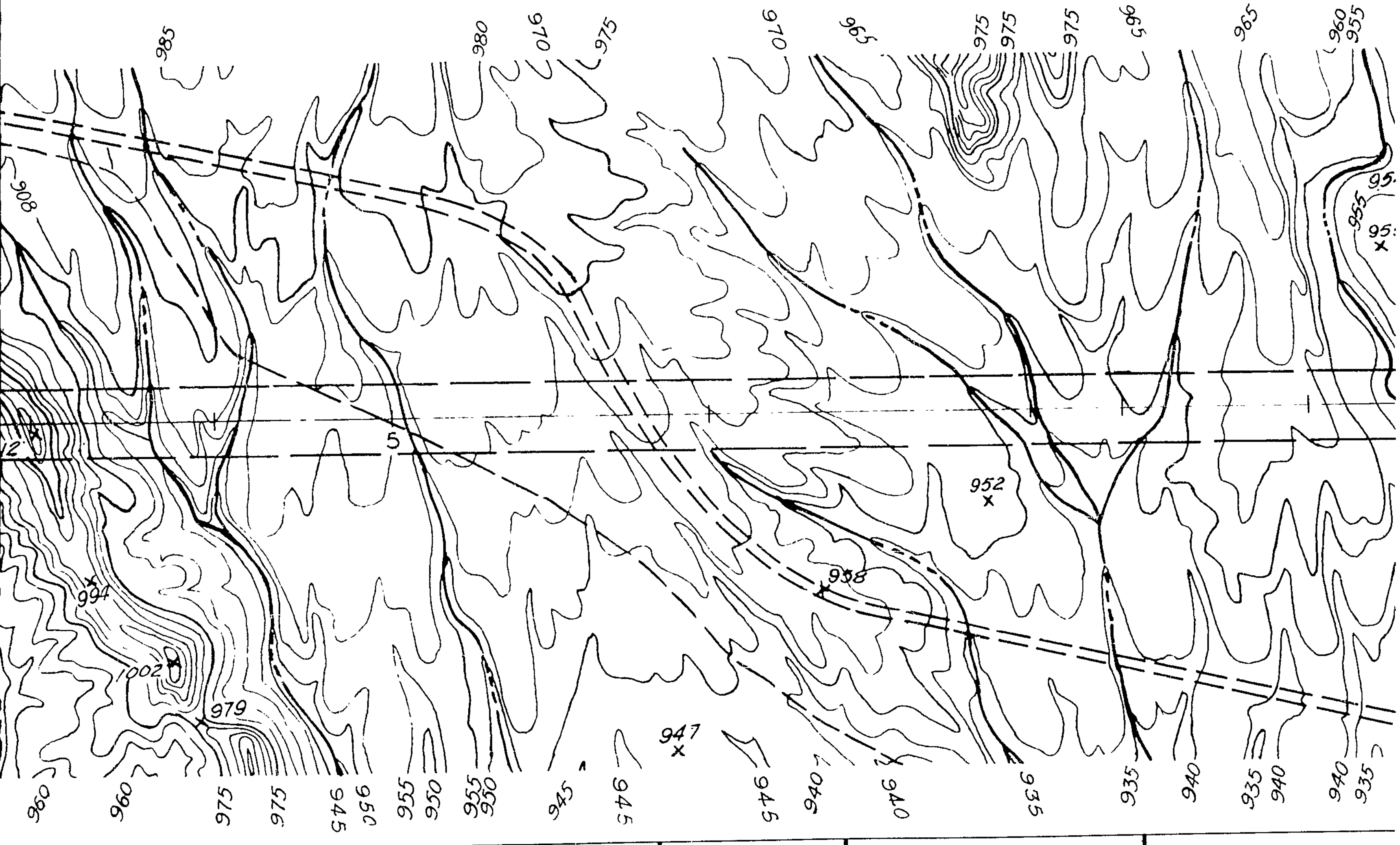
LEGEND

LIMITS OF TEST COURSE	*TT TERRAIN TYPE
CENTER-LINE STAKE (6)	LS LANDSCAPE
DRAINAGE	GF GROUND FACTOR
IMPROVED ROADS	V VEGETATION
UNIMPROVED ROADS OR TRAILS	

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

3	6,1,1b,2 - 6,10/6,9 - 2/4	

	6,1,1b,2



6,10	6,9	6,10	6,9	6,10	

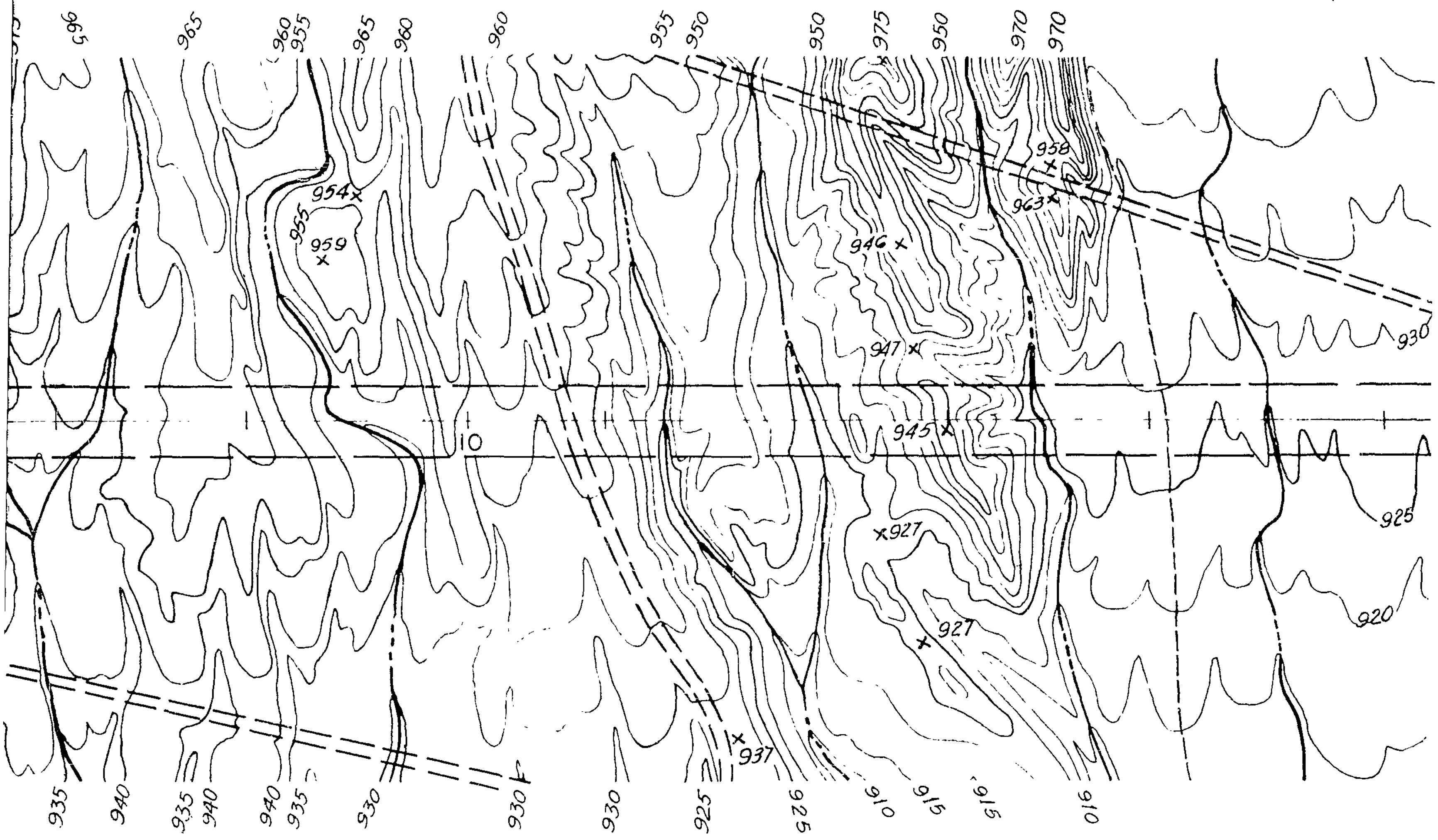
	2/4

N TYPE
CAPE
D FACTOR
ATION

REVERSE

2

6,1,1b,2 - 6,9 - 2/4	6,3,1b,1 - 6,
6,1,1b,2	6,3,1b,



6/9	6,10
4	3/4

3

TOPOG

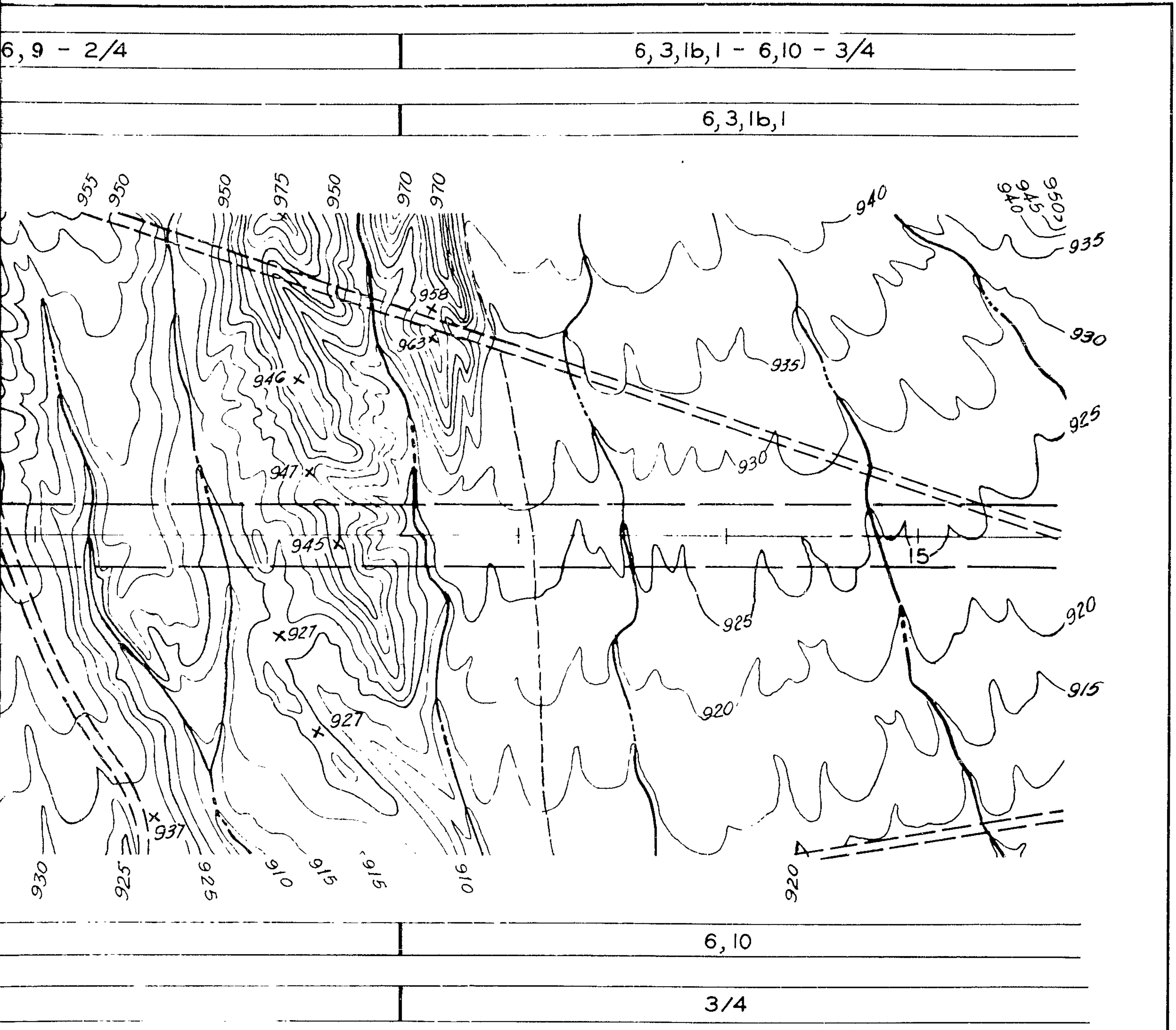
TEST (

SE

SCAL

500 0

CONTOUR



TOPOGRAPHIC MAP

TEST COURSE NO. 6
SEGMENT I

SCALE IN FEET

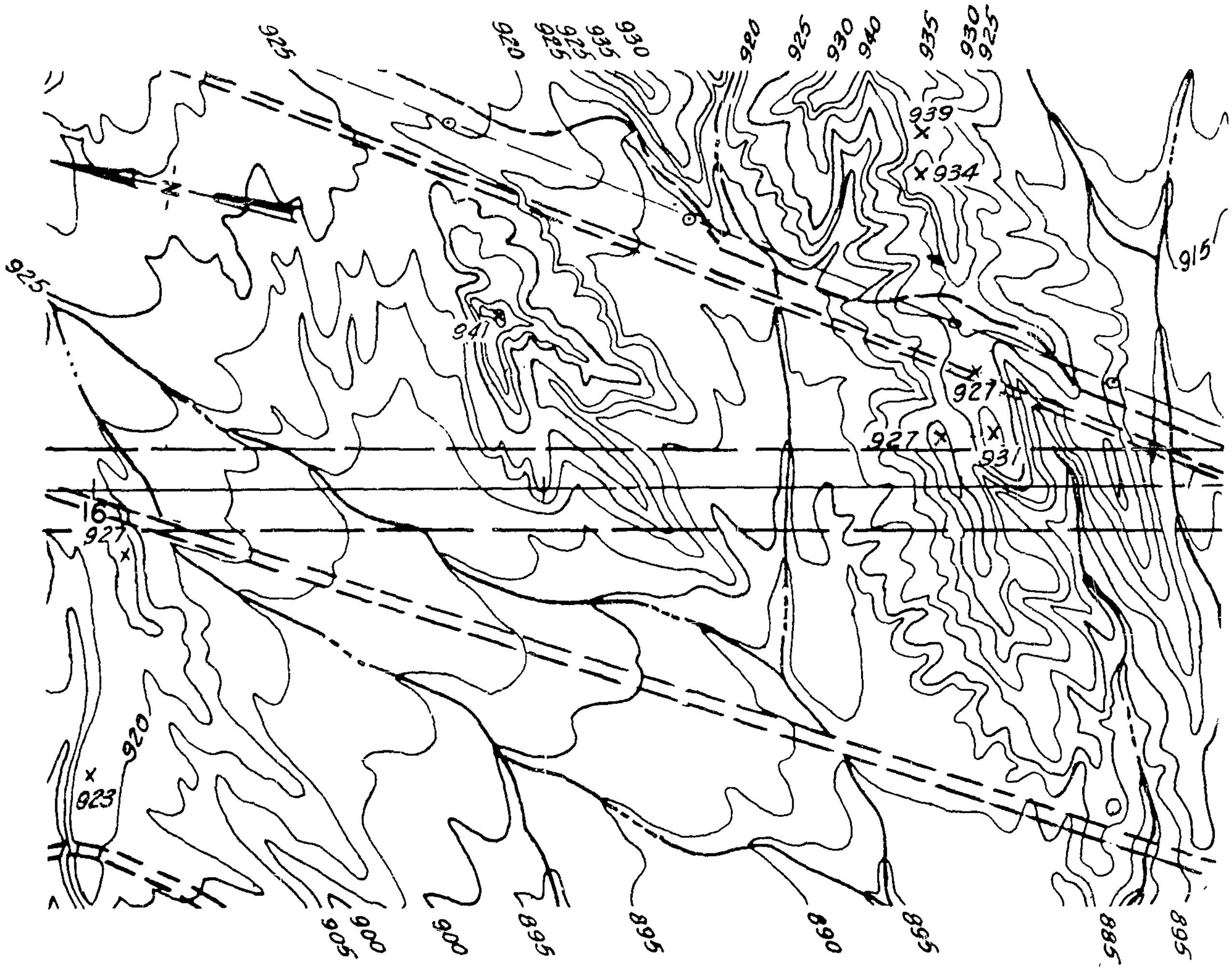
500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT 6,3,1b,1 - 6,10 - 3/4	6,3,1b,1 - 6,10 - 2/4

LS 6,3,1b,1



GF

V 3/4	

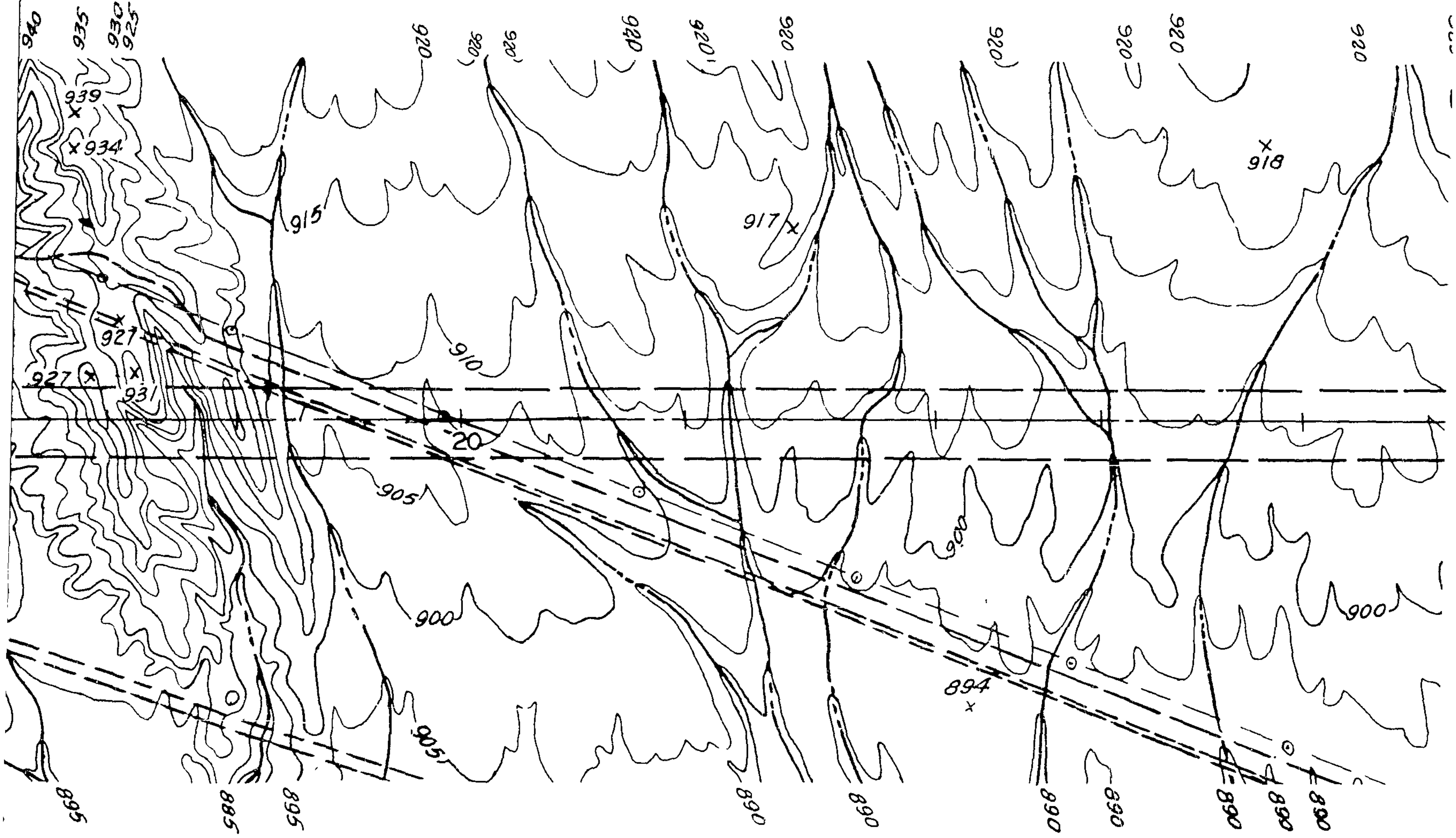
LEGEND

——— ———	LIMITS OF TEST COURSE	*TT	TERRAIN TYPE
——·—┼—— 6	CENTER-LINE STAKE	LS	LANDSCAPE
		GF	GROUND FACTOR
——-·-·-——	DRAINAGE	V	VEGETATION
═ ═ ═ ═	IMPROVED ROADS		
— — — —	UNIMPROVED ROADS OR TRAILS		

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

- 2/4	7,1,1b,1 - 6,10 - 2/4
	7,1,1b,1



6,10	
	2/4

RAIN TYPE
DSCAPE
UND FACTOR
ETATION

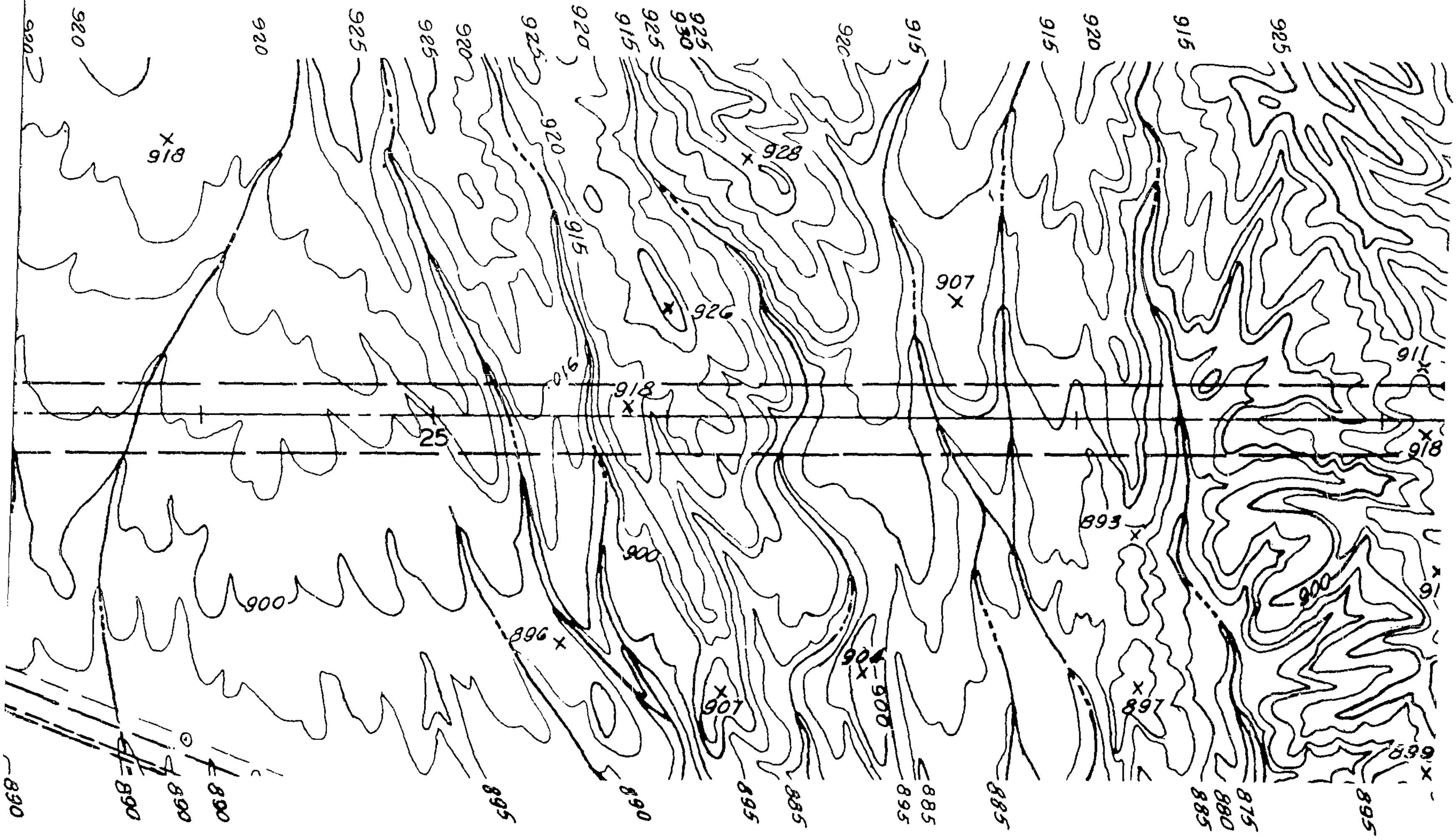
ON REVERSE

2

2,1,1b,2 - 6,10/6,9 - 2/4

2,1,1

2,1,1b,2



6,10/6,9

2/4

TOP

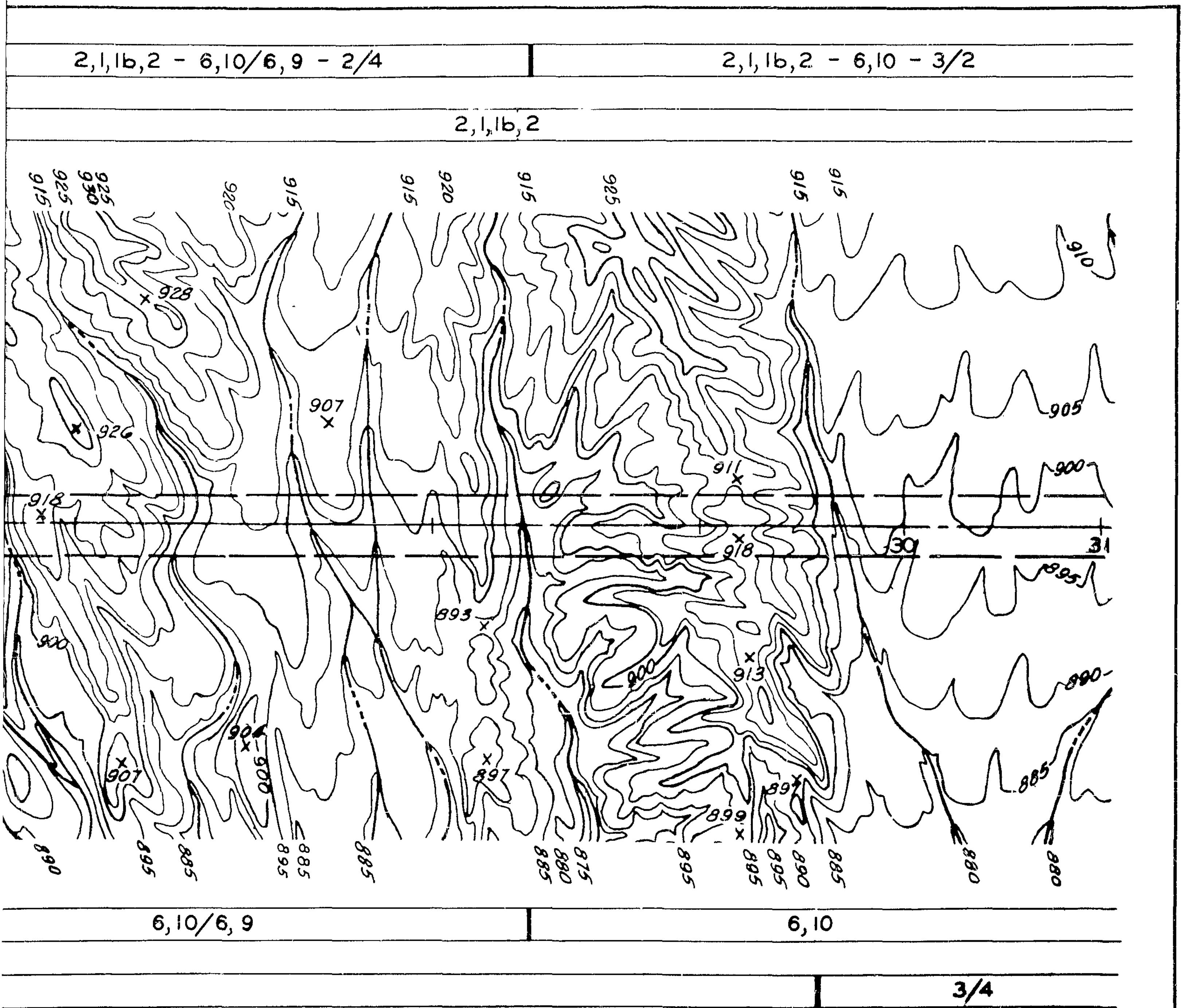
TES

S

500

CONT

3



TOPOGRAPHIC MAP
TEST COURSE NO. 6
SEGMENT 2

SCALE IN FEET

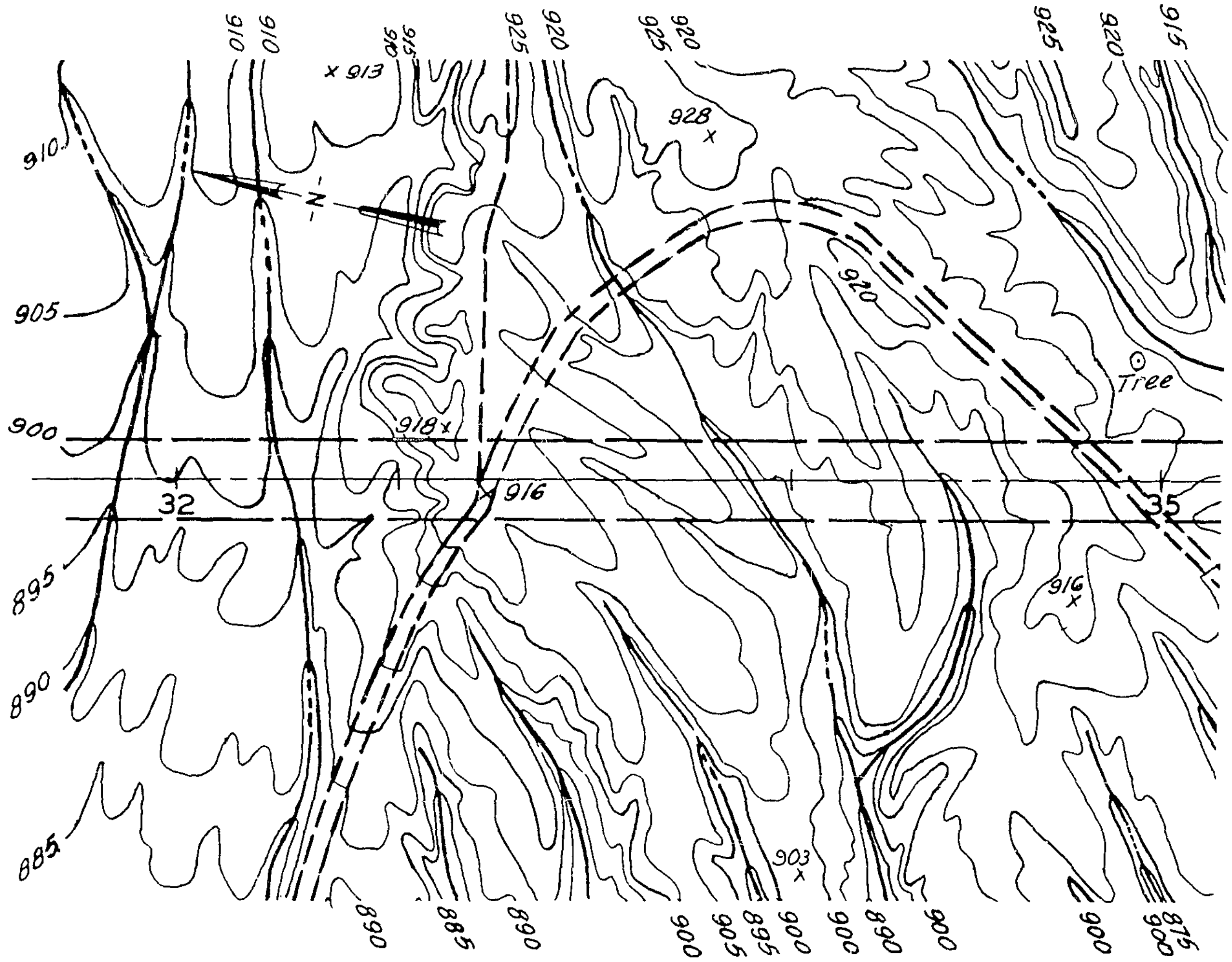
500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT 2,1,1b,2-6,10-3/2

LS 2,1,1b,2



GF 6,10

V 3/4

LEGEND

LIMITS OF TEST COURSE

CENTER-LINE STAKE (6)

DRAINAGE

IMPROVED ROADS

UNIMPROVED ROADS OR TRAILS

*TT TERRAIN TYPE

LS LANDSCAPE

GF GROUND FACTOR

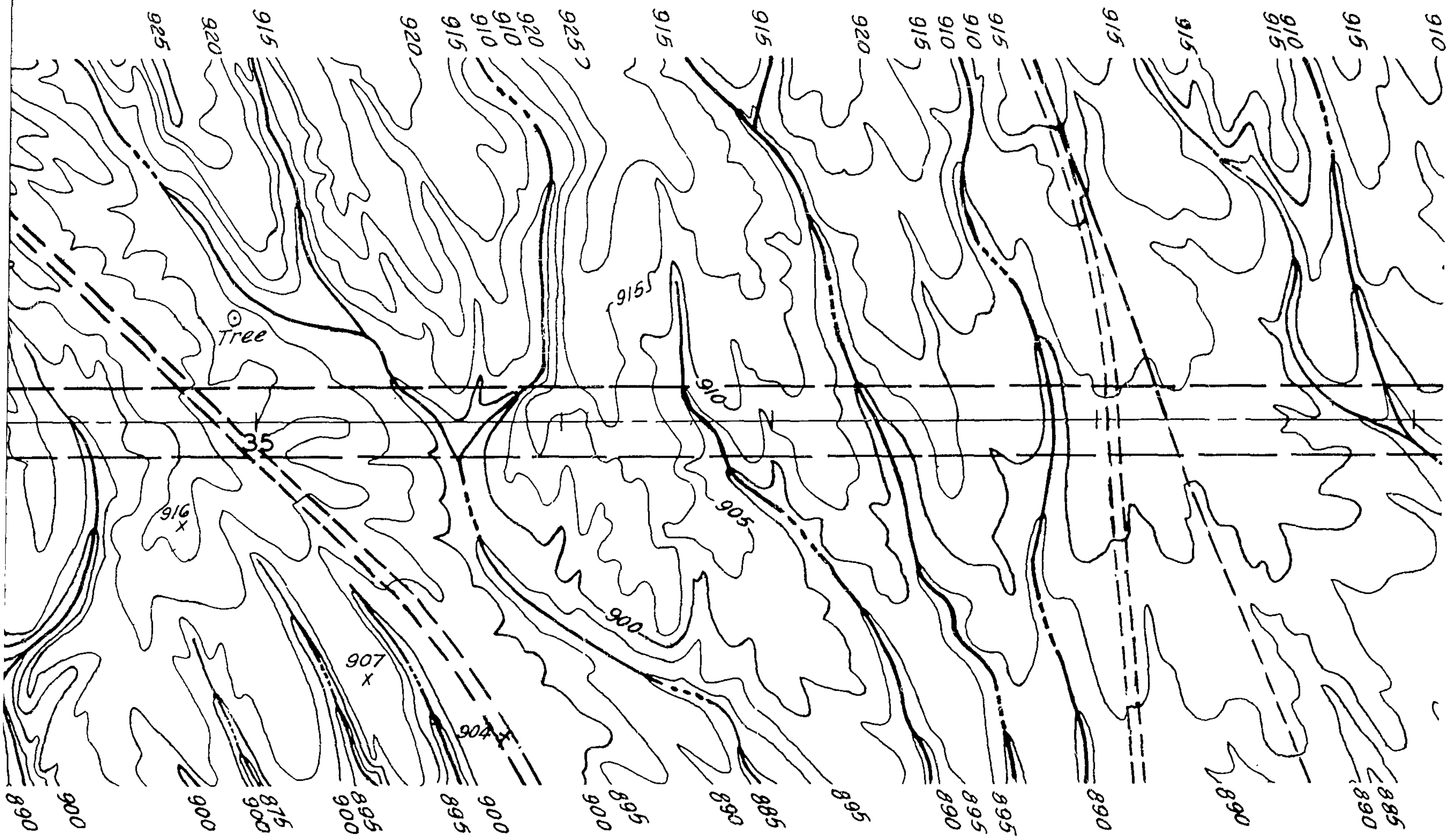
V VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

1,3,1b,2 ¬ 6,9/6,10 - 2

1,3,1b,2



6,9/6,10

2/4

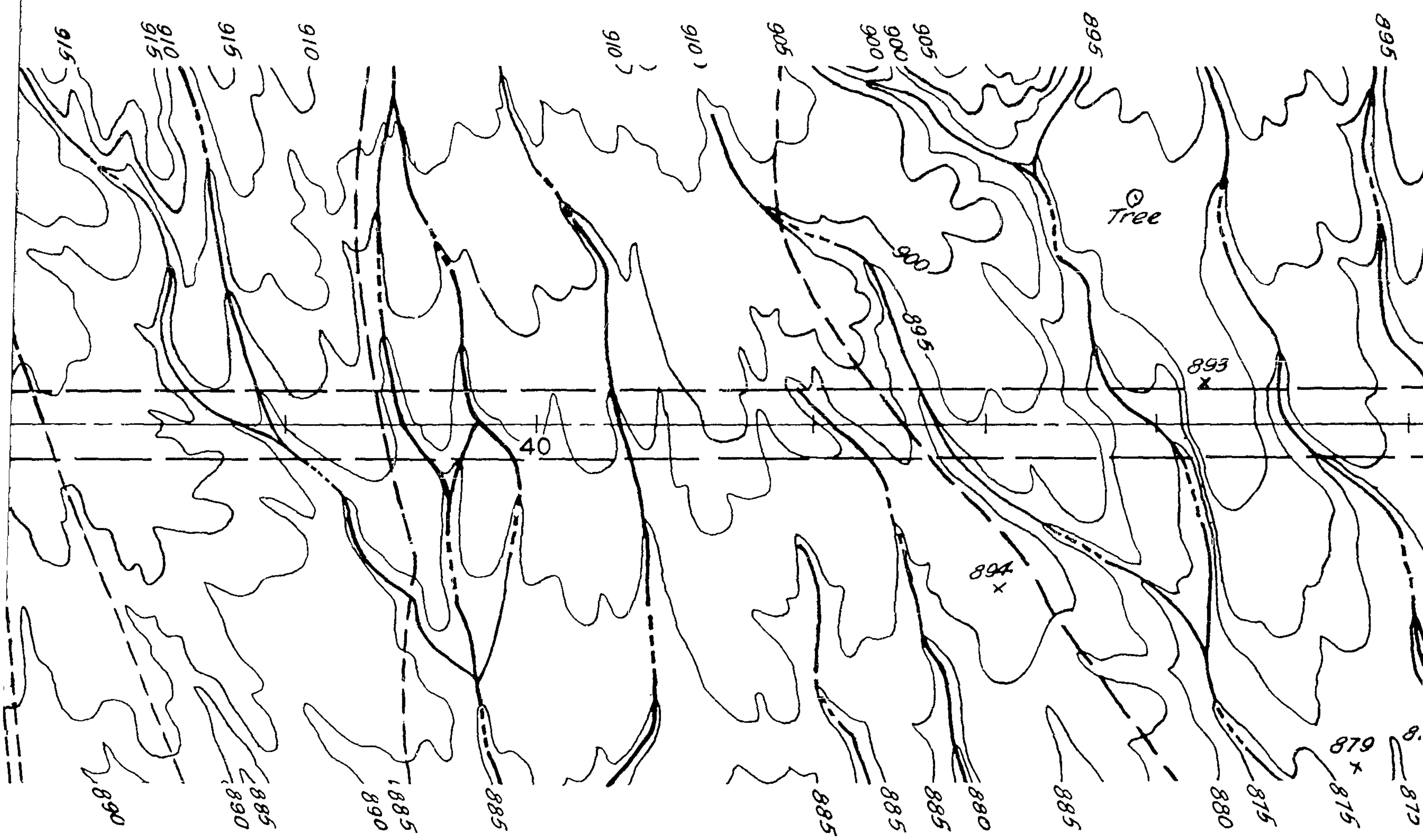
RAIN TYPE
DSCAPE
UND FACTOR
ETATION

ON REVERSE

2

b,2 ⌐ 6,9/6,10 - 2/4

1,3,1b,2



6,10	6,9/6,10

3

TOPOG

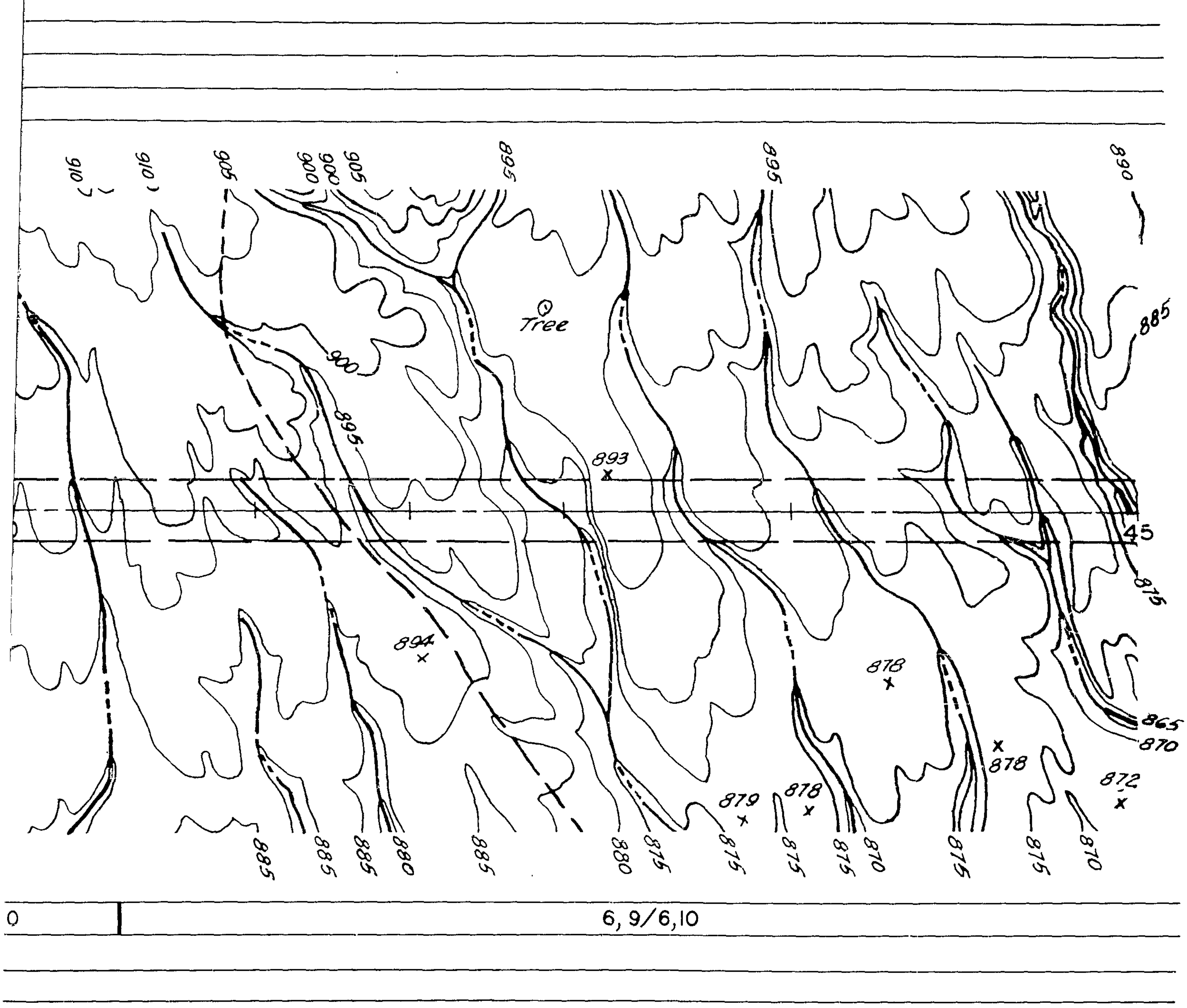
TEST

S

SCA

500 0

CONTOU



TOPOGRAPHIC MAP

TEST COURSE NO. 6
SEGMENT 3

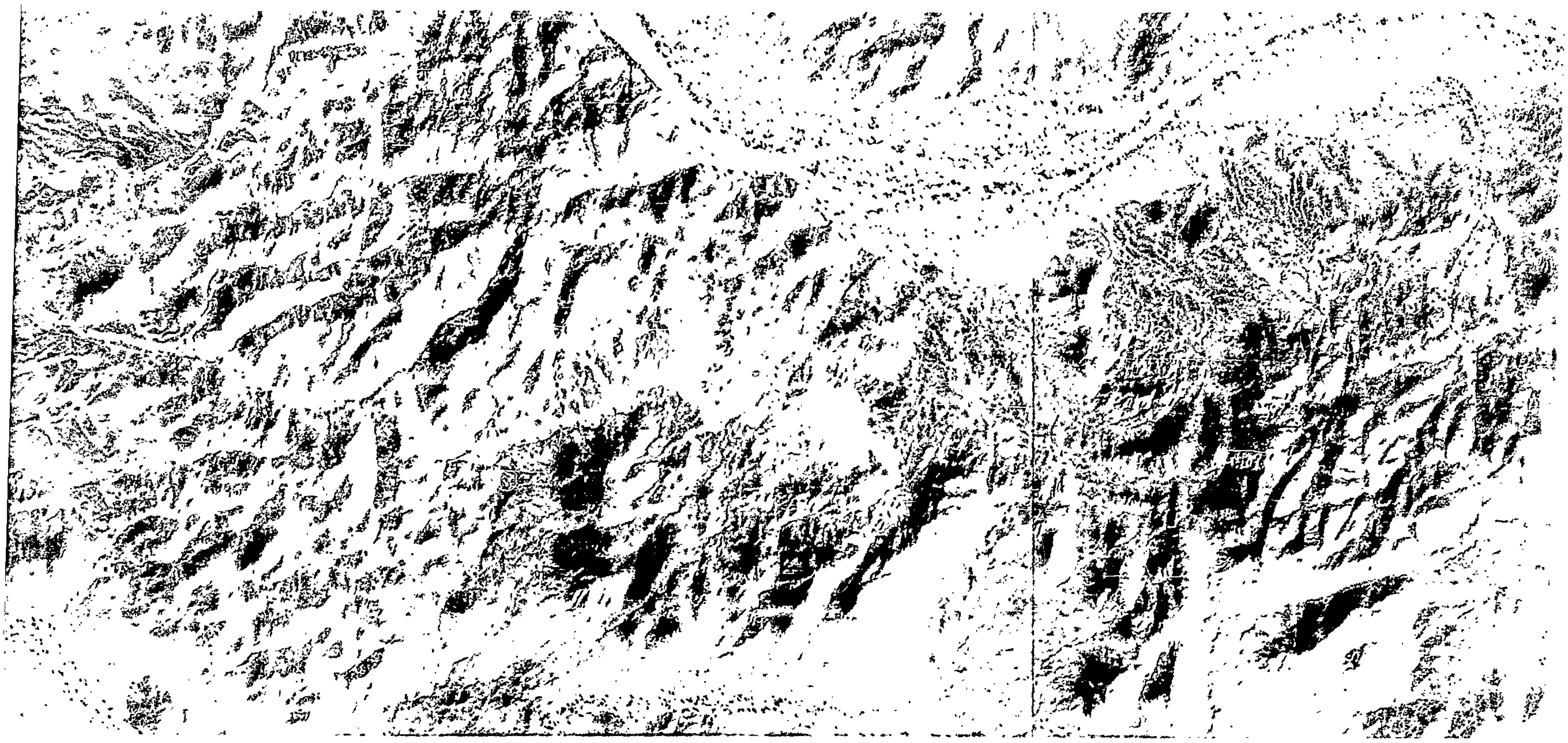
SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

1



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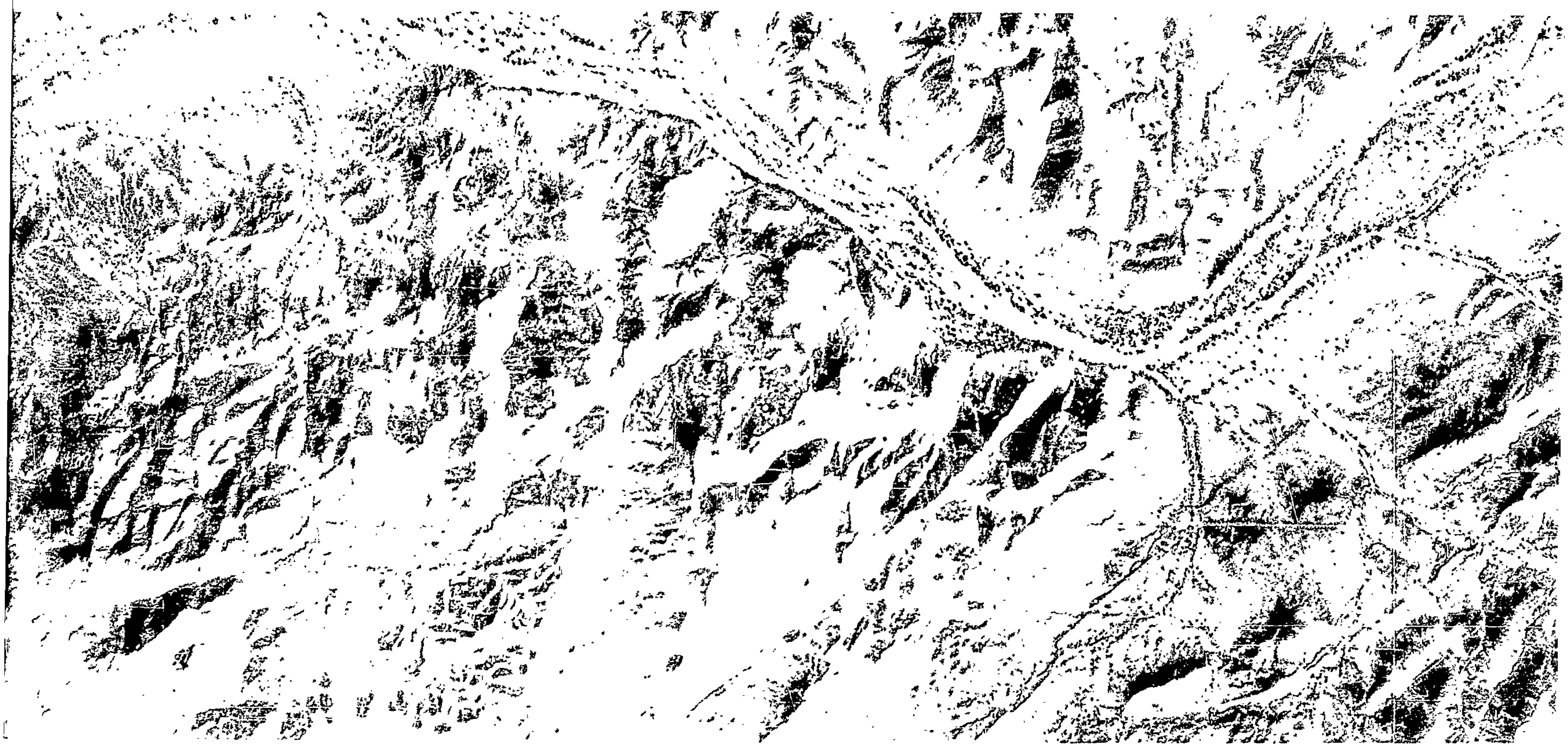
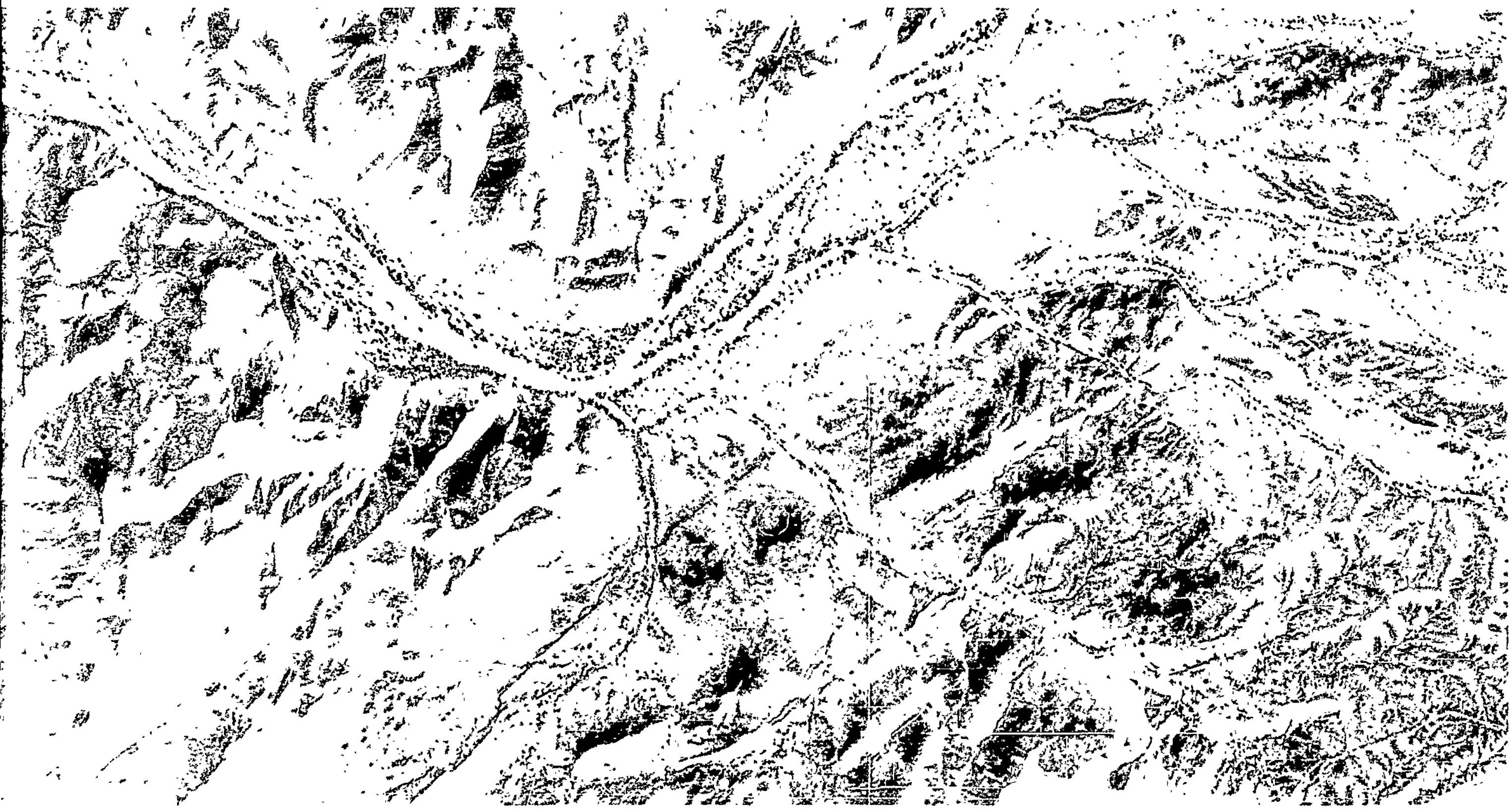


3

1000



AERIAL MOSAIC

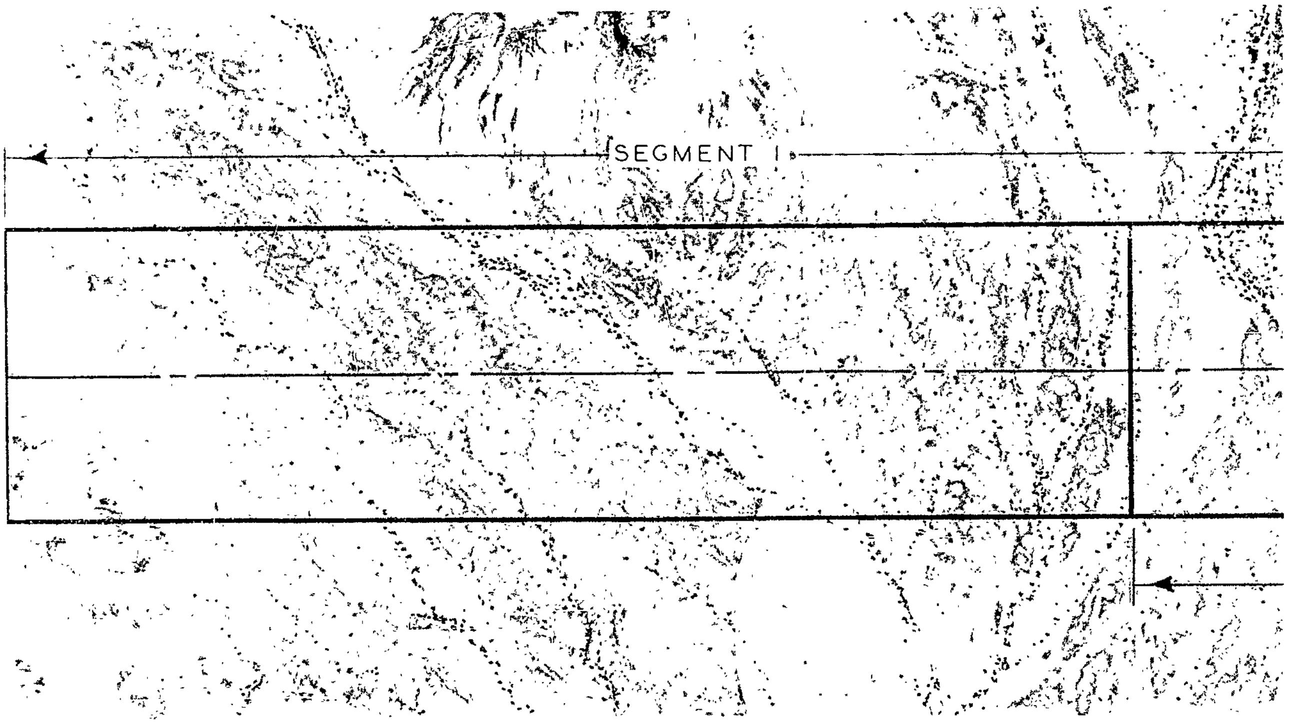
TEST COURSE NO. 7

SCALE IN FEET

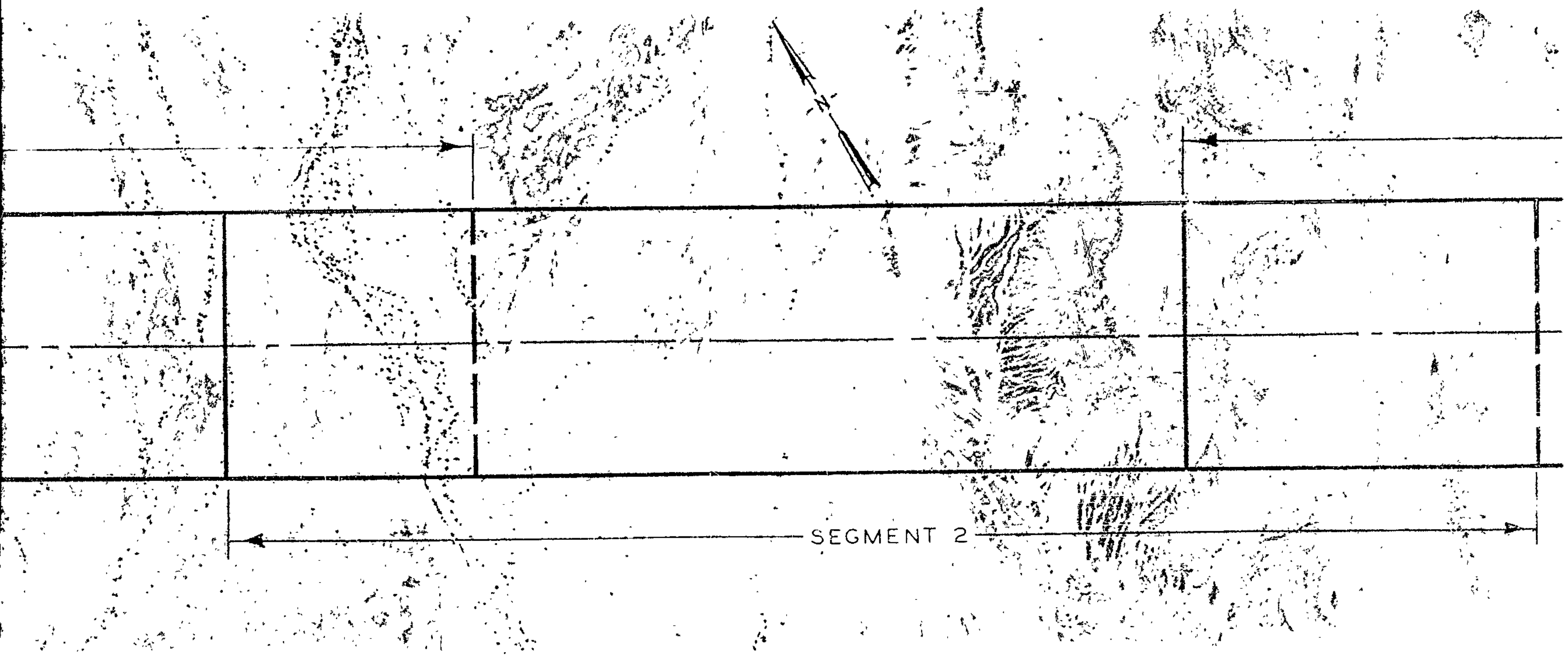
1000 0 1000 2000

4

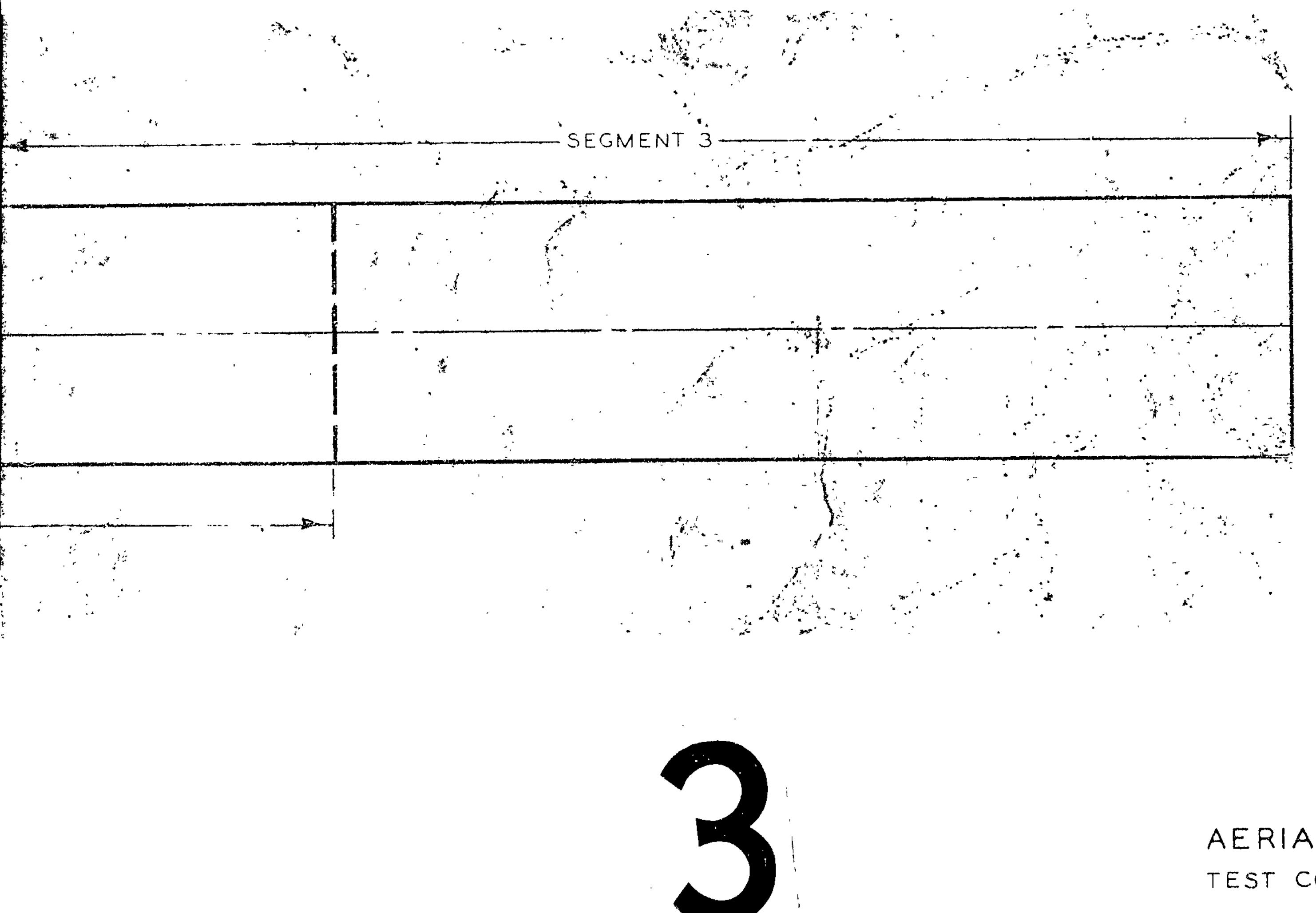
PLATE 26



1



2



3

AERIAL MOSAIC

TEST COURSE NO. 8

SCALE IN FEET

1000 0 1000 20

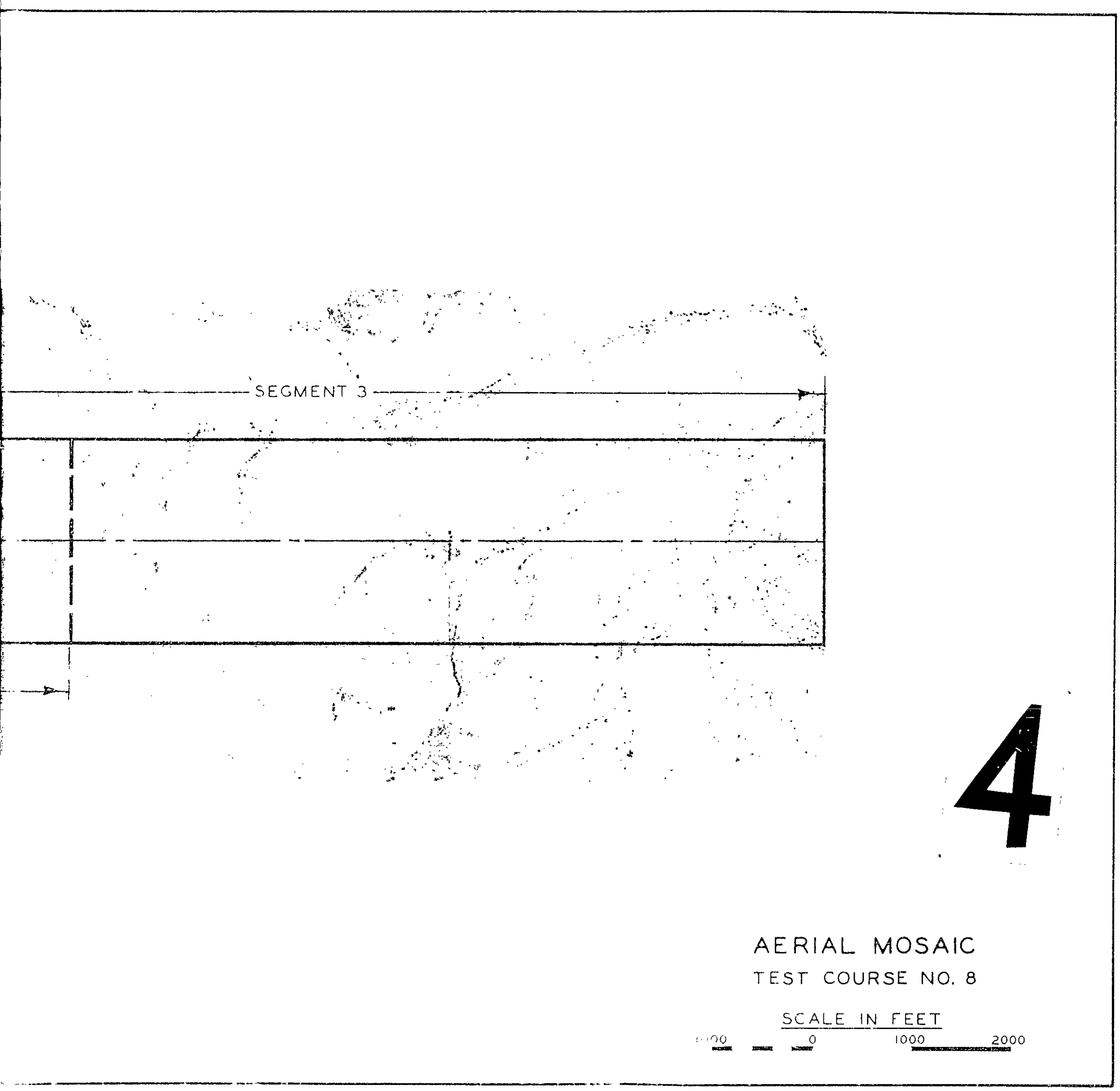

SEGMENT 3
4
AERIAL MOSAIC
TEST COURSE NO. 8
SCALE IN FEET
0
1000
2000

PLATE 27

TERRAIN

TEST CO

LANDSCAPE															GROU			
PLAN-PROFILE				SLOPE OCCURRENCE PER 10 MILES			CHARACTERISTIC SLOPE				CHARACTERISTIC RELIEF				SOIL TYPE			
HIGHS ARE	% AREA OCCUPIED BY HIGHS										TYPE I		TYPE II		BARE ROCK & STONY SOIL	GRAVEL	SAND AND/OR GRAVEL W/FINES	S
	>60	40-60	<40	<1	5-20	20-100	0°-1/2°	1/2°-2°	2°-6°	6°-14°	0-10	10-50	0-100	100-400				
FLAT-TOPPED	X			X				X				X					X	
	X			X				X				X					X	
	X			X				X				X					X	
	X			X				X				X					X	
	X			X					X			X					X	
PEAKED OR CRESTED	X				X					X			X				X	
	X				X					X				X	X/		/X	
NO PRONOUNCED HIGHS OR LOWS																		

* EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPING TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE TER THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR COMPL

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO AREALL PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES THE

TERRAIN TYPES

TEST COURSE 8

GROUND FACTORS							VEGETATION				TERRAIN TYPE*						
SOIL TYPE				SOIL CONSISTENCY							LANDSCAPE				GROUND† FACTORS		VEGETATION†
BARE ROCK & STONY SOIL	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT AND/OR CLAY WITH COARSE MATERIAL	DENSE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE	BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	PP	SO	CS	CR	ST	SC	
		X			X			X/		/X	1	1	1b	2	6	9	2/4
		X			X/	/X		X/		/X	1	1	1b	2	6	9/10	2/4
		X			/X	X/		X/	/X		1	1	1b	2	6	10/9	2/3
		X			/X	X/		X/		/X	1	1	1b	2	6	10/9	2/4
		X			X			X/	/X		1	1	2	2	6	9	2/3
		X			X			X/	/X		4	3	3	4	6	9	2/3
X/		/X		X/	/X			X			4	3	3	5	2/6	2/9	2

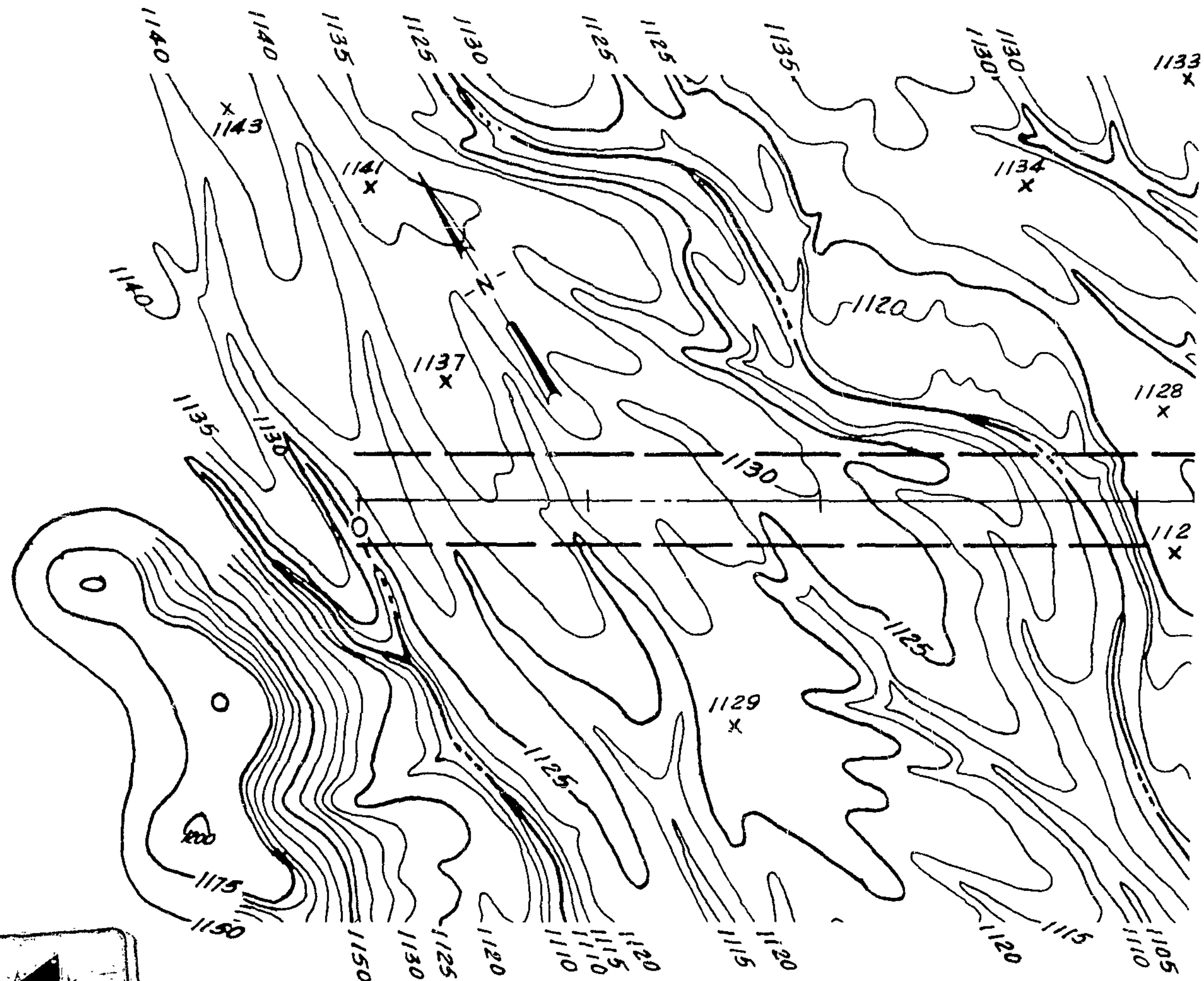
OF SEVEN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL IAT ORDER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY IEEN INDICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

) VEGETATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS. IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE IATOR IN THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2

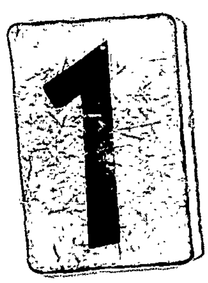
*TT 1,1,1b,2-6,9-2/4

LS



GF 6/9

V 2/3



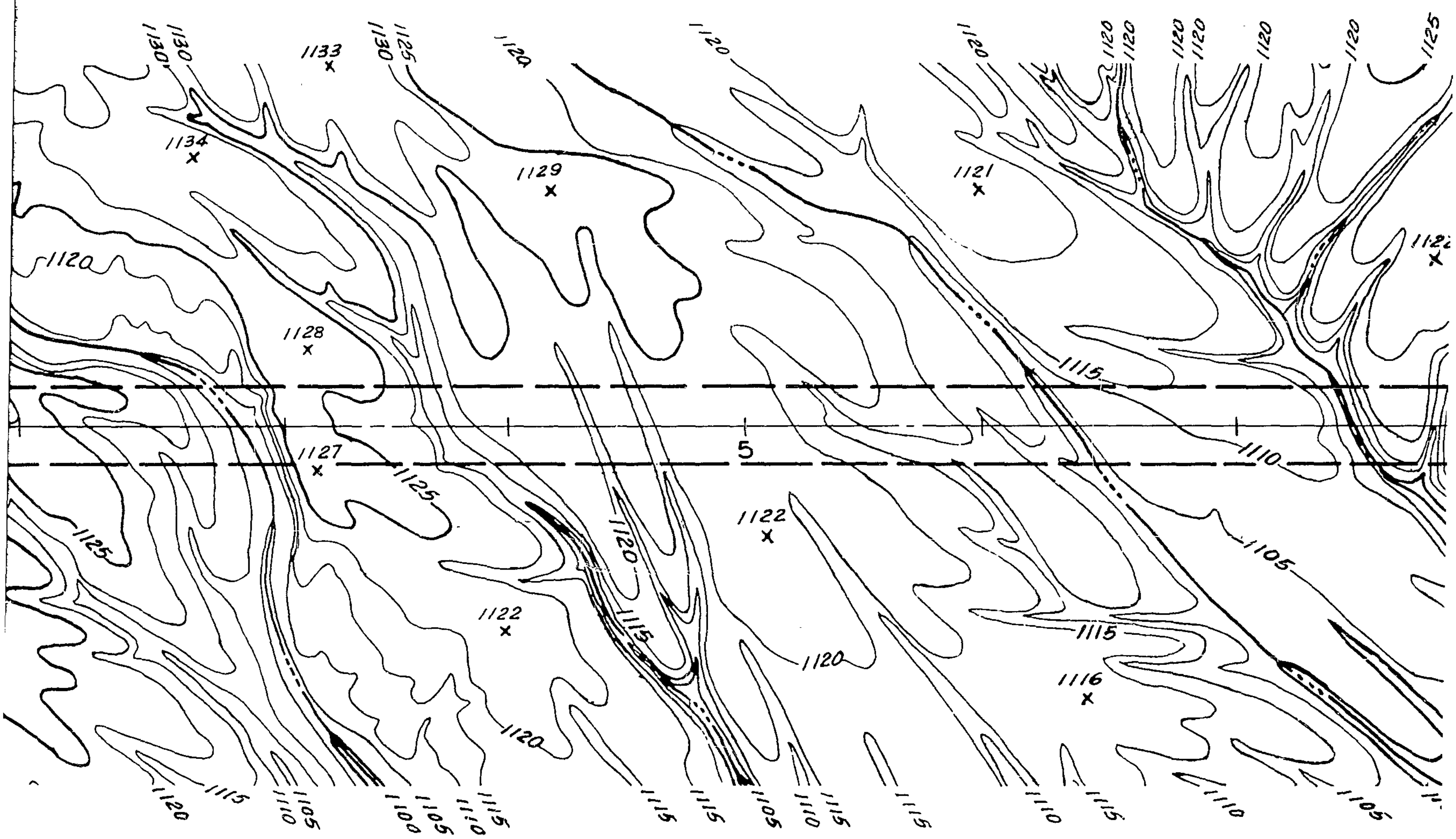
LEGEND

LIMITS OF TEST COURSE	*TT TERRAIN TYPE
CENTER-LINE STAKE (6)	LS LANDSCAPE
	GF GROUND FACTOR
DRAINAGE	V VEGETATION
IMPROVED ROADS	
UNIMPROVED ROADS OR TRAILS	

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1,1,1b,2 - 6,9 - 2/4	1,1,1b,2

	1,1,1b,2

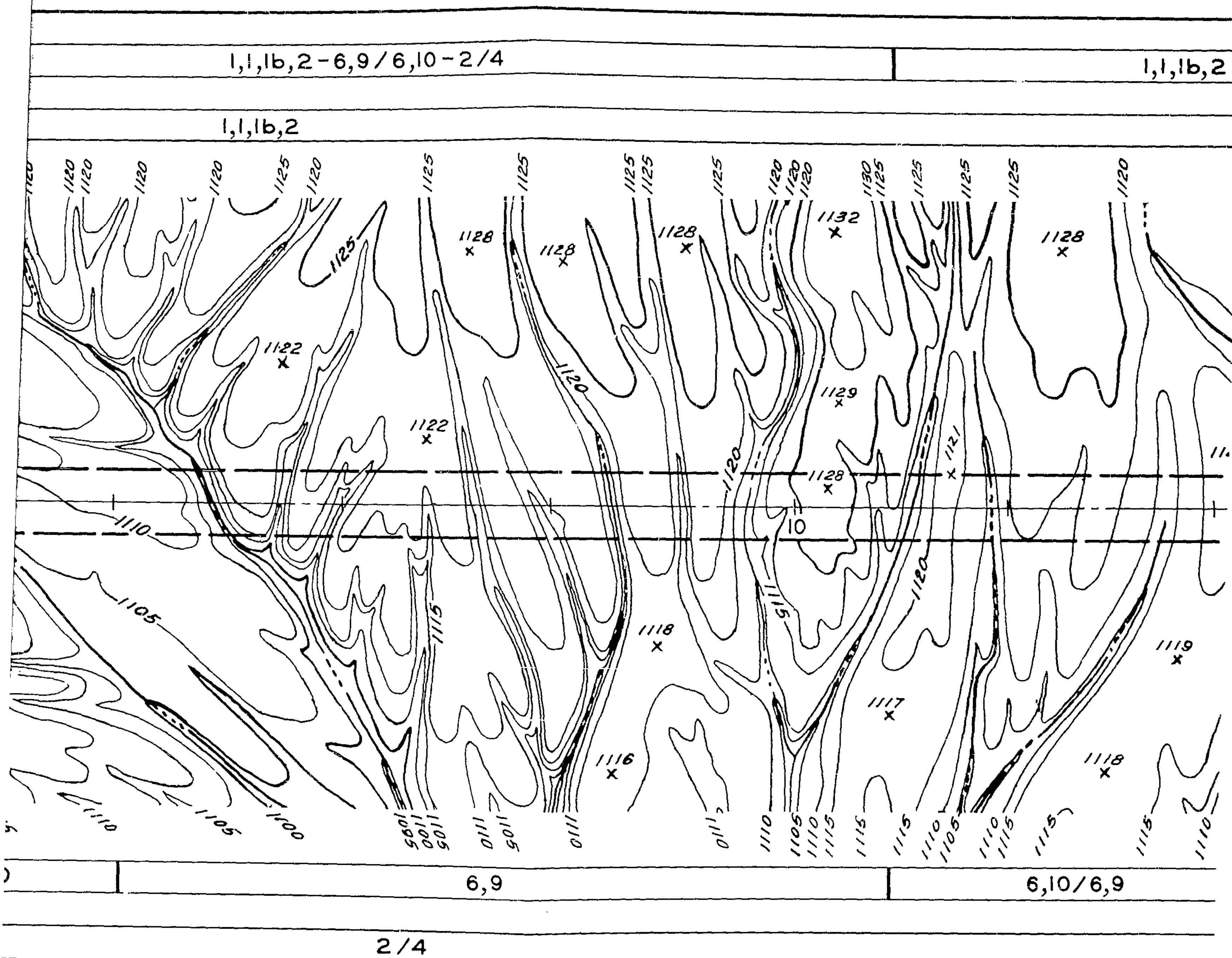


6/9	6,10	

RRAIN TYPE
NDSCAPE
OUND FACTOR
GETATION

S ON REVERSE

2


1,1,1b,2-6,9/6,10-2/4
1,1,1b,2-
1,1,1b,2
1128
1132
1129
1122
1121
1120
1118
1119
1117
1116
1110
1105
10
6,9
6,10/6,9
2/4

3

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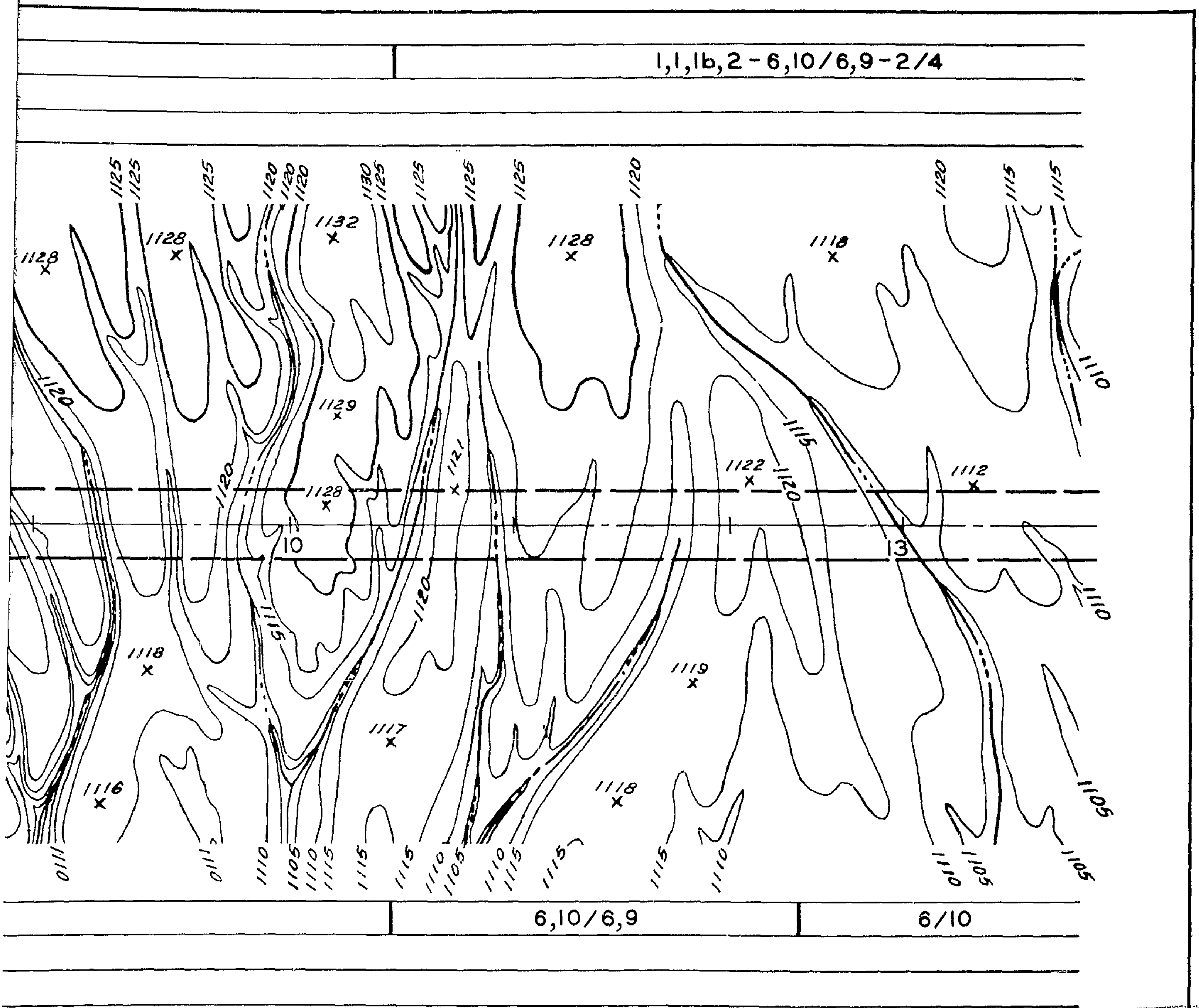
T

500

CO



TOPOGRAPHIC MAP

TEST COURSE NO. 8

SEGMENT I

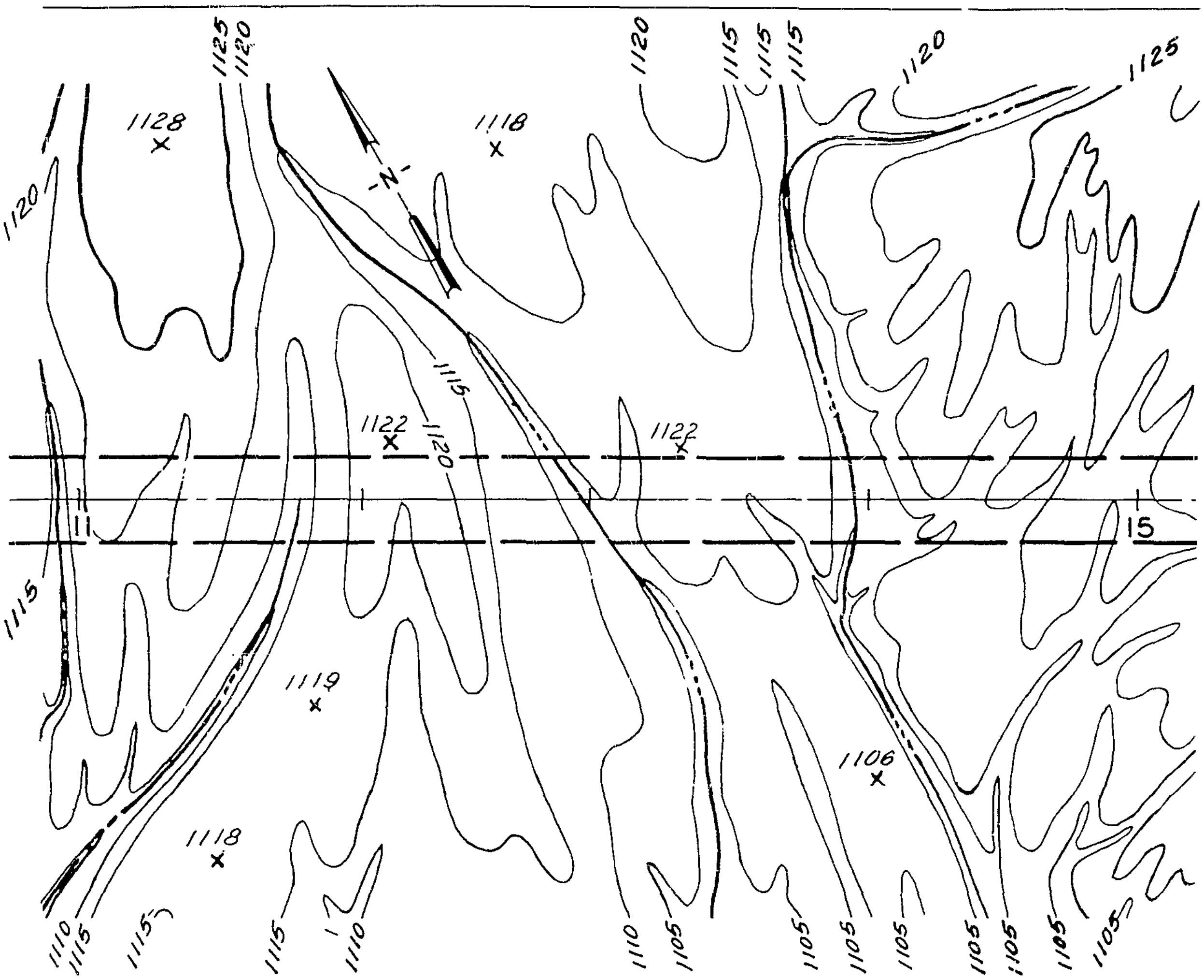
SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT	1,1,1b,2 - 6,10/6,9 - 2/4	
LS		1



GF	6,10/6,9	6,10	
V	2/4		

LEGEND

——— ———	LIMITS OF TEST COURSE
——— ┼ ——— 6	CENTER-LINE STAKE
——— - - - ———	DRAINAGE
═══ ═══	IMPROVED ROADS
— — — —	UNIMPROVED ROADS OR TRAILS

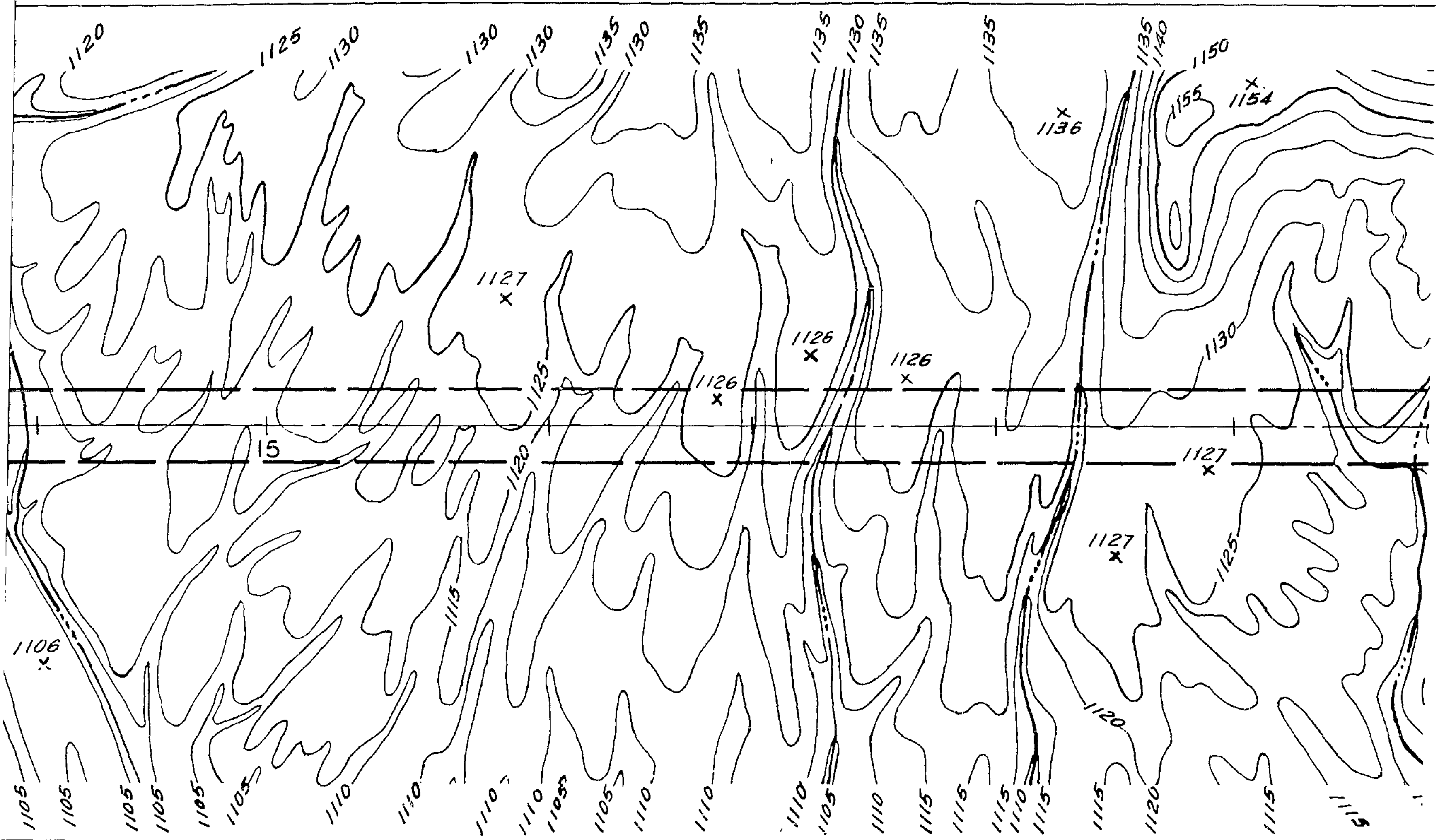
*TT	TERRAIN TYPE
LS	LANDSCAPE
GF	GROUND FACTOR
V	VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

1,1,1b,2 - 6,10/6,9 - 2/3

1,1,1b,2



6,10/6,9

2/3

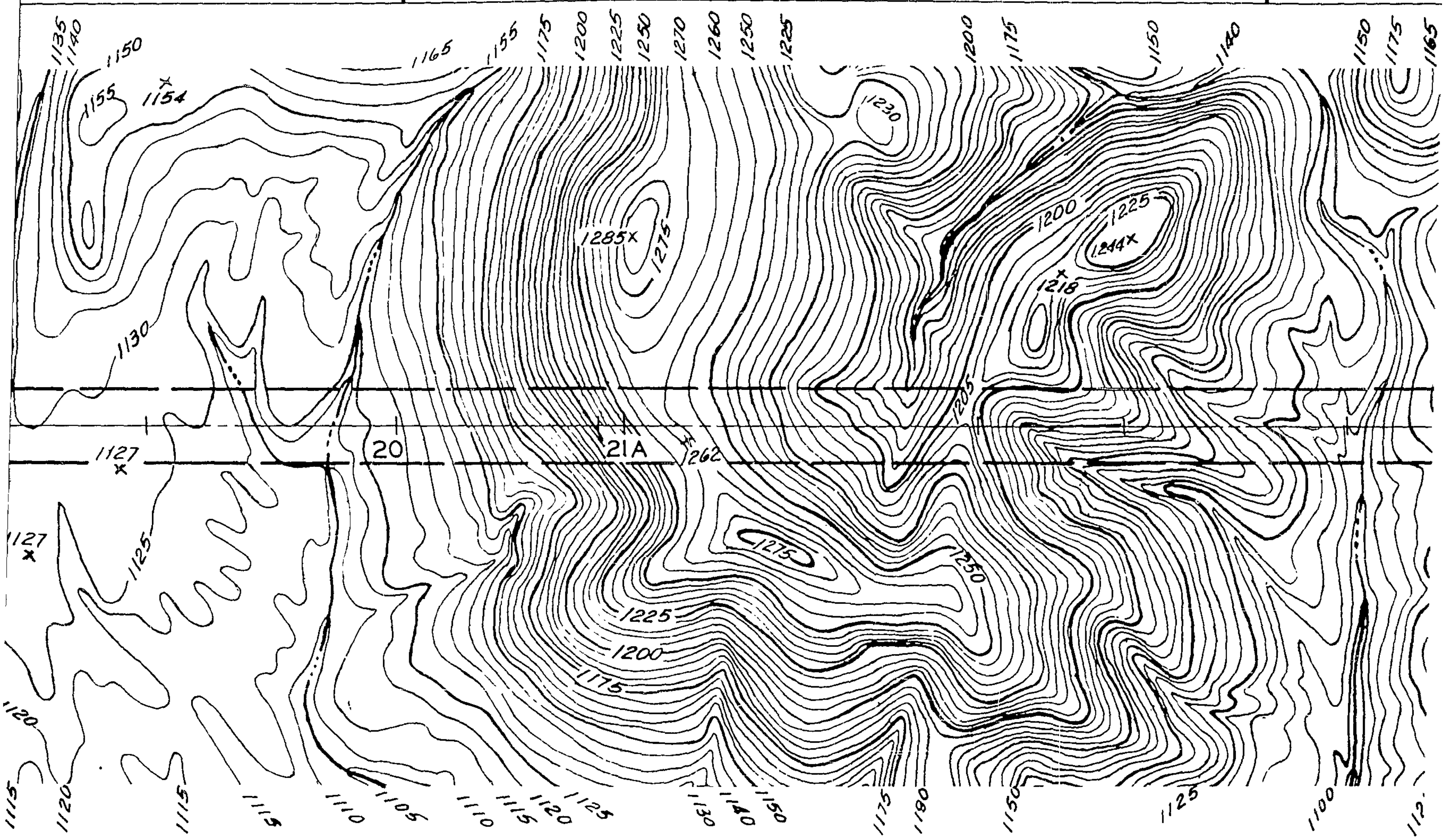
RAIN TYPE
DSCAPE
UND FACTOR
ETATION

ON REVERSE

2

4,3,3,5 - 2,2/6,9 - 2

4,3,3,5



6,9

2,2

2

3

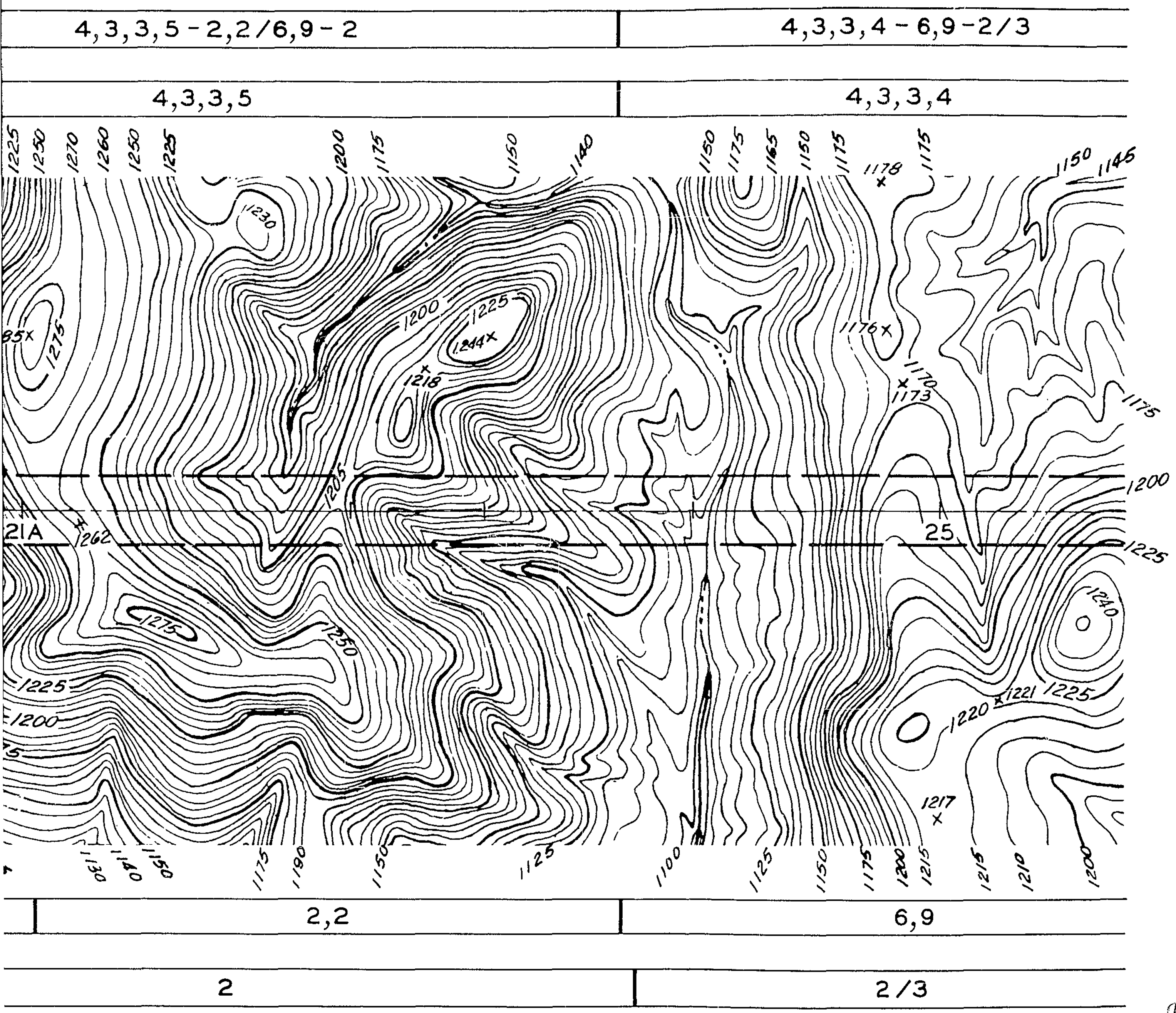
TOP

TES

S

500

CON



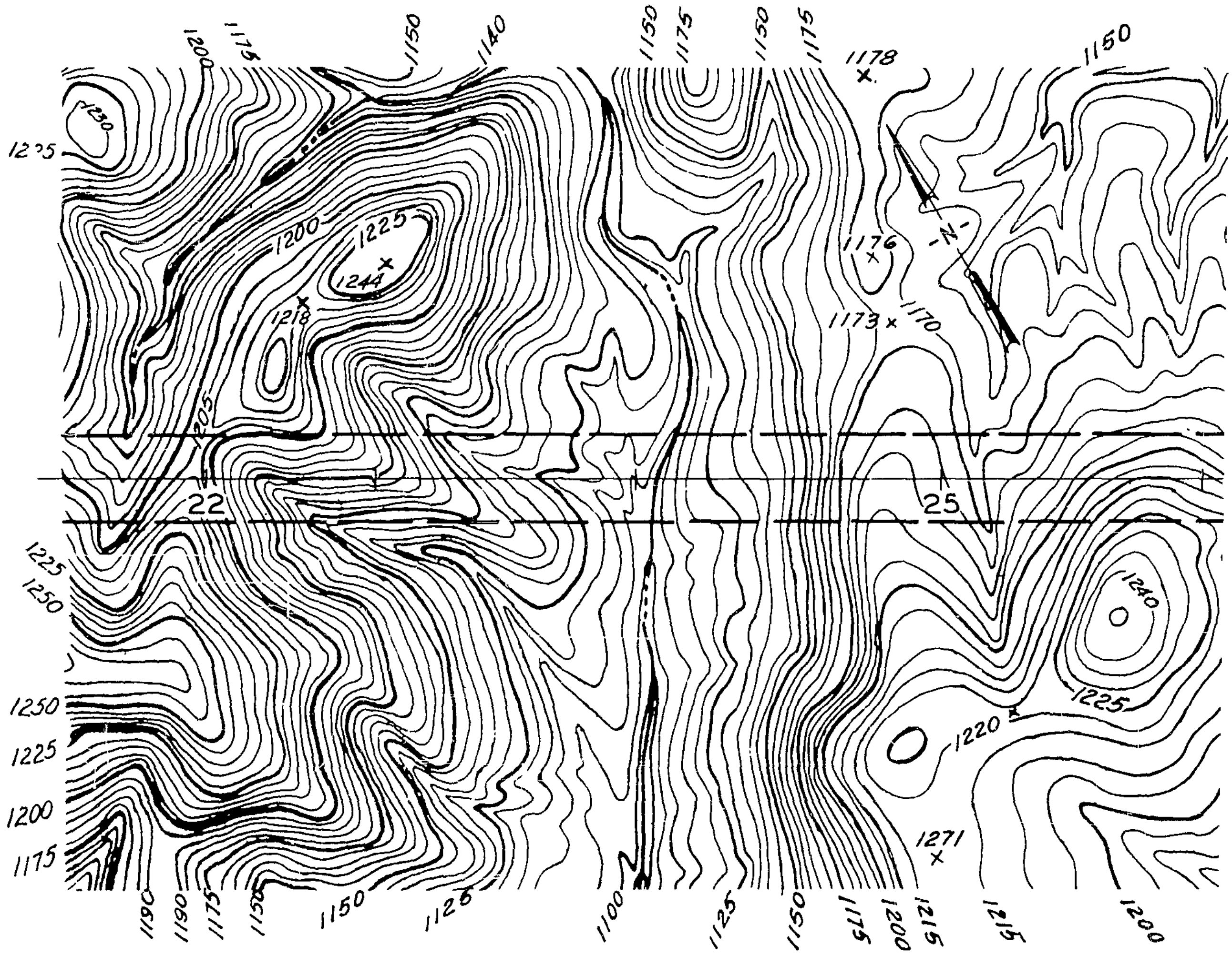
TOPOGRAPHIC MAP
TEST COURSE NO. 8
SEGMENT 2

SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

*TT	4,3,3,5 – 2,2/6,9 – 2	4,3,3,4 – 6,9 – 2/3
LS	4,3,3,5	4,3,3,4



GF	2,2	
V	2	

LEGEND

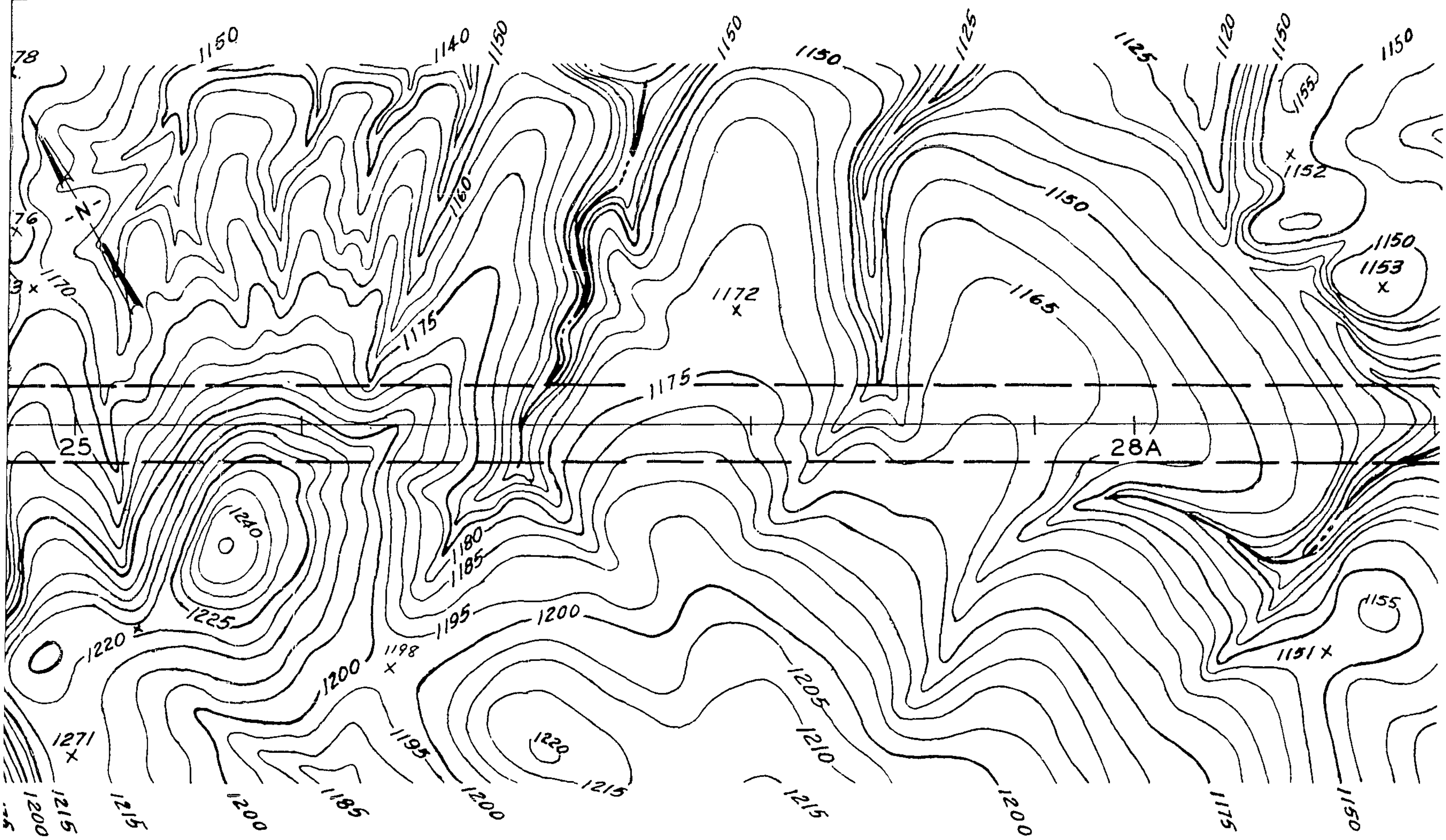
——— ———	LIMITS OF TEST COURSE
——+—— 6	CENTER-LINE STAKE
——- - - ——	DRAINAGE
═ ═ ═ ═	IMPROVED ROADS
— — — —	UNIMPROVED ROADS OR TRAILS

*TT	TERRAIN TYPE
LS	LANDSCAPE
GF	GROUND FACTOR
V	VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

4,3,3,4 - 6,9 - 2/3	1,1,2,2 - 6,9 - 2/3
4,3,3,4	1,1,2,2



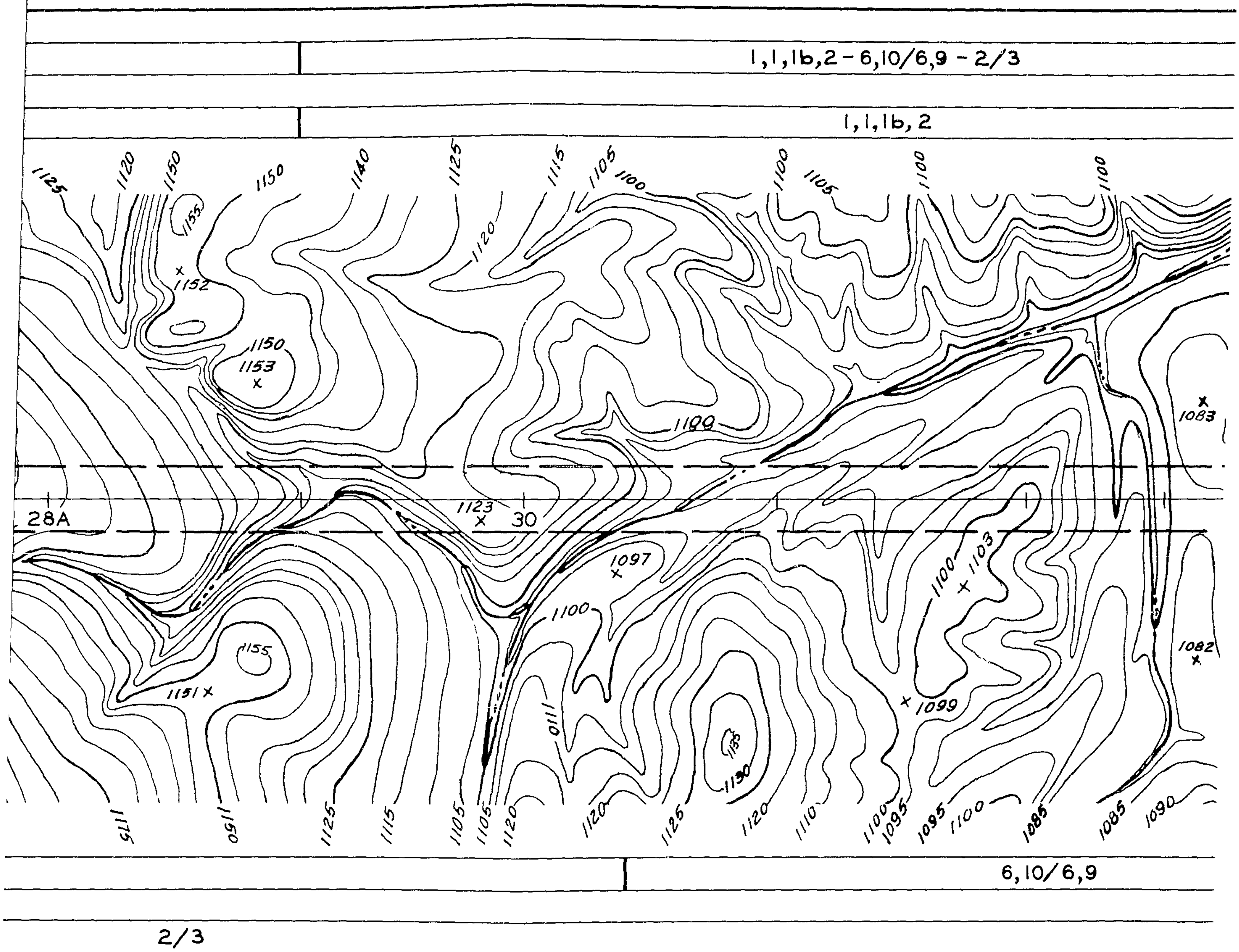
6,9

2/3

RAIN TYPE
DSCAPE
UND FACTOR
ETATION

ON REVERSE

2

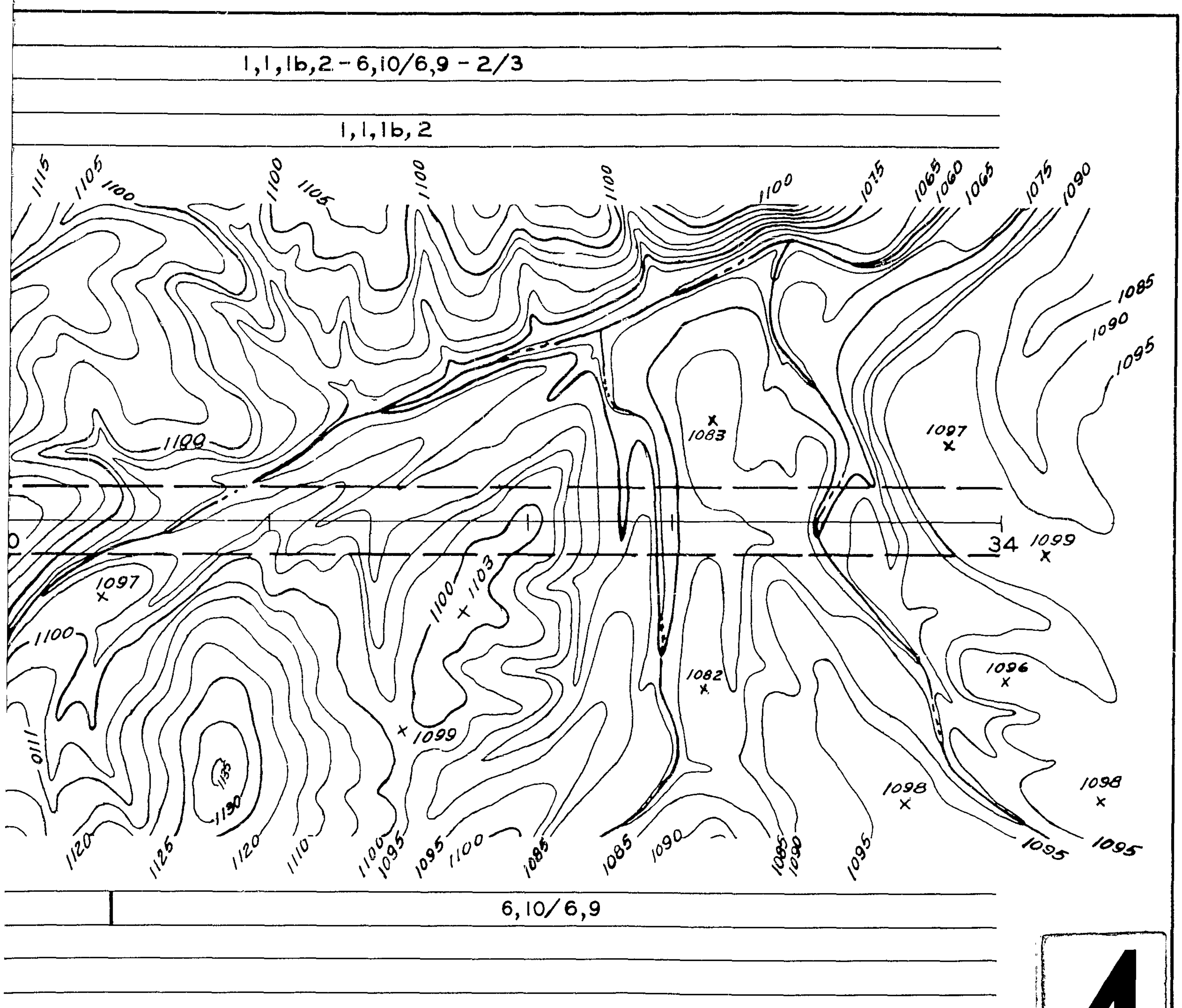

1,1,1b,2-6,10/6,9 - 2/3
1,1,1b,2
28A
30
1123
1152
1153
1150
1155
1151
1097
1100
1103
1099
1083
1082
1130
6,10/6,9
2/3

3

TO
TE

500

CO

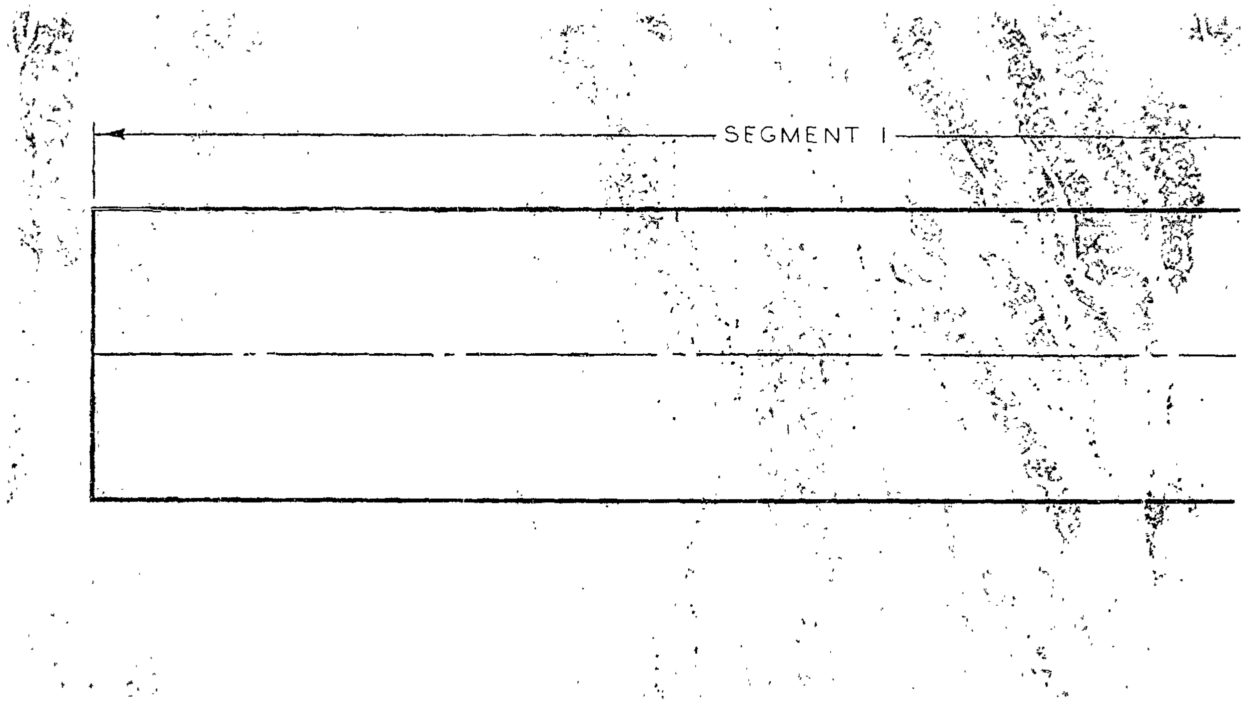


TOPOGRAPHIC MAP
TEST COURSE NO. 8
SEGMENT 3

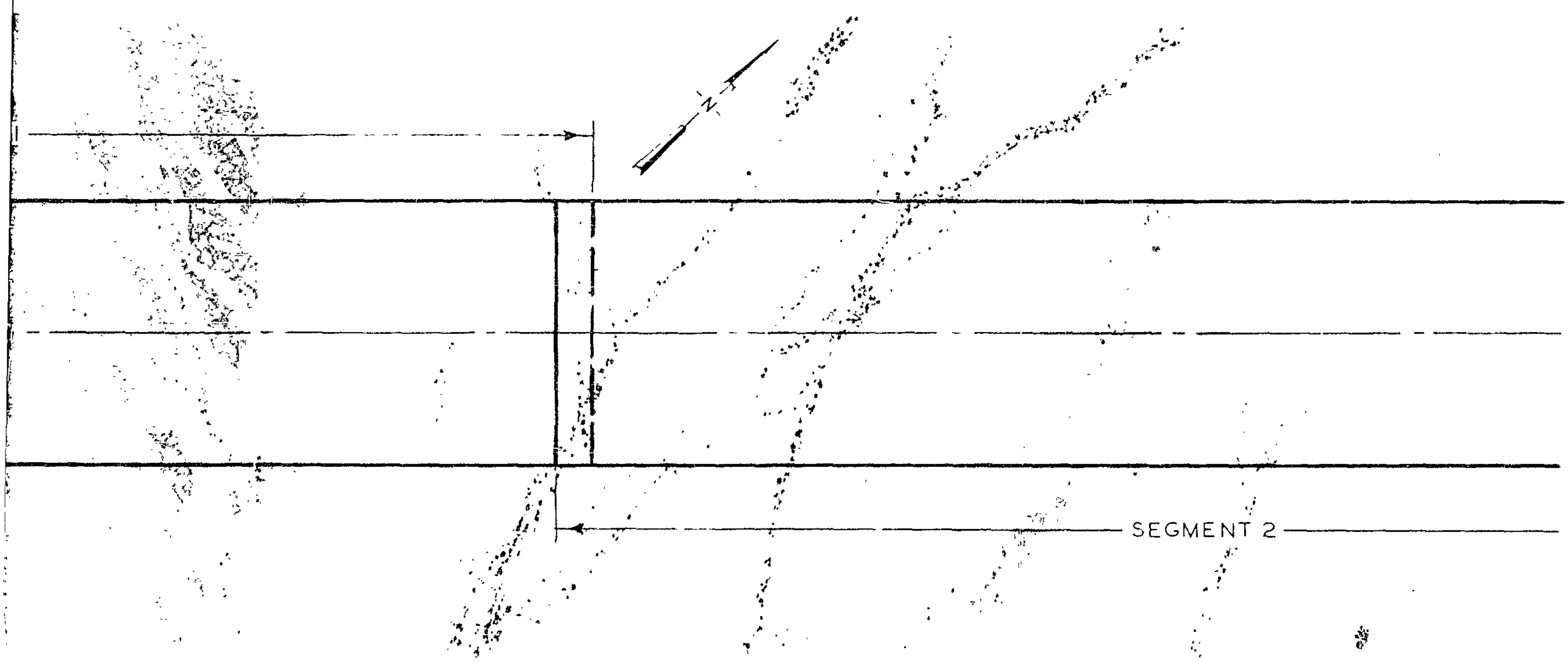
SCALE IN FEET

500 0 500 1000

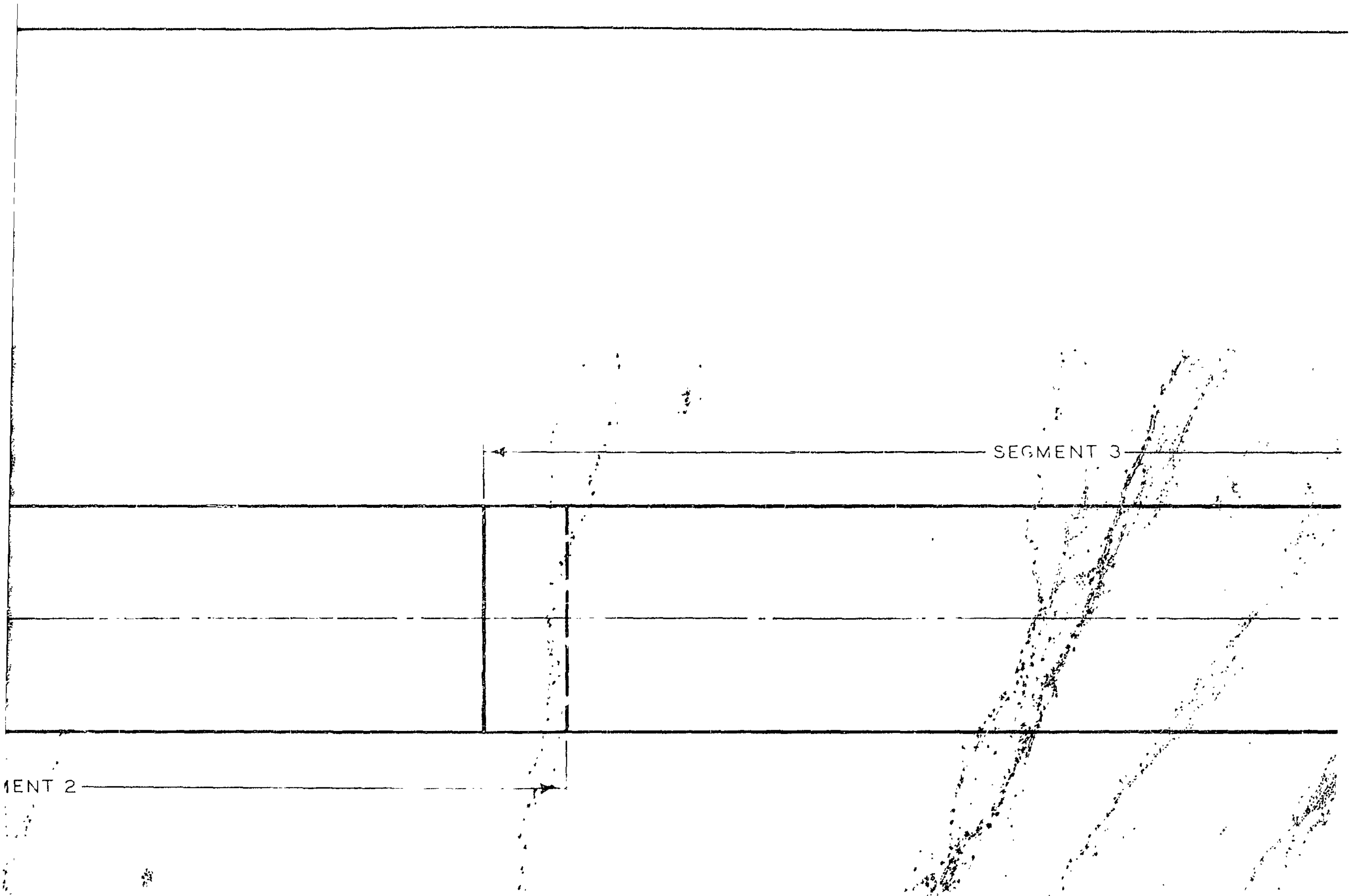
CONTOUR INTERVAL = 5 FT



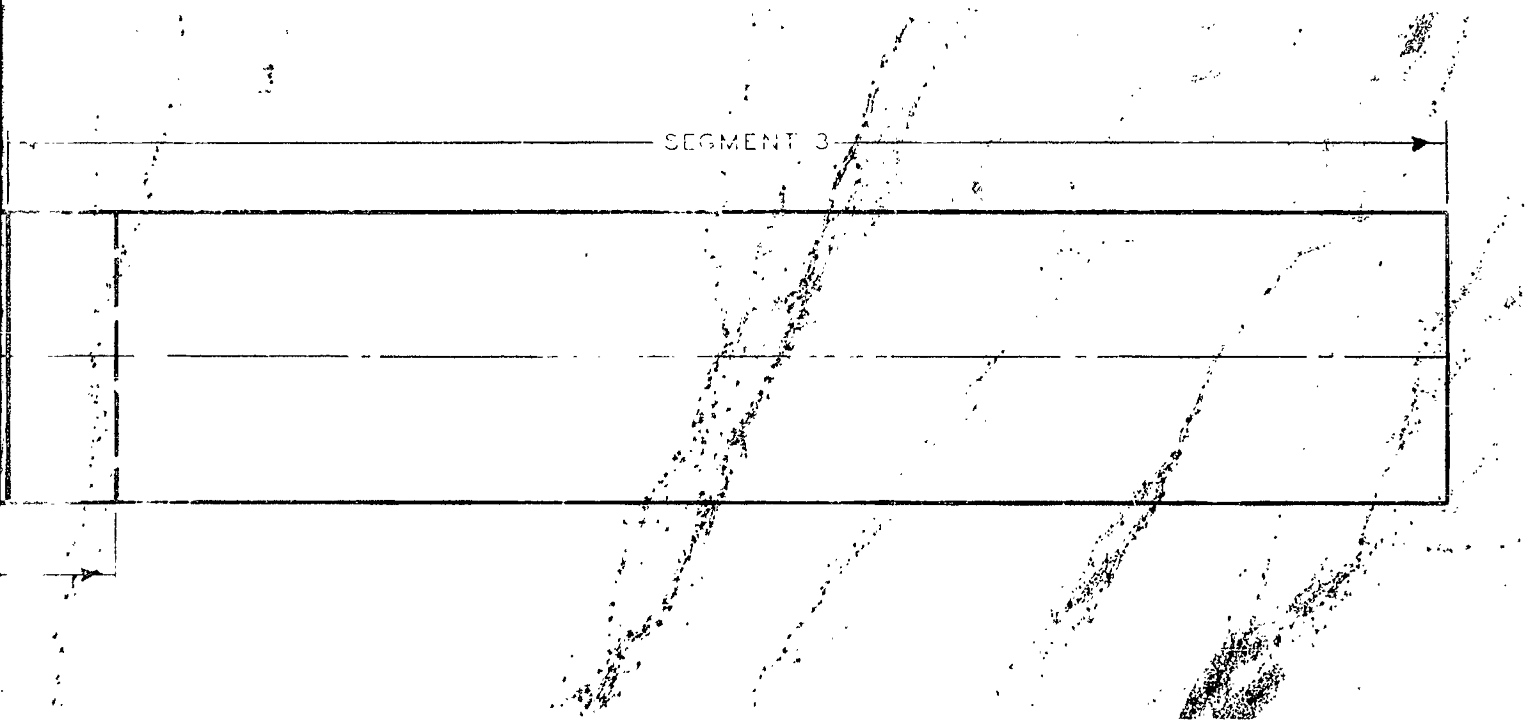
1



2



3



4

AERIAL MOSAIC
TEST COURSE NO. 9

SCALE IN FEET
1000 0 1000 2000

TERRAIN T

TEST COUR

LANDSCAPE															GROUND F			
PLAN-PROFILE				SLOPE OCCURRENCE PER 10 MILES			CHARACTERISTIC SLOPE				CHARACTERISTIC RELIEF				SOIL TYPE			
HIGHS ARE	% AREA OCCUPIED BY HIGHS										TYPE I		TYPE II		SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT A… CLAY… CO… MATI…
	>60	40-60	<40	<1	5-20	20-100	0°-1/2°	1/2°-2°	2°-6°	6°-14°	0-10	10-50	0-100	100-400				
FLAT-TOPPED																		
PEAKED OR CRESTED																		
NO PRONOUNCED HIGHS OR LOWS		X		X			X				X						X	
		X		X			X				X						X	
		X		X			X					X					X	
		X		X				X				X					X	

• EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPING UNIT TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE TERM OI THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR COMPLETE

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO AREALLY PF PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES THE NUM

TERRAIN TYPES

TEST COURSE 9

GROUND FACTORS							VEGETATION				TERRAIN TYPE*						
SOIL TYPE				SOIL CONSISTENCY			BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	LANDSCAPE				GROUND† FACTORS		VEGETATION†
AND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT AND/OR CLAY WITH COARSE MATERIAL	LOOSE >12" BELOW SURFACE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE					PP	SO	CS	CR	ST	SC	
		X				X	X/		/X		7	1	1a	1	6	10	1/3
		X				X			X/	/X	7	1	1e	1	6	10	3/4
		X			X/	/X	X/			/X	7	1	1a	2	6	9/10	1/4
		X			X/	/X	X/			/X	7	1	1b	2	6	9/10	1/4

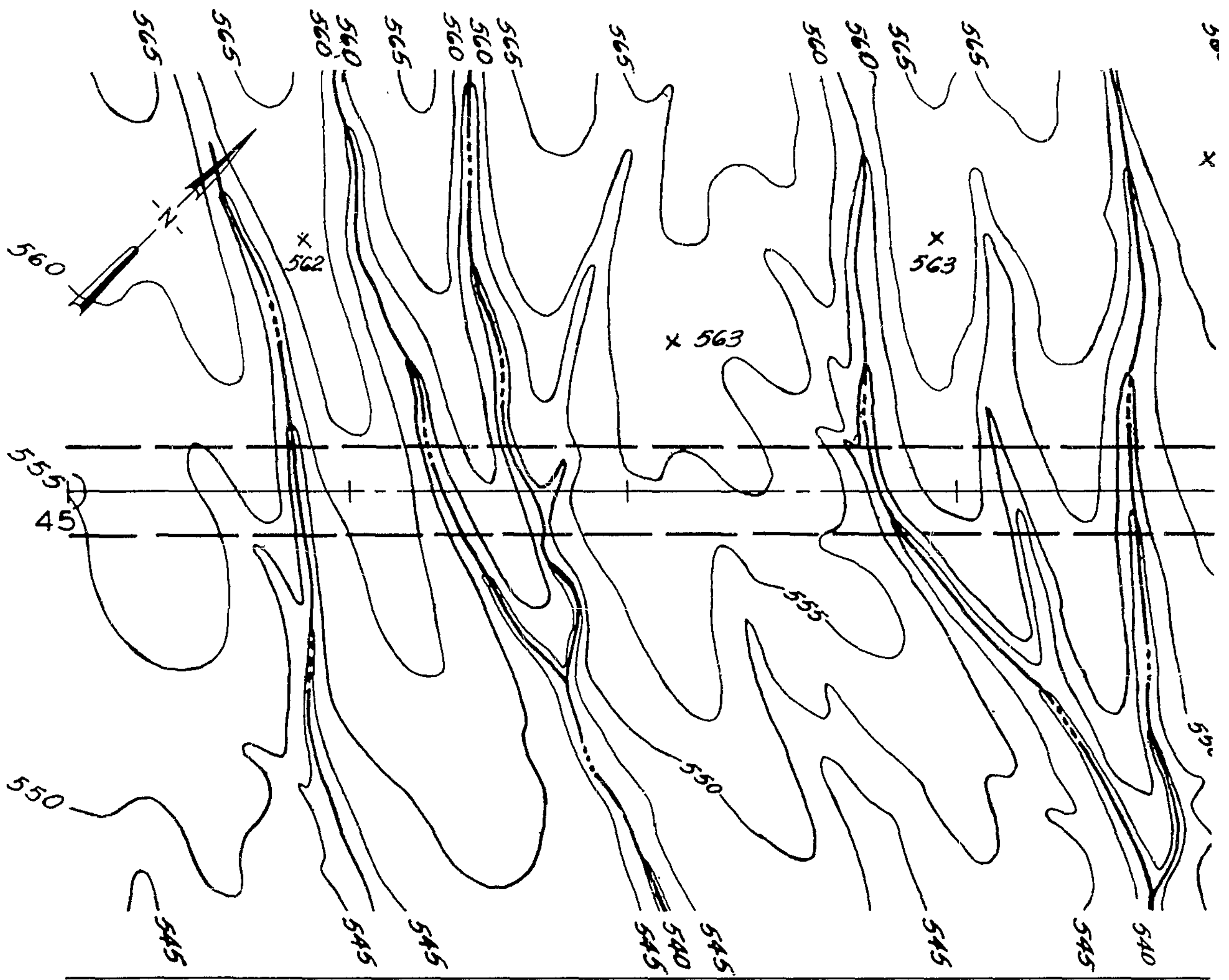
EN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL
)ER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY
DICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

TATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS. IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE
N THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2

*TT 7,1,1b,2 - 6, 9/6,10 - 1/4

LS 7,1,1b,2



GF

V

LEGEND

LIMITS OF TEST COURSE

CENTER-LINE STAKE (6)

DRAINAGE

IMPROVED ROADS

UNIMPROVED ROADS OR TRAILS

*TT TERRAIN TYPE

LS LANDSCAPE

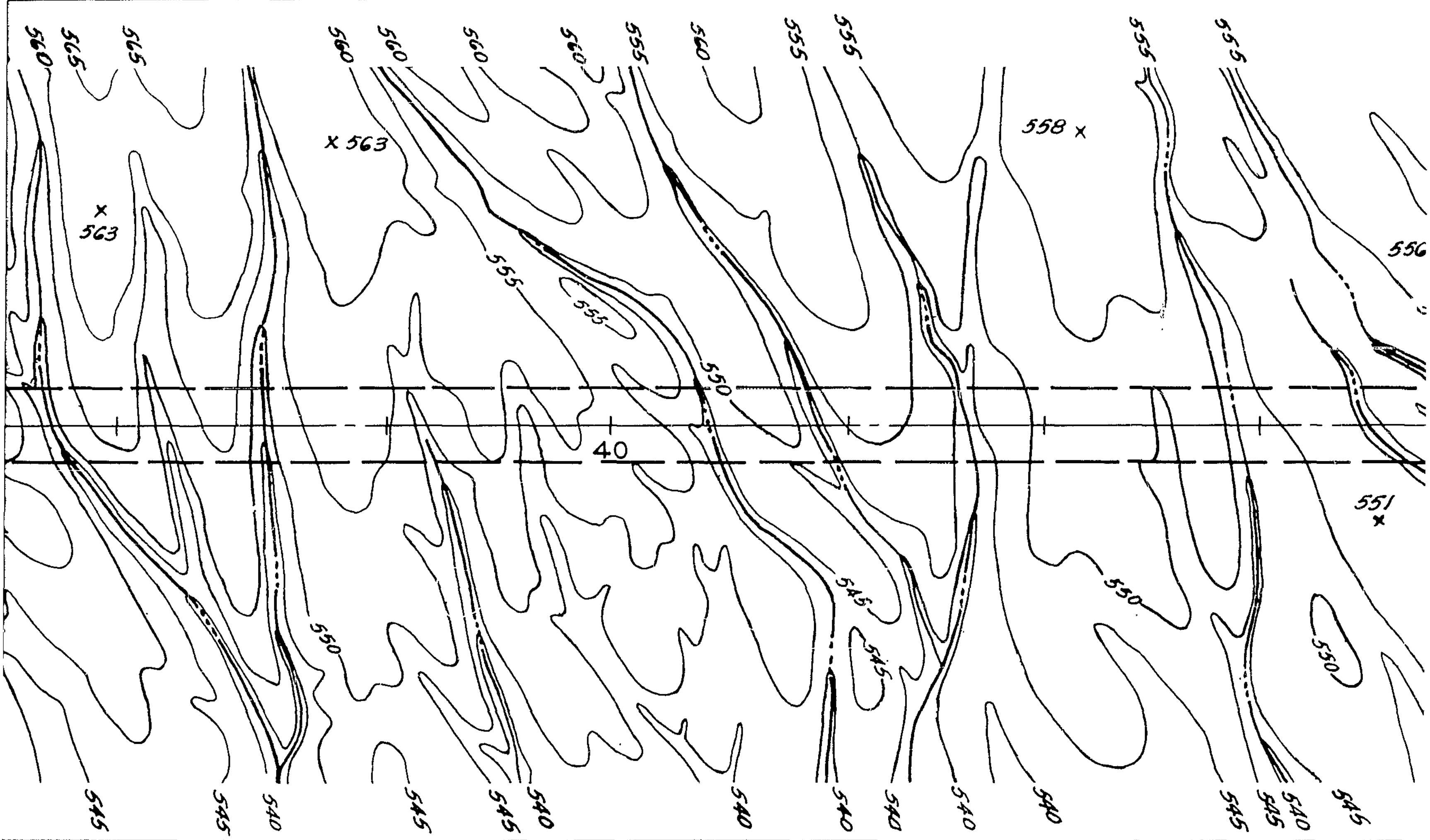
GF GROUND FACTOR

V VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

7,1,1b,2 - 6,9/6,10 - 1/4

7,1,1b,2



6,9/6,10

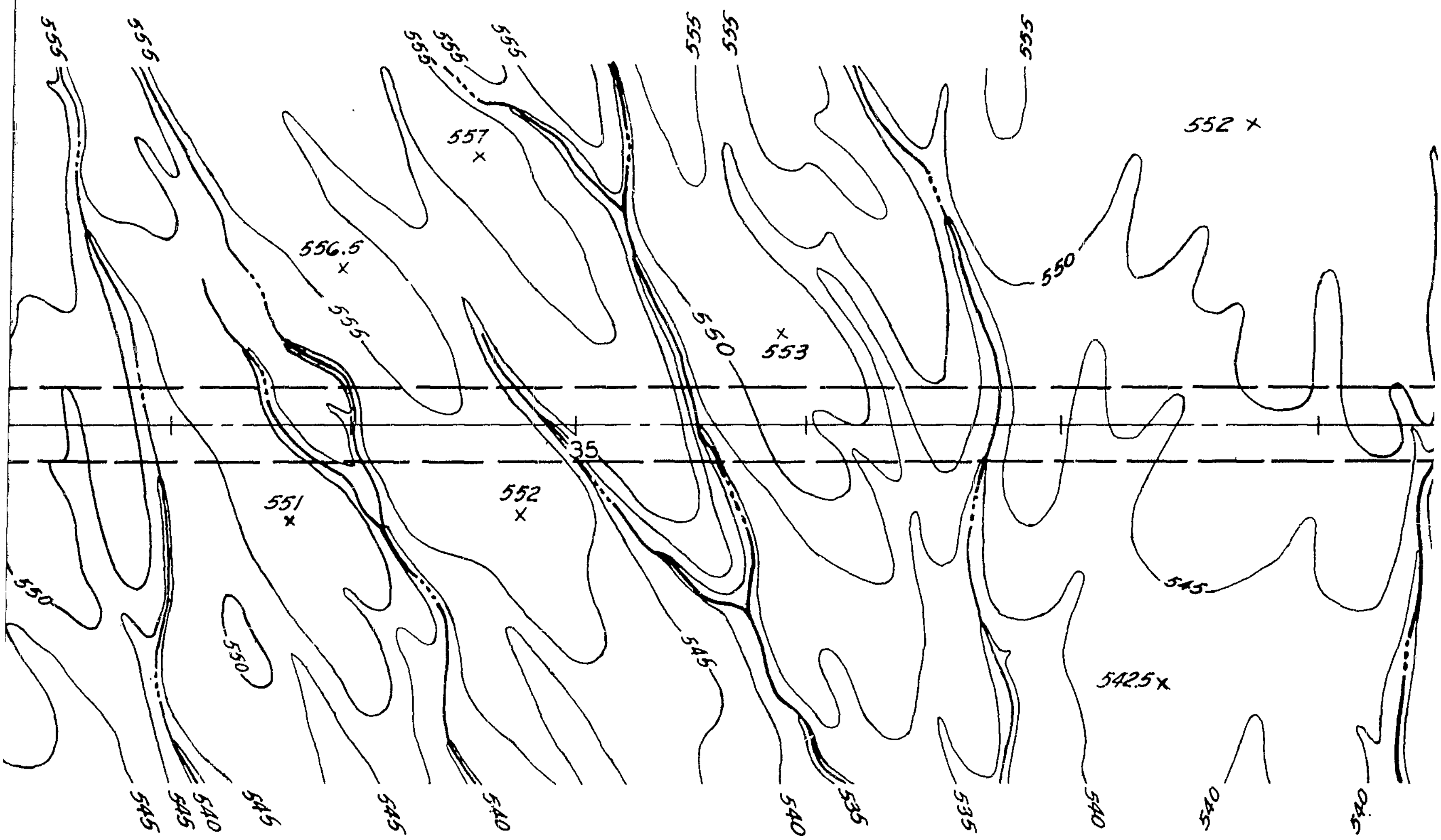
1/4

2

RRAIN TYPE
NDSCAPE
OUND FACTOR
GETATION

ON REVERSE

7, I, Ia, 2 - 6, 9/6, 10 - 1/4	7, I, Ia, I
7, I, Ia, 2	7, I,



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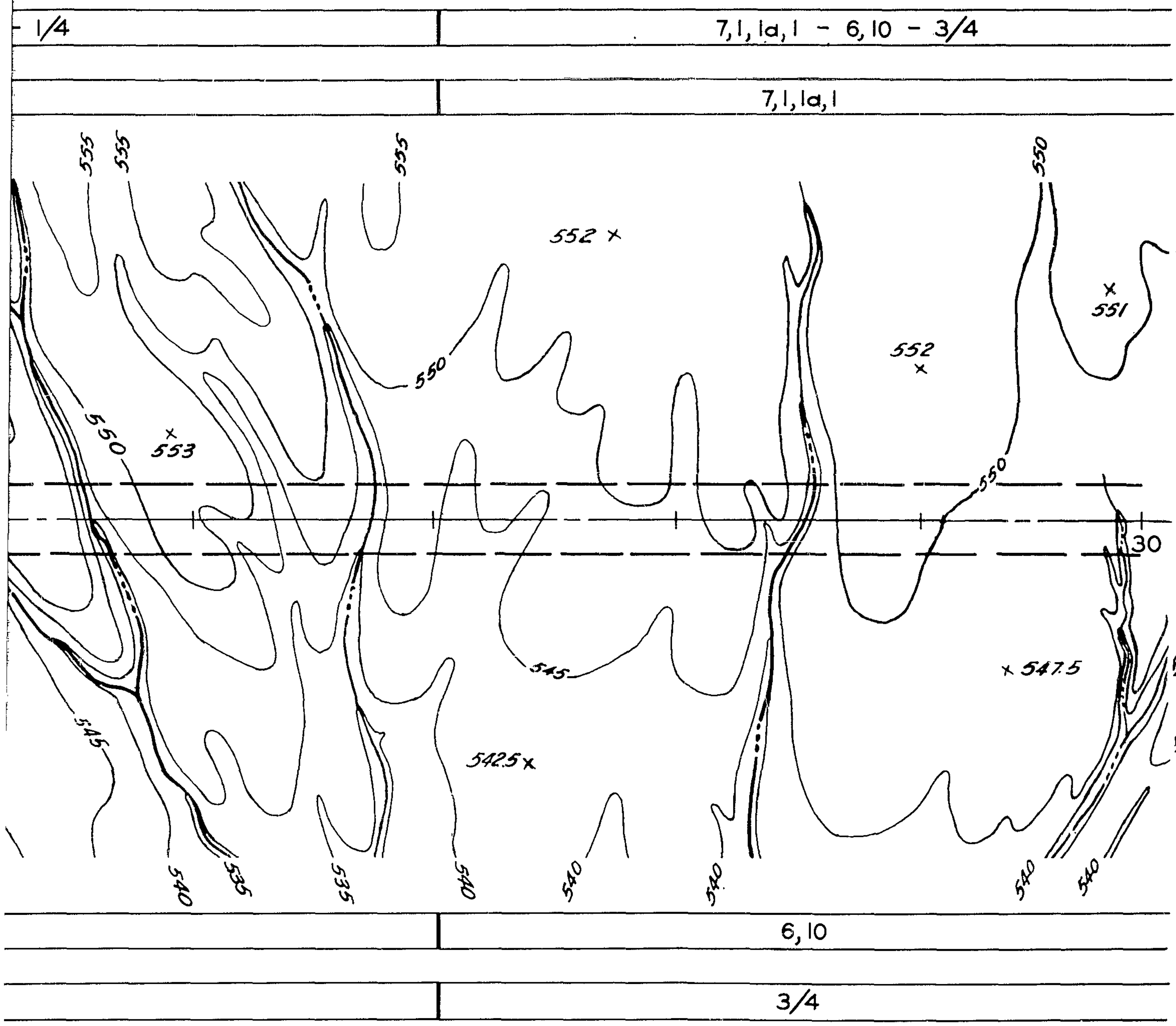


TOPOGRAPHIC MAP
TEST COURSE NO. 9
SEGMENT I

SCALE IN FEET

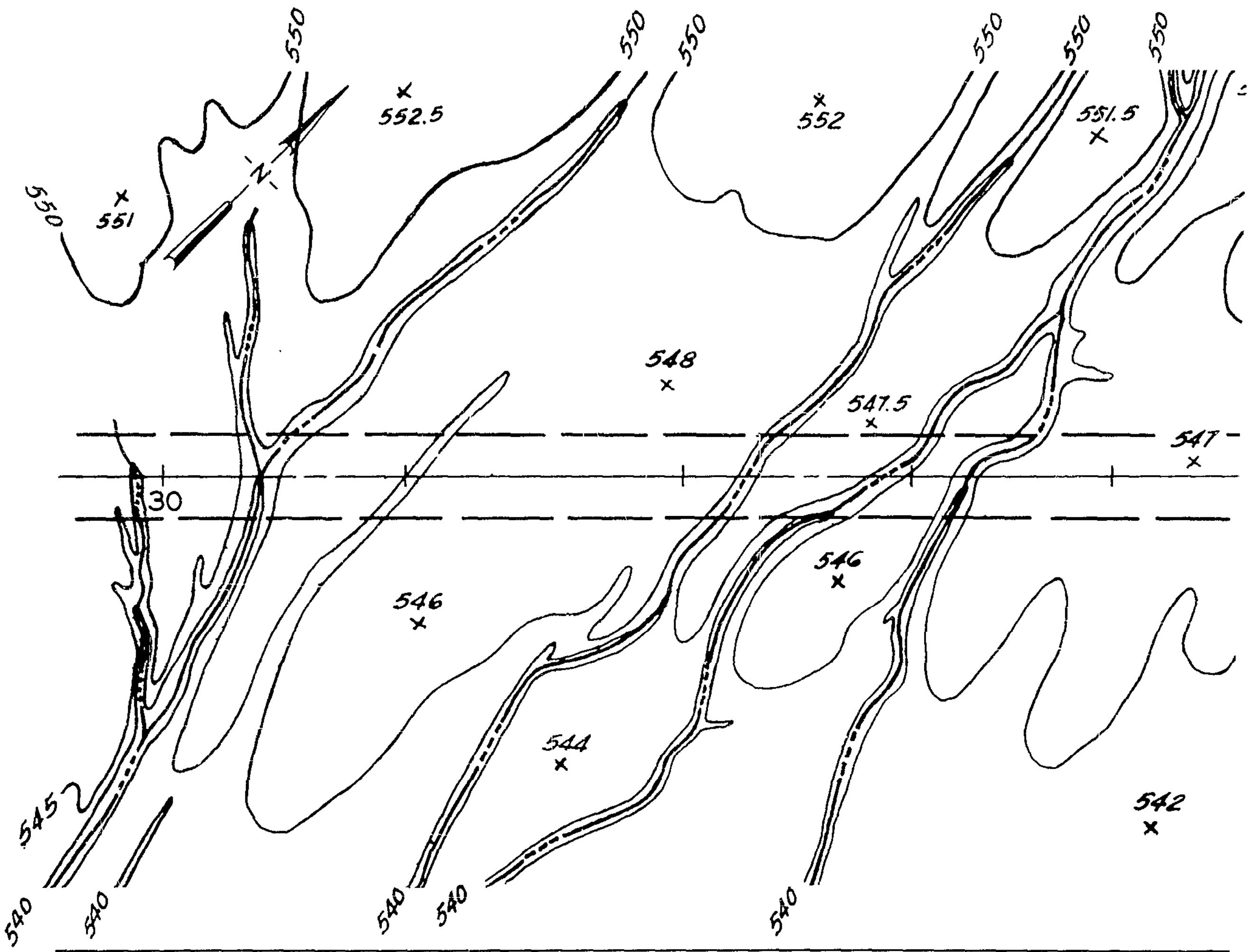
500 0 500 1000

CONTOUR INTERVAL = 5 FT

4

*TT 7,1,1a,1 - 6,10 - 3/4

LS



GF

V 3/4

LEGEND

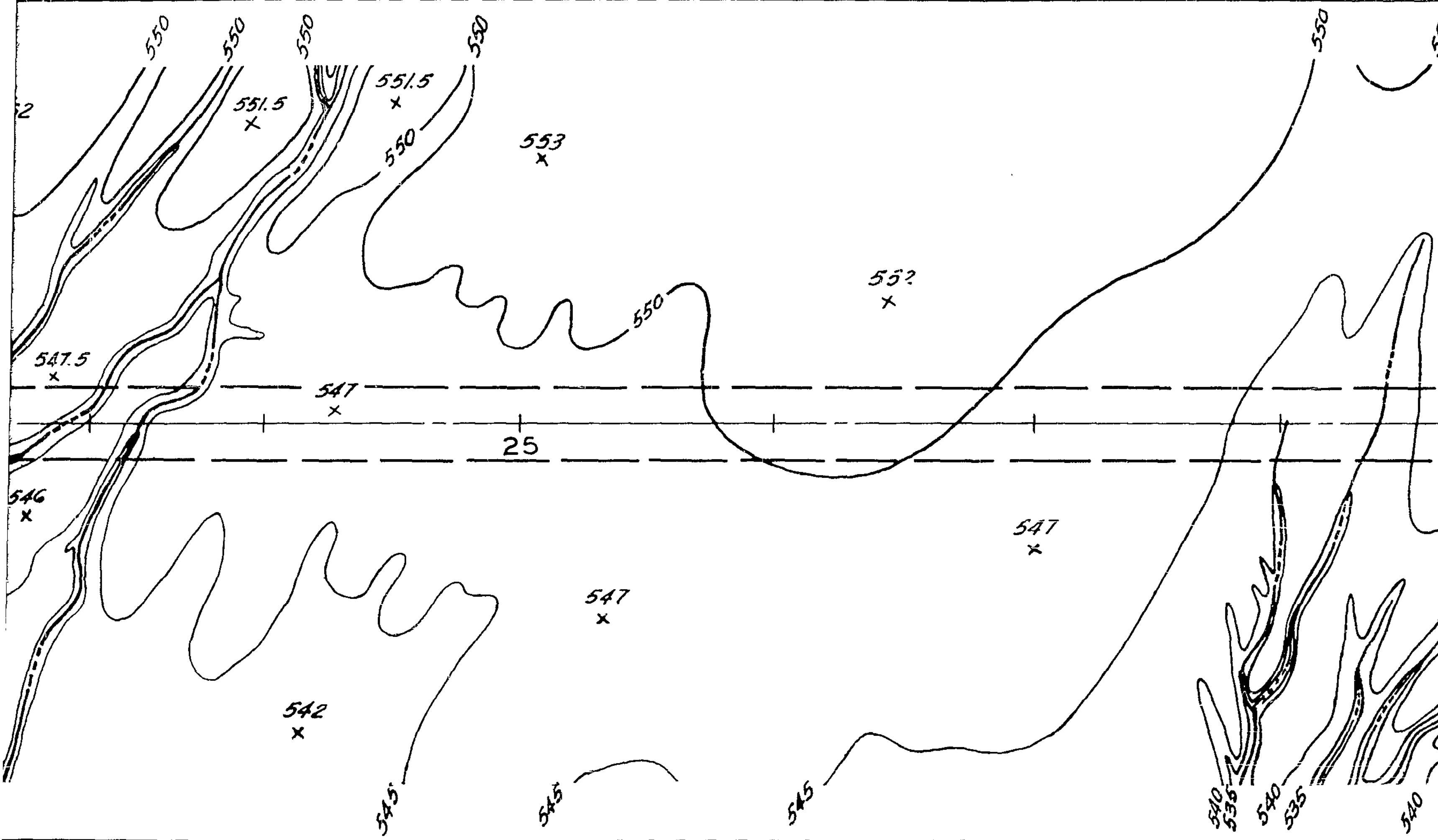
——— ———	LIMITS OF TEST COURSE
———+——— 6	CENTER-LINE STAKE
———-·-·———	DRAINAGE
═ ═ ═ ═	IMPROVED ROADS
— — — —	UNIMPROVED ROADS OR TRAILS

*TT	TERRAIN TYPE
LS	LANDSCAPE
GF	GROUND FACTOR
V	VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

7,1,1a,1

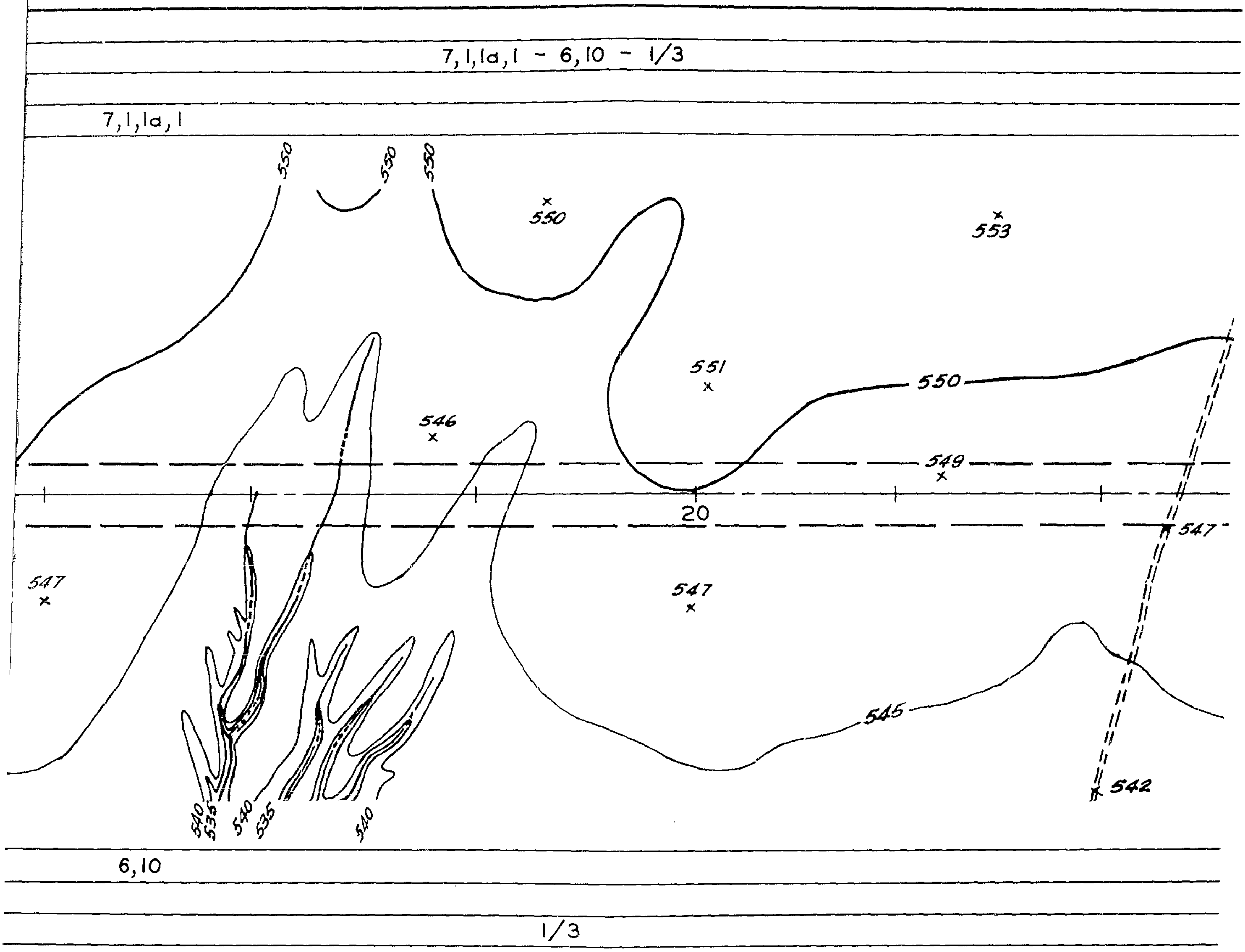


6,10

2

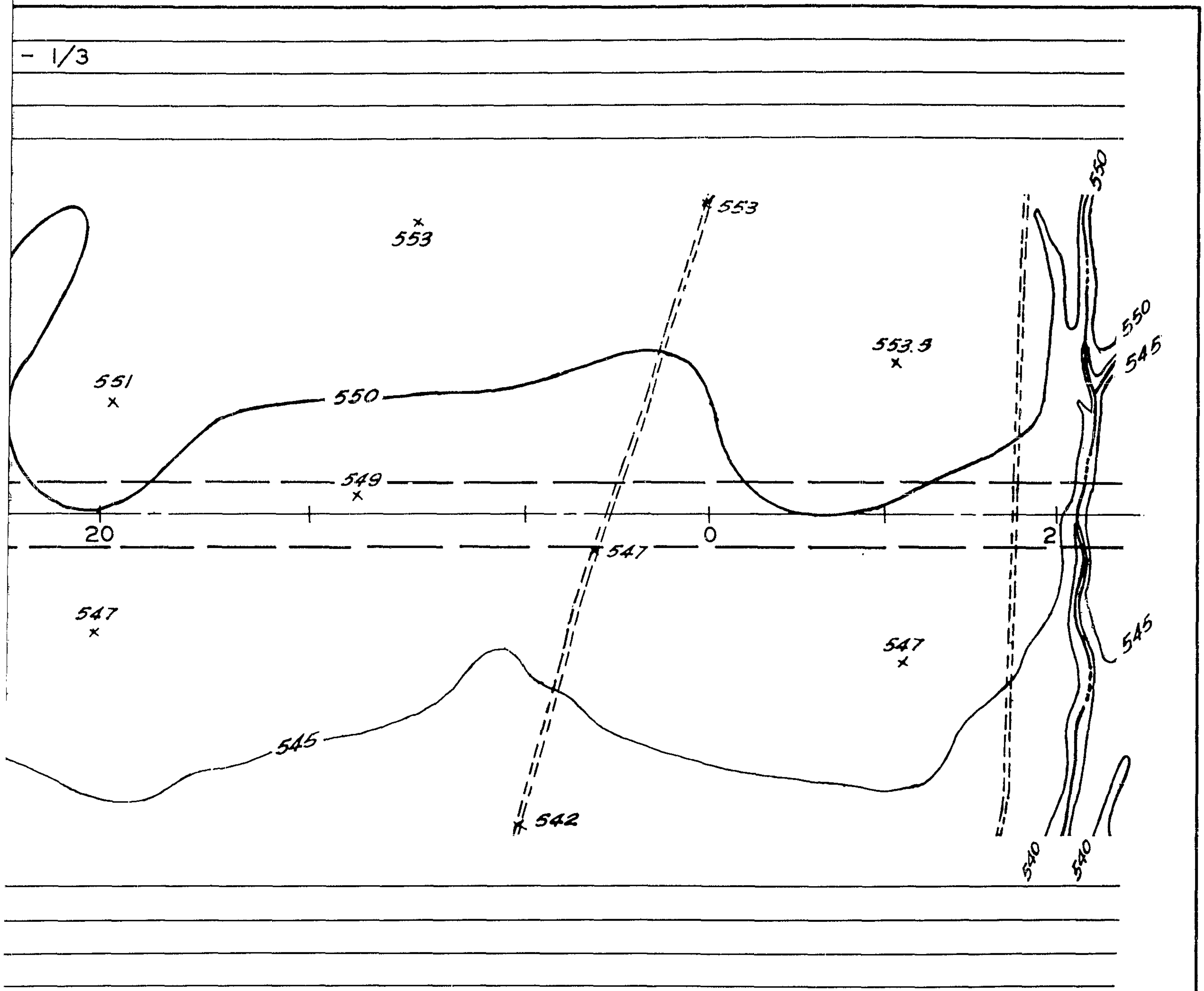
RAIN TYPE
DSCAPE
JND FACTOR
ETATION

ON REVERSE


7,1,1a,1 - 6,10 - 1/3
7,1,1a,1
550
550
550
550
553
551
550
546
549
20
547
547
547
545
542
540
535
540
535
540
6,10
1/3

3

500



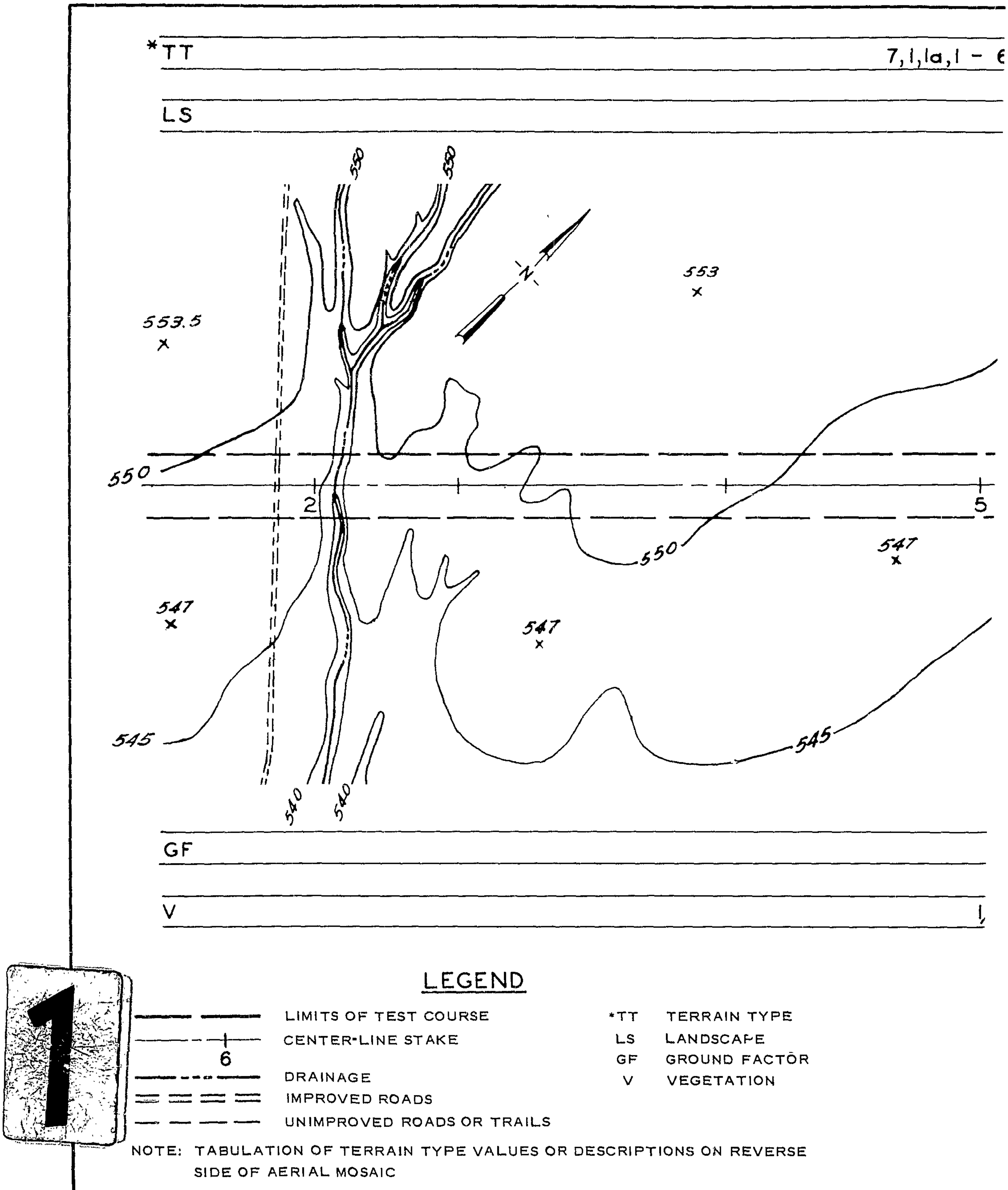
4

TOPOGRAPHIC MAP
TEST COURSE NO. 9
SEGMENT 2

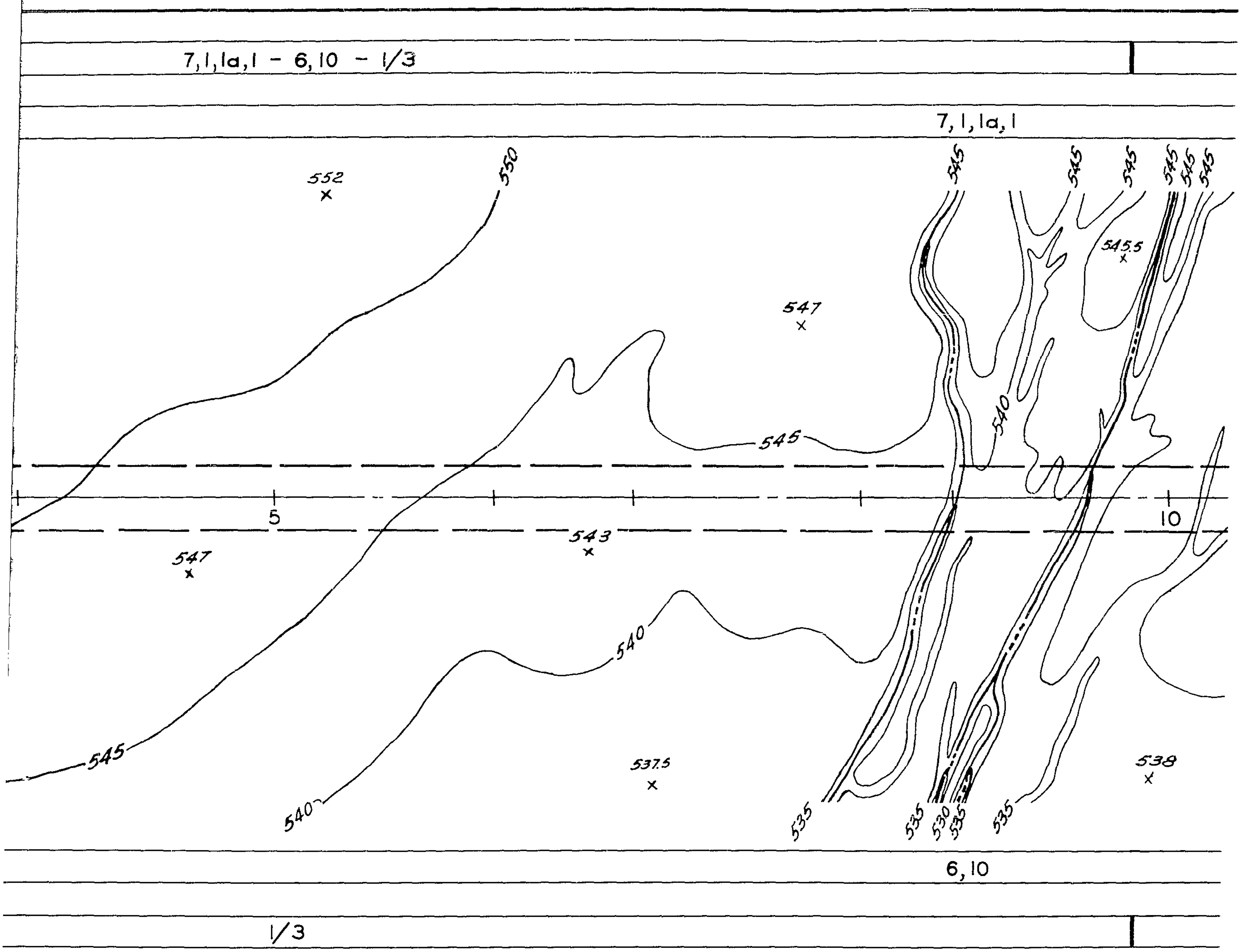
SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT



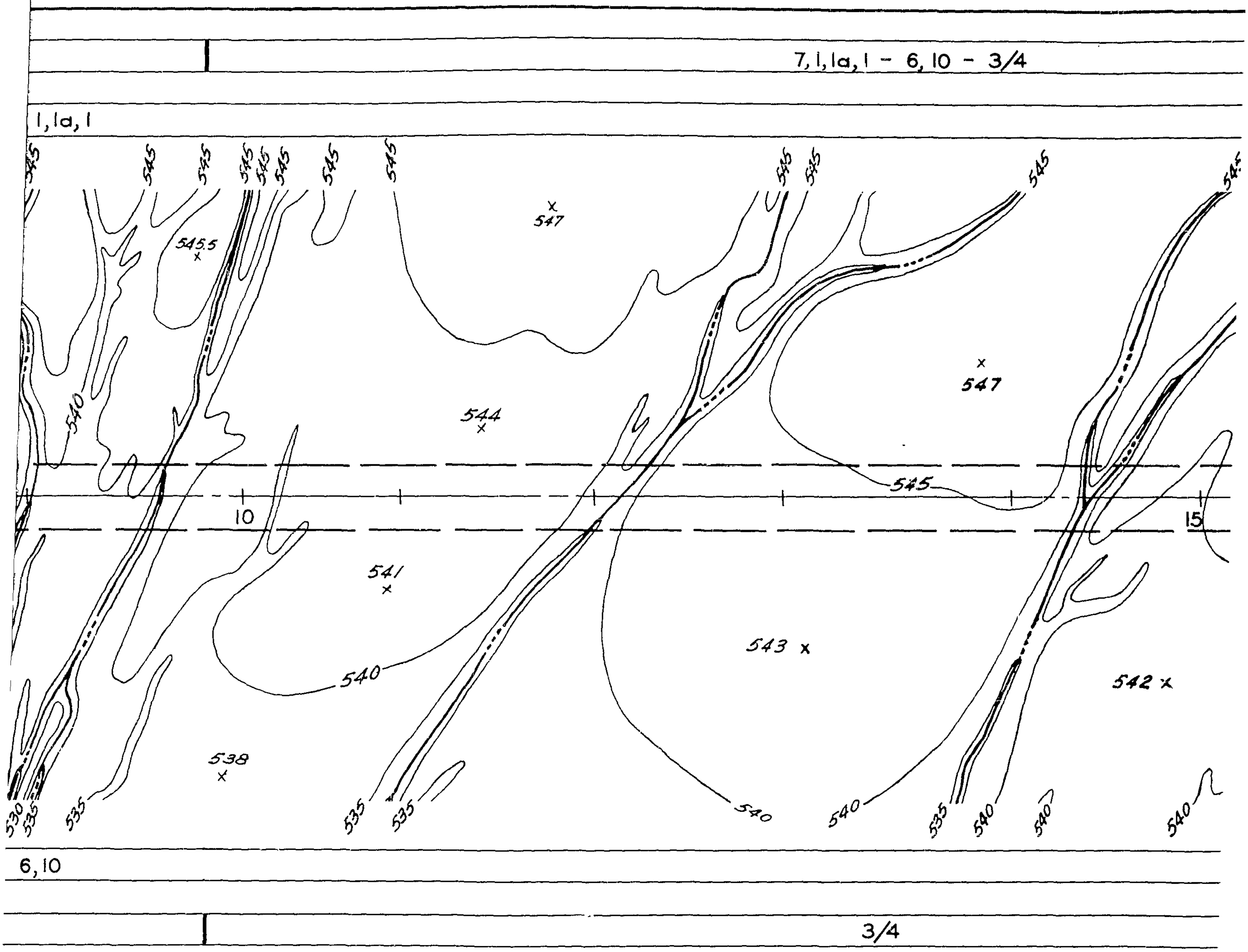
*TT
7, 1, 1a, 1 - 6
LS
553.5
553
550
550
550
550
547
547
547
545
545
540
540
2
5
GF
V
1,
LEGEND
LIMITS OF TEST COURSE
CENTER-LINE STAKE
6
DRAINAGE
IMPROVED ROADS
UNIMPROVED ROADS OR TRAILS
*TT TERRAIN TYPE
LS LANDSCAPE
GF GROUND FACTOR
V VEGETATION
NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC



AIN TYPE
SCAPE
ND FACTOR
TATION

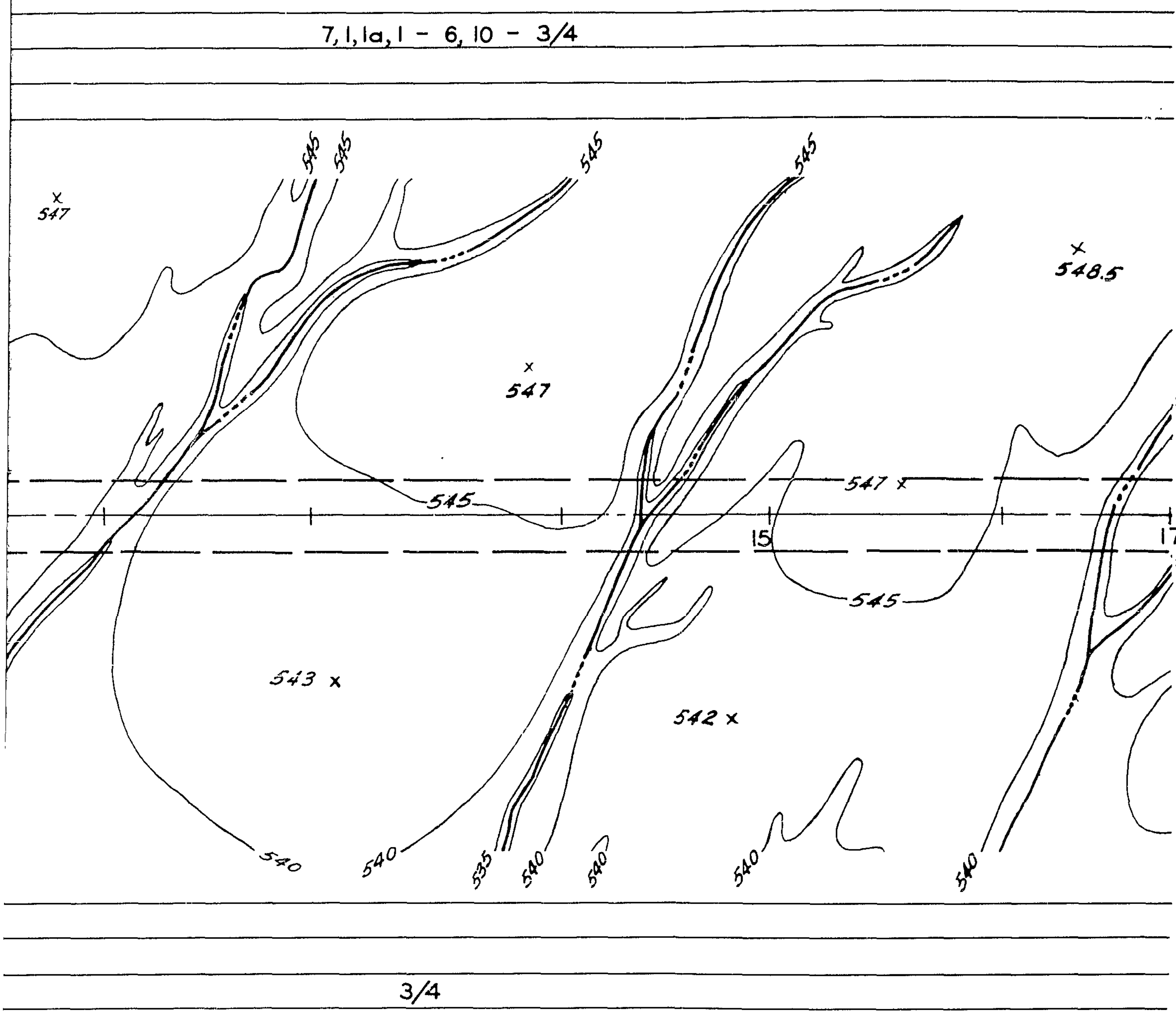
N REVERSE

2



3

TOP
TES
S
500
CONT



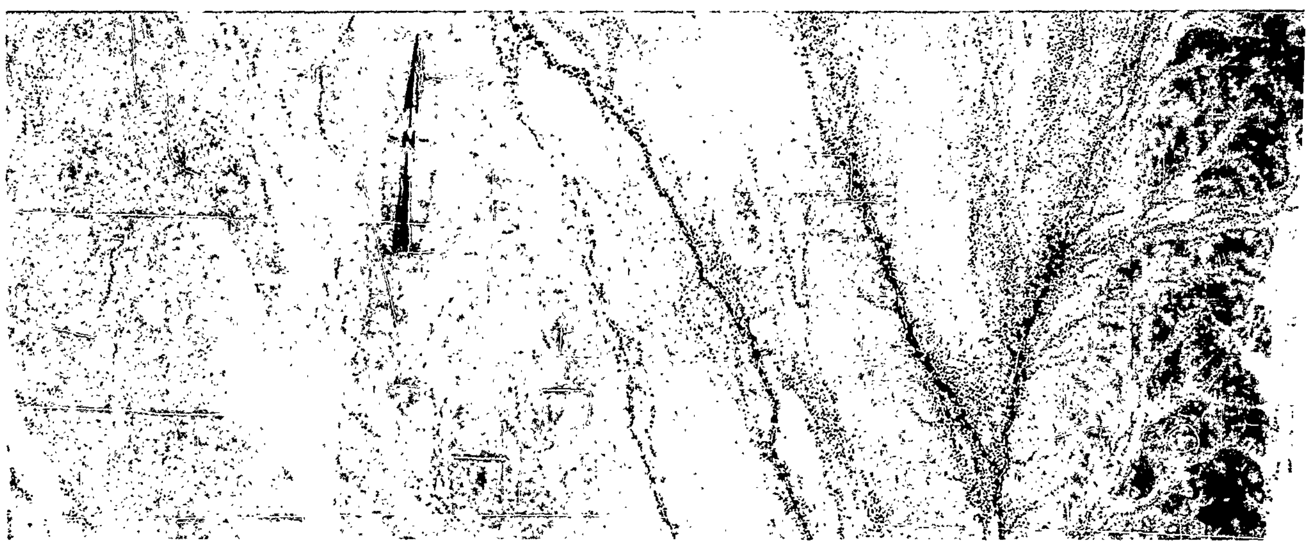
4

TOPOGRAPHIC MAP
TEST COURSE NO. 9
SEGMENT 3

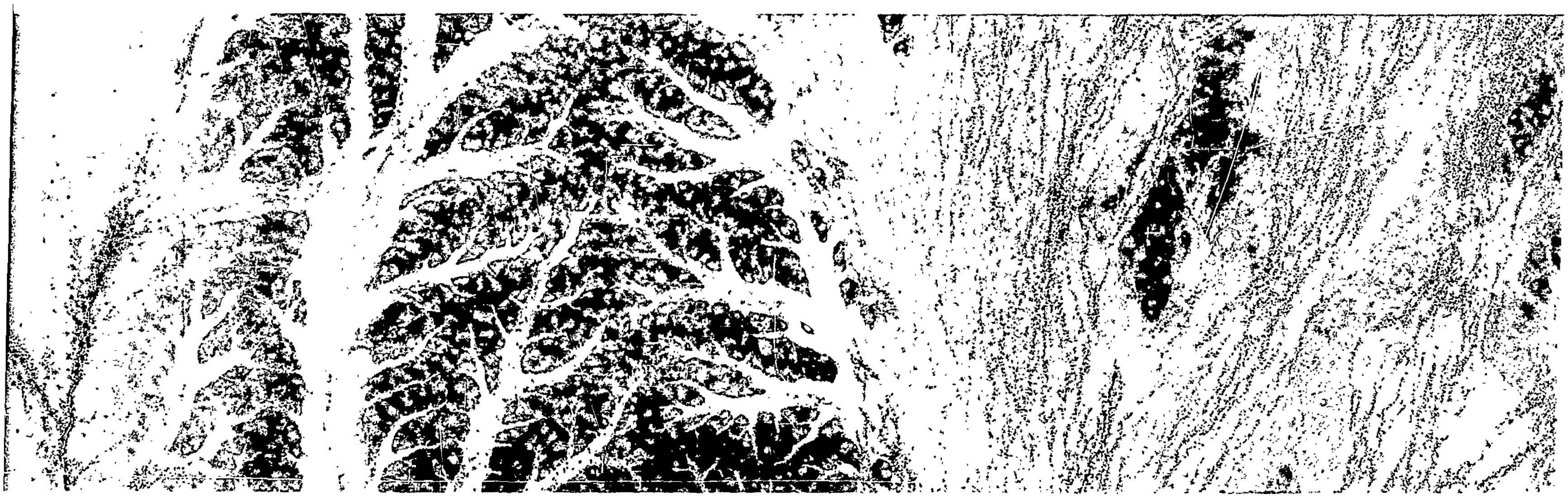
SCALE IN FEET

500 0 500 1000

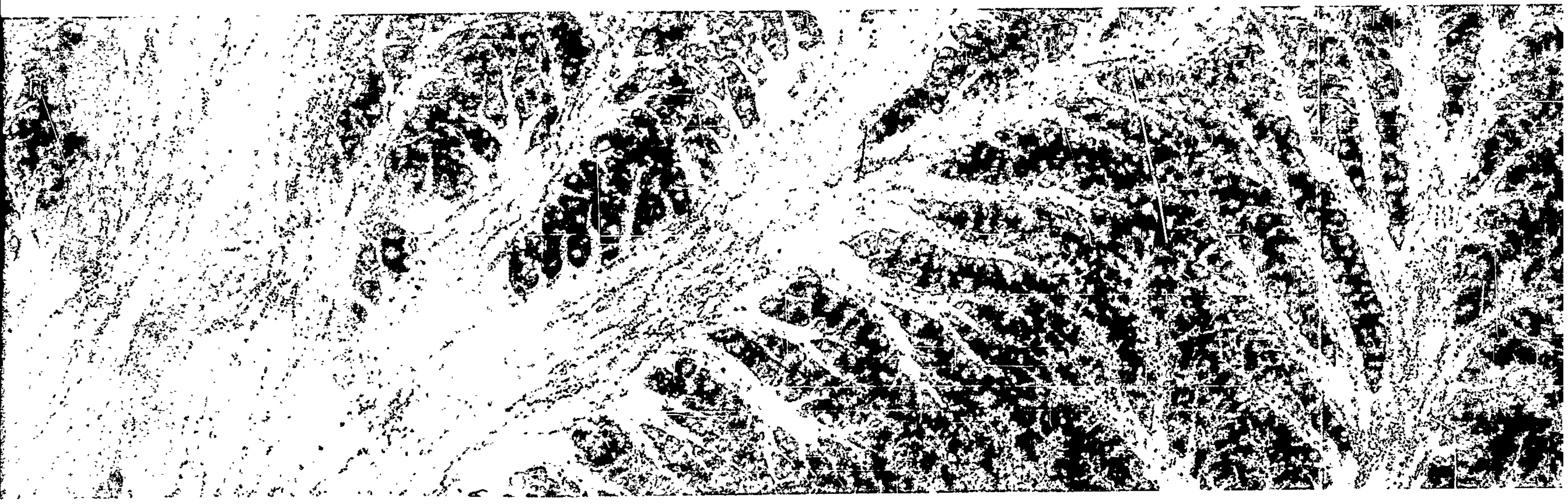
CONTOUR INTERVAL = 5 FT



1



2



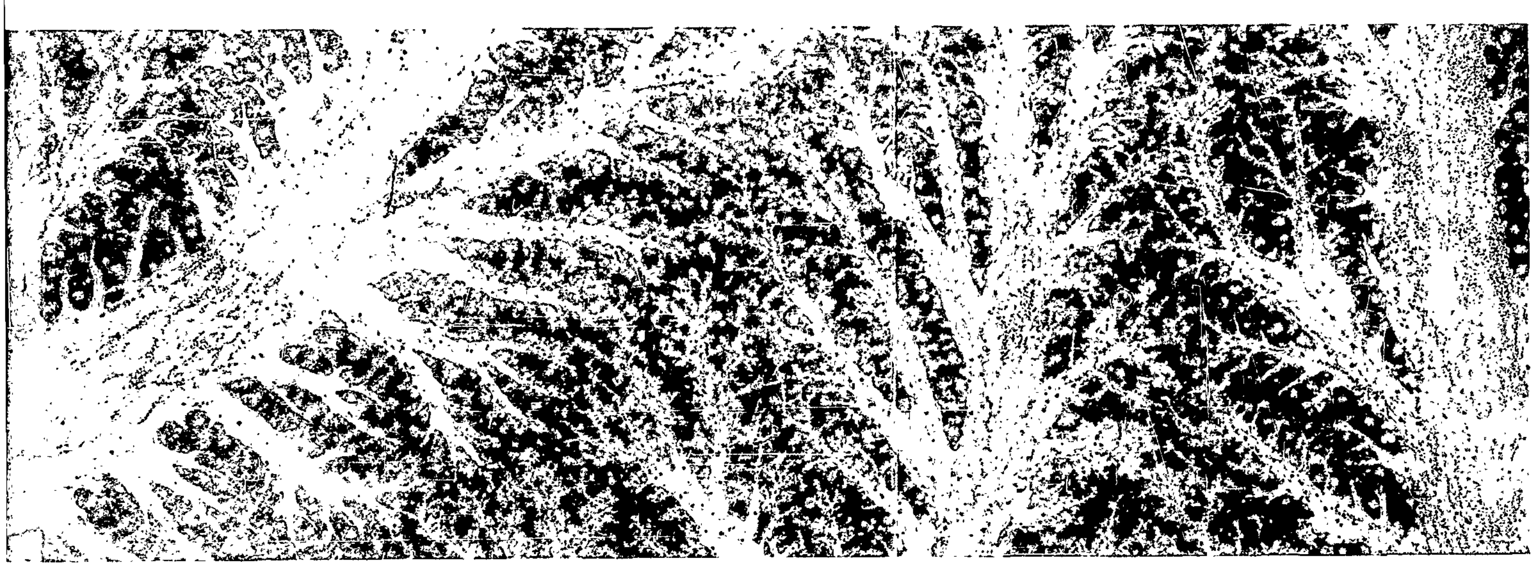
3

AEF

TES

SC

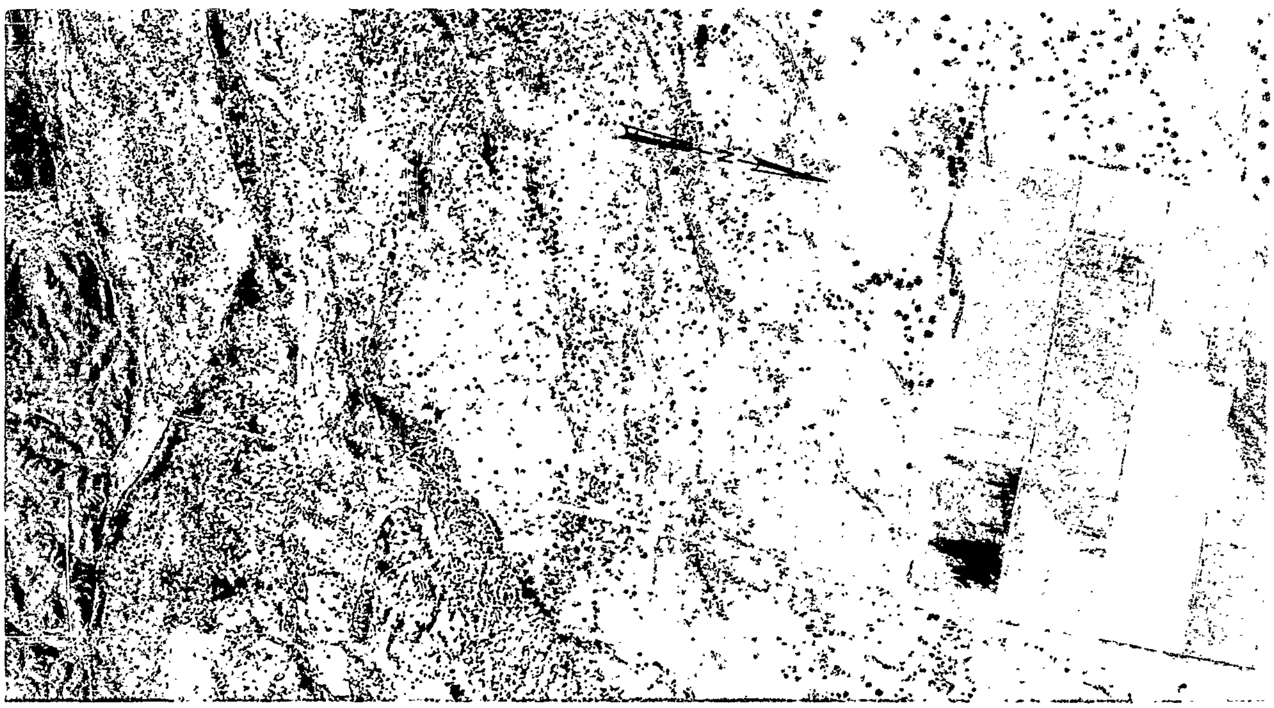
1000



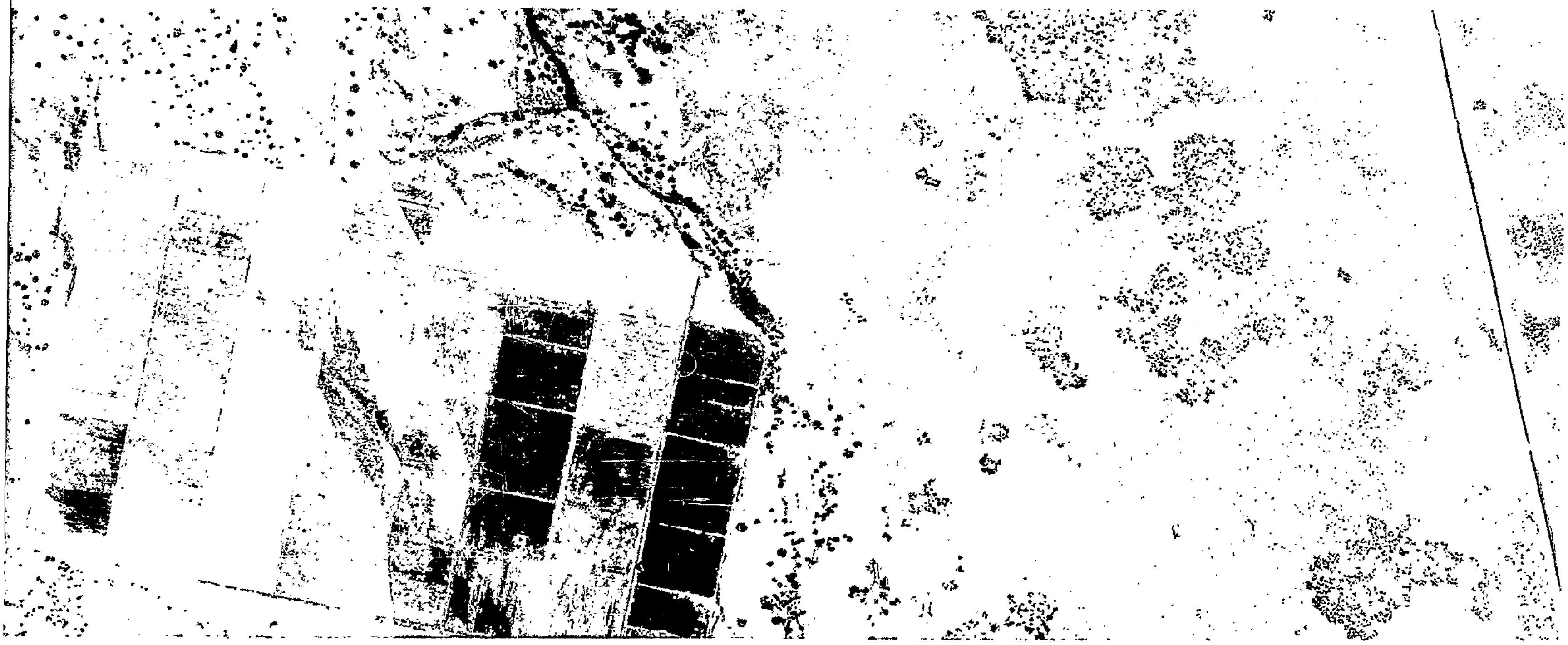
4

AERIAL MOSAIC
TEST COURSE NO. 10

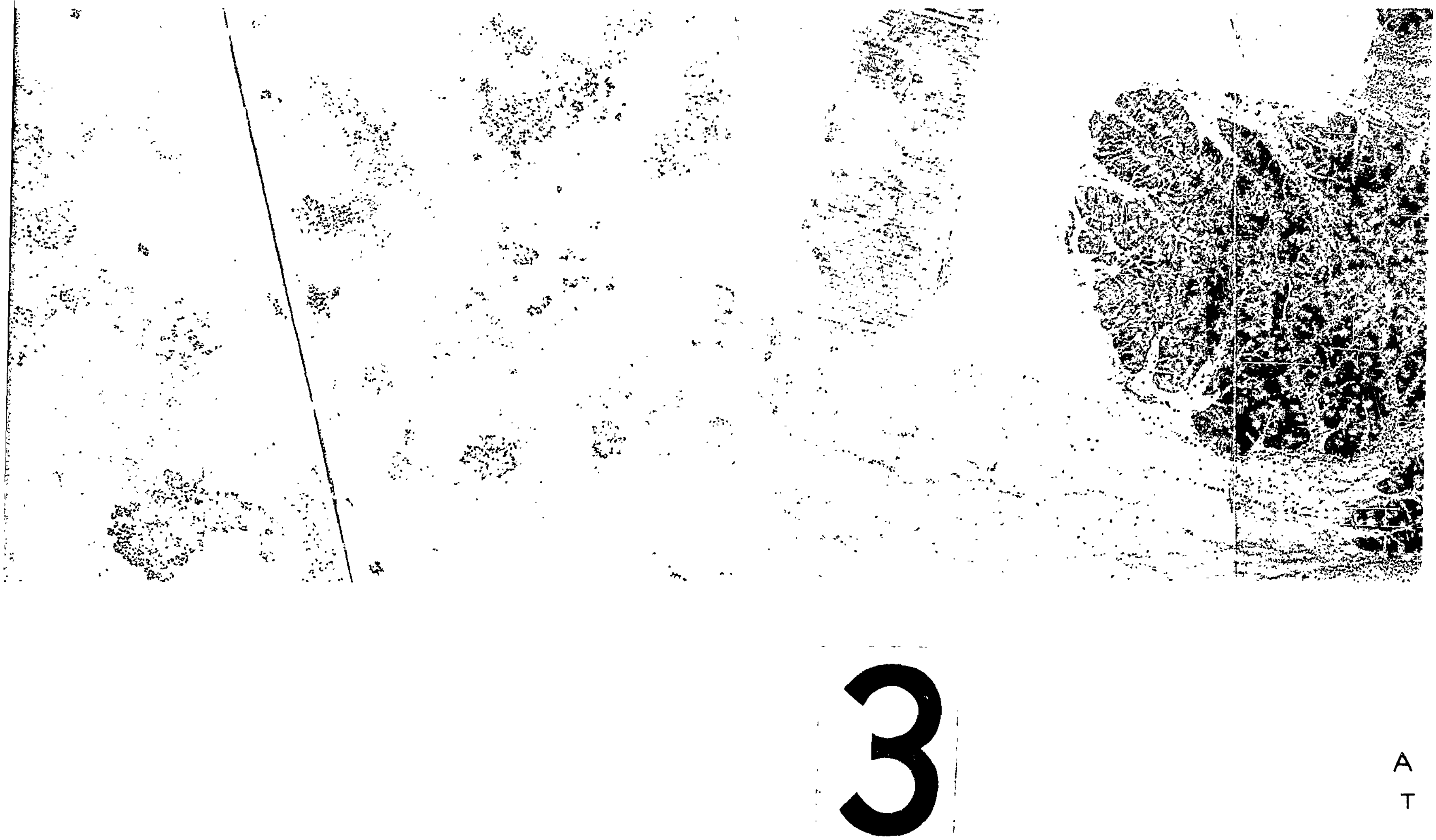
SCALE IN FEET
1000 0 1000 2000



1



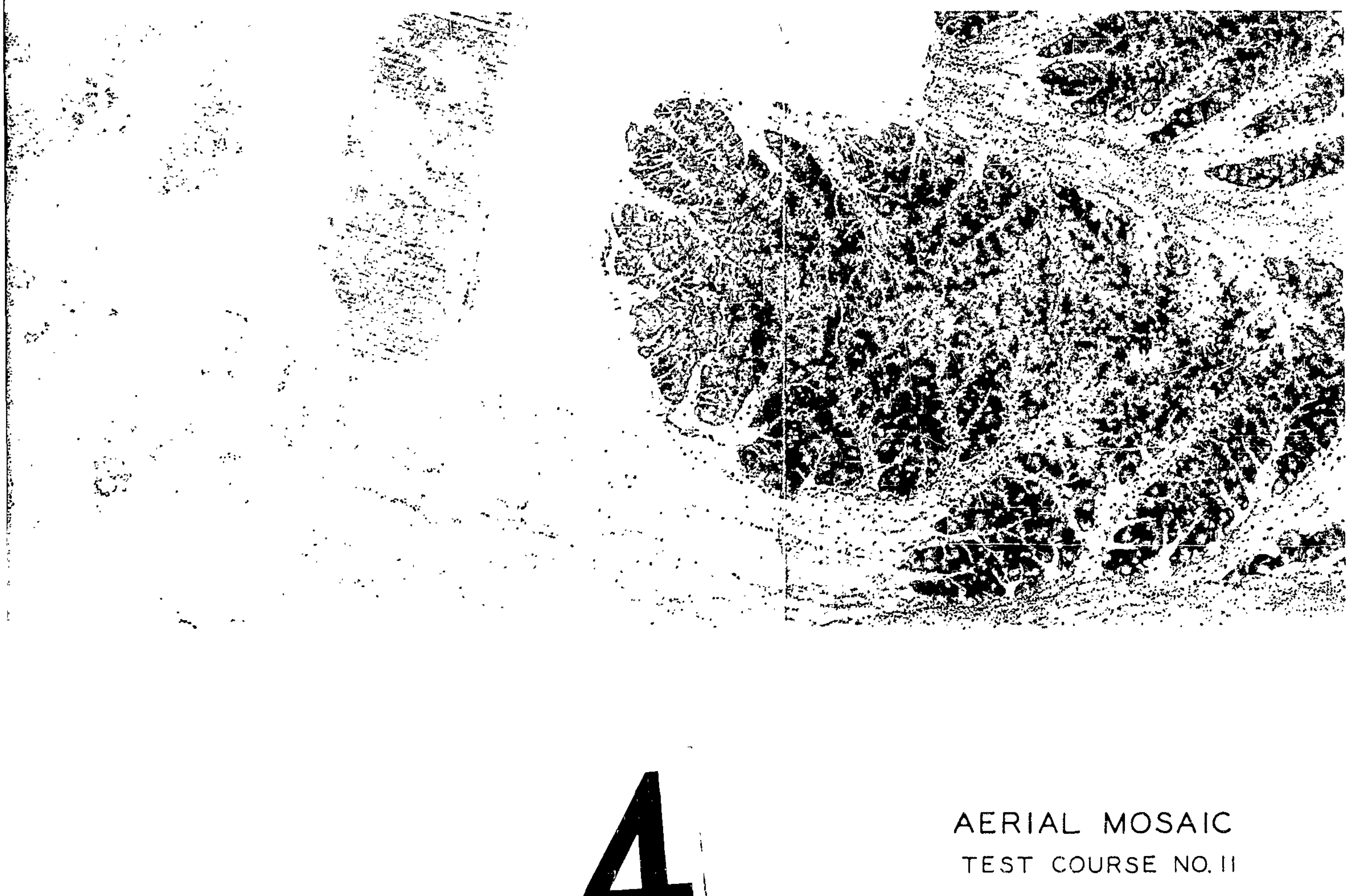
2



3

A
T

1000



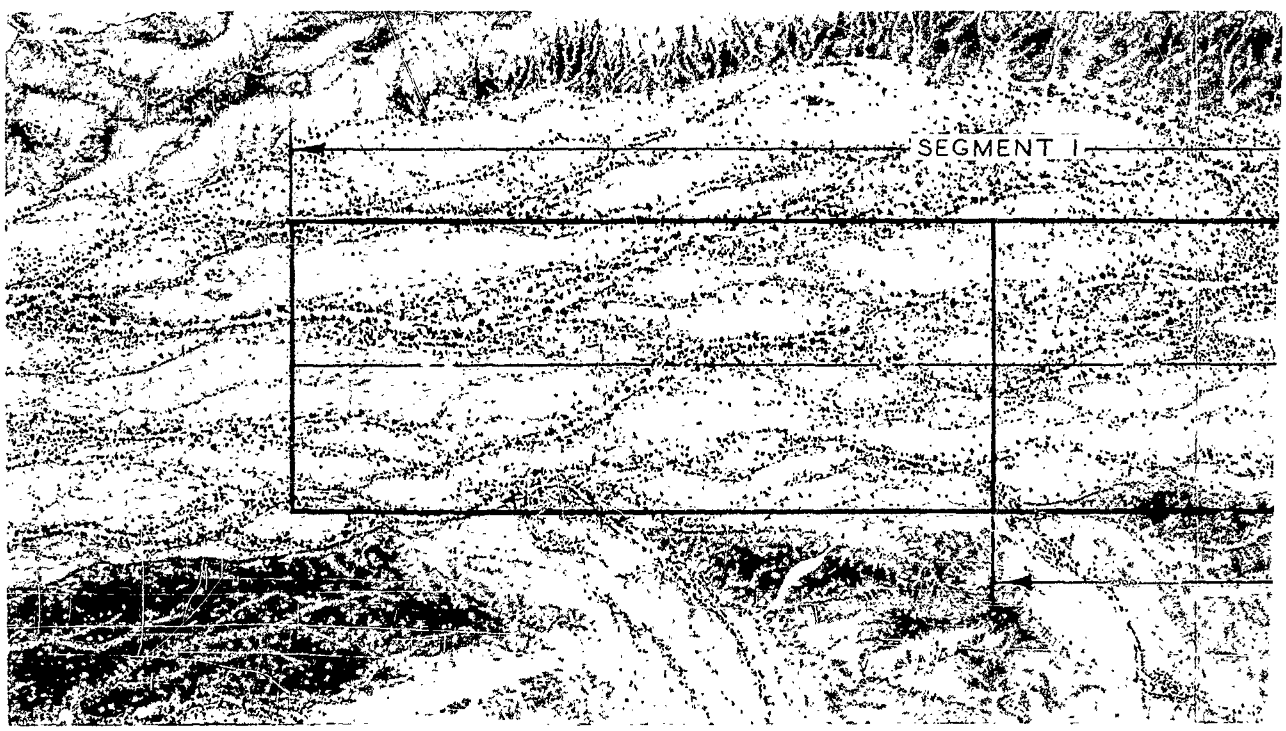
4

AERIAL MOSAIC

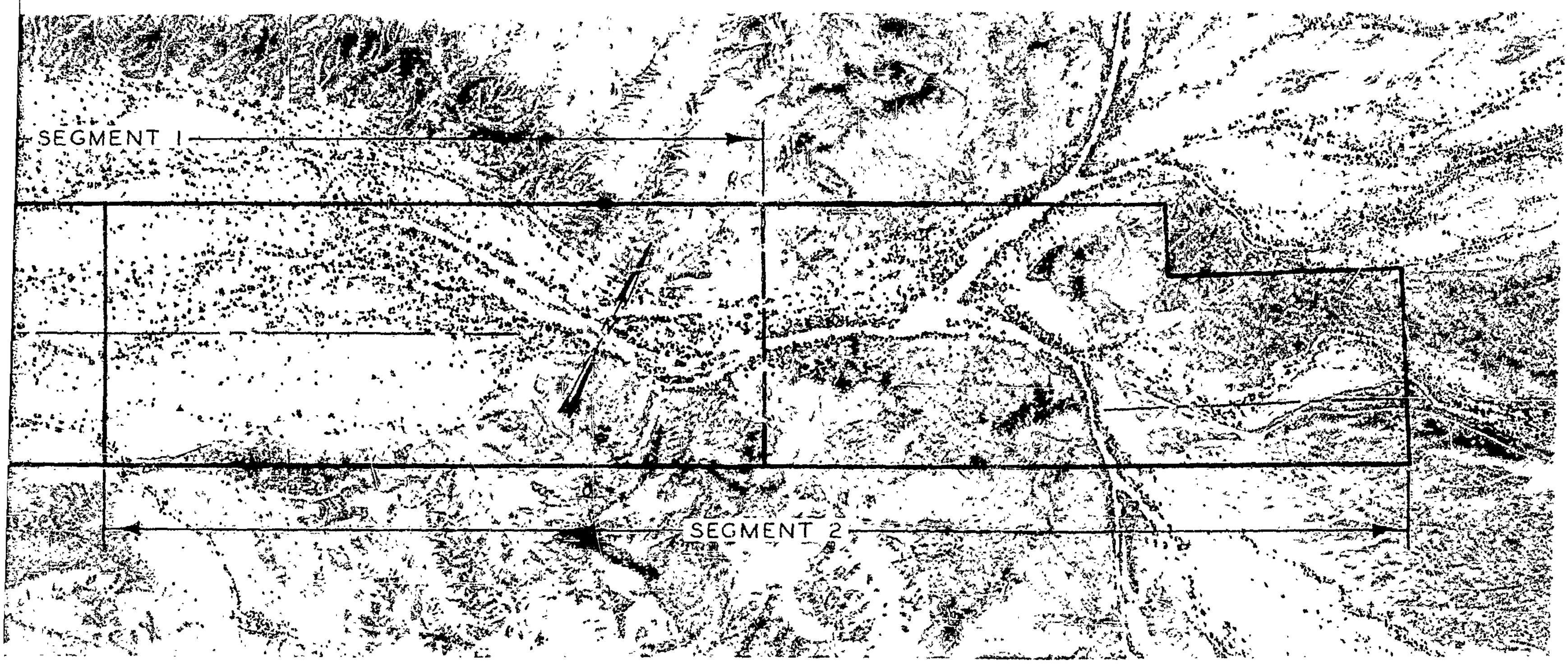
TEST COURSE NO. 11

SCALE IN FEET

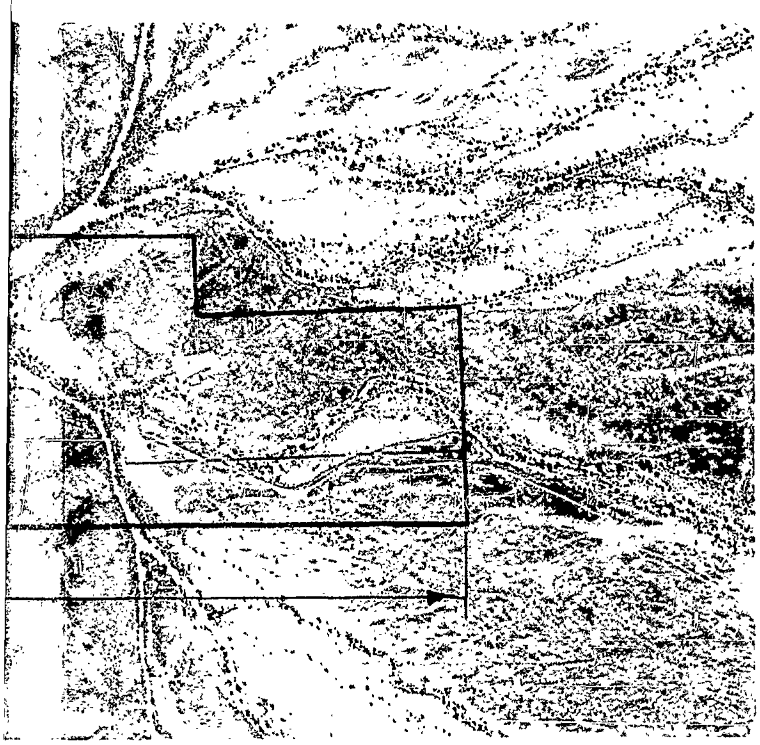
1000 0 1000 2000



1



2



AERIAL MOSAIC

TEST COURSE NO. 12

SCALE IN FEET

1000 0 1000 2000

TERRAI

TEST C

LANDSCAPE															GRO		
PLAN-PROFILE				SLOPE OCCURRENCE PER 10 MILES			CHARACTERISTIC SLOPE				CHARACTERISTIC RELIEF				SOIL TYPE		
HIGHS ARE	% AREA OCCUPIED BY HIGHS										TYPE I		TYPE II		SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES
	>60	40-60	<40	<1	5-20	20-100	0°-1/2°	1/2°-2°	2°-6°	6°-14°	0-10	10-50	0-100	100-400			
FLAT-TOPPED																	
PEAKED OR CRESTED																	
NO PRONOUNCED HIGHS OR LOWS		X		X			X				X					X	
		X		X			X				X						X
		X		X				X			X						X
		X		X				X			X						X

• EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPIN
TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE T
THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR COM

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO AREA
PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES T

TERRAI

TEST C

HIGHS ARE	LANDSCAPE														GRC		
	PLAN-PROFILE: % AREA OCCUPIED BY HIGHS			SLOPE OCCURRENCE PER 10 MILES			CHARACTERISTIC SLOPE				CHARACTERISTIC RELIEF: TYPE I		TYPE II		SOIL TYPE		
	>60	40-60	<40	<1	5-20	20-100	0°-1/2°	1/2°-2°	2°-6°	6°-14°	0-10	10-50	0-100	100-400	SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES
FLAT-TOPPED																	
PEAKED OR CRESTED																	
NO PRONOUNCED HIGHS OR LOWS		X		X			X				X					X	
		X		X			X				X						X
		X		X				X			X						X
		X		X				X			X						X

* EACH TERRAIN TYPE IN THE LEGEND IS IDENTIFIED BY A SERIES OR AN ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPIN TYPE (ST), SOIL CONSISTENCY (SC), AND VEGETATION, ALWAYS DESIGNATED IN THAT ORDER. THE RANGE OR DESCRIPTIVE T THOSE RANGES OR MAPPING UNITS OCCURRING ALONG THE TEST COURSE HAVE BEEN INDICATED IN THIS LEGEND. FOR COM

† DUAL SYMBOLIZATIONS OR COMPLEXES (E.G. 2/4) OCCURRING UNDER GROUND AND VEGETATION FACTORS INDICATE NO AREA PREDOMINANT IS SHOWN AS THE NUMERATOR, THE SUBORDINATE AS THE DENOMINATOR IN THE FRACTION. (X/) INDICATES T

1

TERRAIN TYPES

TEST COURSE 12

TIC		GROUND FACTORS							VEGETATION				TERRAIN TYPE*						
		SOIL TYPE				SOIL CONSISTENCY			BARREN	SPARSE SHRUBS AND GRASSES	SCATTERED SHRUBS AND GRASSES	SCATTERED SHRUBS AND/OR SCRUBBY TREES	LANDSCAPE				GROUND† FACTORS		VEGETATION†
YPE II		SAND	GRAVEL	SAND AND/OR GRAVEL W/FINES	SILT AND/OR CLAY WITH COARSE MATERIAL	LOOSE >12" BELOW SURFACE	DESERT PAVEMENT	DENSE LAYER WITHIN 12" OF SURFACE					PP	SO	CS	CR	ST	SC	
0	100-400																		
			X			X			/X			X/	7	1	1a	1	4	1	4/1
				X				X		X/		/X	7	1	1a	1	6	10	2/4
				X				X		X/		/X	7	1	1b	1	6	10	2/4
				X			/X	X/		X/		/X	7	1	1b	1	6	10/9	2/4

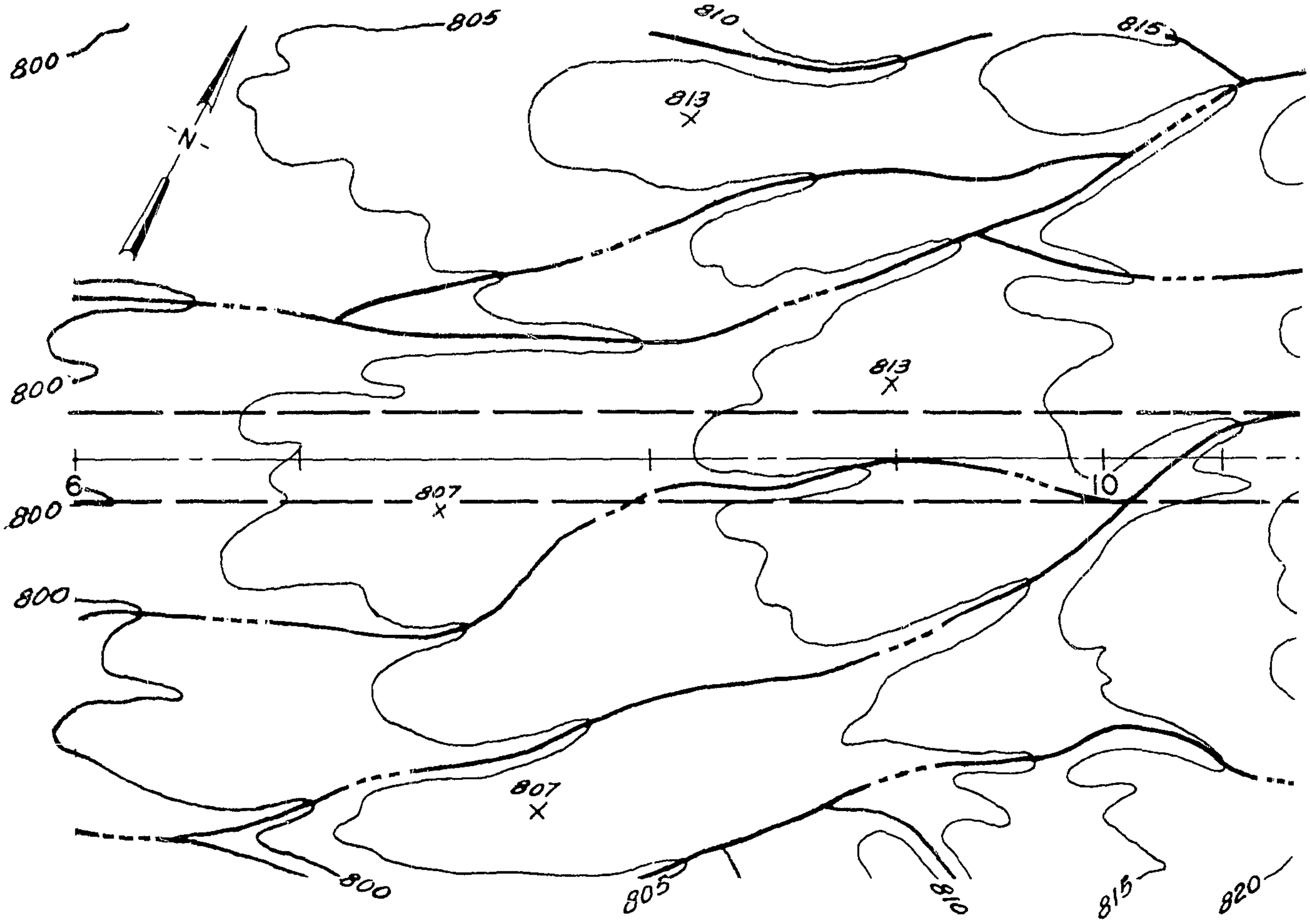
ARRAY OF SEVEN SYMBOLS INDICATING THE MAPPING UNITS OF PLAN-PROFILE (PP), SLOPE OCCURRENCE (SO), CHARACTERISTIC SLOPE (CS), CHARACTERISTIC RELIEF (CR), SOIL ED IN THAT ORDER. THE RANGE OR DESCRIPTIVE TERM OF EACH MAPPING UNIT IS IDENTIFIED BY AN (X) UNDER THE COLUMN CORRESPONDING TO THE TERRAIN FACTOR. ONLY HAVE BEEN INDICATED IN THIS LEGEND. FOR COMPLETE DESCRIPTION OF THE MAPPING UNITS SEE FIGS. 1-6 AND 8.

UND AND VEGETATION FACTORS INDICATE NO AREALLY PREDOMINANT TYPE OCCURS. IN SUCH INSTANCES, THE TWO MOST COMMONLY OCCURRING TYPES ARE MAPPED; THE DENOMINATOR IN THE FRACTION. (X/) INDICATES THE NUMERATOR AND (/X) THE DENOMINATOR IN THE BODY OF THE LEGEND.

2

*TT 7,1,1a,1-6,10-2/4

LS 7,1,1a,1



GF

V

LEGEND

LIMITS OF TEST COURSE	
CENTER-LINE STAKE (6)	
DRAINAGE	
IMPROVED ROADS	
UNIMPROVED ROADS OR TRAILS	

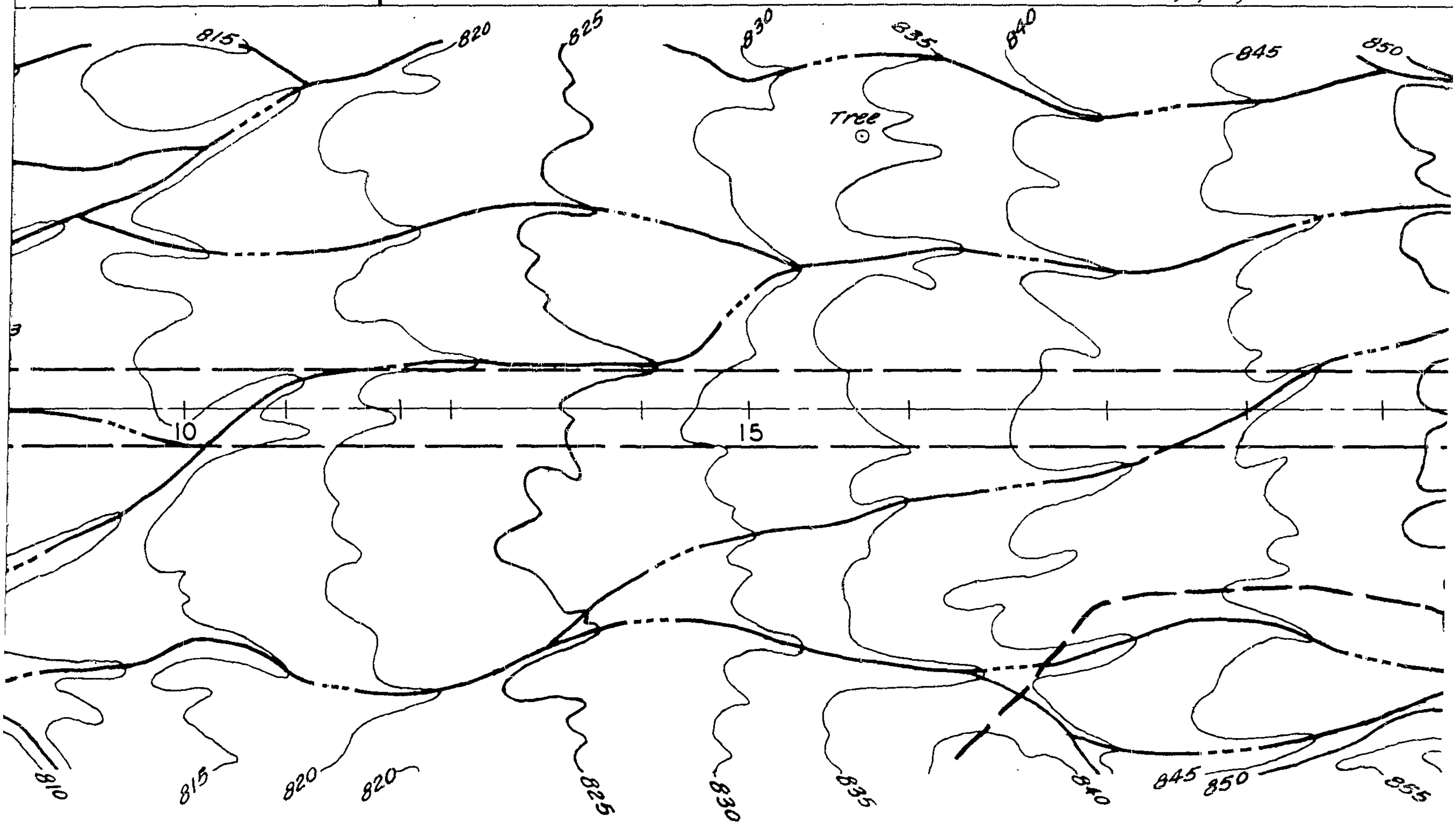
*TT	TERRAIN TYPE
LS	LANDSCAPE
GF	GROUND FACTOR
V	VEGETATION

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

1

7,1,1b,1-6,10-2/4

7,1,1b,1



6,10

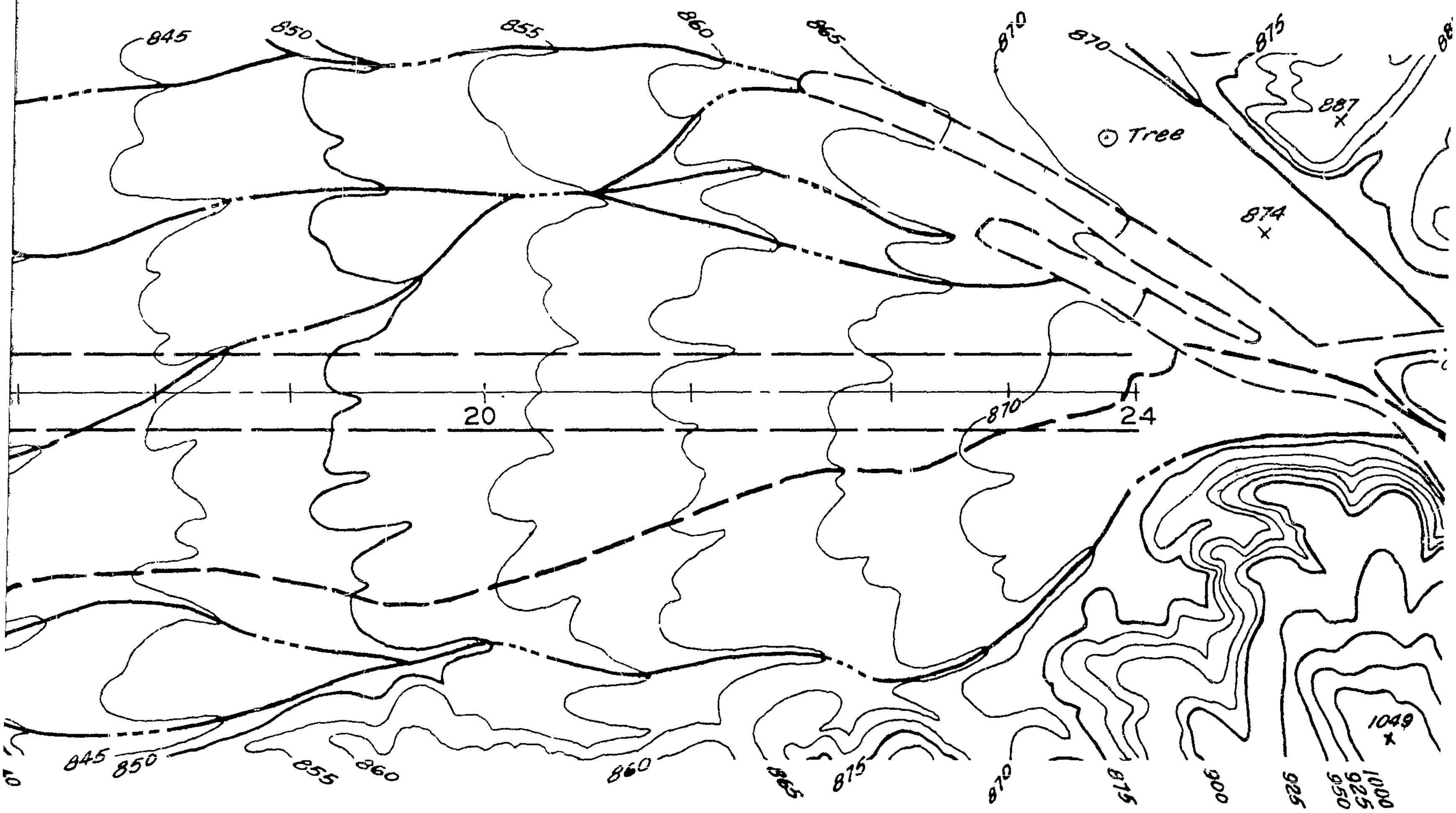
2/4

TYPE
PE
FACTOR
TION

REVERSE

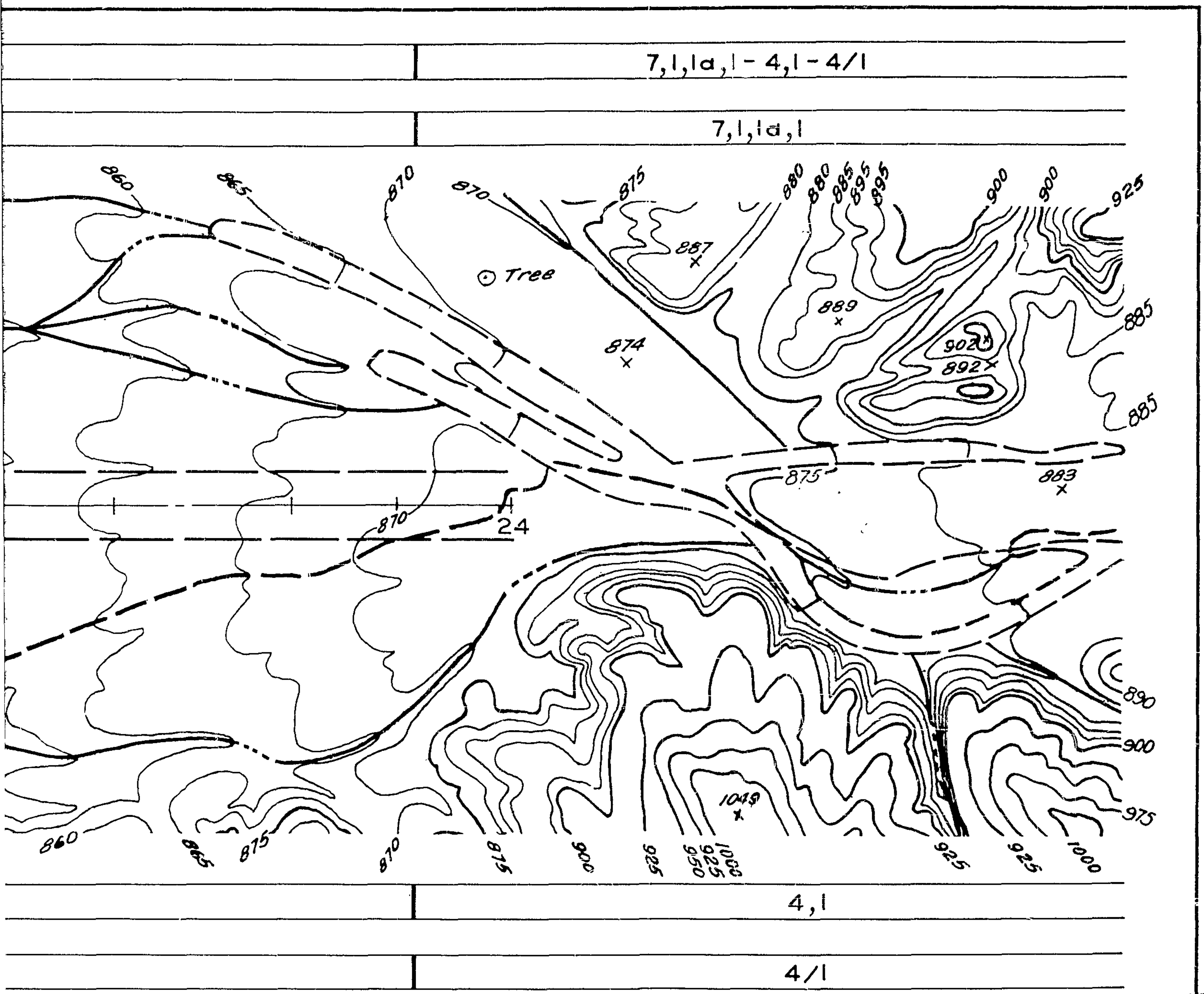
2

1,1b,1-6,10-2/4	7,1,1a,1-4,1
7,1,1b,1	7,1,1a,



3

TOPO
TEST
S
SCA
500 0
CONTOU



4

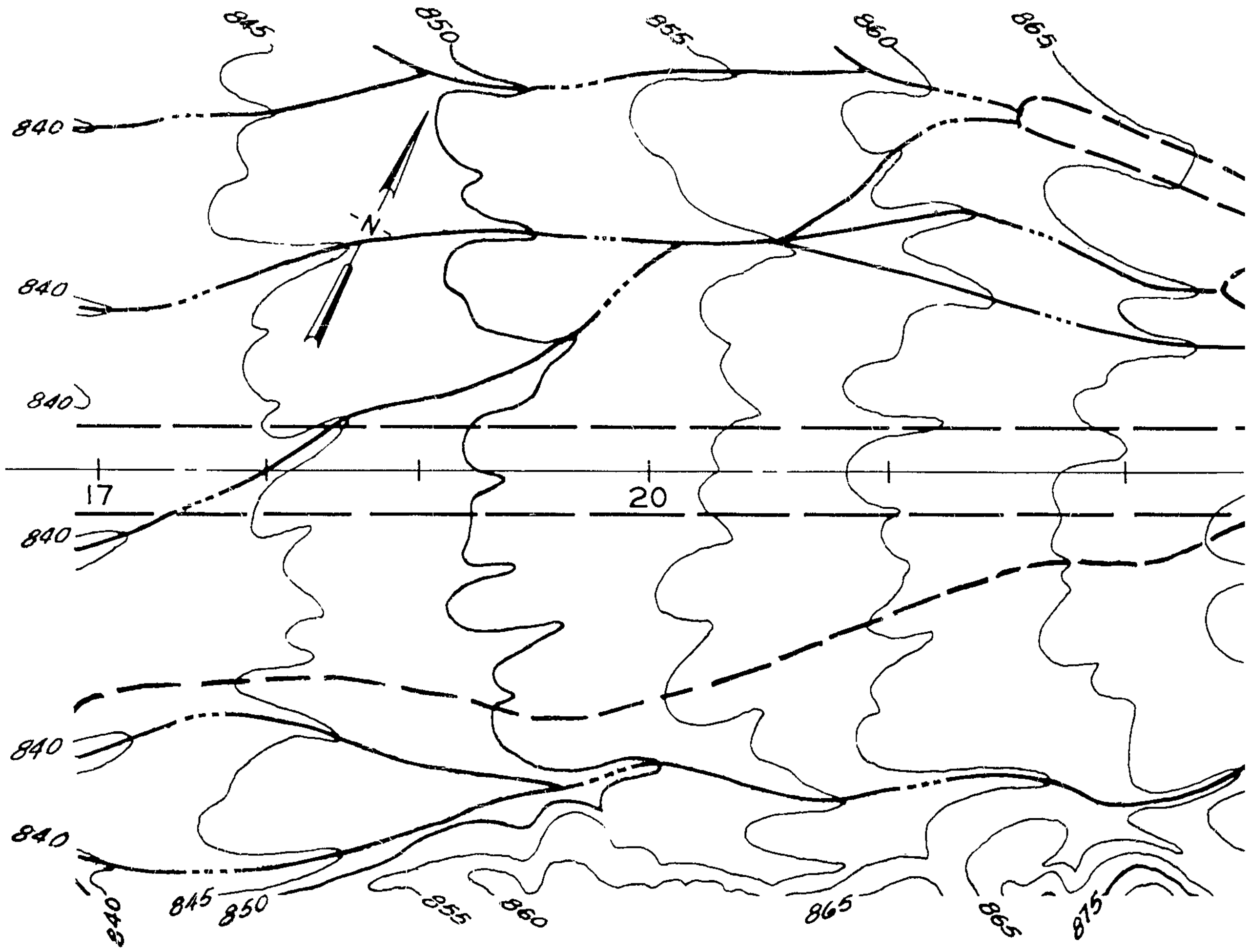
TOPOGRAPHIC MAP
TEST COURSE NO. 12
SEGMENT 1

SCALE IN FEET

500 0 500 1000

CONTOUR INTERVAL = 5 FT

* TT	7,1,1b,1 - 6,10 - 2/4
LS	7,1,1b,1



GF	6,10
V	2/4

LEGEND

LIMITS OF TEST COURSE

CENTER-LINE STAKE 6

DRAINAGE

IMPROVED ROADS

UNIMPROVED ROADS OR TRAILS

*TT TERRAIN TYPE

LS LANDSCAPE

GF GROUND FACTOR

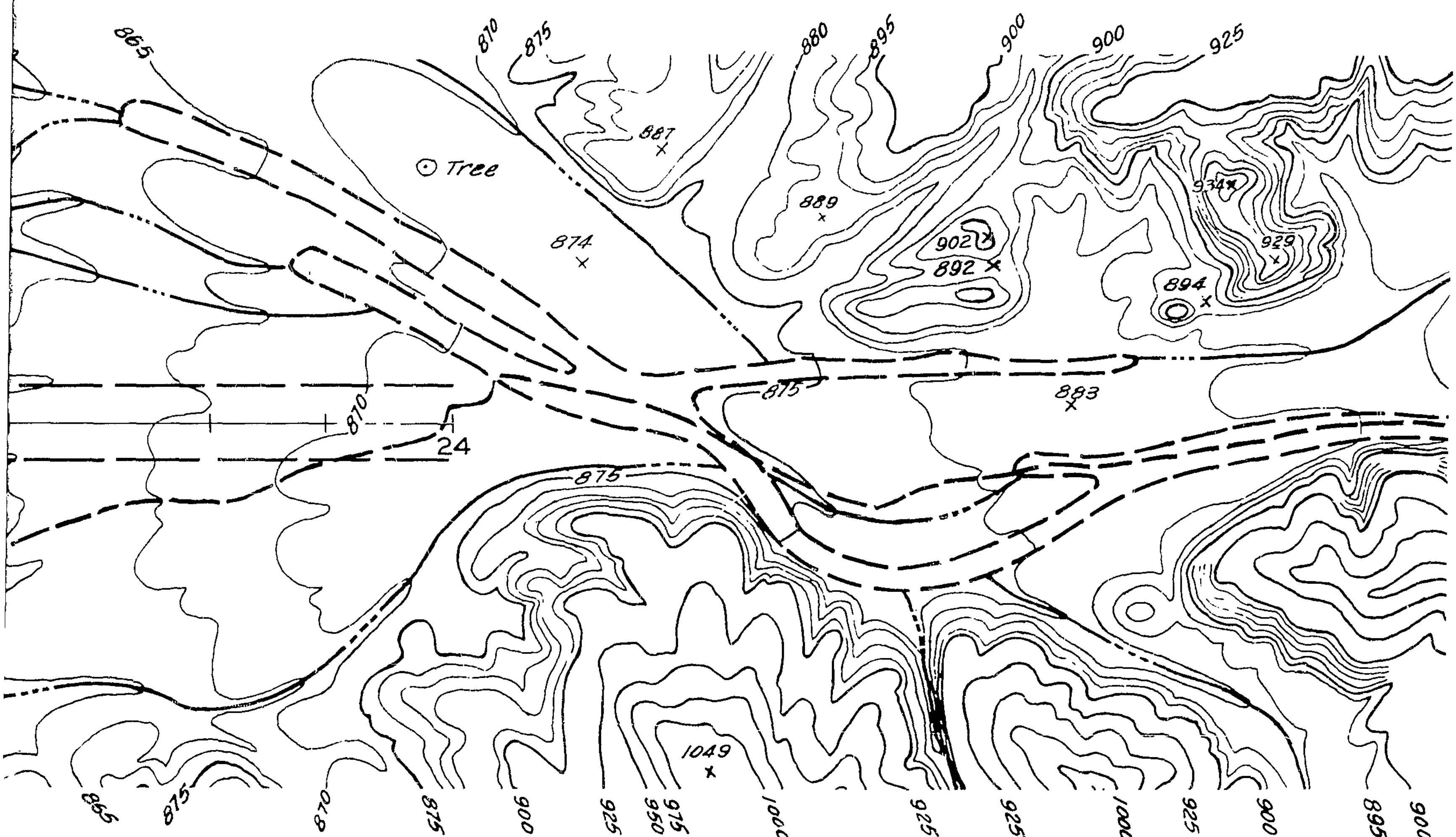
V VEGETATION

1

NOTE: TABULATION OF TERRAIN TYPE VALUES OR DESCRIPTIONS ON REVERSE SIDE OF AERIAL MOSAIC

7,1,1a,1 - 4,1 - 4/1

7,1,1a,1



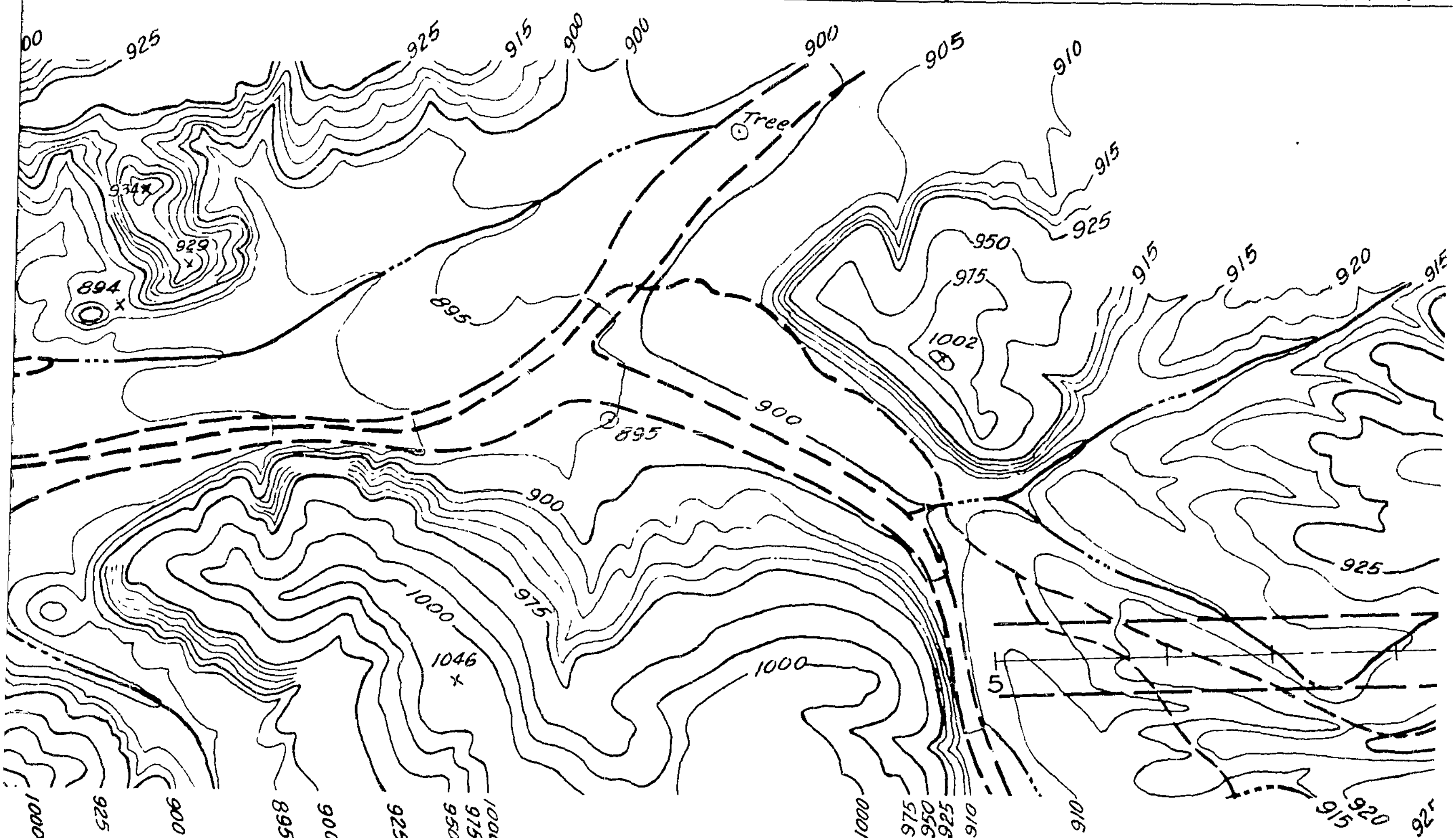
4,1

IN TYPE
CAPE
D FACTOR
ATION

REVERSE

2

,1 - 4,1 - 4/1	7,1,1b,1 - 6,10/6,9
7,1,1a,1	7,1,1b,1



4,1	6,10/6,9
4/1	2/4

3

TOP

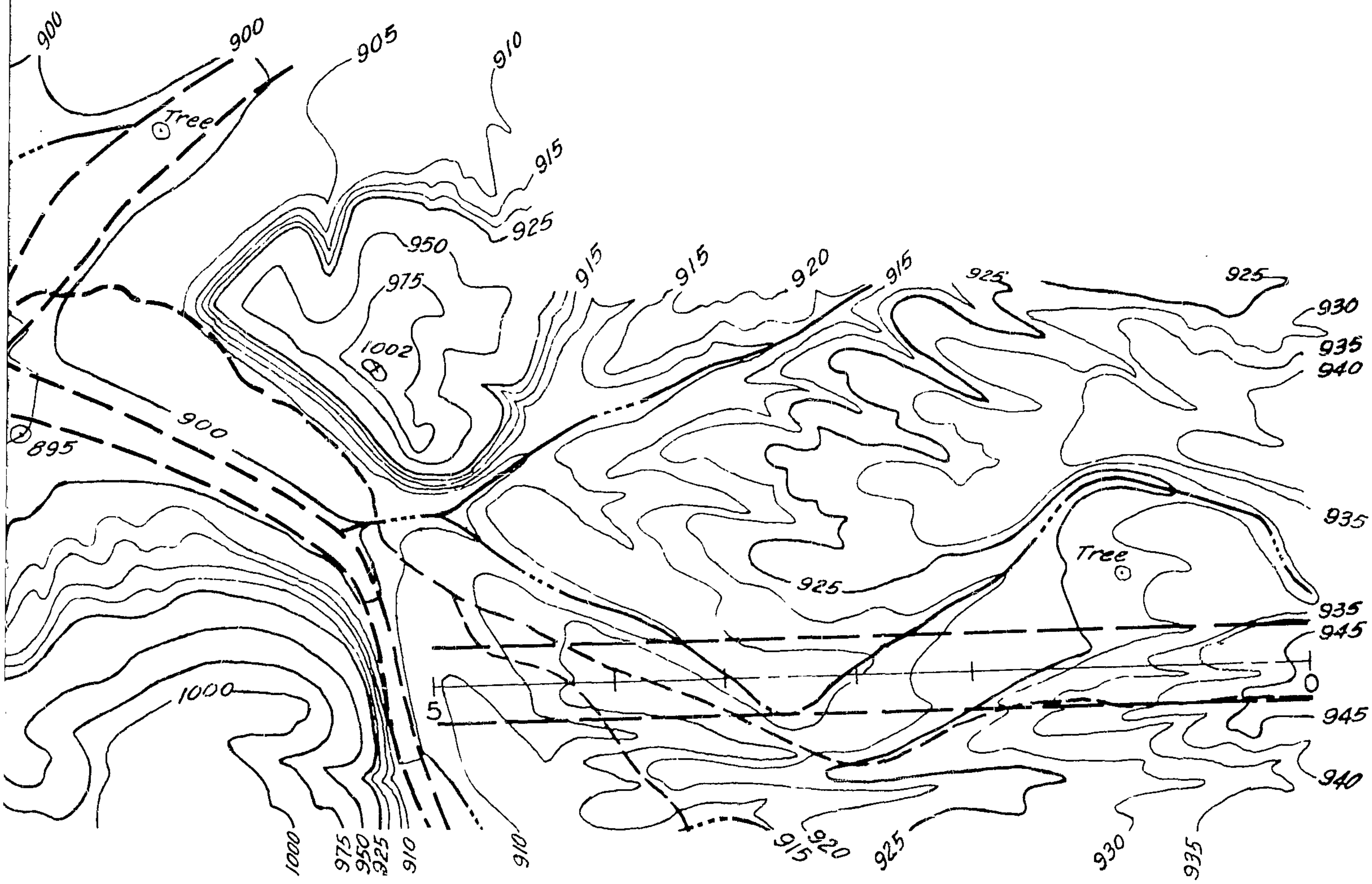
TES

SC

500

CONT

	7,1,1b,1 - 6,10/6,9 - 2/4
	7,1,1b,1



	6,10/6,9
	2/4

TOPOGRAPHIC MAP
TEST COURSE NO. 12
SEGMENT 2

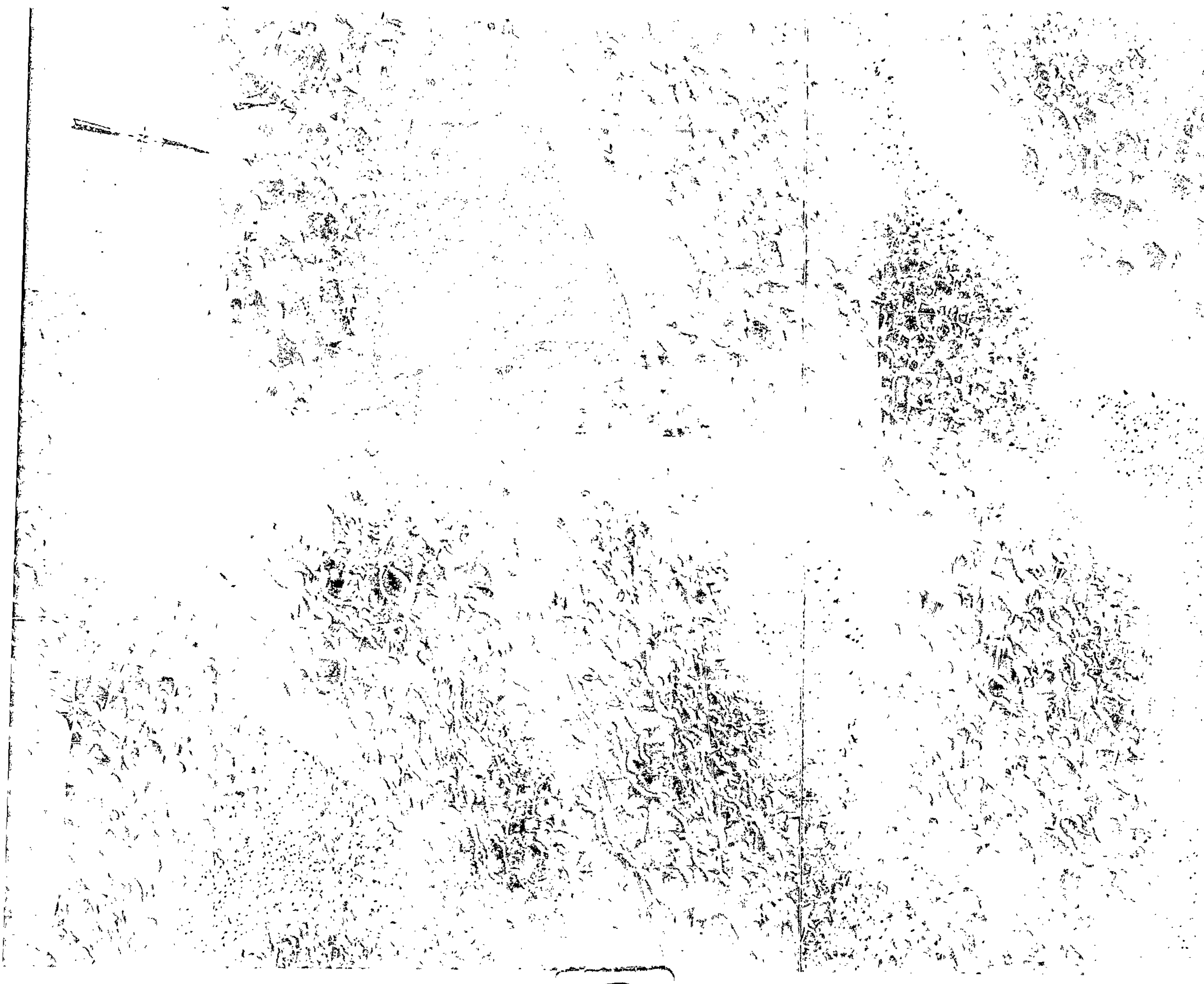
SCALE IN FEET

500 0 500 1000

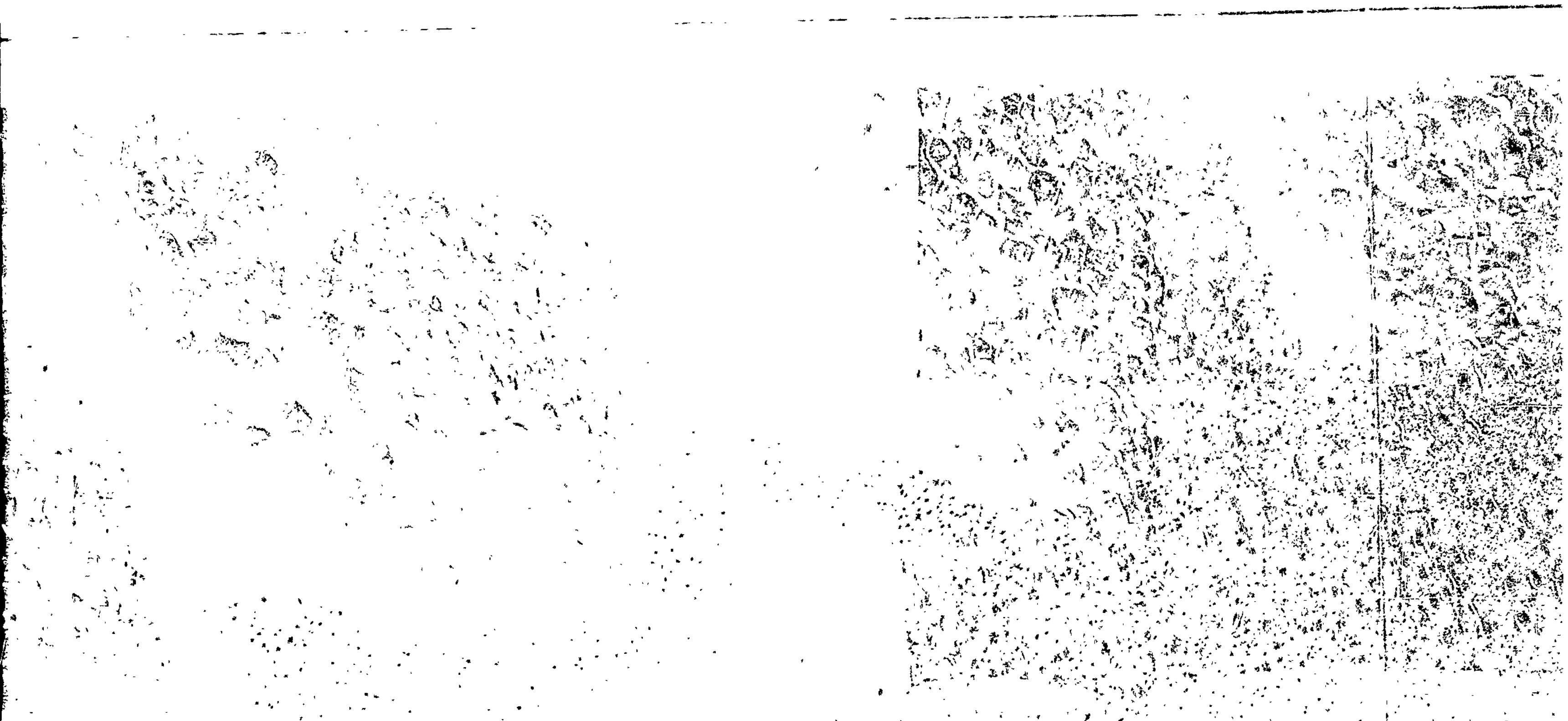
CONTOUR INTERVAL = 5 FT

4

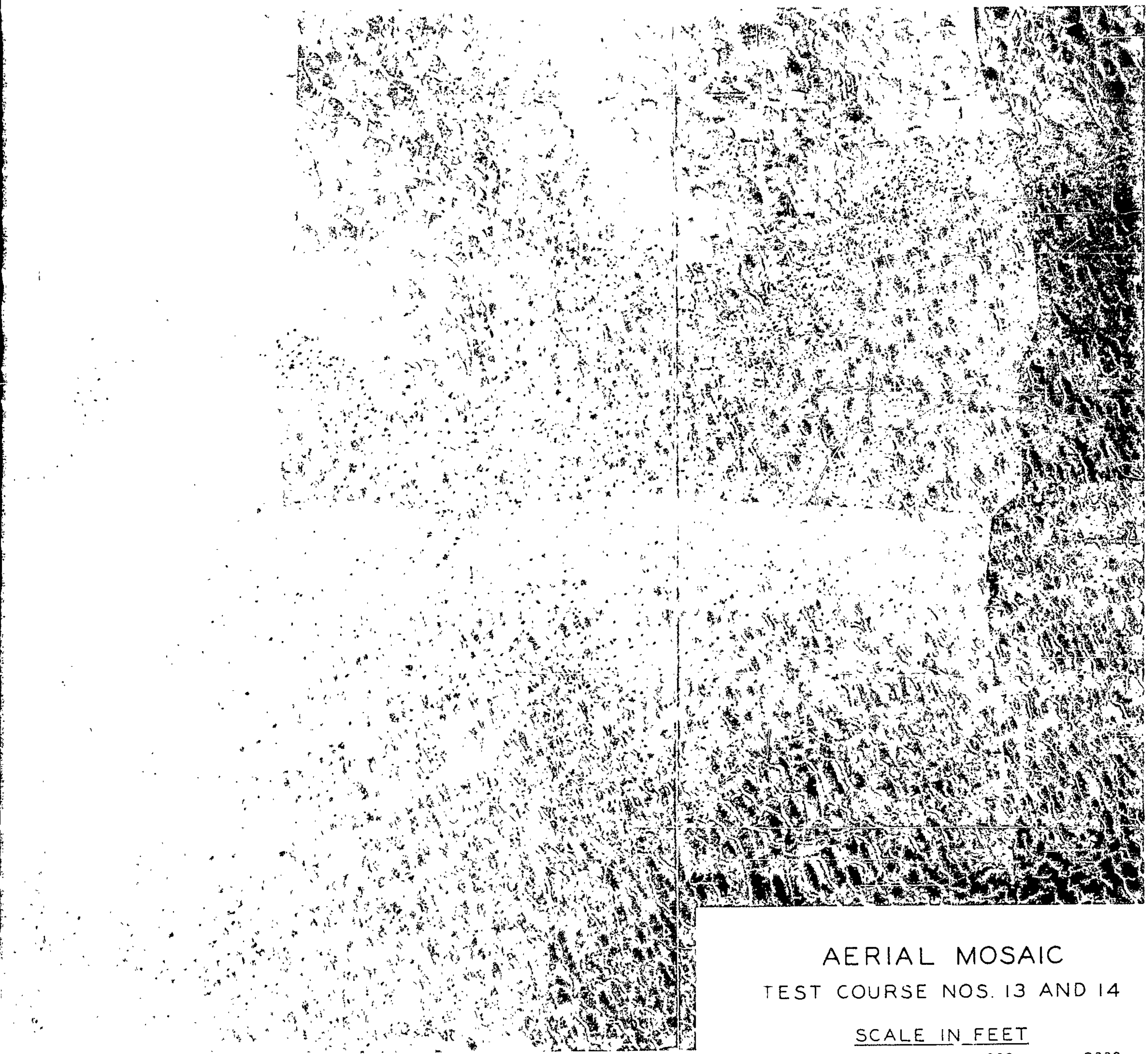
1



2



3



AERIAL MOSAIC

TEST COURSE NOS. 13 AND 14

SCALE IN FEET

1000 0 1000 2000

4

U. S. Army Engineer Waterways Experiment Station, E, Vicksburg, Miss. PROJECT OTTER (OVERLAND TRAIN TERRAIN EVALUATION RESEARCH); PRETEST REPORT, by C. R. Kolb and J. H. Shamburger. December 1961, vii, 29 pp - illus. (Technical Report No. 3-588, Report 1)
Unclassified report

Performance in desert areas of the Overland Train, a logistical cargo carrier, is to be tested in 1962 at the Yuma Test Station by the U. S. Army Transportation Research Command (TRECOM). To realistically evaluate test results, TRECOM needs to know the representativeness of the terrain over which the Overland Train is tested compared with world desert terrain conditions. Projects concerned with terrain analysis and evaluation have been conducted at the Waterways Experiment Station (WES) for several years, and a classification system and technique for mapping terrain factors have been developed. Many deserts, including that at Yuma, have been mapped. From the Yuma terrain factor maps, test courses for the Overland Train were tentatively selected. A major field investigation was then conducted of these courses. Terrain types classified according to the WES system along nine of the courses are tentatively compared to the terrain of world deserts. Additional reports are planned after actual testing is completed.

UNCLASSIFIED
1. Deserts
2. Terrain
3. Vehicles

I. Kolb, C. R.
II. Shamburger, J. H.
III. Waterways Experiment Station, Technical Report No. 3-588, Report 1

U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss. PROJECT OTTER (OVERLAND TRAIN TERRAIN EVALUATION RESEARCH); PRETEST REPORT, by C. R. Kolb and J. H. Shamburger. December 1961, vii, 29 pp - illus. (Technical Report No. 3-588, Report 1)
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