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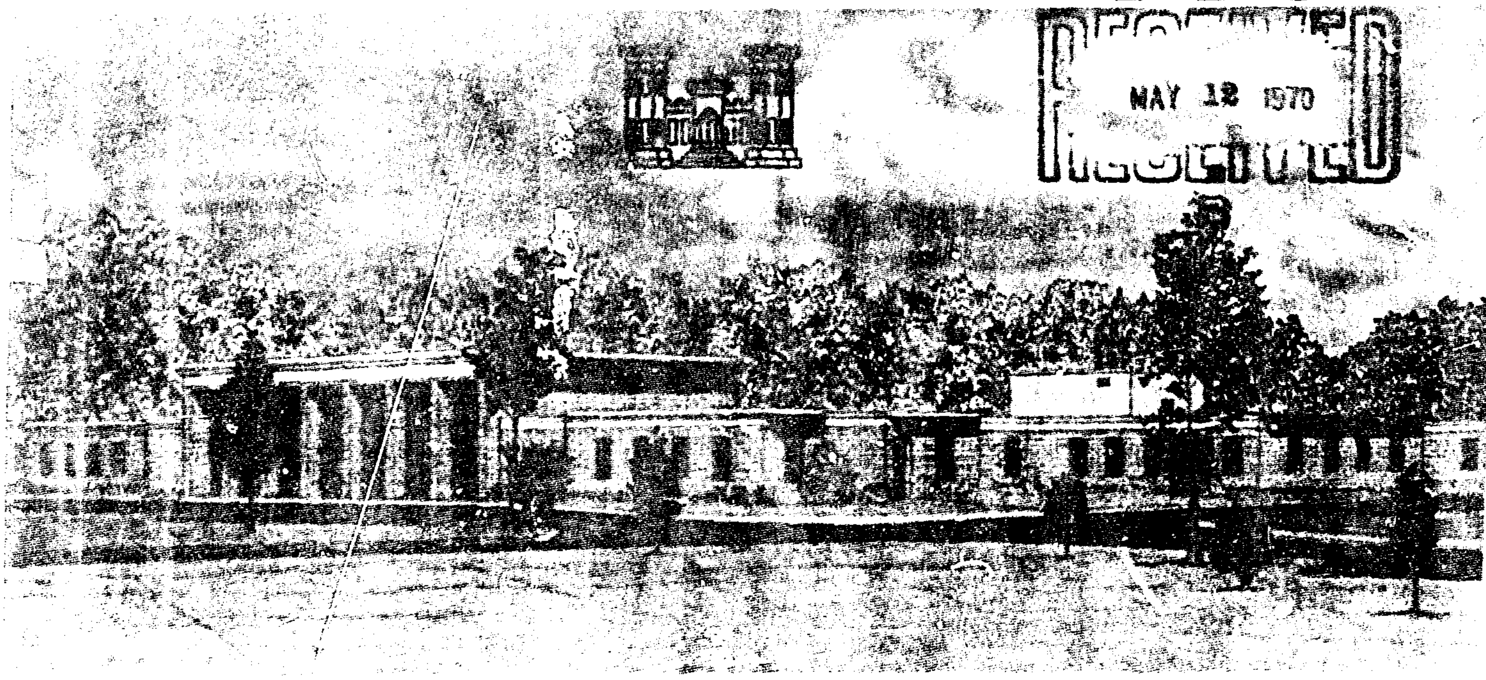
TECHNICAL REPORT M-70-5

PERFORMANCE OF RIVERINE UTILITY CRAFT (RUC) IN RIVERINE ENVIRONMENTS

by

B. G. Schreiner, R. P. Smith, C. E. Green



April 1970

Sponsored by Naval Ship Systems Command, Department of the Navy

Conducted by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

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FOREWORD

The tests reported herein were requested and funded by the Department of the Navy, Naval Ship Systems Command. The tests were conducted during November 1969 at four sites in south Louisiana by personnel of the U. S. Army Engineer Waterways Experiment Station (WES), Vehicle Studies Branch, under the general supervision of Messrs. W. G. Shockley and S. J. Knight, Chief and Assistant Chief, respectively, of the Mobility and Environmental Division, and A. A. Rula, Chief, Vehicle Studies Branch, and under the direct supervision of Mr. E. S. Rush, Chief, Soil-Vehicle Studies Section. Mr. B. G. Schreiner supervised the field testing. This report was written by Messrs. Schreiner, R. P. Smith, and C. E. Green.

Acknowledgments are made to Mr. Dave Amick, Naval Ship Systems Command, and Mr. Walter Fales, Chrysler Corporation, Defense Engineering, for arranging logistical support and general guidance, and to Mr. J. Kasuboski, engineer, and Mr. J. Faught, operator/mechanic, both of Chrysler Corporation, who assisted materially toward a successful field test program.

Director of the WES during the program was COL Levi A. Brown, CE. Technical Director was Mr. Fred R. Brown.

CONTENTS

CONTENTS

CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

Multiply	By	To Obtain
inches	2.54	centimeters
feet	0.3048	meters
miles (U. S. statute)	1.609344	kilometers
square inches	6.4516	square centimeters
square feet	0.092903	square meters
cubic inches	16.3871	cubic centimeters
gallons (U. S. liquid)	0.003785	cubic meters
pounds	0.45359237	kilograms
tons	907.185	kilograms
pounds per cubic foot	16.0185	kilograms per cubic meter
miles per hour	1.609344	kilometers per hour
gallons (U. S.) per hour	22.7088	liters per hour

SUMMARY

A program of tests was performed in November 1969 in south Louisiana to evaluate the performance of the Riverine Utility Craft (RUC) in riverine environments. The RUC is an amphibian that employs a locomotion concept based on the Archimedean screw. It moves by means of two counterrotating rotors that give forward and backward thrust. The RUC is powered by two 380-hp engines and is designed to carry a payload of 2000 lb; gross weight is 13,000 lb. The RUC's unusual concept of locomotion places it outside the normal classification of wheeled and tracked vehicles designed to operate on land and the normal classification of crafts designed to operate in water such as motorboats, air-propelled boats, or air cushion vehicles. The Navy has coined a definition of the RUC as a "zero-draft craft" since it floats in water entirely on its propulsion elements and there is no water displacement by the hull.

The purpose of the test program was to determine quantitatively the performance of the RUC in riverine environments. Specifically, the purposes were to (a) develop craft performance-soil strength (rating cone index, RCI) relations in terms of maximum straight-line speed, maximum maneuver speed, and minimum time required to turn 180 deg, (b) determine water-exit capabilities, (c) determine the speed attained in a variety of test courses and terrain types commonly found in wetland marshes, and (d) determine the degree of analogy of the terrain types tested with terrain types at selected areas of the Mekong Delta.

Results of the tests indicated that maximum straight-line water speed was 15.7 knots and maximum speed on an RCI of 2 was 25 knots. On the firmest soil tested (RCI of 93), the maximum straight-line speed was 3.6 knots. Maneuvering through standard slalom test courses reduced maximum straight-line speeds by an average of 32.1 percent. Minimum time required to make a 180-deg turn was found to be related to RCI and type of turn. Skid and pivot turns were made with little difficulty on RCI's of about 6 or less. On RCI's greater than about 6, turns were best made by a sweeping arc movement which generally required considerable time and area. On a first-pass basis the RUC was consistently able to negotiate a vertical bank height of about 3 ft. The vehicle cone index (VCI_1) of the RUC is considered to be zero.

The RUC was able to negotiate all 23 terrain types tested. The highest maximum speed on the first pass was 19.4 knots in one terrain type and the lowest maximum speed was 1.6 knots in one terrain type. Fifteen

of the 23 terrain types were negotiated at speeds between 4.1 and 10.0 knots. The average maximum first-pass speed over all 23 terrain types was 9.0 knots.

Of the 134 terrain types identified in six selected areas in the Mekong Delta, 7 were analogous, 55 were highly analogous, 55 were moderately analogous, and 17 were slightly analogous to one or more terrain types identified along the Louisiana mobility test courses.

The RUC can operate in riverine environments for which it was designed. The craft's performance is most effective in water and wet marshes of low soil strength. The RUC also has a performance capability in areas considered highly restrictive to or even inaccessible by boats and other amphibious craft.

Appendix A discusses the comparison of terrain types tested during the RUC program with those identified in selected sections of the Mekong Delta. Appendix B presents detailed descriptions of soil profiles along the Louisiana mobility test courses.

PERFORMANCE OF THE RIVERINE UTILITY CRAFT (RUC) IN RIVERINE ENVIRONMENTS

PART I: INTRODUCTION

Background

1. The Riverine Utility Craft (RUC) was designed and built by Chrysler Corporation Defense Engineering for the former Naval Inshore Warfare Project. The Naval Ship Systems Command is responsible for the development of the RUC under Contract No. N00024-69-C-0216 with Chrysler Corporation and for the fabrication of 10 RUC's to be used for engineering and military potential tests. The RUC was designed for operation in riverine environments that are considered highly restrictive to or even inaccessible by conventional boats or other amphibious craft. The craft was designed to perform most effectively in water and wet marsh environments; however, performance to a lesser degree in other environments was expected.

2. On 25 July 1969 the Naval Ship Systems Command requested the U. S. Army Engineer Waterways Experiment Station (WES) to undertake a test program with the RUC similar to one conducted in 1963 with the Marsh Screw Amphibian.[1] Arrangements were made and a test program was conducted in the young deltaic areas of the Mississippi River that are similar to areas of the Mekong River Delta in South Vietnam. The RUC field tests were conducted with RUC No. 3 near Houma, La., during the period 12-29 November 1969. This report presents the results of the test program.

Purpose

3. The test program was conducted to determine quantitatively the performance of the RUC in riverine environments. Specifically, the purposes of the tests were (a) to develop craft performance-soil strength (rating cone index) relations in terms of maximum straight-line speed, maximum maneuver speed, and minimum time required to turn 180 deg, (b) to

determine water-exit capabilities, (c) to determine the speed attained in a variety of test courses and terrain types commonly found in wetland marshes, and (d) to determine the degree of analogy of the terrain types tested with terrain types at selected areas of the Mekong Delta.

Scope

4. The types of tests and the number of each type conducted with the RUC are tabulated below. The same driver was used in all the tests.

Type of Test	No. of Tests Conducted
Mobility (passes)	30
Straight-line speed	11
Maneuver speed	10
Minimum time required to turn 180 deg	10
Water exit	9
Vehicle cone index for 50 passes	1

Also, based on results of a few tests, a limited discussion is presented of the minimum soil strength (vehicle cone index) requirements for 1 and 50 passes of the craft.

Previous Studies of Screw-Propelled Vehicles

5. Experiments with counterrotating screw rotors (such as those of the RUC) for propelling vehicles were made as early as the 1920's when a Fordson tractor was modified for duty over snow and ice.[2] In 1948 in Britain the idea of a screw-driven amphibious tractor was proposed by LTC H. O. Nelson.[2]

6. The WES study[1] of the Marsh Screw Amphibian indicated that when operating on terrain not having free water on the surface the vehicle tested did not have sufficient power, and that when crossing obstacles such as rice-field dikes or vertical step heights the vehicle performed poorly because it has no suspension system. However, the vehicle traveled

at speeds of 5 to 6 mph* in deep water and of 20 to 25 mph in certain marsh areas where shallow surface water provided lubrication for the rotors and the soil conditions were ideal for efficient operation of the screw-type locomotion elements.

7. In 1964 the U. S. Army General Equipment Test Activity, Fort Lee, Va., conducted military potential tests with the Marsh Screw Amphibian in areas in Virginia and Louisiana.[3] Conclusions from these tests were generally that the vehicle had military potential when operating in terrain for which it was designed.

Definitions

8. Certain special terms used in this report are defined below.

General terms

Ground mobility. The ability of a ground contact vehicle to move across a landscape without benefit of roads or engineering assistance. Thus, a measure of ground mobility is a measure of the vehicle-terrain interaction.

Trafficability test. A test conducted in a homogeneous area to determine vehicle-terrain relations.

Mobility test. A test to determine vehicle performance in terms of average speed over a straight-line course covering several terrain types. In a mobility test the driver is instructed to drive as fast as practicable, consistent with safety to himself, the vehicle, and the cargo.

Soil terms

Unified Soil Classification System (USCS).[4] A soil classification system based on identification of soils according to their textural and plastic qualities and on their grouping with respect to engineering behavior.

Fine-grained soil. A soil of which more than 50 percent (by weight) of the grains will pass a No. 200 U. S. Standard Sieve (smaller than 0.074 mm in diameter).

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* A table of factors for converting British units of measurement to metric units is presented on page ix.

Coarse-grained soil. A soil of which more than 50 percent (by weight) of the grains will be retained on a No. 200 sieve (larger than 0.074 mm in diameter).

Organic soil. The living, dying, and dead vegetation that forms a surface mat, and the mixture of partially decomposed and disintegrated organic material (commonly known as peat or muck) below the surface mat. Small quantities of mineral soil may or may not be mixed with the organic material.

Critical layer. The layer of soil regarded as most pertinent to establishing relations between soil strength and vehicle performance. For 50-pass tests in fine-grained soils and sands with fines, poorly drained, it is usually the 6- to 12-in. layer; however, it may vary with weight of vehicle and with soil strength profile. For 1-pass tests it is usually, but not always, closer to the surface.

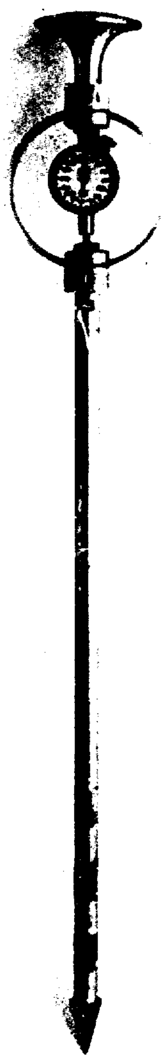


Fig. 1. Cone penetrometer

Soil strength terms

Cone index (CI). An index of the shearing resistance of a medium obtained with a cone penetrometer (shown in fig. 1). The value represents the resistance of the medium to penetration of a 30-deg cone of 0.5-sq-in. base or projected area. The number, although usually considered dimensionless in trafficability studies, actually denotes pounds of force on the handle divided by the area of the cone base in square inches.

Remolding index (RI). A ratio that expresses the proportion of original strength of a medium that will remain under a moving vehicle. The ratio is determined from cone index measurements made before and after remolding a 6-in.-long sample using the equipment shown in fig. 2. The test sample is obtained with a trafficability sampler (shown in fig. 3).

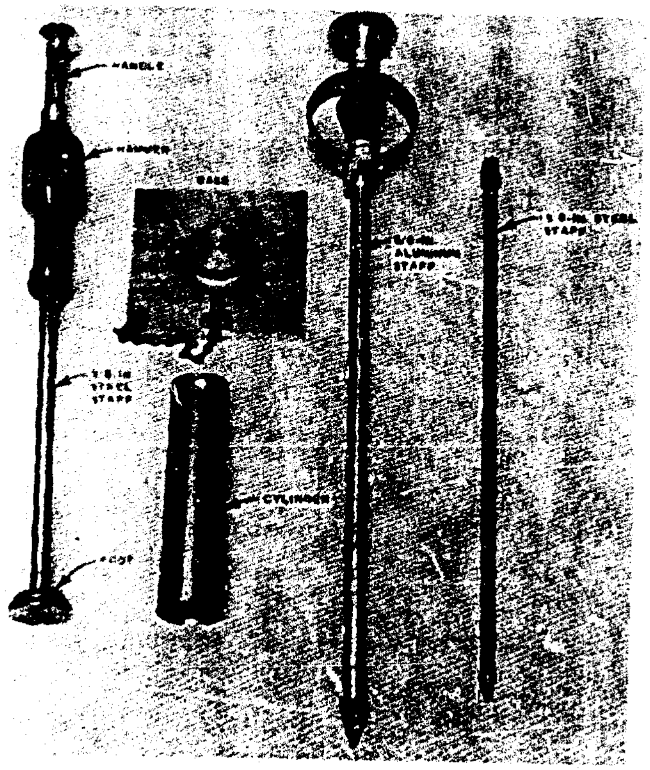


Fig. 2. Remolding equipment and cone penetrometer

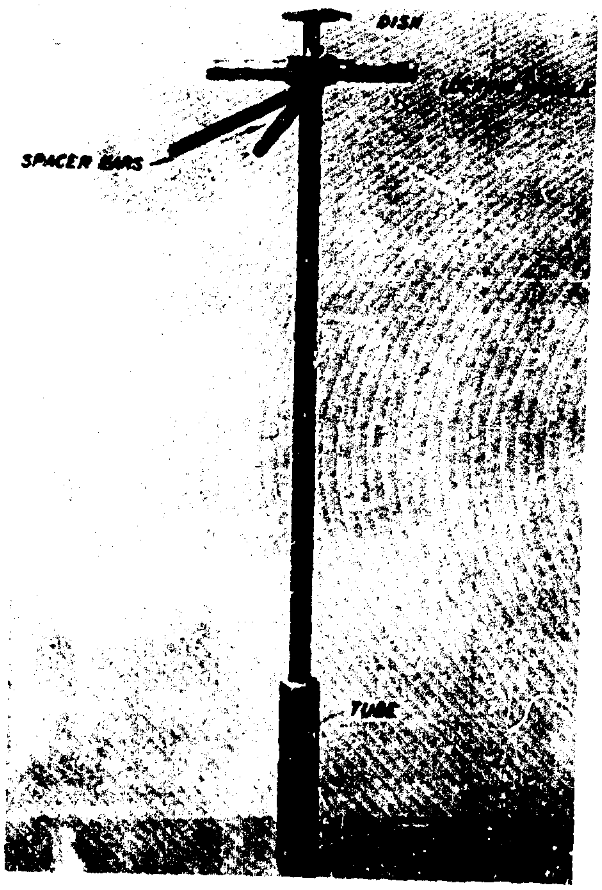


Fig. 3. Trafficability sampler

Rating cone index (RCI). The product of the measured CI and the RI of the same layer.

Terrain terms

Terrain terms are defined in Appendix A.

Vehicle terms

Immobilization. The inability of a self-propelled vehicle to go forward or backward.

Pass. One trip of a vehicle over a test course.

Multiple passes. More than one pass of a vehicle in the same path over a test course.

Mobility index (MI). A dimensionless number that results from a consideration of certain vehicle characteristics. It is used to obtain an estimate of VCI.

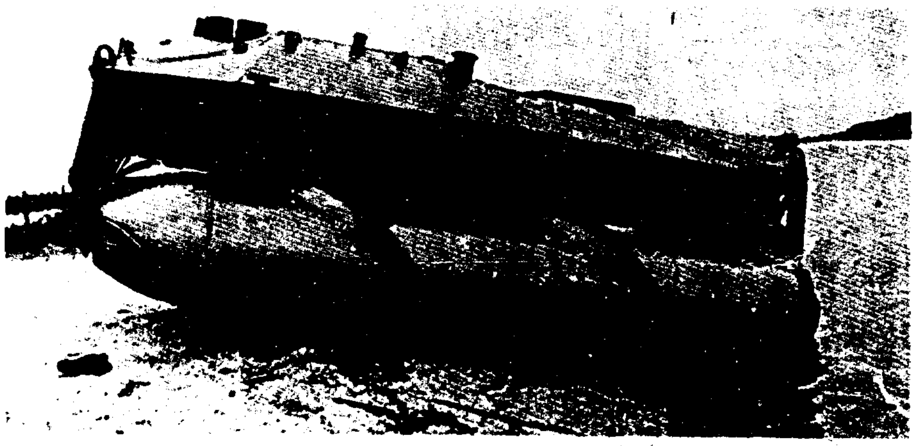
Vehicle cone index (VCI). The minimum rating cone index (RCI) that will permit a vehicle to complete a specified number of passes; thus, VCI_{50} means the minimum RCI necessary to complete 50 passes, and VCI_1 means the minimum RCI necessary to complete one pass. As the values of VCI decrease, the go-no go performance capability of a vehicle increases. Examples of VCI_1's are as follows:

Vehicle	Experimental VCI_1*
XM759, 1-1/2-ton logistical carrier (Airoll concept)	0
M29C, 1/4-ton carrier, tracked (Weasel)	5
M116, 1-1/2-ton carrier, tracked	7
MEXA 2-1/2-ton carrier, tracked	7
MEXA 2-1/2-ton carrier, wheeled, 10x10	7
M274, 1/2-ton carrier, wheeled, 4x4 (Mule)	9
M113, armored personnel carrier, tracked	15
M37, 3/4-ton truck, 4x4	23
M35, 2-1/2-ton truck, 6x6	26

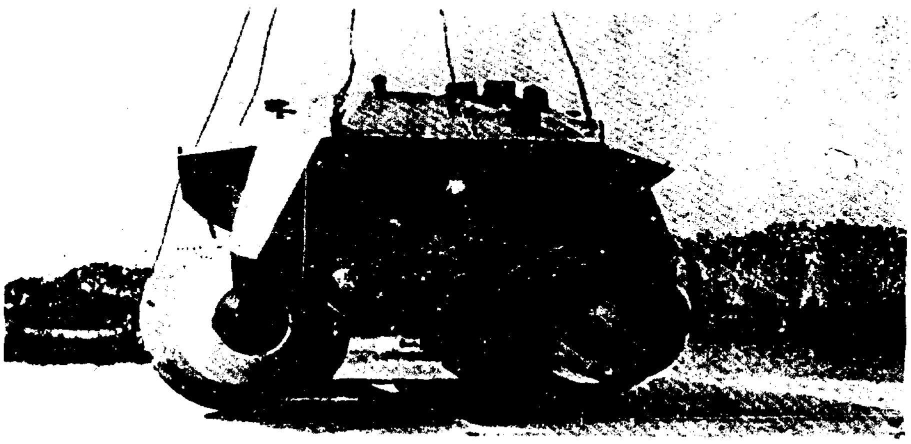
* For comparison, a man on foot could make one trip (pass) across a soil having a VCI_1 of 4.

PART II: DESCRIPTION OF THE RUC

9. The RUC's unusual concept of locomotion places the RUC outside the normal classification of wheeled and tracked vehicles designed to operate on land, and the normal classification of crafts designed to operate in water such as motorboats, air-propelled boats, or air cushion vehicles. However, it should be placed in a general classification as an amphibian since it operates best in deep water and on water-covered soil surfaces. The Navy has coined a definition of the RUC as a "zero-draft craft" since it floats in water entirely on its propulsion elements and there is no water displacement by the hull. The vehicle is shown in fig. 4.



a. Side view



b. Front view

Fig. 4. The RUC

Craft Characteristics

10. Pertinent data on the RUC are shown in the characteristics data sheet, fig. 5. All testing was conducted at a gross weight of 13,000 lb, near full load displacement. Fuel level was maintained at about 250 gal for all tests.

Propulsion System

Tractive elements

11. The RUC travels on two aluminum rotors. The front end of each rotor is tapered. The nontapered portion (hub) of the rotors is 39 in. in diameter. The rotors are filled with closed cell foam to provide buoyancy for the craft in case the aluminum rotors are damaged. The front ends of the rotors are truncated to provide a flat section for attaching hull supports. Two helical blades (1/2 in. thick and 9-1/2 in. wide) are welded to each rotor in a continuous pattern from front to rear. The helical blade angle is 52 deg with the vertical (at hub surface). The rotors can be counterrotated to give forward or backward thrust to the craft. Steering and turning are accomplished generally by varying the rotational speed of the rotors. The craft will "crab" sideways in a sweeping arc on firm soil if both rotors are permitted to rotate in the same direction; however, in soft soil with both rotors rotating in the same direction, the craft will pivot.

Power train

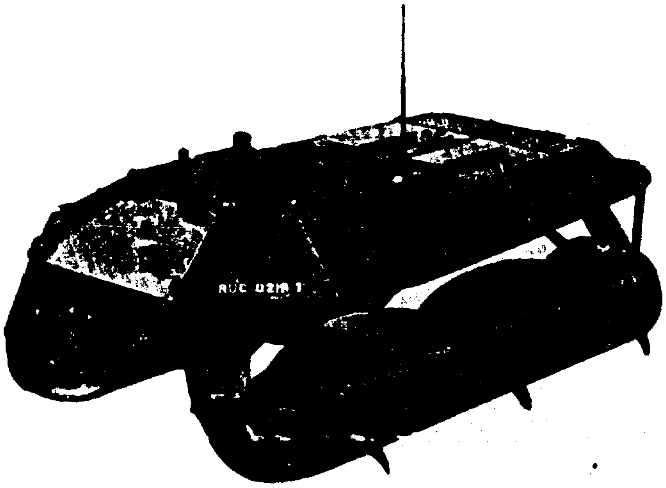
12. Each rotor has a separate power train that consists of an engine, torque converter, transmission, and gear-driven final drive unit. In case of an engine or transmission failure, the craft can be powered with one engine by utilizing the hydraulic emergency steering system and cross-drive belt.[5]

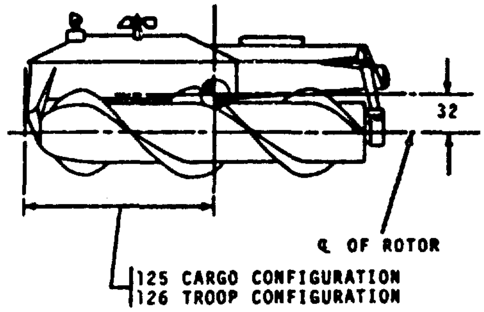
Test Personnel's Observations of RUC Performance

13. During the course of the tests, test personnel made the

CHARACTERISTIC DATA	NAVSHIPS

RIVERINE UTILITY CRAFT (RUC)





GENERAL

Crew	2
Payload	5 Passenger or 2000 Lb. Cargo
Weight, Gross	
Cargo Configuration	13,085 lb.
Troop Configuration	12,570 lb.
Weight, Net (less fuel, crew, cargo, ammunition	9,655 lb.
Fuel Tank Capacity	340 gal.

DIMENSIONS

Length, Overall	242 in.
Beam, Overall	168 in.
Height	
From bottom of rotor w/canopy	137 in.
From bottom of rotor w/o canopy	104 in.
Rotor Spacing (center to center)	110 in.
Rotor Diameter (over drum)	39 in.
Rotor Diameter (over helix)	58 in.
Ground Clearance Under Hull	49 in.

PERFORMANCE

Maximum speed (cargo Config.)	
Water	15 kt.
Swamp and Tidal Flats	17.5 kt.
Snow	18.0 kt.
Hard Surface	3 kt, (side mode)
Cruising Range	8 hr at 15 kt.
Fuel Consumption (on water)	43 gal/hr.
Obstacle Climbing Ability	
Vertical Rigid Wall	20 inches
Vertical Earth Wall	36 inches
Maximum Trench Crossing Width	6 ft. 8 in.

POWER TRAIN

Engine Type	(2) Chrysler Spark Ignition Water cooled
Displacement	440 cubic inches
Maximum Speed	4500 rpm
Gross Power	380 hp at 4500 rpm
Transmission Type	(2) Chrysler Torque-flite Model A727 2 Speed Automatic with torque converter
Final Drive	
Upper	(2) Spiral Bevel 4.11:1 Ratio
Lower	(2) Spiral Bevel 6.17:1 Ratio
Overall Ratio	25.3:1
Cooling System	(2) Radiator with engine driven fan
Fuel	MIL-G-5572 Grade 115-145 Aviation fuel; MIL-G-3056 combat gasoline, for emergency use only

CONTROLS

Steering type	Throttle steer
Smallest turning radius	Pivot
Shift position	Forward-Neutral-Reverse

November 1969

Fig. 5. Vehicle characteristics (sheet 1 of 2)

CHARACTERISTIC DATA	NAVSHIPS

ELECTRICAL SYSTEM

System Voltage (Nominal)	24-volts DC
Batteries	(4) 12V, 45-Ampere hour capacity
Alternator	(2) 28-VDC 60-ampere

COMMUNICATIONS EQUIPMENT

Radio Set AN/PRC-77	Man Pack Portable Frequency Modulated
Frequency Range	30.00 to 52.95 MC and 53.00 to 75.95 MC
Power Source	12-VDC Dry Battery 38?/PRC-25 or 398/U
Radio Set AN/VRC-64	Craft Mounted, Frequency Modulated
Frequency Range	30.00 to 52.95 MC and 53.00 to 75.95 MC
Power source	24-V DC Craft

ARMAMENT

Gun mounts, type	Four universal pintle supports
Machine Gun, 7.62-mm, M60D	
Elevation	65 degrees
Depression	-10 degrees (forward)
Grenade Launcher, 40-mm, MK19	
Elevation	45 degrees
Depression	-19 degrees (forward)

VISION AND LOCATION INSTRUMENTS

Periscope, M27 (Driver's)	Four
Magnification	1x
Field of view	150 deg horizontal 50 deg. vertical
Compass	Danforth, Corsair model, with external compensating magnets

AMMUNITION

Stowage provisions for	1,000 rds., 7.62-mm 216 rods., 40-mm

OTHER

Contractor	Defense Operations Division Chrysler Corporation
Contract	No. N00024-69-C-0216

Date Prototype: 1969

Current Status: Prototype

November 1969

Fig. 5 (sheet 2 of 2)

following qualitative observations of the RUC's mechanical performance as opposed to its mobility performance capabilities discussed later.

a. A windshield is essential when operating the craft at high rotational speed in soft soil and marshy areas to protect the operator and cargo compartment from flying debris (figs. 6 and 7). (Some protective shield may be planned for future

Fig. 6. High-speed pass on soft, wet soil. Note flying soil and surface debris

Fig. 7. Soft soil and debris on windshield and craft after a speed test

RUC's, but no shield was included as a standard item on the one used in these tests.

b. The craft had adequate power in all terrain conditions tested.

c. An experienced operator/mechanic was necessary for the entire test program to ensure maximum performance capabilities of the craft.

d. The screw-type propulsion system of the RUC is extremely destructive to soft soil terrains.

PART III: TEST PROGRAM

Selection, Location, and Description of Test Sites

Selection

14. Four riverine test sites in south Louisiana used in a previous program were used in the RUC test program. In a previous study,[6] certain sections of the Mekong Delta, South Vietnam, were selected as being representative of terrain conditions found in the entire Mekong Delta. The terrain conditions in these sections were described in terms of terrain factors, including surface composition (soil strength), surface geometry, and vegetation. Test sites in south Louisiana were selected on the basis of the similarity of their terrain to that of the areas studied in the Mekong Delta.

Location

15. General locations of the sites are shown in fig. 8. The number

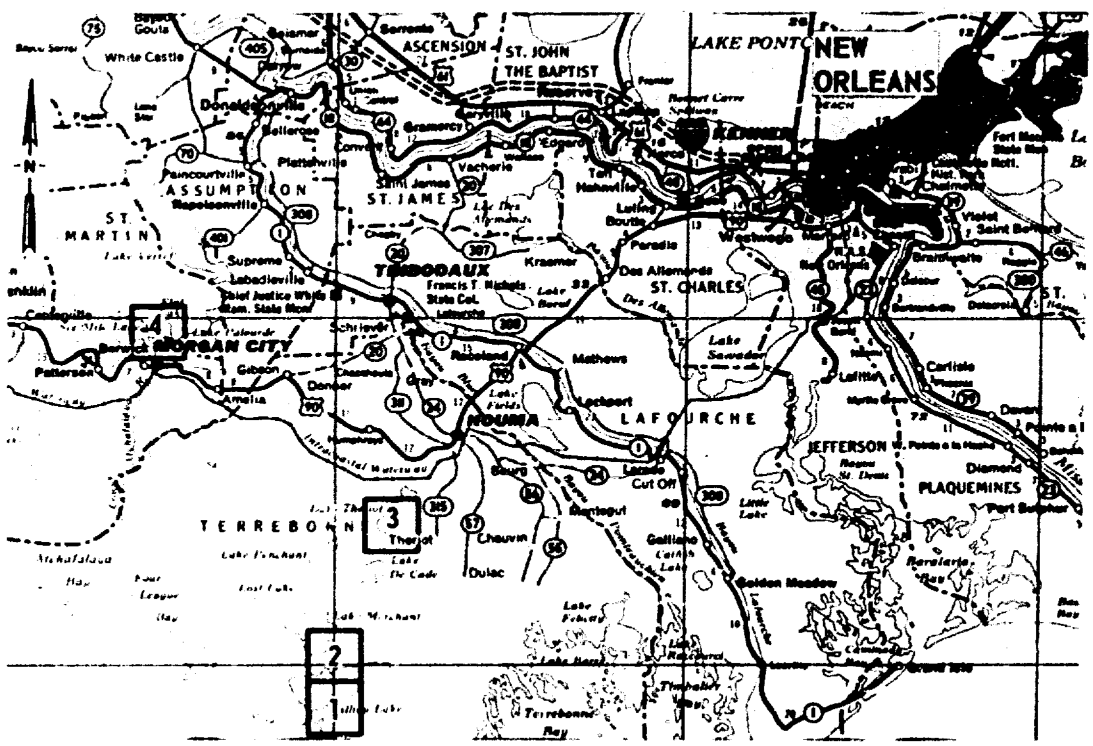


Fig. 8. General location of Louisiana test sites

within each area outlined by a heavy boundary line is the site number.

Description

16. General test site descriptions are given in the following paragraphs. To assist in site description, surface profile, vegetal cover, soil strength in terms of RCI, and photographs of the mobility test courses are shown in plates 1-4.

17. Bayou du Large, La., site 1. This test site (fig. 9) is southwest of Houma, La., and approximately 1/2 mile north of Caillou Lake on Bayou du Large. Site 1 has a wide range of soil strengths and terrain types. Tidal action influences the depth of surface water. Bayou du Large is bordered by 200-ft-wide sections of clay soil with some organic material. Organic soil and areas of floating vegetal mat adjoin the clay sections. Mobility and trafficability tests were conducted in a wide variety of terrain types at this site. Plate 1 shows the surface profile and photographs of the mobility test course.

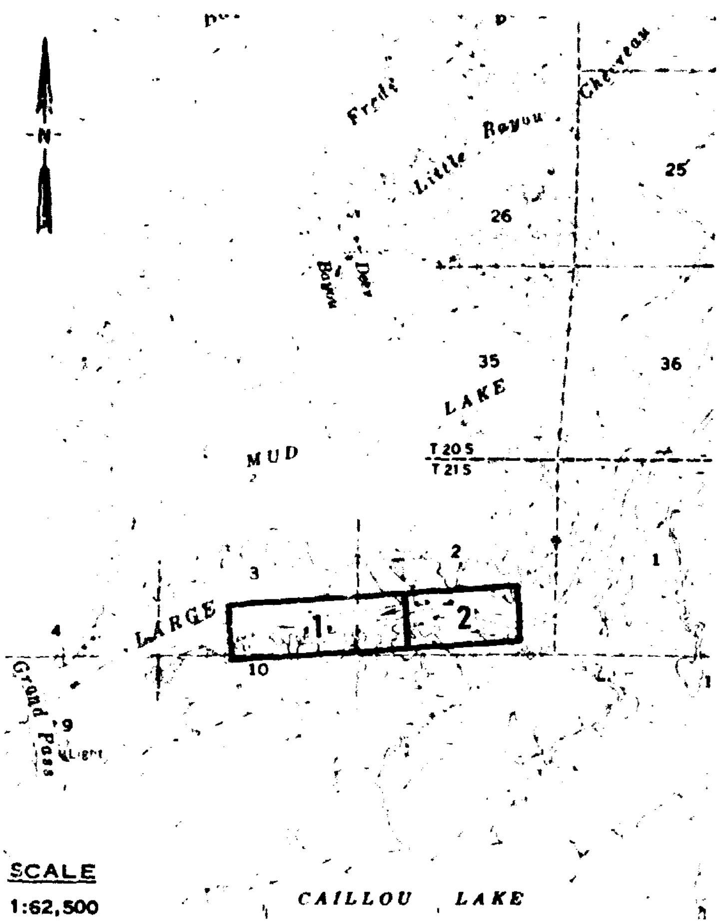


Fig. 9. Bayou du Large, La., sites 1 and 2

18. Bayou du Large, La., site 2. Site 2 (fig. 9) is east of and adjacent to site 1. At site 2, Bayou du Large is bordered by sections of relatively firm clay soil that are approximately 50 ft wide on the north side and 150 ft wide on the south. Weak organic soil adjoins the

clay sections on each side of the bayou. At this site the bayou has relatively high banks (approximately 4 ft) that normally are not covered by high tide. Both mobility and trafficability tests were conducted at site 2. Plate 2 shows the surface profile and photographs of the mobility test course.

19. Minors Canal, La., site 3. Site 3 (fig. 10) is that section of Minors Canal that is southeast of Lake Theriot. Minors Canal is flanked by low berms of highly organic soil. Extensive areas of vegetal mat floating on water adjoin the berms. The vegetation was primarily alligator and marsh grasses with areas of dense cane. Only mobility tests were conducted at this site. Plate 3 shows the surface profile and photographs of the mobility test course.

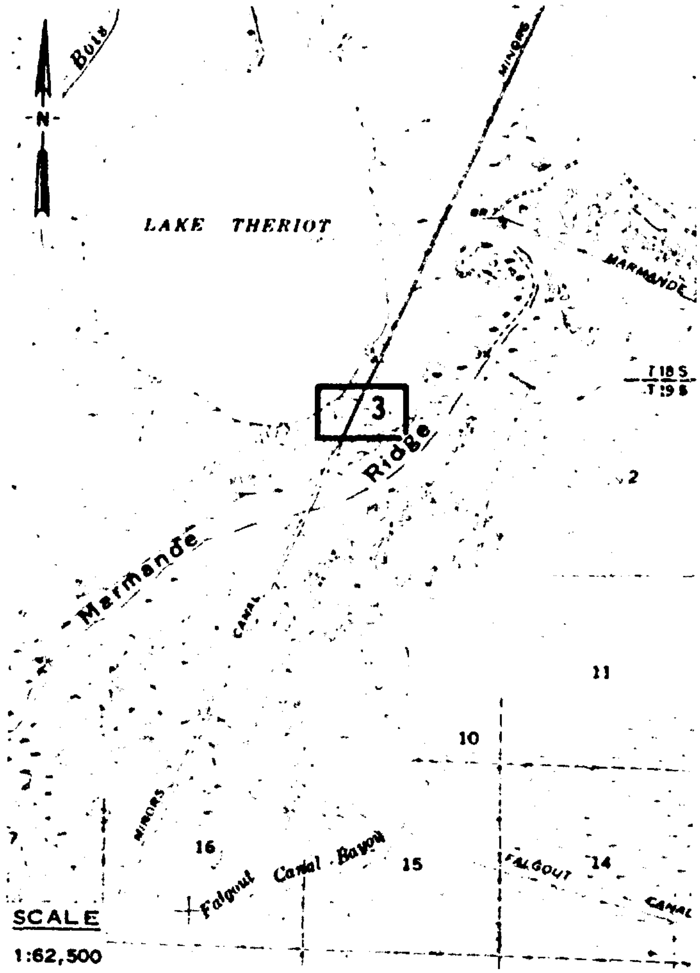


Fig. 10. Minors Canal, La., site 3

20. Morgan Island, La., site 4. This site (fig. 11) is on Morgan Island in Six Mile Lake which is 4 miles upstream from Morgan City, La. Depth of surface water at this site is affected by tide, wind direction, and river stage. Soils encountered at the site were sandy clay, silty clay, and organic clay. Vegetation included dead lily pads, willow trees, and alligator and marsh grasses. Mobility and trafficability tests were conducted at this site. Surface profiles and photographs of the mobility test courses are given in plate 4.

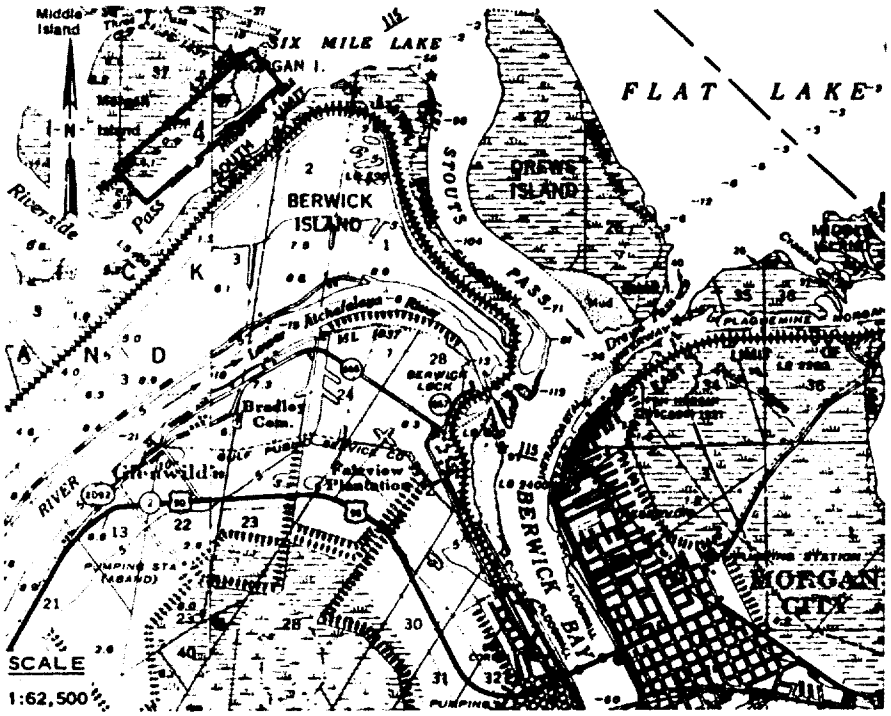


Fig. 11. Morgan Island, La., site 4

Test Procedures and Data Collected

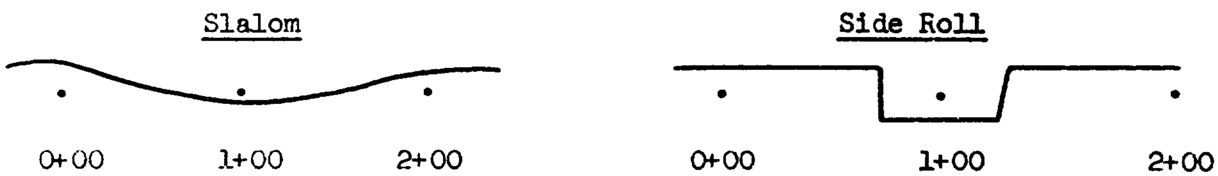
Trafficability tests

21. Maximum straight-line speed tests. Maximum-speed tests were conducted with the RUC on straight-line test lanes. Each lane was 200 ft long in an area of uniform soil strength. Ample distance was allotted at the beginning of each test lane to allow the RUC to accelerate to its maximum speed before entering the lane. The time required for the craft to traverse the lane was recorded, and the maximum speed was calculated from distance traveled and time elapsed.

22. Before each test a sufficient number of cone index measurements were made to determine that the soil was uniform and of the desired strength. Cone index of the soil was measured at the surface and at 3-in. vertical increments to a depth of 18 in., and at 24-, 30-, and 36-in. depths. Remolding indexes were measured for the 0- to 6-in., 6- to 12-in., and 12- to 18-in. depths. Moisture content and density samples were taken

for the same soil layers at each remolding index station. In addition, the moisture content of the 0- to 1-in. layer was determined. Representative bulk soil samples were obtained for soil classification purposes. Vegetation was described in terms of height and estimate of percentage of ground cover.

23. Maximum maneuver-speed tests. Maximum maneuver-speed tests were conducted in an undisturbed section of the straight-line test courses and were given corresponding test numbers. The maneuver courses were 200 ft in length; a stake was located on the course at the 100-ft mark. Ample room was allotted at the beginning of each course so that the RUC could accelerate to its maximum speed before entering the course. The craft would approach the first stake, and if the soil strength was weak enough to allow the craft to skid-turn, it would run the course in a slalom pattern (see diagram below). If the craft could not skid-turn, it would approach the



middle stake, roll to the side, proceed forward past the middle stake, roll back, and continue to the stake at sta 2+00, as shown in the diagram above. The time required for the craft to complete the course was recorded, and the speed was calculated from the time required to traverse the maneuver course divided into the straight-line distance of 200 ft.

24. The soil and vegetation data collected for the straight-line speed tests were considered adequate for the maneuver tests.

25. Minimum time required to turn.* Tests were conducted in an undisturbed section at the locations of the straight-line and maneuver tests to determine the time required to execute a 180-deg turn. The test was

* The original intent was to measure minimum turning radii; however as testing began, it became obvious that these measurements could not be made accurately because of the craft's unique propulsion system and because of ground disturbance after the turns were made. More details on procedures are given in paragraph 42.

started at zero speed, and the driver maneuvered the RUC as fast as possible through a 180-deg turn. The area and time required to make each turn were recorded.

26. The soil and vegetation data collected for the straight-line speed tests were also considered adequate for the turn tests.

27. Water-exit tests. Water-exit tests were conducted with the RUC approaching land at a right angle to the vertical banks. The RUC would approach the bank slowly (approximately 2 mph) so as not to damage the craft when it attempted to negotiate each bank configuration. Ground and water profiles were obtained for all tests. Cone index and remolding index were measured beneath the water surface and on the bank at the water-land interface. Moisture content, density, and bulk samples were obtained for laboratory classification from the surface to a depth of 18 in. for each test. Notes were recorded on the performance of the craft.

28. VCI test. This test was conducted in an undisturbed test area 100 ft long. The craft was operated in its lowest gear at a speed of approximately 2 mph and was driven back and forth in a straight line until it became immobilized or completed 50 passes. Before traffic began, cone index, remolding index, and soil samples for field and laboratory identication and moisture content and density determination were collected in the same manner as for the speed tests.

29. During traffic, rut depths were measured, and action of the craft and soil was recorded.

Mobility tests

30. At each test site one straight-line test course was laid out to include a number of different terrain types. The test course and points of change in terrain type along the course were clearly marked with stakes and flags to determine the speed of the RUC in each terrain type and to assist the driver in maintaining the desired position on the course. The test courses were positioned to ensure that the test craft would enter each terrain type at a right angle. After the test course had been laid out and the soil and vegetation data collected had been examined, the driver was given specific instructions regarding the course layout and the significance of markers on the course. He was also instructed to maintain

a maximum speed that, in his judgment, would not endanger his safety or damage the cargo or craft. The time required for the craft to cross each individual terrain type (from the time the front of the RUC entered until the time the front exited the terrain type) was measured by a stopwatch and recorded for each test. Usually, the RUC traversed each test course in one direction and then turned around and made the second pass in the opposite direction, following the same path as that of the first pass. Generally, this pattern was followed until several successive passes were made with the craft. The average test course speed was calculated from the total time required to traverse the mobility course divided into the total length of the course.

31. Sufficient data were taken to describe each terrain type adequately. Cone index measurements were made along the center line of each test within each terrain type. Because the distances across terrain types varied, cone indexes were measured at various horizontal intervals. Remolding index measurements were made, and soil samples for moisture content and density determinations and for field and laboratory identification of soil type were collected at arbitrary locations within most terrain types in the same manner as for the speed tests. Vegetation data were collected in terms of kind of vegetation, height, root depth, and percentage of ground cover for each terrain type (where feasible, stem diameter and stem spacing were measured). A rod and level were used to measure the terrain profiles of the test course and to establish water levels. From this profile, measurements of surface and hydrologic features were obtained. Pertinent observations of craft performance on each pass were recorded.

PART IV: ANALYSIS OF DATA

32. The data collected during the test program are analyzed below. It will be recalled that trafficability tests are designed to develop pertinent terrain-vehicle performance relations in homogeneous terrain conditions. These relations are required to adequately describe the performance of a vehicle operating in natural terrain. Mobility tests are designed to determine vehicle performance in terms of maximum safe speed at which a vehicle negotiates a course covering several different terrain types.

Trafficability Tests

33. The relations developed include (a) RCI versus maximum straight-line speed, (b) RCI versus maximum maneuver speed, and (c) RCI versus minimum time required to make a 180-deg turn. Also included in this analysis is the establishment of the limiting conditions in terms of bank step heights that produce immobilizations, and a discussion of VCI testing. In establishing the soil strength-performance relations, the 0- to 6-in. layer was considered to be the critical layer for the RUC, except as noted in discussions of VCI tests. RCI was used as a measure of soil strength for the tests conducted in fine-grained soils and organic soils that contained sufficient decomposed organic matter for which a remolding index could be obtained.

Maximum straight-line speed tests

34. These tests were conducted to determine the relation of maximum straight-line speed to soil strength. RCI and related data are shown for each test in table 1. A summary of performance data is shown in table 2. In table 2, the average speed shown (last column) is the "maximum straight-line speed." Each test was conducted as described in paragraph 21, except that the two engines of the RUC were run at maximum rpm's as dictated by soil conditions but at no greater rpm than 4500. The driver was instructed to steer as close as possible to the straight-line course. Ruts formed after tests on soils of different strengths are shown in fig. 12.

35. The maximum straight-line speed is plotted versus 0- to 6-in.

a. On soil having an RCI of 93

b. On soil having an RCI of 2

Fig. 12. Rut patterns formed by RUC after maximum straight-line speed tests

RCI in plate 5. Also included in the plot is the maximum water speed. A curve of visual best fit was drawn through the data points. This curve shows an increase in speed from a low of 3.6 knots at an RCI of 93 (firmest soil available for testing) to a high of 25 knots at an RCI of 2. The maximum water speed (plotted at 0 RCI) was 15.7 knots. Soil strengths between an RCI of 6 and about zero had the greatest effects on changes in maximum speed.

36. Surface condition and soil material apparently have some effect on maximum speed for a given RCI. An example of this apparent effect can be seen by examining tests 4 and 11, both conducted on RCI's of 2. Test 4 (19.1 knots) was conducted on a highly organic soil containing roots and root fibers; the surface was covered with about 3 in. of water and there was a 20 percent coverage of 30-in.-high grass. Test 11 (25.0 knots) was conducted on a clay soil containing very little organic material; the surface was only about 50 percent covered with 1/2 in. of water and there was a 5 percent coverage of dead lily pads. The effects of water depth alone on speed in these tests are inconclusive since two different soil materials were encountered. It is tentatively concluded that for these tests the resistance to rotor movement caused by the fibrous highly organic soil was greater than the resistance caused by the clay soil.

37. On an RCI of 6, two other tests (1 and 3) were conducted wherein different maximum speeds were measured; this difference also is believed to have been caused by differences in surface condition and soil material. Test 1 (7.4 knots) was conducted on a highly organic soil similar to that of test 4 described above. Ninety percent of the surface was covered with 1/2 in. of water and 95 percent of the surface was covered with 24-in.-high marsh grass. In test 3 (11.9 knots) the soil was mostly organic but contained more clay than that in test 1. In test 3, 70 percent of the soil surface was covered with 1/2 in. of water; 80 percent was covered with 16-in.-high Bermuda grass and 1 in. of soft, viscous material of unmeasurable strength. It is tentatively concluded in examining the results of these two tests that the increase in speed in test 3 over that attained in test 1 can be partially attributed to the lubricating effect on the rotors of the

soft, viscous material covering the surface and to the difference in soil material.

38. In summary, the results of maximum straight-line speed tests tend to indicate that (a) when operating on soils of equal RCI the RUC attains higher speeds on clay soil than on highly organic soil and (b) as little as 1 in. of fluid material on the surface will permit the RUC to attain higher speeds. Nevertheless, the curve shown in plate 5 may be considered a reasonable average. Had time for testing permitted, curves showing the combined effects of RCI and surface condition could have been developed. It should be noted that in tests 4, 10, and 11, at the speeds attained, mud and surface debris were thrown onto the craft and restricted the operator's line of sight. Had the test lanes been longer, the speeds probably could not have been sustained because of the accumulation of mud and debris onto the driver and windshield. In cross-country operation it would be unsafe to maintain these speeds.

Maximum maneuver-speed tests

39. Ten maximum maneuver-speed tests were conducted. Soil strength and related data for each test are summarized in table 1 and maximum maneuver speeds (time required to traverse the maneuver course divided by the straight-line distance of 200 ft) are shown in table 3. (Maximum maneuver speed refers to the average speed shown in table 3.) Both slalom and roll types of maneuvers were attempted on each maneuver test course. The type of maneuver that gave the highest speed is shown.

40. For each maneuver course the maximum maneuver speed regardless of type of maneuver is plotted versus 0- to 6-in. RCI in plate 6; the maximum maneuver speed achieved in water is also shown. A curve of best visual fit is drawn through the data points. The curve shown for maximum maneuver speed versus RCI is very similar to the one for maximum straight-line speed (also shown in plate 6), and the reduction in speed required to maneuver for a given RCI can be seen by comparing the two curves. The plotted data indicate that on an RCI of about 6 or greater, higher maneuver speeds were attained by the craft rolling sideways through part of the test than by slalom maneuvering. The data also indicate that maximum maneuver speed is affected by surface conditions and soil type in the same

manner as that for the straight-line speeds.

41. The following tabulation is based on the curves in plate 6, and indicates the percentage of speed lost by maneuvering for a selected range of soil strengths (RCI's) and the average loss for the selected RCI's (including water).

RCI	Straight-Line Speed,* knots	Maneuver Speed,* knots	Speed Loss,** %
Water	15.7	10.4	33.8
1	23.3	16.7	28.3
2	24.8	17.7	28.6
4	13.0	7.3	43.8
6	9.9	5.8	41.4
12	7.6	4.4	42.1
20	6.5	4.0	38.5
35	5.5	3.9	29.1
65	4.5	3.5	22.2
90	3.7	3.2	13.5
		Average	32.1

* Read from curves in plates 5 and 6.

** $\%\ \text{speed loss} = \frac{\text{straight-line speed} - \text{maneuver speed}}{\text{straight-line speed}} \times 100$.

In the selected RCI's the percent speed loss ranged from 13.5 on an RCI of 90 to 43.8 on an RCI of 4, and the average percent speed loss for all selected RCI's was 32.1. The percent speed loss was 33.8 percent in water; it decreased for RCI's of 1 and 2 and increased sharply at 4 RCI. From 4 to 90 RCI, there is an almost steady decrease in percent speed loss.

Time required to turn

42. In brief review, the RUC's rotors are powered independently, each having its own engine and throttle. The rotors can be powered to rotate in the same direction or in directions opposite to each other, and power (and rotation) can be varied simultaneously on each rotor. For analysis purposes, types of turns employed by the RUC had to be considered; each type is described below.

a. Skid turn. Just enough torque was applied to one rotor to prevent rotation while ample torque was applied simultaneously to the opposite rotor to accomplish rotation, thus producing a skid-steer effect.

b. Pivot or arc. Both rotors were powered in the same rotational direction and at about the same speed, causing a pivot turn in water and soft soils and a sweeping arc action on firm soils.

c. Variable. The RUC was jockeyed back and forth using skid, pivot, and arc action until a turn was accomplished.

43. Seventeen turn tests were conducted. Soil strength and related soil data for each test are summarized in table 1, and type of turn and time and area required to accomplish a turn for each test are shown in table 4. Results are summarized in the following tabulation in order of increasing RCI.

Test No.	Type Turn	Time, sec	0- to 6-in. RCI
9 (water)	Pivot	5.0	0
10A	Pivot	7.0	1
10B	Skid	20.0	1
4A	Pivot	12.0	2
4B	Skid	13.5	2
11A	Pivot	5.0	2
11B	Skid	9.0	2
5A	Pivot	26.0	5
5B	Skid	14.0	5
1A	Pivot	19.5	6
1B	Skid	21.0	6
3	Variable	49.0	6
2A	Arc	45.0	12
2B	Variable	188.0	12
6A	Arc	57.0	35
6B	Variable	204.0	35
8	Variable	170.0	93

44. The test data show that the RUC was able to make a pivot turn in water in 5 sec. In RCI's of 1 to 6, skid and pivot turns could be made in from 5 to 26 sec. Of the five tests conducted on soils of 6 RCI or less, four tests show it took less time to execute a turn by pivoting than by skidding. On soils with RCI's greater than 6, pivot and skid turns were either difficult or impossible, and variable or arc turns were the most

successful. Where arc and variable-type turn tests were conducted on the same soil strengths of about 6 RCI or greater, less time was required to make the arc turns. The arc turn, however, required greater turning area (table 4) than the variable-type turn. The amount of rotor area in contact with the ground may also affect the time required to complete a variable-type turn on firm soils. The area of the rotors in contact with the ground was greater in test 6B (RCI of 35) than in test 8 (RCI of 93). The increased resistance caused by increase in contact area of the rotors with the soil surface in test 6B may have contributed to a slower turning speed than that in test 8.

Water-exit tests

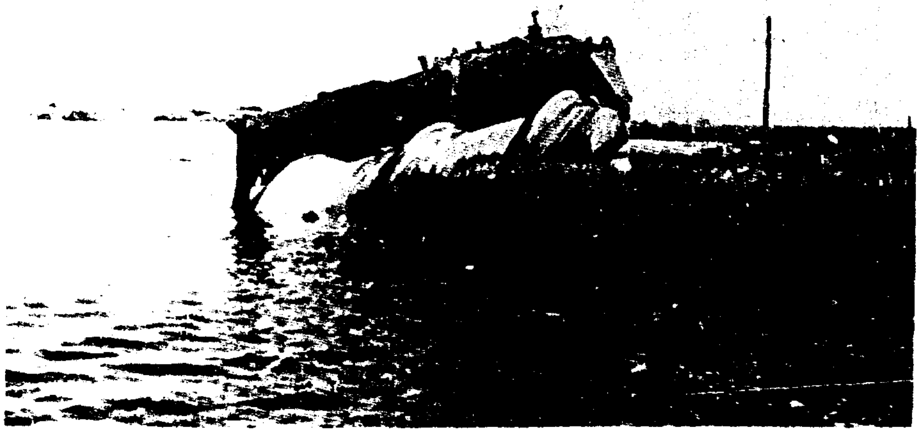
45. The water-exit tests were run on vertical banks ranging from 2.20 to 4.50 ft high to determine the maximum bank step height that the RUC could negotiate. An attempt was made to establish limiting conditions for banks and soil strengths that would produce an immobilization. However, the desired combination of bank heights and soil strength was not found.

46. Nine water-exit tests were conducted at Bayou du Large, La. A summary of soil data taken on the bank and on the bayou bottom is given in table 5. Ground and water profiles for each test are shown in plate 7. Water-exit tests in progress are shown in fig. 13 and bank damage after passage of RUC is shown in fig. 14. On each profile (plate 7) the RUC is positioned in relation to the progress it made in negotiating the bank. Where the RUC is shown to the left of the bank, the indication is that the craft negotiated the bank. In all tests the banks were deformed under traffic. The dashed line in plate 7 indicates the deformation that occurred on the first pass.

47. Test results are summarized below.

Test No.	Step Height ft	0- to 6-in. RCI of Bank	First-Pass Results Go	First-Pass Results No Go	Test No.	Step Height ft	0- to 6-in. RCI of Bank	First-Pass Results Go	First-Pass Results No Go
5	4.50	176		X	2	2.78	19	X	
8	3.48	381		X	3	2.65	17	X	
4	3.05	16	X		1	2.50	16	X	
6	3.00	203		X	7	2.20	468	X	
9	2.82	425	X						

a. RUC unable to climb bank in test 6



b. RUC climbing bank in test 2

Fig. 13. Water-exit tests in progress

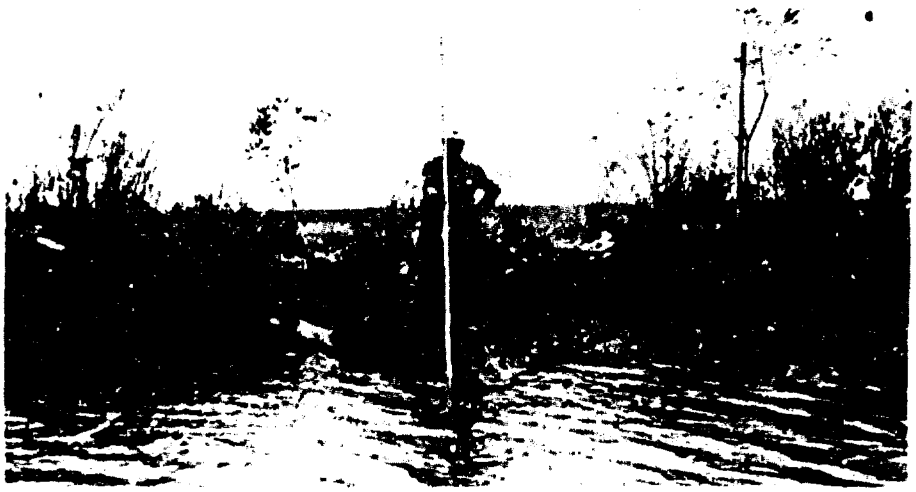


Fig. 14. Bank damage after passage of RUC, test 7

48. The data indicate that the RUC could not consistently negotiate steps higher than about 3 ft. Test 4 (bank RCI of 16) had a step height of 3.05 ft and the RUC was able to climb it on the first attempt, whereas test 6 (bank RCI of 203) had a step height of 3 ft and the RUC could not climb it on the first or second pass. Other tests with step heights above 3.05 ft were no go on the first pass; however, on the second pass, the RUC was able to climb the 3.48-ft step height (test 8, RCI of 381), but the bank was deformed in the attempt. On the basis of the discussion above of tests 4, 6, and 8, there does not appear to be a consistent relation between soil strength, step height, and go or no go performance.

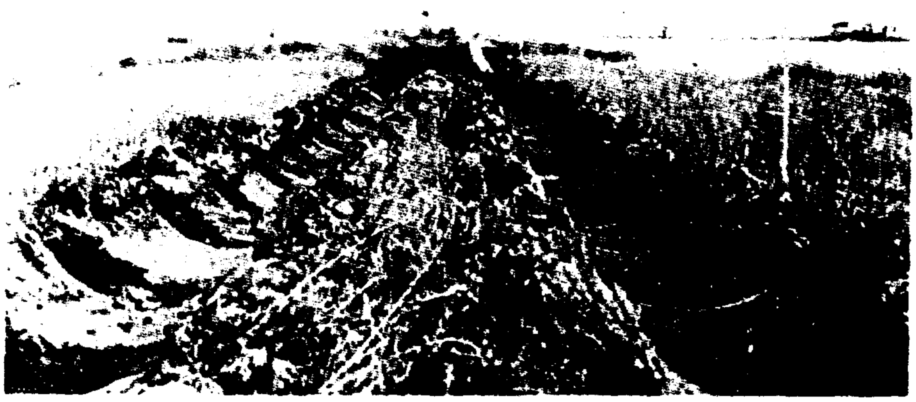
Vehicle cone index tests

49. Vehicle cone index (VCI) tests are usually conducted to determine the minimum soil strength in terms of RCI that will just permit a vehicle to make a prescribed number of passes, usually one and fifty. Also, as soil strength increases above the minimum required, the performance of conventional vehicles increases. This type of test, though meaningful for more conventional ground vehicles, is not applicable in the same sense to special craft such as the RUC because as soil strength decreased, the performance increased. However, in an effort to gain some insight into each performance category, the VCI of the RUC was analyzed to a minor extent. Time did not permit a complete investigation of the RUC's capabilities in terms of VCI.

50. In numerous speed and maneuver tests on extremely soft soils (RCI's as low as 1) the RUC was able to make one pass with relative ease. Therefore, VCI for one pass (VCI_1) may be considered to be zero. In terms of VCI for 50 passes (VCI_{50}) one test was conducted on an RCI of 12 (6- to 12-in. layer). Data for this test (test 12) are shown in table 1. The test in progress is shown in fig. 15. The craft completed 50 passes with ease although ruts after 50 passes were 24 in. deep. Mud accumulation on the blades and rotors was minimal and did not hamper back-and-forth movement. Results of this one test and observations of performance over the straight-line speed test courses indicate that a wet, slushy material would permit 50 passes, and on this basis VCI_{50} would also be zero. However, a soft soil (RCI less than 12) might cause the RUC to immobilize if

a. After 4 passes

b. After 30 passes



c. After 50 passes

Fig. 15. Rut patterns during and after traffic (test 12, table 1)

deep ruts formed and caused the undercarriage to drag. In such cases, VCI_{50} would be greater than zero. A soil with RCI greater than 12 might cause the RUC to immobilize on a 50-pass basis because of lack of power resulting from a greater increase in torque requirements due to increased frictional resistance between soil and rotors with progressive rutting.

Mobility Tests

51. Mobility tests with the RUC were conducted on four test courses. Summaries of soil and terrain data for each test course are shown in tables 6 and 7, respectively. Detailed soil profile descriptions are given in Appendix B. A summary of speed test results is shown in table 8. Profiles of the test courses, including soil strength, vegetation height, surface water level, and ground photographs are shown in plates 1-4. Analysis of data was made on the basis of craft speed over terrain types and test courses. As stated previously, the same driver was used for all tests.

Speeds on various types of terrain

52. The mobility tests were conducted on 23 different types of terrain. Speeds recorded on each terrain type on each mobility test course for each pass are given in table 8. The maximum first-pass speed of the RUC on each terrain type tested is given below.

Terrain Type No.	Site No.	Maximum First-Pass Speed, knots
1	1, 4	15.2*
2	1	8.6*
3	1, 3	6.2*
4	1	9.0
5	1	13.3
6	1	8.8
7	1	7.7
8	2	4.6
9	2	7.8
10	2	3.2

(Continued)

* Average.

Terrain Type No.	Site No.	Maximum First-Pass Speed, knots
11	2	7.3
12	2	1.6
13	2	4.5
14	2	7.2
15	3	11.9
16	3	4.5
17	3	7.2
18	3	9.8
19	3	8.3*
20	4	16.5
21	4	19.4*
22	4	5.9
23	4	18.7

* Average.

An examination of the tabulation above indicates that on the first pass the RUC attained the highest maximum speed of 19.4 knots in terrain type 21; the lowest maximum speed of 1.6 knots occurred in terrain type 12. Terrain type 21 consisted of two mud flats, both covered with dead water lilies and having soil strengths of 1 and 3 RCI. Terrain type 12 was a natural levee (RCI of 0- to 6-in. layer was 180) covered with 10-ft-high scrub bushes.

53. The speed according to an arbitrary speed class that the craft achieved on the first pass in the terrain types tested is given below.

Speed Class, knots	No. of Terrain Types in Which Vehicle Achieved Speed Class on First Pass
0 (immobilization)	0
0.1 to 2.0	1
2.1 to 4.0	1
4.1 to 6.0	4
6.1 to 8.0	6
8.1 to 10.0	5
10.1 to 12.0	1
12.1 to 14.0	1
14.1 to 16.0	1

(Continued)

Speed Class, knots	No. of Terrain Types in Which Vehicle Achieved Speed Class on First Pass
16.1 to 18.0	1
18.1 to 20.0	2
Total	23

From the tabulation above it can be seen that the RUC was able to negotiate all terrain types tested. The minimum speed class of 0.1 to 2.0 knots occurred in one terrain type, and the maximum speed class of 18.1 to 20.0 knots was achieved in two terrain types. The data also show that the RUC negotiated the majority (15 of 23) of the terrain types at speeds between 4.1 and 10.0 knots.

Mobility test course speeds

54. The average test course speeds of the RUC for each mobility test are shown in table 8. The maximum first-pass speed was 15.0 knots at site 4 and the minimum first-pass speed was 4.9 knots at site 2. In terms of overall soil strength (RCI), site 4 had the softest terrain and site 2 the firmest terrain.

55. As shown in table 8, difficulties were encountered at sites 1 and 4. At site 1 in passes 1A and 1B, speeds were considered to be unsafe and not representative of cross-country operation. In two passes, as the RUC traveled from sta 1+02 to 7+42, mud and debris accumulated on the RUC's windshield and the driver's view was obscured. Furthermore, at test site 4 in pass 2 between sta 2+64 and 3+52 the speed was considered to be unsafe for the vehicle and driver because tall, dense vegetation obscured the driver's view.

Speeds on repetitive passes

56. At sites 1, 2, and 3 after the first pass, the average test course speed of the RUC increased with repetitive passes. At site 1 speed increased from 9.5 to 13.4 knots, at site 2 speed increased from 4.9 to 6.1 knots, and at site 3 speed increased from 7.4 to 14.6 knots. The speeds of the last one or two passes on each test course were considered to be about the maximum safe speed for the RUC. The increase in speed was due to the driver becoming more familiar with the test course on each

succeeding pass, deterioration of the test course with traffic, and water accumulating in the ruts left by the craft in previous passes. Test personnel believed that the water accumulation in the ruts and test course deterioration reduced the RUC's resistance to motion in some of the terrain types and thereby contributed to the increased speed.

57. At site 4 average test course speed did not increase with repetitive passes. Generally the speed on each pass remained near 15 knots. The driver was able to operate the RUC at the maximum safe speed on the first pass. Furthermore, though the test course deteriorated and the driver became more familiar with the terrain with succeeding passes speed performance did not improve.

Summary

58. In summary, the mobility tests indicate that the average maximum first-pass speed over the 23 terrain types encountered was 9.0 knots. Also, maximum speeds were lowest in tall, woody vegetation and on firm ground. And as expected, maximum speeds were highest in the wet marsh terrains. Mud and surface debris thrown onto the windshield from the rotors obscured the driver's vision and reduced maximum safe speeds in a number of terrain types. Increase in speeds with repetitive passes was attributed partly to course deterioration and increase in free surface water in the craft's path and partly to the driver's becoming more familiar with the test course with each succeeding test pass.

Comparison of Terrain Types of Selected Mekong Delta Areas and Mobility Test Courses

59. A comparison of terrain types of selected Mekong Delta areas and mobility test courses is presented in detail in Appendix A. In summary, 134 terrain types were identified in the Mekong Delta. Of these terrain types, 7 were analogous, 55 were highly analogous, 55 were moderately analogous, and 17 were slightly analogous to one or more of the terrain types identified along the four mobility test courses. Furthermore, all 23 terrain types identified along the mobility test courses had some degree of analogy with terrain types identified in the Mekong Delta. The exact number of terrain types that may occur in the Mekong Delta is not known;

however, based on the location of the Mekong Delta study areas, it is believed those terrain types mapped are representative and many of the terrain types would probably be encountered almost anywhere in the Delta. It should be pointed out, however, that terrain types other than marshland do occur within the Mekong Delta that would restrict RUC operations (for example, terrain types with dense vegetation with stems larger than 3 in. and those with vertical step heights greater than 3 ft). A study to determine the probability of occurrence of terrain types that would restrict RUC operation is beyond the scope of this report.

Comparison of RUC and XM759 and M116 Performances

60. Performance tests were conducted in 1967 with the XM759 and M116 on mobility courses adjacent to three of the courses used in the RUC performance tests.[6] Comparisons of performance of the three vehicles can be made in terms of maximum speed over three of the mobility test courses and in terms of VCI_1. Briefly, the XM759 is an amphibious vehicle that employs the Airoll locomotion concept. Its normal payload in the 1967 tests was 1-1/2 tons and its gross weight was 13,000 lb. The M116 is a standard amphibious tracked vehicle; its normal payload was 1-1/2 tons and its gross weight was 10,600 lb.

Speeds over the mobility test courses

61. The three test courses over which comparative speed performances could be made were Bayou du Large site 1, Minors Canal, and Morgan Island. Terrain measurements from the two test programs indicate the courses were similar at the times tests were run. Comparative first-pass speeds are shown below.

	First-Pass Speeds, mph		
Vehicle	Bayou du Large	Minors Canal	Morgan Island
RUC	11.0	8.6	17.3
XM759	7.3	7.0	6.6
M116	*	*	*

* M116 was immobilized because of soft soils along each test course.

As shown in the tabulation on the preceding page, the RUC negotiated the test courses at higher speeds than the XM759 and the M116 could not complete any of the test course passes. In terms of percentages, the RUC's speeds were faster than the XM759's by 51 percent at Bayou du Large, 23 percent at Minors Canal, and 162 percent at Morgan Island. It should be pointed out, however, that on firmer terrain, the RUC's cross-country speed would be lower than the XM759's. For example, on an RCI of 14 (table 8, Bayou du Large, terrain type 6) the RUC's first-pass speed was 9.9 mph (8.8 knots), whereas the speed of the XM759 was 11.6 mph on that same terrain (reference 6, table 10, Bayou du Large, terrain type 7). As RCI increased, the RUC's speed decreased and the XM759's speed increased. Over the same terrain the M116's speed was 10.5 mph.

VCI_1 comparisons

62. In terms of VCI_1 both the RUC and the XM759 are considered to have VCI_1's of zero, while the M116 has an experimental VCI_1 of 7. In comparison insofar as being able to negotiate extremely soft soils, regardless of speed and maneuverability, the performances of the RUC and the XM759 are good and the M116's performance is poor.

PART V: SUMMARY OF TEST RESULTS AND RECOMMENDATIONS

Summary of Test Results

63. A summary of results of the test program reported herein is given in the following paragraphs.

Maximum straight-line speed

64. Maximum straight-line speed-RCI relations were developed (plate 5). The maximum speed attained was 25 knots on an RCI of 2; however, this speed could not have been sustained for distances much longer than the 200-ft test course because mud and debris were thrown onto the craft and restricted the operator's vision. On an RCI of 93 (firmest soil tested) the maximum straight-line speed was 3.6 knots. Maximum straight-line speed in water was 15.7 knots. Generally for the same soil strength, higher speeds were attained on clay soil than on organic soil (paragraphs 34-38).

Maximum maneuver speed

65. Maximum maneuver speed-RCI relations were developed (plate 6). The maximum maneuver speed attained was 17.7 knots on an RCI of 2; the lowest maximum maneuver speed of 3.0 knots occurred on soil having an RCI of 93. Maximum maneuver speed in water was 10.4 knots. The average speed loss by maneuvering as compared to straight-line speeds for selected soil strengths was 32.1 percent; this included water and soil tests. The RUC could maneuver through test courses on RCI's of about 6 or less by skid steering; however, in test courses on RCI's of about 6 or greater, higher maneuver speeds were attained by the craft rolling sideways through part of the test than by slalom maneuvering (paragraphs 39-41).

Minimum time required to turn

66. The minimum time required to make a 180-deg turn was found to be related to RCI and type of turn. Skid and pivot turns were made with little difficulty on RCI's of about 6 or less. Generally on soil of this strength pivot turns were made a little faster than skid turns. On RCI's greater than about 6, turns were made only by variable or arc movement. Generally the fastest turns on these soil strengths were made by arc movement; however, arc turns required greater areas. In water, pivot turns

required less time than other types of turns in soil and in most cases were accomplished in less time than similar turns on soil (paragraphs 42-44).

Water exit

67. On a first-pass basis the RUC was consistently able to negotiate a vertical bank height of about 3 ft or less. Bank deformation occurred on all banks (paragraphs 45-48).

Vehicle cone index

68. The RUC was able to traverse all soil strengths tested; therefore, its VCI_1 may be considered to be zero. Because of the limited scope of the test program, determination of VCI_{50} was not attempted, but it is conceivable that the craft could also make 50 passes on a soil strength of practically 0 RCI; therefore, VCI_{50} of the RUC could be considered to be zero. However, on the basis of one test, the RUC completed 50 passes on an RCI of 12 but created 2-ft ruts. This would indicate that it may be possible to immobilize the craft on a 50-pass basis on a soil at some optimum strength (paragraphs 49 and 50).

Mobility

69. The RUC was able to negotiate all 23 terrain types tested. The highest maximum speed on the first pass was 19.4 knots in one terrain type and the lowest maximum speed was 1.6 knots in one terrain type. Fifteen of the 23 terrain types were negotiated at speeds between 4.1 and 10.0 knots (paragraphs 52 and 53).

70. On the four mobility test courses, the maximum first-pass speed was 15.0 knots at site 4 and the minimum first-pass speed was 4.9 knots at site 2 (paragraph 54).

71. The average maximum first-pass speed over all 23 terrain types was 9.0 knots (paragraph 58).

72. Increase in average test course speeds with repetitive passes was attributed partly to course deterioration and increase in free surface water in the craft's path and partly to the driver's increasing familiarity with the test course with each succeeding test pass (paragraphs 56 and 57).

Comparison of terrain types

73. Of the 134 terrain types identified in selected areas of Mekong Delta, 7 were analogous, 55 were highly analogous, 55 were moderately analogous, and 17 were slightly analogous to one or more of the terrain types identified along the four mobility test courses (paragraph 59).

Observations of RUC during tests (paragraph 13)

74. A windshield is essential to protect the operator of the RUC and its cargo compartment from flying mud and debris when operating at high rotational speeds.

75. An experienced operator/mechanic was considered essential for the entire program to ensure maximum performance in all tests.

76. The craft had adequate power in all terrain conditions tested.

77. The screw-type propulsion system of the RUC is extremely destructive to soft soil terrains.

Overall performance in riverine environments

78. In general, based on the specific performance parameters mentioned in paragraphs 64-73, it is concluded that the RUC can operate in the riverine environments for which it was designed. The craft's performance is most effective in water and wet marshes of low soil strengths. The RUC also has a performance capability in areas considered highly restrictive to or even inaccessible by boats and other amphibious craft.

Recommendations

79. Based on results of this test program, its somewhat limited scope, and results of performance tests with another screw-propelled craft, the Marsh Screw Amphibian, it is recommended with regard to further RUC investigation that:

a. Speed and maneuver performance capabilities be determined on coarse-grained soils, such as ocean beaches, river sand beaches and bars, and sand tidal flats. Such testing is considered a natural follow-up to the test program reported herein since coarse-grained soil areas are the most pertinent transitional areas between water and soil that remained untested. These soils will produce high rotor friction which may degrade the performance of the RUC.

b. Slope-climbing performance capabilities be determined on fine-grained soils (clays and silts) of various moisture conditions.

c. Step-height performance capabilities be determined when the craft touches the bank while floating in water.

d. Towing capability tests in water be conducted to possibly develop a means to predict slope and step-height performance.

e. VCI_{50} be determined in fine-grained soils.

f. Limited studies be made to eliminate the problem of flying mud and debris during high rotational speeds in soft soils and marshland terrains.

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Summary of

Site Location	Test No.	Cone Index at Depths, in. 0	3	6	9	12	15	18	24	30	36	Average C of Laye 0-6	3-9
Bayou du Large, La.	1	20	19	9	6	6	9	10	11	14	15	16	11
	2	11	32	28	36	35	34	31	34	36	50	24	32
	3	3	22	21	14	11	12	16	23	30	29	15	19
	4	3	4	4	5	6	7	9	10	9	10	4	4
	5	6	18	13	9	6	8	9	12	15	50	12	13
	6	43	76	64	55	55	54	59	69	74	86	61	65
	7	44	66	50	54	52	48	50	53	64	72	53	57
	8	79	191	68	80	86	91	94	100	130	164	113	113
	9	Water											
Morgan Island, La.	10	1	1	2	3	4	5	7	9	9	9	1	2
	11	3	5	7	7	9	10	11	15	19	22	5	6
Bayou du Large, La.	12*	10	16	18	21	25	33	38	48	50	55	15	18

* The vehicle made 50 passes with ease. The rut depths after various passes wer

Table 1

Soil Data and Test Results, Speed, Turn, Maneuver, and VCI Tests

one Index rs, in.		Remolding Index of Layers, in.			Rating Cone Index of Layers, in.				Moisture Content of Layers, % Dry Weight				Dry Density of Layers, pcf		
6-12	12-18	0-6	6-12	12-18	0-6	3-9	6-12	12-18	0-1	0-6	6-12	12-18	0-6	6-12	12-1
7	8	0.40	0.50	0.50	6	5	4	4	326.8	444.6	542.2	488.2	11.2	10.4	11.
33	33	0.48	0.62	0.56	12	18	20	18	119.7	123.1	61.2	63.4	36.0	61.6	60.
15	13	0.40	0.60	0.69	6	10	9	9	207.1	212.8	70.4	66.9	23.5	53.0	60.
5	7	0.46	0.46	0.50	2	2	2	4	436.5	728.0	374.5	144.9	7.7	14.9	32.
9	8	0.42	0.42	0.45	5	5	4	4	544.6	788.3	662.1	398.0	6.5	8.8	13.
58	56	0.58	0.68	0.40	35	41	39	22	99.2	53.3	34.9	39.1	66.4	85.2	80.
52	50	0.54	0.64	0.67	29	34	33	34	40.2	47.6	43.1	47.9	69.0	75.7	71.
78	90	0.82	0.64	0.79	93	82	50	71	22.7	28.4	37.6	35.4	90.9	82.3	84.
3	5	0.62	0.68	0.69	1	1	2	3	131.1	106.0	137.0	216.8	43.0	35.5	23.
8	10	0.50	0.60	0.62	2	3	5	6	80.3	79.5	60.3	61.5	52.9	64.3	61.
21	32	0.60	0.58	0.78	9	11	12	25	54.3	58.6	72.7	58.3	62.7	56.0	64.

e: 1st pass, 11.3 in.; 10th pass, 20.4 in.; 30th pass, 24 in.; 50th pass, 24 in.

..., Maneuver, and VCI Tests

... Cone Index ... Layers, in.		Moisture Content of Layers, % Dry Weight				Dry Density of Layers, pcf			USCS Soil Classification	Surface Condition		
										Water		Depth of Slush in.
6-12	12-18	0-1	0-6	6-12	12-18	0-6	6-12	12-18		Depth in.	% Coverage	
4	4	326.8	444.6	542.2	488.2	11.2	10.4	11.6	OH-Pt	0.5 to 0	90	--
20	18	119.7	123.1	61.2	63.4	36.0	61.6	60.5	CH-OH	0.5 to 0	80	1
9	[illegible]	207.1	212.8	79.4	66.9	23.5	53.0	60.8	CH	0.5 to 0	70	1
2	4	436.5	728.0	374.5	144.9	7.7	14.8	32.8	OH-Pt	2.5 to 3	100	--
4	4	544.6	788.3	662.1	398.0	6.5	8.8	13.9	OH-Pt	2	100	--
39	22	99.2	53.3	34.9	39.1	66.4	85.2	80.8	CH	--	--	--
33	34	49.2	47.6	43.1	47.9	69.9	75.7	71.0	CH	--	--	--
50	71	22.7	28.4	37.6	35.4	89.8	82.3	84.7	CH	--	--	--
2	3	131.1	106.0	137.0	216.8	43.0	35.5	23.5	CH	0.5	50	--
5	6	80.3	79.5	60.3	61.5	52.8	64.3	61.5	CH			
12	25	54.3	58.6	72.7	58.3	62.7	56.0	64.4	CH	0.5 to 0	80	1

...in.; 30th pass, 24 in.; 50th pass, 24 in.

Table 2

Summary of Test Results, Maximum Straight-Line Speed Tests

Test No.	Max Speed, knots				
	Pass 1A	Pass 1B	Pass 1C	Pass 1D	Avg
		Bayou du Large, La., Sites 1 and 2			
1	6.8	7.0	8.5	--	7.4
2	7.9	9.0	--	--	8.4
3	9.2	12.9	13.5	--	11.9
4	19.1*	19.1*	13.9**	--	19.1*
5	12.5	10.8	11.8	--	11.7
6	5.5	4.2	5.3	--	5.0
7	6.2	--	--	--	6.2
8	3.6	--	--	--	3.6
9 (water)	15.8	16.0	15.6	15.4	15.7
		Morgan Island, La., Site 4			
10	22.8*	23.7*	--	--	23.2*
11	26.3*	23.7*	--	--	25.0*

Note: Each pass was conducted in undisturbed terrain.
* These speeds were considered to be unsafe because the driver's vision was obscured by mud and debris on the windshield.
** Maximum safe speed as determined by driver.

Table 3

Summary of Test Results, Maximum Maneuver-Speed Tests

Test No.	Roll or Slalom	Maximum Speed, knots: Bayou du Large, La., Sites 1 and 2: Pass 1A	Pass 1B	Avg	Morgan Island, La., Site 4
1	Slalom	4.2	--	4.2	--
2	Roll	4.4	--	4.4	--
3	Slalom	6.9	--	6.9	--
4	Slalom	10.4	--	10.4	--
5	Slalom	7.4	7.6	7.5	--
6	Roll	3.8	--	3.8	--
8	Roll	3.0	--	3.0	--
9 (water)	Slalom	9.9	10.8	10.4	--
10	Slalom	--	--	--	16.7
11	Slalom	--	--	--	17.7

Note: Each pass was conducted in undisturbed terrain.

Table 4

Summary of Test Results, Turn Tests

Test No.	Type of Turn	Time, sec	Area Required to Make 180-deg Turn, sq ft
1A	Pivot	19.5	[illegible],180
1B	Skid	21.0	353
2A	Arc	45.0	24,925
2B	Variable	188.0	15,000
3	Variable	49.0	4,800
4A	Pivot	12.0	245
4B	Skid	13.5	353
5A	Pivot	26.0	3,925
5B	Skid	14.0	628
6A	Arc	57.0	34,856
6B	Variable	204.0	30,000
8	Variable	170.0	5,652
9 (water)	Pivot	5.0	157
10A	Pivot	7.0	353
10B	Skid	20.0	[illegible],133
11A	Pivot	5.0	628
11B	Skid	9.0	628

Summary of Soil D

Test No.	Station Location	Cone Index at Depths, in. 0	3	6	9	12	15	18	24	30	36	Average Cone of Layers, 0-6	3-9	6-12
1	Bank	17	35	32	28	25	27	32	34	40	36	28	32	28
	Underwater	18	22	25	30	28	35	44	54	52	61	22	26	28
2	Bank	14	41	47	37	30	26	26	32	38	38	34	42	38
	Underwater	18	27	32	27	24	36	46	39	54	55	26	29	28
3	Bank	14	40	36	42	39	34	30	31	39	43	30	39	39
	Underwater	5	12	22	24	24	46	50	58	65+	60+	13	19	23
4	Bank	23	31	34	34	32	36	40	48	48	52	29	33	33
	Underwater	7	11	20	22	27	34	34	38	33	38	13	18	23
5	Bank	195	250	190	207	222	274	267	231	228	304	212	216	206
	Underwater	7	13	23	27	40	60	71	92	96	100	14	21	30
6	Bank	245	273	218	179	189	202	204	207	211	224	245	223	195
	Underwater	6	14	14	18	26	38	53	70	74	83	11	15	19
7	Bank	143	379	304	260	231	241	254	216	199	200	275	314	265
	Underwater	7	16	19	20	23	26	36	54	91	100	14	18	21
8	Bank	164	295	214	203	186	199	171	186	183	183	224	237	201
	Underwater	7	19	27	35	38	54	50	65	82	90	18	27	33
9	Bank	218	314	219	196	190	175	204	230	225	245	250	243	202
	Underwater	12	16	17	24	41	46	45	79	91	98	15	19	27

Table

ıta, Water-Exit Test at Bayou du Large, La.

Index, in.	Remolding Index of Layers, in.			Rating Cone Index of Layers, in.				Moisture Content of Layers, % Dry Weight				Dry Density of Layers, pcf		
12-18	0-6	6-12	12-18	0-6	3-9	6-12	12-18	0-1	0-6	6-12	12-18	0-6	6-12	12-18
28	0.56	0.54	0.72	[illegible]	18	15	20	126.4	129.7	133.4	53.7	[illegible]	35.7	65.4
36	0.74	0.73	0.73	16	19	20	26	153.3	101.0	50.3	47.9	43.4	70.4	72.6
27	0.56	0.54	0.72	19	23	21	19	126.4	129.7	133.4	53.7	35.5	35.7	65.4
35	0.74	0.73	0.73	19	21	20	26	153.3	101.0	50.3	47.9	43.4	70.4	72.6
34	0.56	0.54	0.72	17	21	21	24	126.4	129.7	133.4	53.7	35.5	35.7	65.4
40	0.74	0.73	0.73	10	14	17	29	153.3	101.0	50.3	47.9	43.4	70.4	72.6
36	0.55	0.53	0.74	16	18	17	27	76.1	75.0	100.4	50.2	53.0	43.0	70.1
32	0.38	0.51	--	5	8	12	--	67.6	107.6	53.1	--	42.8	48.2	--
254	0.83	0.85	0.66	176	181	175	168	30.8	21.7	21.2	30.4	89.2	85.6	84.6
57	0.56	0.30	0.24	8	9	9	14	37.0	39.5	32.9	35.9	79.8	87.3	83.9
198	0.83	0.85	0.66	203	187	166	131	30.8	21.7	21.2	30.4	89.2	85.6	84.6
39	0.56	0.30	0.24	6	6	6	9	37.0	39.5	32.9	35.9	79.8	87.3	83.9
242	1.70	1.17	0.97	468	452	310	235	11.6	20.1	34.8	32.7	74.1	77.1	87.1
28	0.63	0.70	0.50	9	12	15	14	54.3	44.1	35.3	39.5	74.9	84.4	80.5
185	1.70	1.17	0.97	381	341	235	179	11.6	20.1	34.8	32.7	74.1	77.1	87.1
47	0.63	0.70	0.50	11	18	23	24	54.3	44.1	35.3	39.5	74.9	84.4	80.5
190	1.70	1.17	0.97	425	350	236	184	11.6	20.1	34.8	32.7	74.1	77.1	87.1
44	0.63	0.70	0.50	9	13	19	22	54.3	44.1	35.3	39.5	74.9	84.4	80.5

ble 5

xit Test at Bayou du Large, La.

emolding Index f Layers, in.			Rating Cone Index of Layers, in.				Moisture Content of Layers, % Dry Weight				Dry Density of Layers, pcf			USCS Soil Classi- fication
6	6-12	12-18	0-6	3-9	6-12	12-18	0-1	0-6	6-12	12-18	0-6	6-12	12-18	
56	0.54	0.72	16	18	15	20	126.4	129.7	133.4	53.7	35.5	35.7	65.4	CH
74	0.73	0.73	16	19	20	26	153.3	101.0	50.3	47.9	43.4	70.4	72.6	--
56	0.54	0.72	19	23	21	19	126.4	129.7	133.4	53.7	35.5	35.7	65.4	CH
74	0.73	0.73	19	21	20	26	153.3	101.0	50.3	47.9	43.4	70.4	72.6	--
56	0.54	0.72	17	21	21	24	126.4	129.7	133.4	53.7	35.5	35.7	65.4	CH
74	0.73	0.73	10	14	17	29	153.3	101.0	50.3	47.9	43.4	70.4	72.6	--
55	0.53	0.74	16	18	17	27	76.1	75.0	100.4	50.2	53.0	43.0	70.1	CH
88	0.51	--	5	8	12	--	67.6	107.6	53.1	--	42.8	68.2	--	--
33	0.85	0.66	176	181	175	168	30.8	21.7	21.2	30.4	89.2	85.6	84.6	CH
56	0.30	0.24	8	9	9	14	37.0	39.5	32.9	35.9	79.8	87.3	83.9	--
33	0.85	0.66	203	187	166	131	30.8	21.7	21.2	30.4	89.2	85.6	84.6	CH
56	0.30	0.24	6	6	6	9	37.0	39.5	32.9	35.9	79.8	87.3	83.9	--
0	1.17	0.97	468	452	310	235	11.6	20.1	34.8	32.7	74.1	77.1	87.1	CH
3	0.70	0.50	9	12	15	14	54.3	44.1	35.3	39.5	74.9	84.4	80.5	--
0	1.17	0.97	381	341	235	179	11.6	20.1	34.8	32.7	74.1	77.1	87.1	CH
3	0.70	0.50	11	18	23	24	54.3	44.1	35.3	39.5	74.9	84.4	80.5	--
0	1.17	0.97	425	350	236	184	11.6	20.1	34.8	32.7	74.1	77.1	87.1	CH
3	0.70	0.50	9	13	19	22	54.3	44.1	35.3	39.5	74.9	84.4	80.5	--

[illegible]

[illegible] Data, [illegible] Tests

[illegible] of Depth [illegible], in.						Average Cone Index of Layers, in.				Remolding Index of Layers, in.			Rating Cone Index of Layers, in.				Moisture Content of Layers, [illegible]	
[illegible]	[illegible]	[illegible]	24	[illegible]	[illegible]	0-6	3-9	6-12	12-18	0-6	6-12	12-18	0-6	3-9	6-12	12-18	0-1	0-6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11	[illegible]	11	10	[illegible]	0.56	0.55	0.46	5	6	6	4	367.0	517.2
[illegible]	[illegible]	[illegible]	[illegible]	10	11	[illegible]	4	[illegible]	[illegible]	0.46	0.31	0.48	1	2	2	3	557.1	718.8
[illegible]	[illegible]	10	14	17	21	12	14	11	[illegible]	0.39	0.46	0.56	4	6	5	5	354.3	327.6
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13	16	0.46	0.50	0.61	7	8	6	10	279.3	168.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	[illegible]	[illegible]	25	0.70	0.54	0.50	8	11	10	12	94.7	86.6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	17	21	35	0.56	0.58	0.53	7	10	12	19	77.4	71.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44	[illegible]	[illegible]	[illegible]	34	0.47	0.58	0.61	14	18	19	21	162.8	184.3
[illegible]	10	[illegible]	14	[illegible]	22	4	[illegible]	[illegible]	10	0.41	0.56	0.48	2	3	4	5	240.0	162.0
[illegible]	[illegible]	10	11	14	[illegible]	12	11	[illegible]	[illegible]	0.39	0.42	0.42	5	4	3	3	243.8	453.0
[illegible]	[illegible]	[illegible]	[illegible]	30	32	[illegible]	[illegible]	17	[illegible]	0.57	0.62	0.62	9	10	11	12	623.6	331.9
[illegible]	[illegible]	[illegible]	40	40	40	32	[illegible]	42	[illegible]	0.54	0.64	0.67	17	21	27	34	49.2	47.6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	134	[illegible]	[illegible]	124	0.82	0.64	0.79	110	92	61	98	22.7	28.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22	[illegible]	[illegible]	[illegible]	0.53	0.45	0.44	12	15	16	17	44.6	42.4
[illegible]	[illegible]	[illegible]	133	147	[illegible]	[illegible]	[illegible]	137	123	1.00	[illegible]	0.65	180	146	118	80	38.7	36.2
[illegible]	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	52	50	60	0.70	0.71	0.62	38	36	36	37	71.3	38.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	31	[illegible]	41	[illegible]	0.48	0.70	0.56	15	22	29	30	281.2	129.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3	[illegible]	4	--	--	--	3*	3*	3*	4*	--	--
12	[illegible]	[illegible]	[illegible]	16	[illegible]	[illegible]	[illegible]	10	13	0.56	0.44	0.50	4	4	4	6	392.9	210.5
[illegible]	12	[illegible]	[illegible]	[illegible]	[illegible]	11	10	[illegible]	12	0.52	0.46	0.48	6	5	4	6	507.8	319.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11	14	15	[illegible]	0.50	0.48	0.53	6	7	7	8	722.2	108.6
[illegible]	[illegible]	[illegible]	[illegible]	23	[illegible]	11	11	11	[illegible]	0.60	0.46	0.58	7	6	5	10	341.4	246.4
[illegible]	[illegible]	[illegible]	[illegible]	24	24	10	[illegible]	10	17	0.56	0.58	0.46	6	5	6	8	785.7	1185.7
10	[illegible]	1	17	18	[illegible]	[illegible]	10	10	13	0.60	0.45	0.42	5	[illegible]	4	5	1197.0	1531.0
[illegible]	[illegible]	7	[illegible]	[illegible]	[illegible]	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	157.5	93.6
[illegible]	[illegible]	14	20	22	23	5	[illegible]	[illegible]	11	0.52	0.44	0.55	3	3	3	6	68.8	52.1
[illegible]	30	[illegible]	34	[illegible]	33	27	[illegible]	[illegible]	31	0.60	0.50	0.36	16	15	14	11	59.8	54.3
[illegible]	[illegible]	[illegible]	11	13	14	2	4	[illegible]	[illegible]	0.50	0.60	0.62	1	2	3	4	80.3	79.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]	4	[illegible]	0.62	0.68	0.69	1	2	3	3	131.1	106.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10	4	[illegible]	[illegible]	[illegible]	0.50	0.58	0.55	2	3	3	3	194.0	160.9

1.00.

ent of y Wt		Dry Density of Layers, pcf			USCS Soil Classification	Surface Condition			
						Water		Depth of Slush in.	Rut Depth in.
-12	12-18	0-6	6-12	12-18		Depth in.	% Coverage		
14.3	176.7	10.7	7.6	9.4	OH-Pt	?	100	--	14.0
305.1	262.2	7.4	11.0	19.9	OH-Pt	2.5 to 3	100	--	15.8
326.2	120.2	15.8	16.5	38.5	OH	1.5	100	--	12.4
39.3	63.1	20.8	40.4	61.2	CH	0.5 to 0	70	1	9.6
68.7	61.4	47.1	57.7	70.6	CH	0.5 to 0	80	1	10.6
50.0	54.5	57.4	71.1	68.3	CH	Bayou	100	--	--
106.8	47.4	29.3	42.0	72.4	CH-OH	0.5 to 0	80	1	9.6
71.0	74.1	30.6	56.7	55.7	CH-OH	Bayou	100	--	12.2
57.4	493.2	10.0	10.2	12.3	OH-Pt	0.5 to 0	90	--	17.0
87.0	37.3	15.8	18.2	49.9	CH	--	--	--	9.7
43.1	47.6	69.9	75.7	71.0	CH	--	--	--	8.0
37.6	35.4	80.8	82.3	84.7	CH	--	--	--	5.8
39.2	35.2	76.4	85.7	85.8	CH	Bayou	100	--	--
32.3	26.8	74.6	90.3	83.5	CH	--	--	--	4.6
41.8	45.7	79.4	79.5	74.4	CH	--	--	--	8.0
71.4	85.0	35.9	56.3	49.9	CH-OH	--	--	--	8.6
--	--	--	--	--	OH-Pt	1-18	100	--	11.6
720.5	644.6	24.8	7.8	9.0	OH-Pt	--	--	--	13.3
728.6	879.9	17.2	7.8	6.6	OH-Pt	--	--	--	18.2
754.2	675.2	5.4	7.7	8.4	OH-Pt	Canal	100	--	--
597.0	624.0	20.9	8.1	3.7	Pt	--	--	--	20.9
829.4	953.9	4.5	7.9	6.1	Pt	--	--	--	12.2
501.1	482.9	3.5	10.7	10.8	Pt	--	--	--	17.5
62.5	72.0	43.2	61.0	54.9	CH	1-32	100	--	--
48.2	51.1	68.5	71.4	68.8	CH	--	--	--	10.4
46.3	49.0	59.9	70.4	70.4	CH	--	--	--	9.0
60.3	61.5	52.8	64.3	61.5	CH	--	--	--	11.5
37.0	216.8	43.0	35.5	23.5	CH	0.5	50	--	15.7
39.8	232.4	31.1	26.1	22.0	OH			--	12.1

Site Location and No.	Sta	Terrain Type*	No.	Terrain Description	Vegetation [illegible] >1-in. Diam	>.5-in. Diam	[illegible]
Bayou du Large, La., Site 1**	0+00 to 1+02	1,3a(1)-1,3,3,1-1[1]	1	Bayou marsh	--	--	-
	1+02 to 5+41	1,3b(1)-1,3,3,1-1[1]	2	Bayou marsh	--	--	-
	5+41 to 7+42	1,3a(1)-1,3,3,1-1[1]	1	Bayou marsh	--	--	-
	7+42 to 8+55	1,3b(1)-1,3,3,1-1[2]	3	Bayou marsh	--	--	-
	8+55 to 9+23	1,3b(1)-1,3,3,1-2[2]	4	Bayou marsh	--	--	-
	9+23 to 13+27	1d,2d,3d,4d-3/1,3,3-2[2]	5	Bayou	>25	>25	>
	13+27 to 15+49	1,3b(1)-1,3,3,1-3[2]	6	Bayou marsh	--	--	-
	15+49 to 16+60	1d,2d,3d,4d-2,2/3,3,3-1[1]	7	Depression	>25	>25	>
	16+60 to 19+50	1,3b(1)-1,3,3,1-1[1]	2	Bayou marsh	--	--	-
Bayou du Large, La., Site 2	0+00 to 0+77	1,3a(1)-1,3,3,1-2[2]	8	Drained marsh	--	--	-
	0+77 to 2+09	1,3b(1)-1,3,3,1-3[3]	9	Drained marsh	--	--	-
	2+09 to 2+52	1d,2d,3d,4d-1,3,3,1-4[5]	10	Natural levee	>25	>25	>
	2+52 to 4+52	1d,2d,3d,4d-1,3,3-3[2]	11	Bayou	>25	>25	>
	4+52 to 5+23	1,3a(1)-1,3,3,1-5[5]	12	Natural levee	--	--	-
	5+23 to 5+85	1,3b(1)-1,3,3,1-3[4]	13	Drained marsh	--	--	-
	5+85 to 7+45	1,3a(1)-1,3,3,1-3[4]	14	Drained marsh	--	--	-
Minors Canal, La., Site 3**	0+00 to 2+41	1,2b(1)-1,3,3,1-1[1]	15	Marsh flat	--	--	-
	2+41 to 5+10	1,3a(1)-1,3,3,1-1[2]	16	Marsh flat	--	--	-
	5+10 to 5+54	1,3b(1)-1,3,3,1-1[2]	3	Natural levee with spoil	--	--	-
	5+54 to 6+59	1d,2d,3d,4d-1,3,3-1[2]	17	Canal	>25	>25	>
	6+59 to 6+92	1,3a(1)-1,3,3,1-1[1-P]	18	Natural levee with spoil	--	--	-
	6+92 to 9+03	1,3b(1)-1,3,3,1-1[1-P]	19	Flotage	--	--	-
	9+03 to 10+26	1,3b(1)-1.3,3,1-1[1-P]	19	Flotage	--	--	-
Morgan Island, La., Site 4**	0+00 to 1+67	1d,2d,3d,4d-3,3,3-1[1]	20	River	>25	>25	>
	1+67 to 2+64	1,1a(1)-1,3,3,1-1[1]	21	Mud flat	--	--	-
	2+64 to 3+52	1a,2d,3d,4d-1,3,3,1-3[3]	22	Natural levee	2	>25	>
	3+52 to 5+17	1,1a(1)-1,3,3,1-1[1]	21	Mud flat	--	--	-
	5+17 to 6+43	1d,2d,3d,4d-1,3,3,1-1[1]	23	Mud flat	>25	>25	>
	6+43 to 7+55	1,3a(1)-1,3,3,1-1[1]	1	River marsh	>25	>25	>

* A terrain type is identified by an array of groups of class numbers or class number-letter combinations. In the array [illegible]
depth and plant descriptions); (b) surface geometry (step height, approach angle, obstacle spacing, and slope) or hydro[illegible]
sists of two numbers or one number and one number-letter combination, a hydrologic-vegetation association is indicated. [illegible]

For example, terrain type 1a,2a,3d,4d-1,3,3,1-4 represents the following factors and values: vegetation--1a (>1-in.-[illegible]
spaced >25 ft or lacking); surface geometry--1 (step height is <12 in.), 3 (approach angle is >150 deg), 3 (spacing val[illegible]

Where two numbers with a slant line between appear in the approach angle factor of terrain geometry, this indicates th[illegible]

The numbers in brackets refer to a class range of surface composition that was used to identify terrain types along th[illegible]

Fine-Grained RCI 3- to 9-[illegible] Class	[illegible]
[1]	
[2]	
[3]	
[4]	
[5]	

** Bayou du Large, site 1, Minors Canal, and Morgan Island were used in the XM759 test program.[6] The terrain types in t[illegible]

[illegible]

[illegible]	[illegible]	Stem Diam in.	[illegible]	[illegible]	Water Depth ft	[illegible]	Approach Angle deg	Lateral Spacing ft	Slope deg	CI 6-12	RCI 0-6	CI 0-6	Approach Angle deg	Depth ft	Width ft	Vegetation Type
	--	[illegible]	[illegible]		[illegible]	<12	>150	>150	<1.5	10	5	[illegible]	--	--	--	Marsh grass
	--	[illegible]	[illegible]		[illegible]	<12	>150	>150	<1.5	5	1	3	--	--	--	Marsh grass
	--	[illegible]	[illegible]		[illegible]	<12	>150	>150	<1.5	11	[illegible]	12	--	--	--	Marsh grass
	--	[illegible]	[illegible]		[illegible]	<12	>150	>150	<1.5	13	[illegible]	15	--	--	--	Coastal Bermuda grass
	--	[illegible]	[illegible]		0.5	<12	>150	>150	<1.5	15	[illegible]	12	--	--	--	Sea oxeye
[illegible]	>[illegible]	--	--	--	--	--	--	--	--	21	[illegible]	12	176/112	11.0	404	None
	--	[illegible]	100	[illegible]	0.5	<12	>150	>150	<1.5	32	14	20	--	--	--	Coastal Bermuda grass
[illegible]	>[illegible]	--	--	--	12	<12	149/107	>150	<1.5	[illegible]	2	4	--	-	--	None
	--	[illegible]	[illegible]		0.5	<12	>150	>150	<1.5	[illegible]	5	12	--	--	--	Marsh grass
	--	[illegible]	[illegible]	4	1.5	<12	>150	>150	<1.5	17	9	15	--	--	--	Marsh grass
	--	14	[illegible]0	2	0.5	<12	>150	>150	<1.5	42	17	32	--	--	--	Coastal Bermuda grass
[illegible]	>[illegible]	--	--	--	--	<12	>150	>150	<1.5	95	110	134	--	--	--	Barren
[illegible]	>[illegible]	--	--	--	--	--	--	--	--	35	12	22	<150	6.0	200	None
	--	120	[illegible]0	[illegible]	--	<12	>150	>150	<1.5	137	150	180	--	--	--	Scrub brush and Bermuda grass
	--	[illegible]	[illegible]	9	--	<12	>150	>150	<1.5	90	38	55	--	--	--	Coastal Bermuda grass
	--	40	[illegible]	[illegible]	--	<12	>150	>150	<1.5	41	15	31	--	--	--	Marsh grass
	--	[illegible]	100	[illegible]	[illegible]	<12	>150	>150	<1.5	3	--	3	--	--	--	Water lilies
	--	72	50	[illegible]	--	<12	>150	>150	<1.5	10	4	8	--	--	--	Reed cane and marsh grass
	--	12	[illegible]	--	--	<12	>150	>150	<1.5	9	6	11	--	--	--	Marsh grass
[illegible]	>[illegible]	--	--	--	--	--	--	--	--	15	6	11	148/145	7.0	103	None
	--	[illegible]	[illegible]	[illegible]	--	<12	>150	>150	<1.5	11	7	11	--	--	--	Reed cane
	--	[illegible]	[illegible]	--	--	<12	>150	>150	<1.5	10	6	10	--	--	--	Various marsh grasses
	--	[illegible]	[illegible]	--	--	<12	>150	>150	<1.5	10	5	9	--	--	--	Various marsh grasses and scrub
[illegible]	>[illegible]	--	--	--	24 (avg)	--	--	--	--	4	2	3	176	35.0	>60	None
	--	38	0	[illegible]	--	<12	>150	>150	<1.5	7	3	5	--	--	--	Dead water lilies
[illegible]	>[illegible]	--	--	--	--	<12	>150	>150	<1.5	29	16	27	--	--	--	Willows, 25 ft tall, 2-in. diam
	--	37	[illegible]0	[illegible]	--	<12	>150	>150	<1.5	5	1	2	--	--	--	Dead water lilies
[illegible]	>2[illegible]	--	--	--	0.5	<12	>150	>150	<1.5	4	1	2	--	--	--	None
[illegible]	>2[illegible]	[illegible]	75	[illegible]	--	<12	>150	>150	<1.5	6	2	4	--	--	--	Dead water lilies and small will[illegible]

[illegible] each group or factor family is shown in the following order: (a) vegetation (stem diameter and stem spacing) or hydrologic-vegetation association (water [illegible] [illegible]logic geometry (approach angle, water depth, and channel width); and (c) surface composition (soil mass strength). In the array, where the first group co[illegible] Where the second group consists of three numbers, a hydrologic geometry is indicated. (See Appendix A for individual classes used for each factor famil[illegible]

[illegible]diam stems spaced 0-8 ft apart), 2a (>0.5-in.-diam stems spaced 0-8 ft apart), 3d (>6.5-in.-diam stems spaced >25 ft or lacking), 4d (>8.5-in.-diam stems [illegible] [illegible]ue of >150 ft), and 1 (slope is <1.5 deg); surface composition--4 (cone index <1-100).

[illegible]at the approach angle on one side of the terrain type is in a different class range from the approach angle on the other side.

[illegible]e mobility test courses. The class ranges for different types of surface materials are given below:

[illegible]d Soil [illegible]n. Depth	Organic [illegible] Soil CI 0- to 6-in. Depth		Clean Sand CI 0- to 6-in. Depth	
CI Range	Class	CI Range	Class	CI Range
0-6	[illegible]	0-35	[illegible]	...<50
7-15	[illegible]	[illegible]-50	[illegible]	51-100
16-30	[illegible]	[illegible]0	[illegible]	101-150
31-50				
>50				

[illegible]he [illegible] program were generally the same as in the RMC program; however, the length of the test courses in the RMC program was increased at all three sites[illegible]

[illegible]

[illegible]	[illegible]	Step [illegible]	Approach Angle deg	Obstacle Spacing ft	Slope deg	CI 6-12	CI 0-6	RCI 0-6	Approach Angle deg	Depth ft	Width ft	Vegetation Type
			Surface Geometry			Surface Composition	Critical Layer		Hydrologic Geometry			
[illegible]	[illegible]	<12	>150	>150	<1.5	10	[illegible]	[illegible]	--	--	--	Marsh grass
[illegible]	[illegible]	<12	>150	>150	<1.5	5	1	3	--	--	--	Marsh grass
	[illegible]	<12	>150	>150	<1.	11	4	12	--	--	--	Marsh grass
	[illegible]	<12	[illegible]	>150	<1.5	13	7	15	--	--	--	Coastal Bermuda grass
	[illegible]	<12	>150	>150	<1.5	14	8	12	--	--	--	Sea oxeye
--	--	--	--	--	--	20	[illegible]	12	1[illegible]/112	11.0	404	None
[illegible]	[illegible]	<12	>150	>150	<1.5	32	14	22	--	--	--	Coastal Bermuda grass
--	[illegible]	<12	140/1[illegible]	>150	<1.5	7	2	4	--	--	--	None
[illegible]	[illegible]	<12	>150	>150	<1.5	[illegible]	5	12	--	--	--	Marsh grass
[illegible]	[illegible]	<12	>150	>150	<1.5	17	9	15	--	--	--	Marsh grass
[illegible]	[illegible]	<12	>150	>150	<1.5	42	17	32	--	--	--	Coastal Bermuda grass
--	--	<12	>150	>150	<1.5	96	110	134	--	--	--	Barren
--	--	--	--	--	--	55	12	22	<150	6.0	200	None
[illegible]	--	<12	>150	>150	<1.5	1[illegible]7	140	180	--	--	--	Scrub brush and Bermuda grass
[illegible]	--	<12	>150	>150	<1.5	[illegible]	35	55	--	--	--	Coastal Bermuda grass
[illegible]		<12	>150	>150	<1.5	41	35	51	--	--	--	Marsh grass
[illegible]	[illegible]	<12	[illegible]	>150	<1.5	3	--	3	--	--	--	Water lilies
	--	<12	>150	>150	<1.5	10	4	[illegible]	--	--	--	Reed cane and marsh grass
--	--	<12	>150	>150	<1.5	[illegible]	[illegible]	11	--	--	--	Marsh grass
--	--	--	--	--	--	15	6	11	145/145	7.0	103	None
[illegible]	--	<12	>150	>150	<1.5	11	7	11	--	--	--	Reed cane
--	--	<12	>150	>150	<1.5	10	[illegible]	10	--	--	--	Various marsh grasses
--	--	<12	>150	>150	<1.5	10	5	[illegible]	--	--	--	Various [illegible] grasses and scrub brush
--	[illegible]	--	--	--	--	[illegible]	2	3	17[illegible]	35.0	>60	None
[illegible]	--	<12	>150	>150	<1.5	[illegible]	[illegible]	[illegible]	--	--	--	Dead water lilies
--	--	<12	>150	>150	<1.5	25	16	27	--	--	--	Willows, 25 ft tall, 2-in. diam (avg)
[illegible]	--	<12	>150	>150	<1.5	5	1	2	--	--	--	Dead water lilies
--	0.[illegible]	<12	>150	>150	<1.5	4	3	2	--	--	--	None
	--	<12	>150	>150	<1.5	[illegible]	2	4	--	--	--	Dead water lilies and small willows

[illegible] in the following order: (a) vegetation (stem diameter and stem spacing) or hydrologic-vegetation association (water [illegible], water depth, and channel width); and (c) surface composition (soil mass strength). In the array, where the first group consists of three numbers, [illegible] hydrologic geometry is indicated. (See Appendix A for individual classes used for each factor family.)

[illegible]), 2a ([illegible]-in.-diam stems spaced 0-[illegible] ft apart), 3a (>[illegible].5-in.-diam stems spaced >25 ft or lacking), 4d (>8.[illegible]-in.-diam stems [illegible] <1.[illegible] deg): surface composition [illegible] (cone index [illegible]1-100).

[illegible] is in a different class range from the approach angle on the other side.

[illegible] types of surface materials are given below:

[illegible]	[illegible] Class	[illegible] Range
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	51-100
	[illegible]	101-150

[illegible] program; however, the length of the test courses in the [illegible] program was increased at all three sites.

[illegible]

[illegible]

Sta	Terrain Type	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Maximum Speed, knots											
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.1	11.0	10.1	10.1	13.4	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13.0	[illegible]	13.8	[illegible]	13.9	[illegible]
[illegible]		--	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.3	[illegible]	10.3	13.8	16.3	15.3
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.[illegible]	13.1	[illegible]	11.4	13.9	15.9	15.9
[illegible]		[illegible]	[illegible]	[illegible]	11.3	10.1	[illegible]	11.5	10.1	11.8	10.1	13.4	10.2
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	11.[illegible]	[illegible]	13.3	10.0	14.[illegible]	13.[illegible]	14.5	11.4
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.4	[illegible]	13.[illegible]	[illegible]	13.2	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.0	10.1	11.[illegible]	11.[illegible]	9.[illegible]	10.1
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.0	[illegible]	12.[illegible]	10.5	11.6	11.8
Avg test course speed (sta [illegible])		[illegible]	[illegible]	[illegible]	10.[illegible]	[illegible]	11.1	12.4	10.5	13.4	11.9	13.4	[illegible]

[illegible], La., Site [illegible], Mobility Test Course

Pass No.→		1	2	3	4	5	6
Starting Point, Sta→		[illegible]	7+85	[illegible]	7+85	[illegible]	7+85
Sta	Terrain Type	Maximum Speed, knots					
[illegible] to [illegible]+77	[illegible]	[illegible].6	6.1	[illegible].7	[illegible].7	5.7	7.6
[illegible]+77 to [illegible]	[illegible]	7.6	7.1	6.5	7.4	7.1	11.2
[illegible] to [illegible]	1[illegible]	[illegible]	3.2	3.6	6.[illegible]	[illegible]	6.4
[illegible] to [illegible]	11	7.3	[illegible].7	5.8	[illegible]	[illegible].5	6.0
[illegible] to [illegible]	1[illegible]	1.6	3.0	3.0	3.0	7.8	2.6
[illegible] to [illegible]	1[illegible]	[illegible].5	[illegible].4	4.6	[illegible].0	4.7	4.6
[illegible] to 7+85	14	7.2	7.4	7.9	7.9	8.5	7.9
Avg test course speed (sta [illegible] to 7+85)		[illegible].9	4.8	5.5	5.4	5.8	6.1

Minors Canal, La., Site 3, Mobility Test Course

Pass No.→		1	2	3	4	5	6
Starting Point, Sta→		[illegible]	10+26	0+00	10+26	0+00	10+26
Sta	Terrain Type	Maximum Speed, knots					
[illegible] to [illegible]+61	[illegible]	11.9	12.9	12.9	12.9	15.2	13.2
[illegible]+61 to [illegible]+10	1[illegible]	[illegible].5	10.6	13.4	16.0	16.4	16.0
[illegible]+10 to [illegible]	3	[illegible].9	7.7	13.0	10.9	13.0	10.9
[illegible] to [illegible]	17	7.[illegible]	6.2	9.9	10.0	11.3	10.0
[illegible] to [illegible]	[illegible]	[illegible]	7.5	6.9	8.1	9.8	5.1
[illegible] to [illegible]	1[illegible]	9.6	13.2	12.5	15.6	15.6	13.9
[illegible] to 10+26	1[illegible]	[illegible]	14.6	13.5	14.6	14.6	13.5
Avg test course speed* (sta [illegible] to [illegible])		7.4	11.3	12.4	13.4	14.6	13.1

Morgan Island, La., Site 4, Mobility Test Course

Pass No.→		1	2	3	4	5	6
Starting Point, Sta→		0+00	7+55	0+00	7+55	0+00	7+55
Sta	Terrain Type	Maximum Speed, knots					
[illegible] to 1+67	[illegible]	16.5	14.1	12.4	14.1	13.2	13.[illegible]
1+67 to [illegible]	[illegible]	19.2	10.1	13.4	9.1	14.4	11.6
[illegible]		5.9	16.5**	[illegible]	10.2	6.5	13.[illegible]
[illegible] to 5+17	[illegible]	19.5	16.8	19.5	19.5	19.5	18.6
5+17 to 6+4[illegible]	[illegible]	16.7	16.7	16.6	16.6	13.6	13.3
6+4[illegible] to 7+55	[illegible]	22.1	16.6	16.6	16.6	13.6	13.3
Avg test course speed (sta [illegible] to 7+55)		[illegible]	15.[illegible]**	[illegible].8	14.0	13.4	14.9

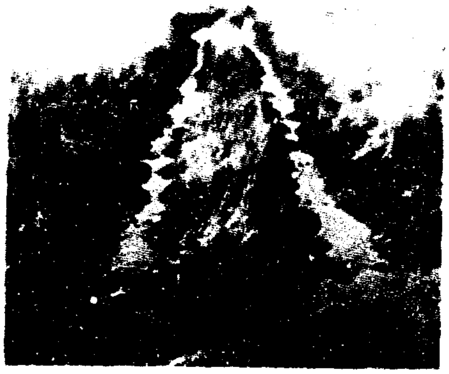
* Speeds on passes 1A and 1B were considered to be unsafe because the driver's vision was obscured by mud and debris on the windshield. Therefore, pass 1C is considered as the first pass. Passes 1A, 1B, and 1C were conducted on undisturbed terrain.

** Speed considered to be unsafe to vehicle and operator because of thick vegetation stand.

LEGEND FOR VEGETATION SYMBOLS

(for plates 1-4)

	Trees or scrub vegetation
	Reed, cane, or cattails
	Water hyacinths or water lilies
	Sea oxeye
	Grasses (wire, needle, broomstraw, marsh, or coastal Bermuda)



Site 1. Looking from sta 1+00 to 0+00

Site 1. Looking from sta 5+40 to 1+00

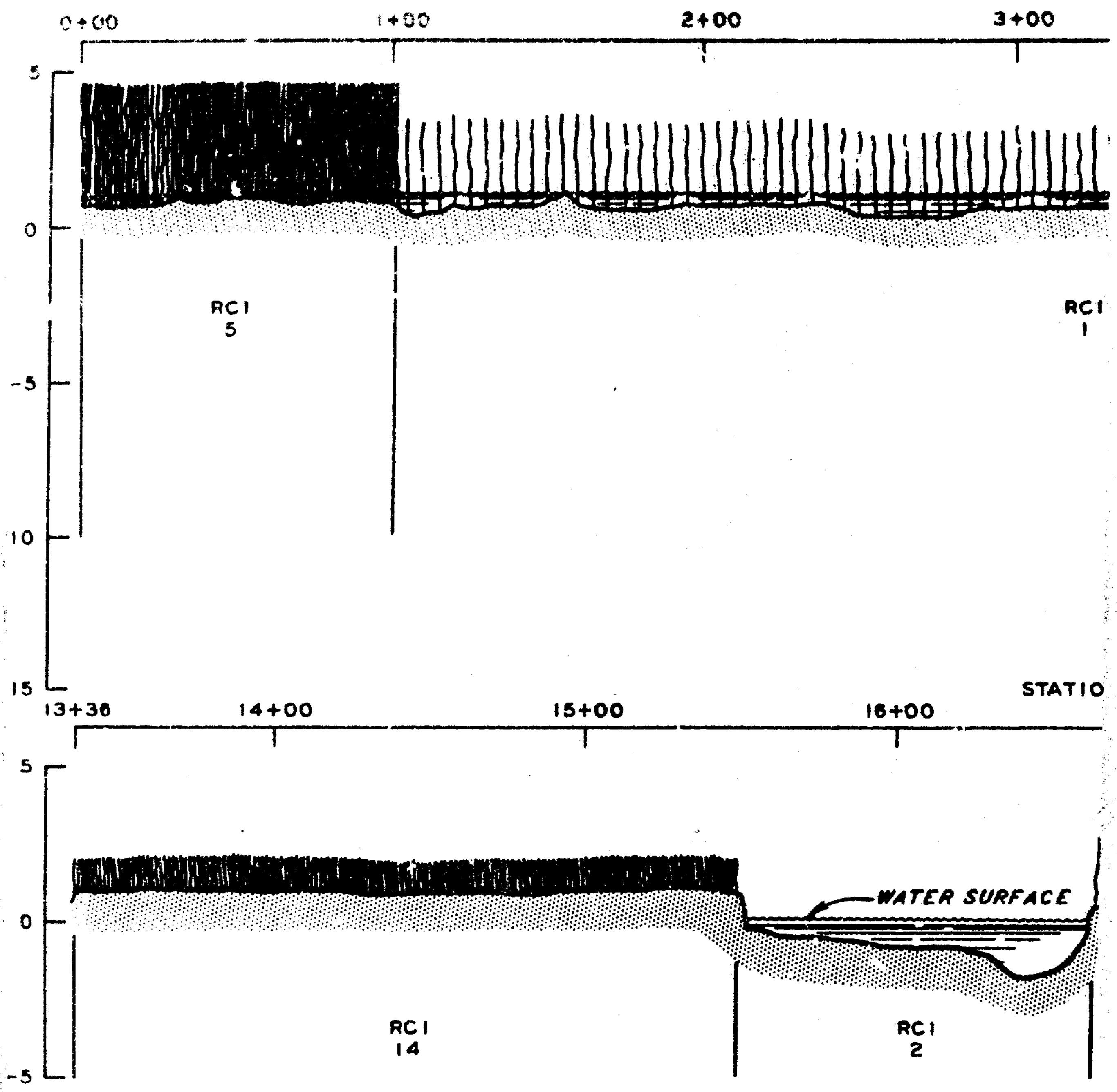
Site 1. Looking from sta 0+00 to 5+40

Site 1. Looking across Bayou du Large (sta 13+50 to 9+25)

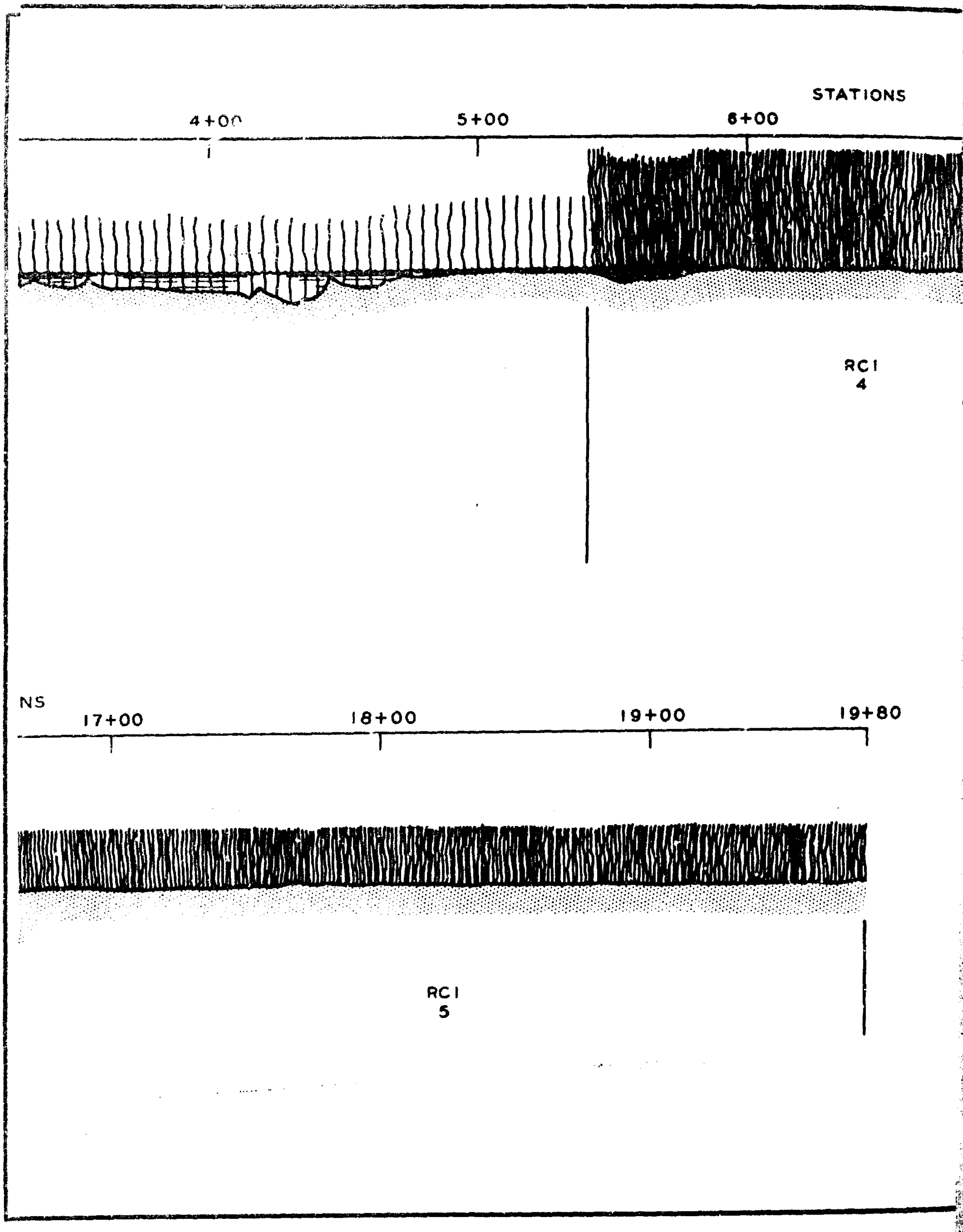
Site 1. Looking from sta 16+65 to 13+50

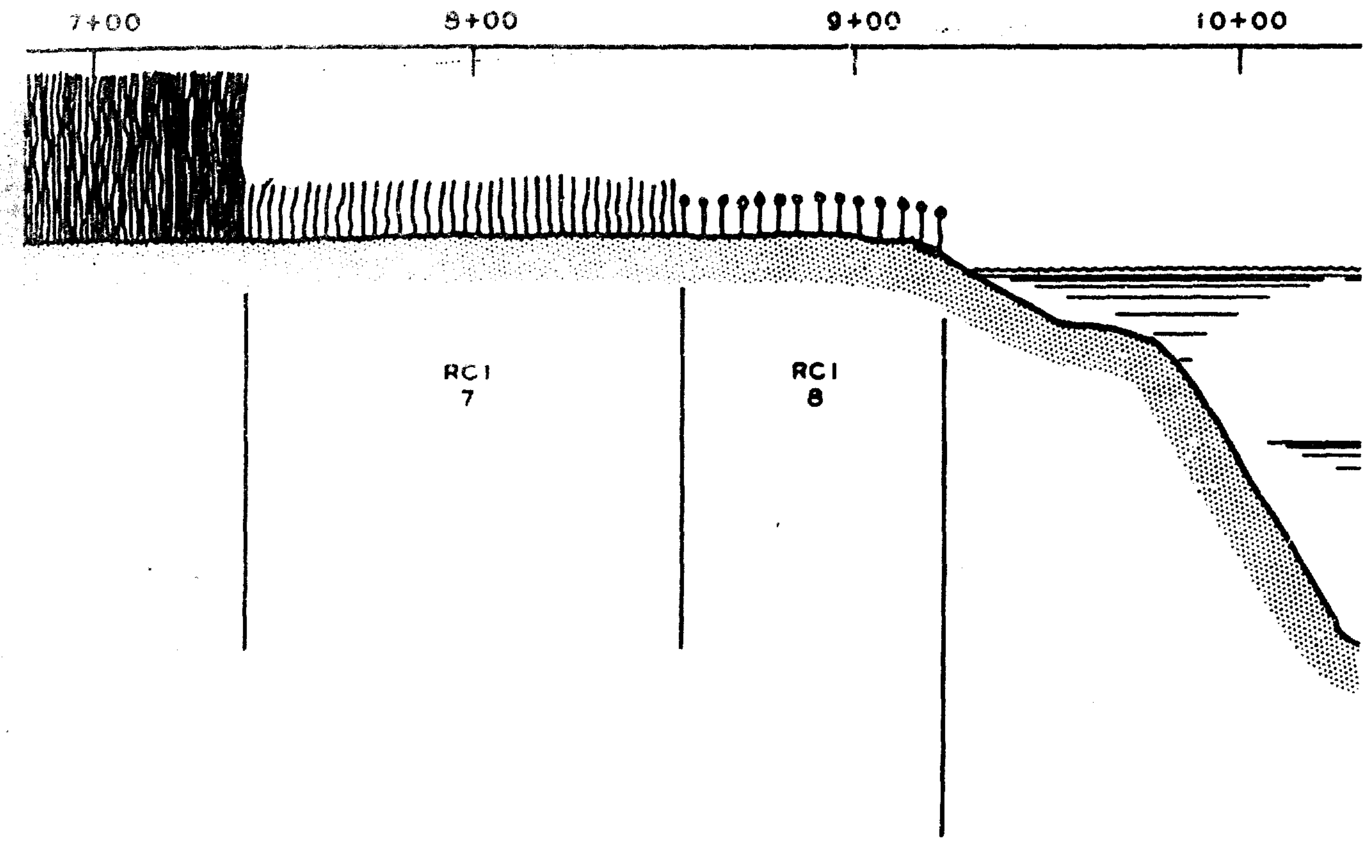
Site 1. Looking from sta 19+80 to 16+65

ELEVATION REFERRED TO WATER SURFACE, FT

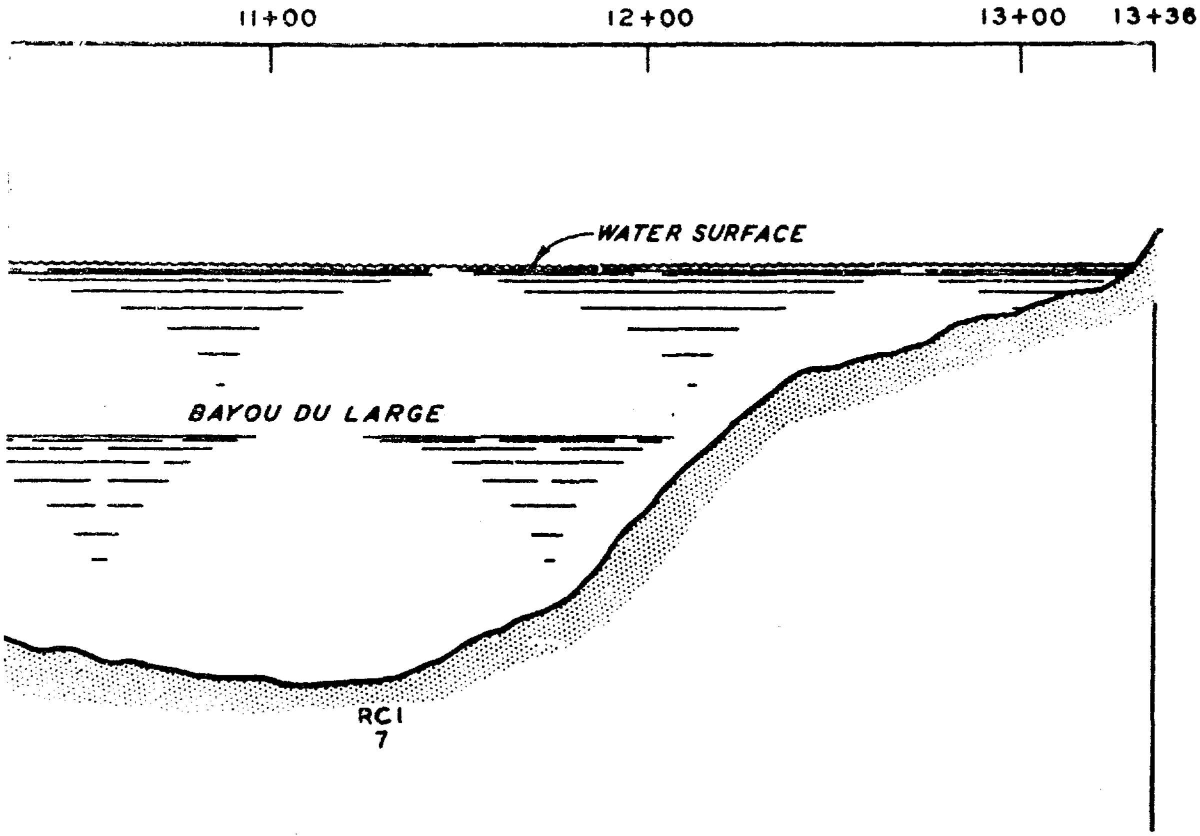


0+00
1+00
2+00
3+00
5
0
-5
10
15
RC1
5
RC1
1
STATIO
13+38
14+00
15+00
16+00
5
0
-5
WATER SURFACE
RC1
14
RC1
2

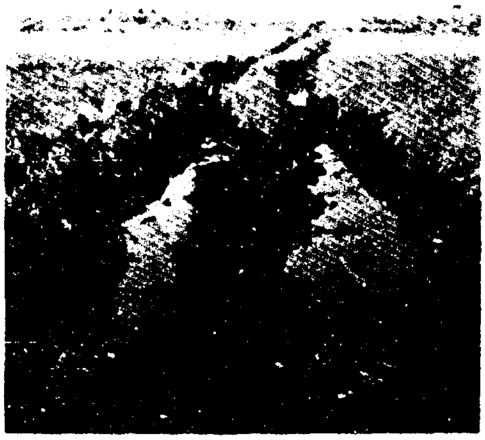

STATIONS
4+00
5+00
6+00
RCI
4
NS
17+00
18+00
19+00
19+80
RCI
5



7+00
8+00
9+00
10+00
RC1
7
RC1
8



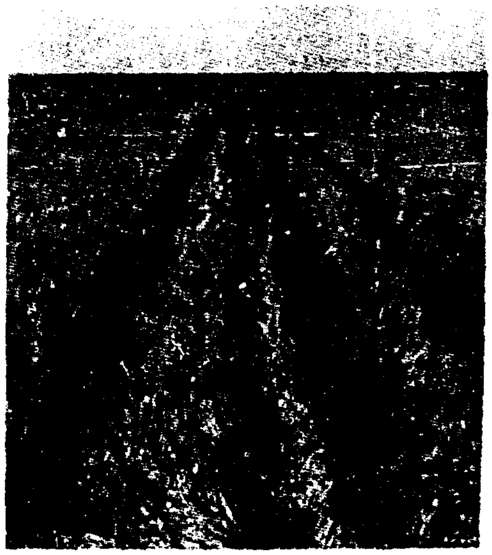
MOBILITY TEST COURSE
VIEWS AND PROFILE
BAYOU DU LARGE, LA.
SITE 1



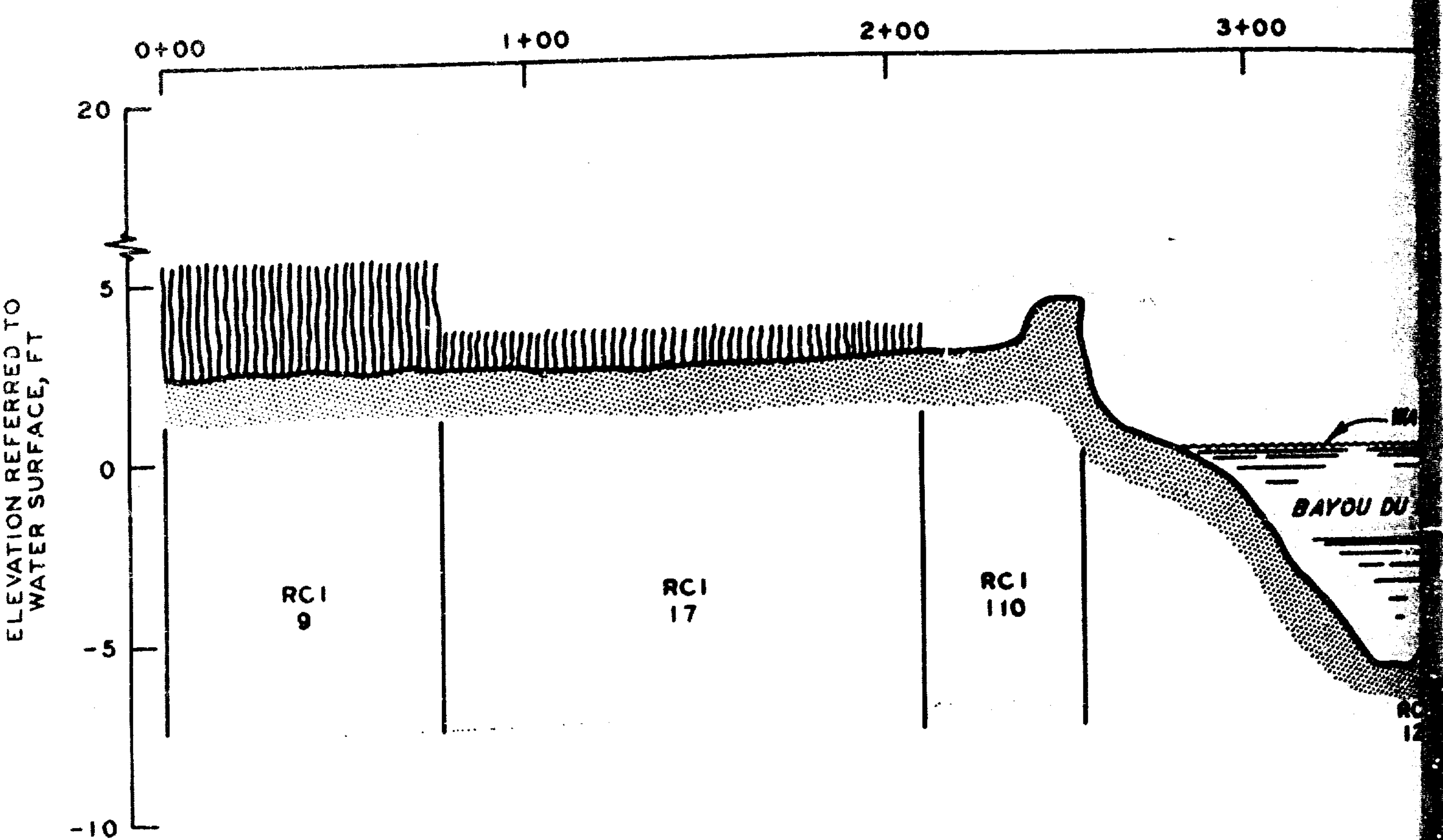
Site 2. Looking from
sta 0+00 to 1+00

Site 2. Looking from
sta 1+00 to 4+00

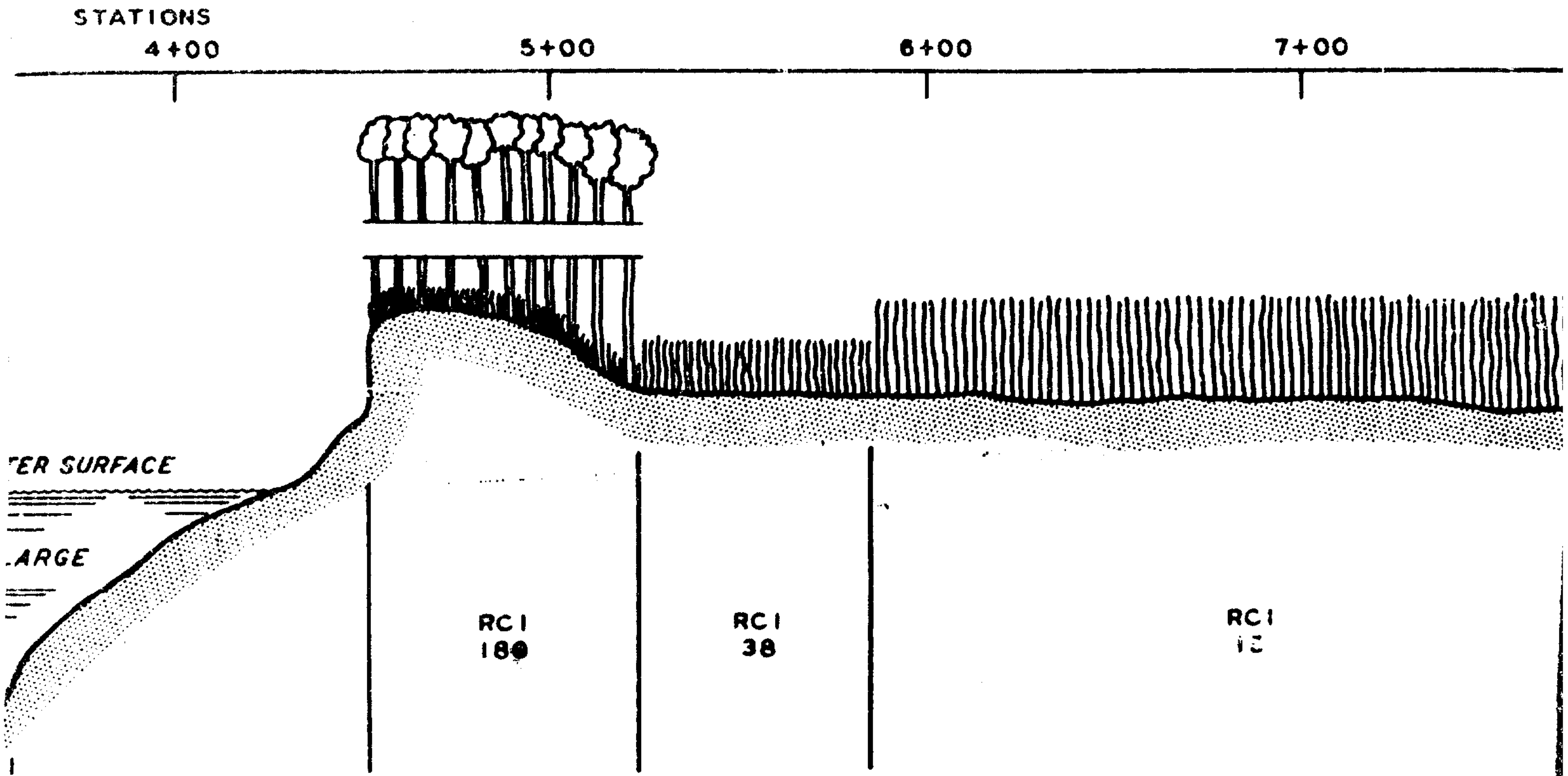
Site 2. Looking from
sta 4+00 to 6+00



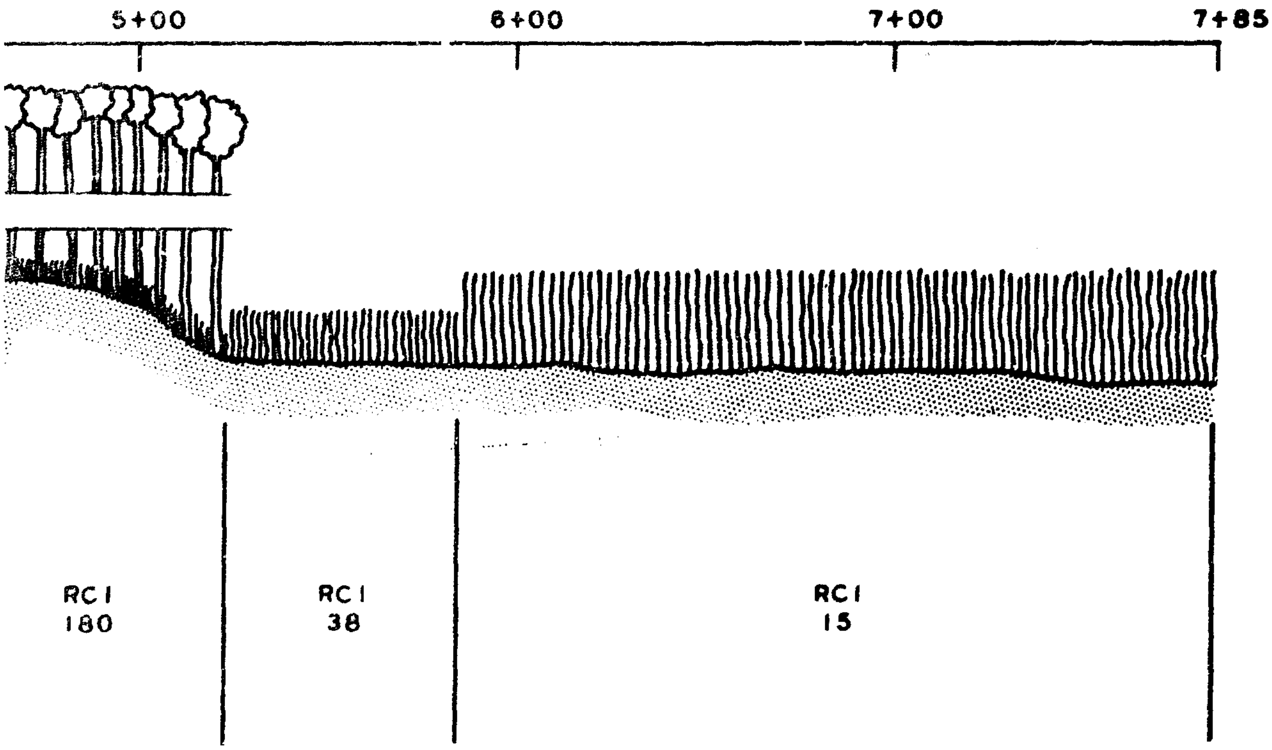
Site 2. Looking from
sta 6+00 to 7+85



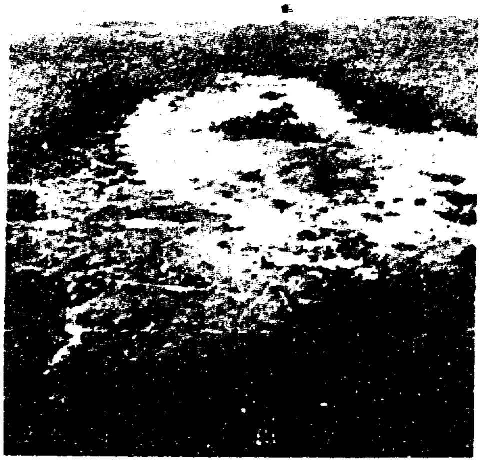
0+00
1+00
2+00
3+00
20
5
0
-5
-10
ELEVATION REFERRED TO WATER SURFACE, FT
RCI 9
RCI 17
RCI 110
BAYOU DU



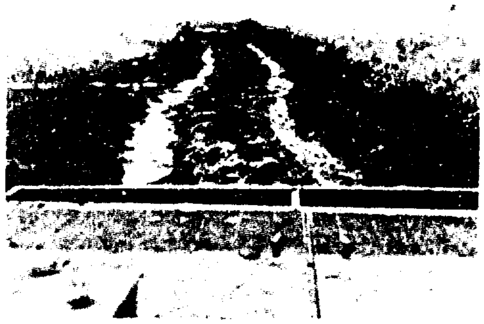
MOBILITY TES
VIEWS AND P
BAYOU DU LA
SITE



MOBILITY TEST COURSE
VIEWS AND PROFILE
BAYOU DU LARGE, LA.
SITE 2



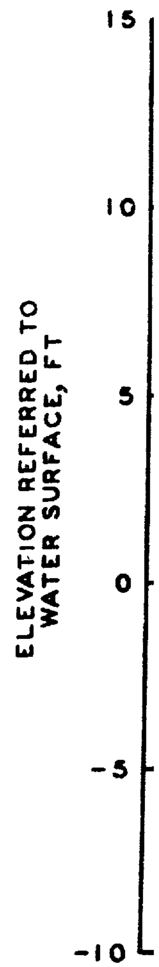
Site 1. Looking from sta 2+60 to 0+00

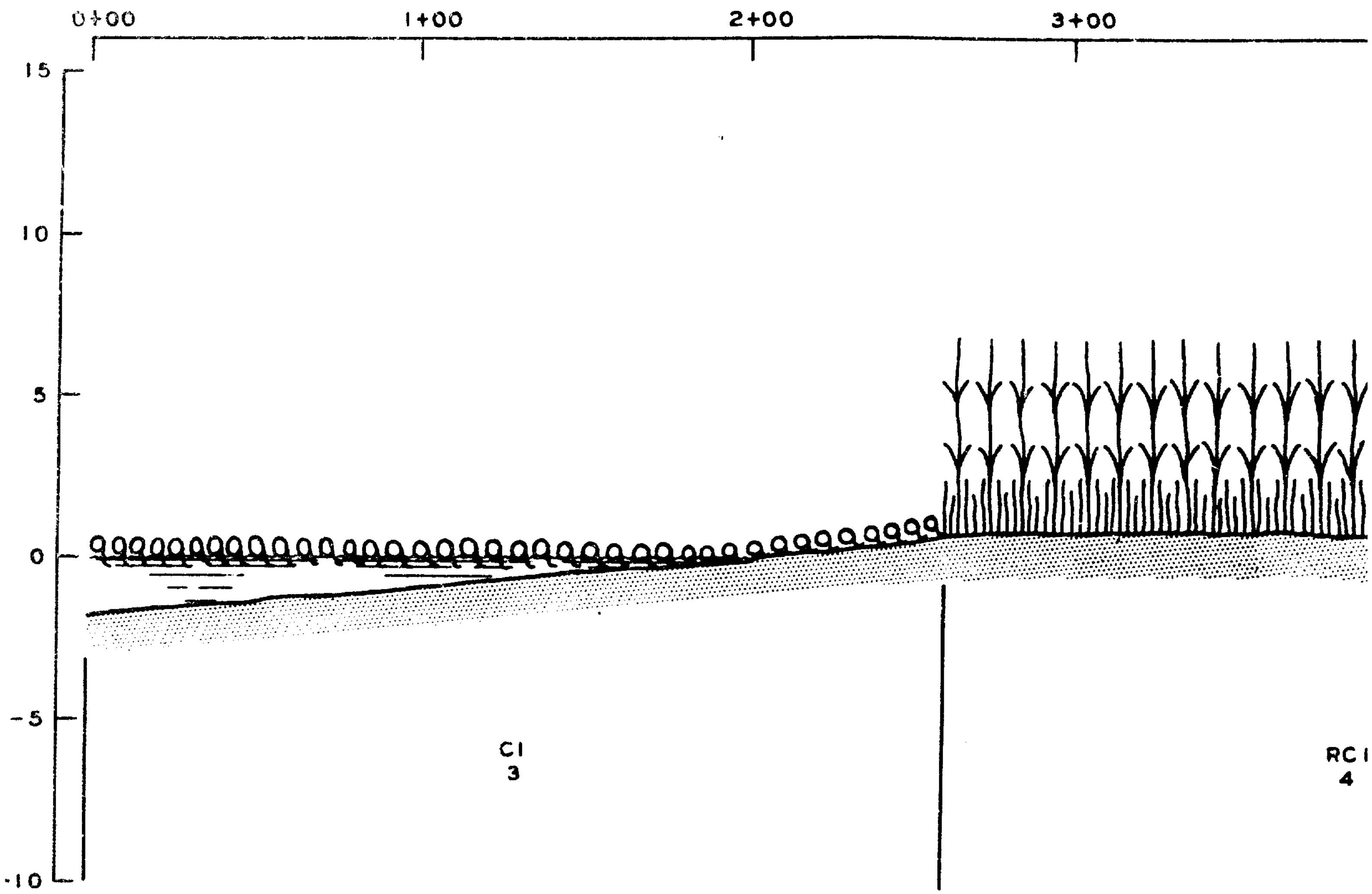


Site 1. Looking from sta 5+25 to 2+60

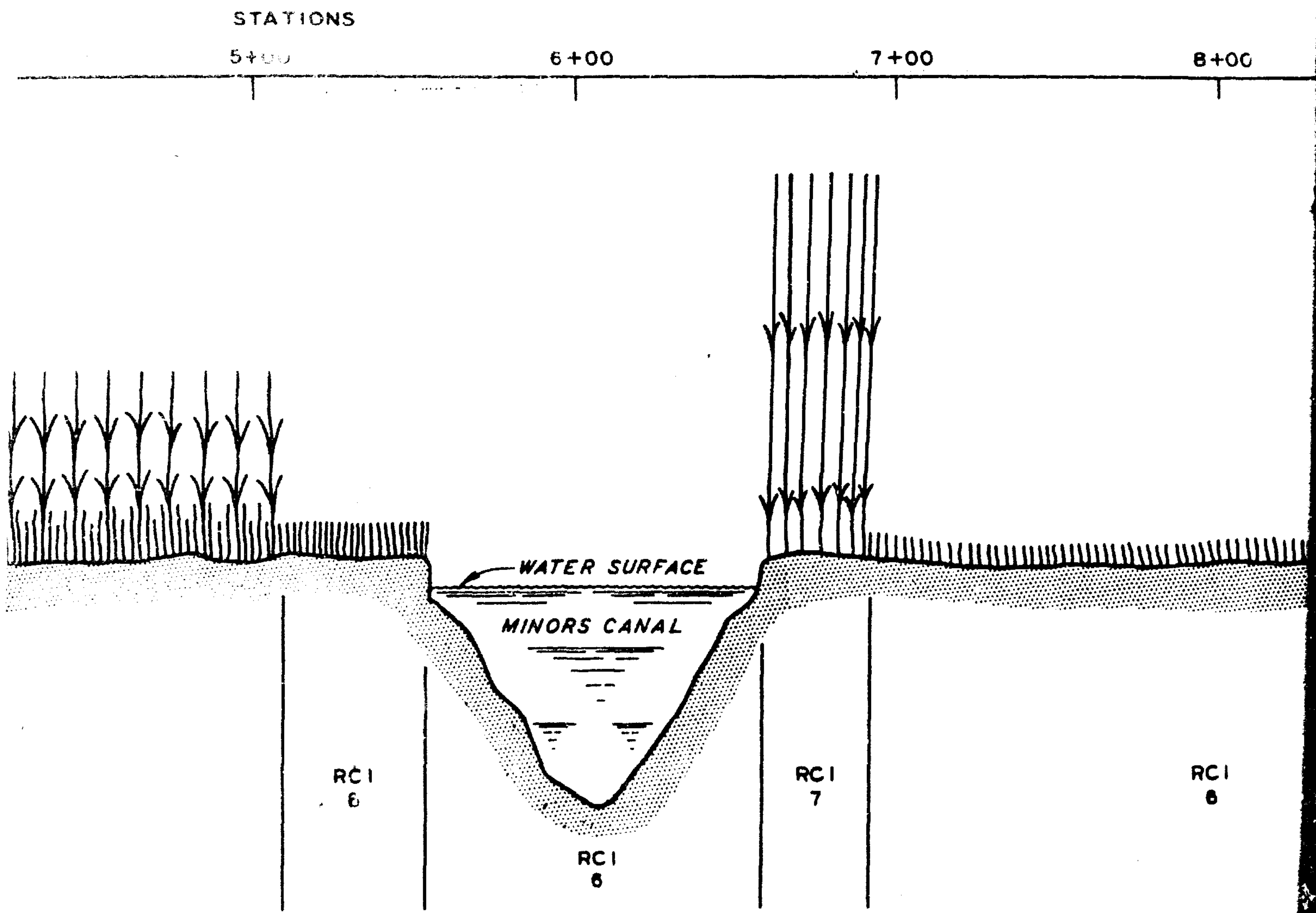
Site 1. Looking across Minors Canal from sta 7+00 to 5+25

Site 1. Looking from sta 10+26 to 7+00

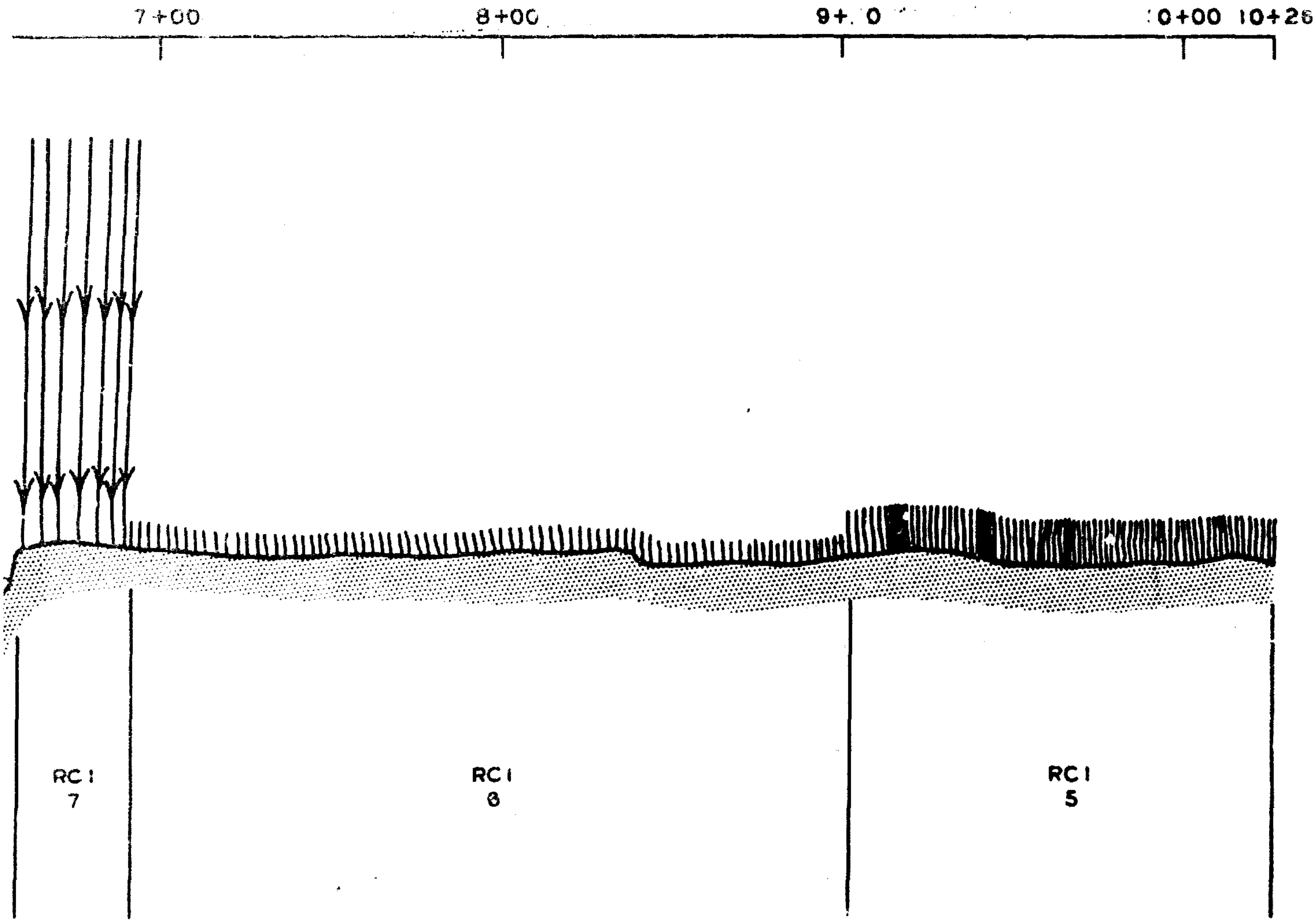




0+00
1+00
2+00
3+00
15
10
5
0
-5
-10
C1
3
RC1
4



STATIONS
5+00
6+00
7+00
8+00
WATER SURFACE
MINORS CANAL
RC I 6
RC I 6
RC I 7
RC I 8

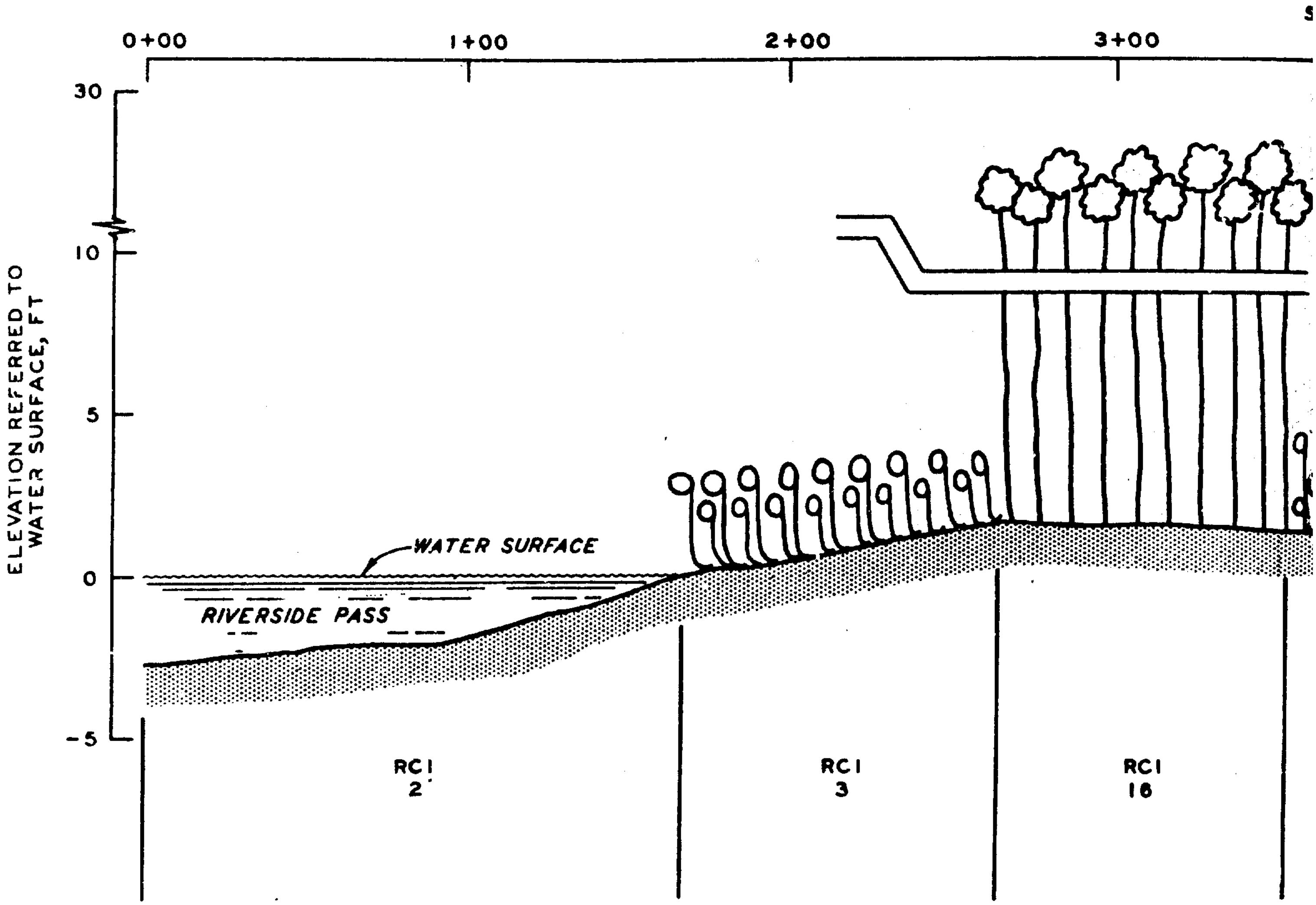


MOBILITY TEST COURSE
VIEWS AND PROFILE
MINORS CANAL, LA.
SITE 3

Site 1. Looking from
sta 0+00 to 2+60

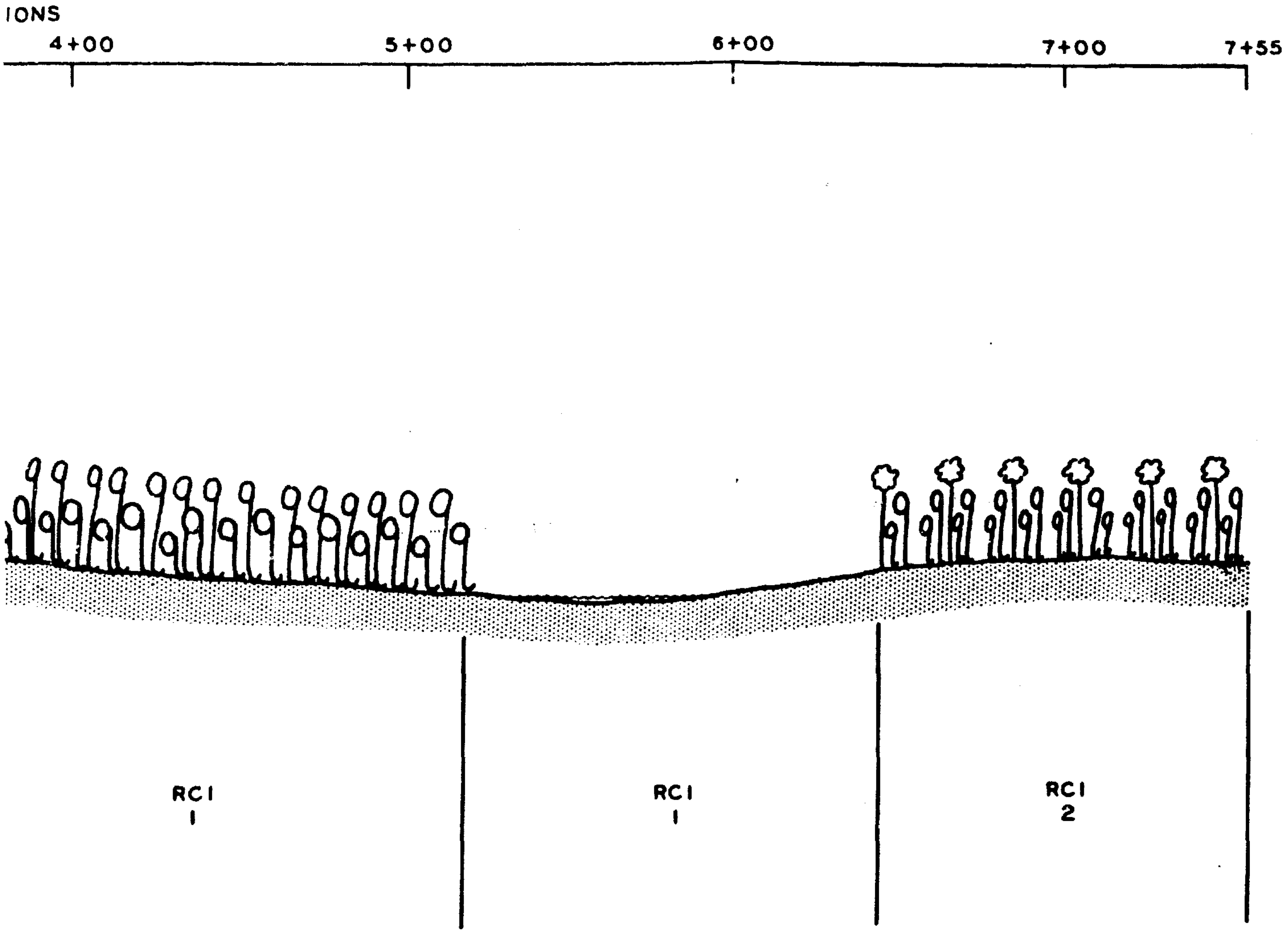
Site 1. Looking from
sta 2+60 to 3+55

Site 1. Looking from
sta 3+55 to 7+55.



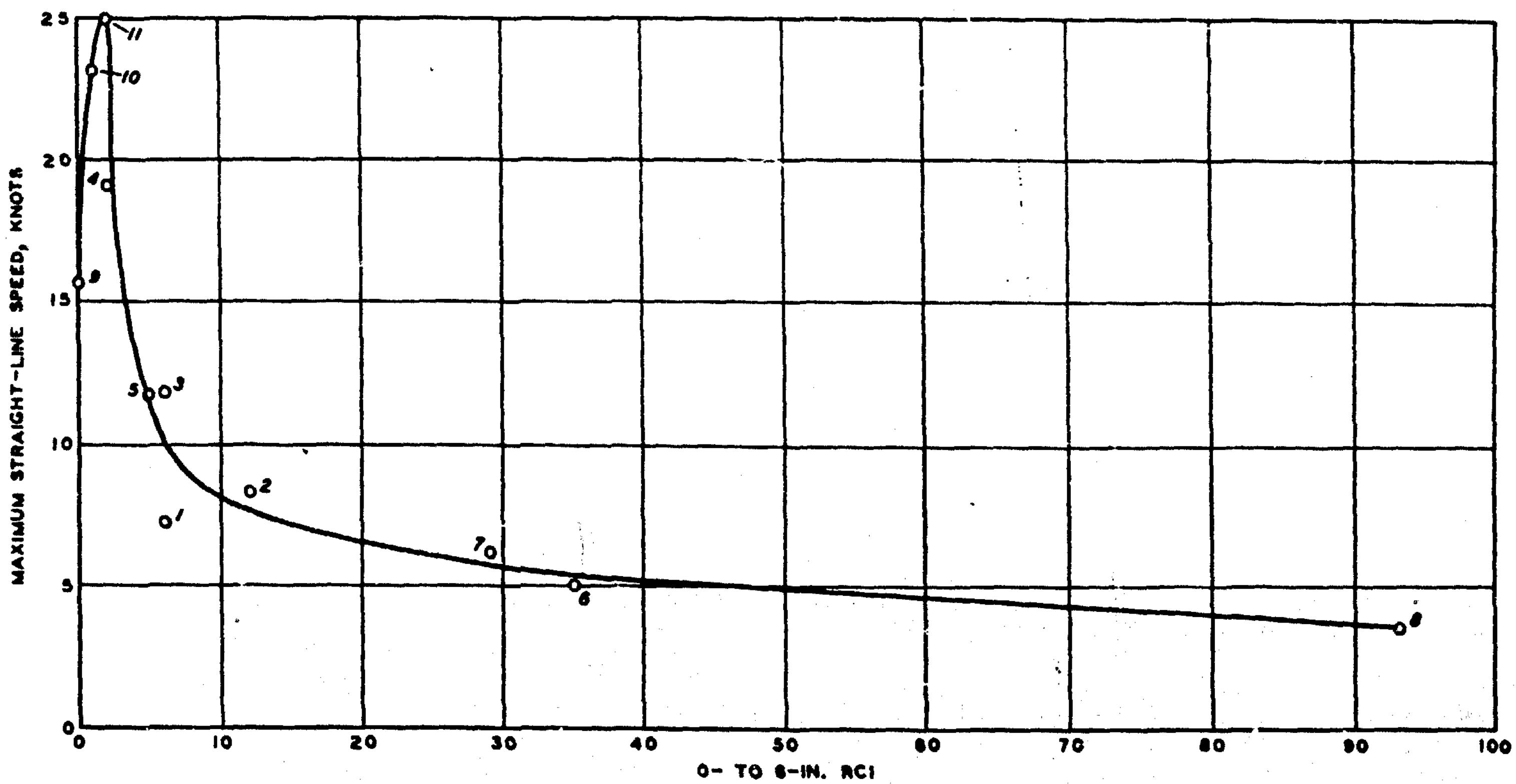
0+00
1+00
2+00
3+00
30
10
5
0
-5
ELEVATION REFERRED TO WATER SURFACE, FT
WATER SURFACE
RIVERSIDE PASS
RCI 2
RCI 3
RCI 16

B



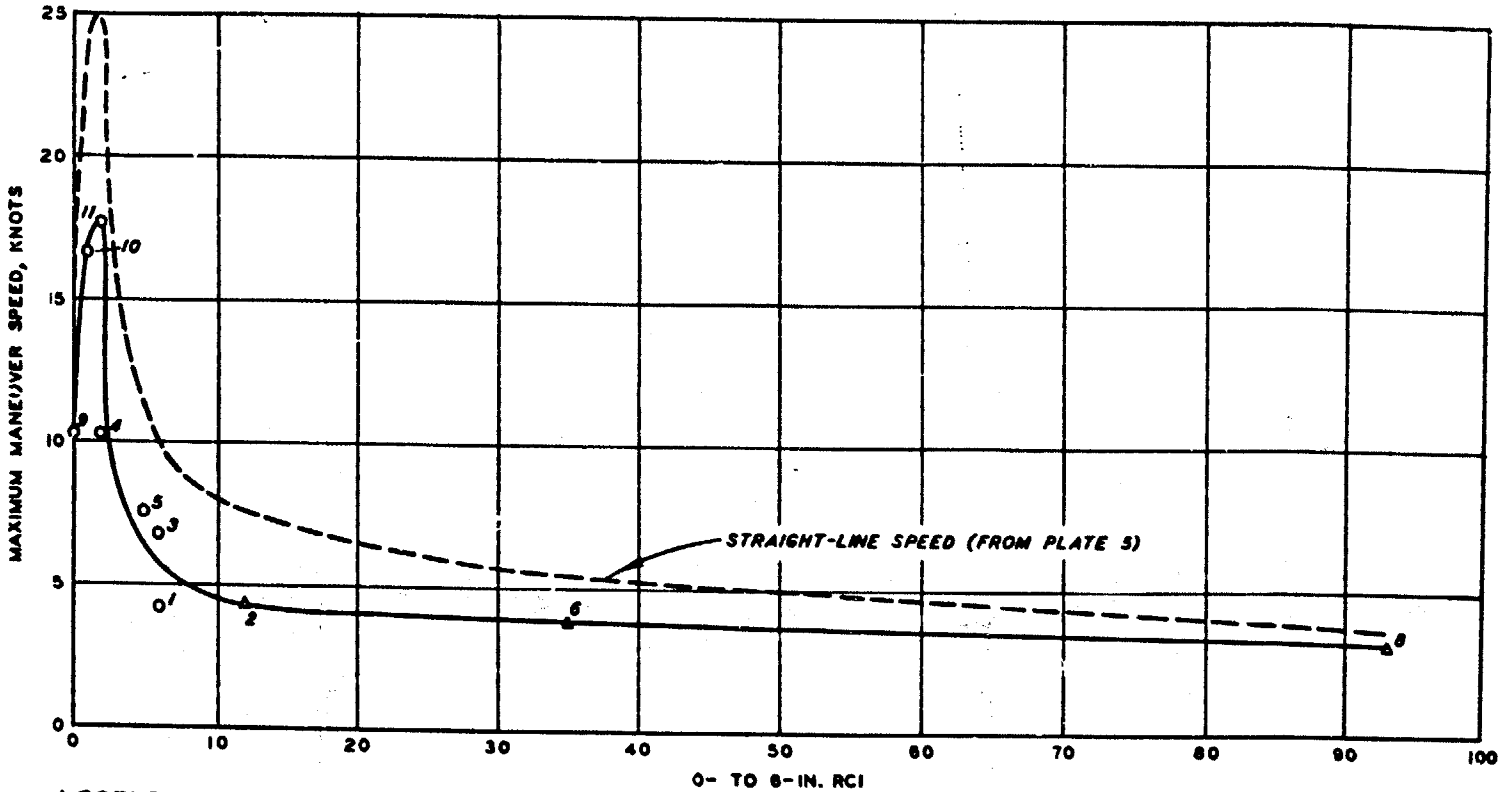
MOBILITY TEST COURSE
VIEWS AND PROFILE
MORGAN ISLAND, LA.
SITE 4

PLATE 4



NOTE: TEST 9 INDICATES MAXIMUM SPEED IN WATER.
RCI DATA ARE FROM TABLE 1.
SPEED DATA ARE FROM TABLE 2.
NUMBERS BESIDE PLOTTED POINTS ARE TEST NUMBERS.

MAXIMUM STRAIGHT-LINE SPEED VS SOIL STRENGTH



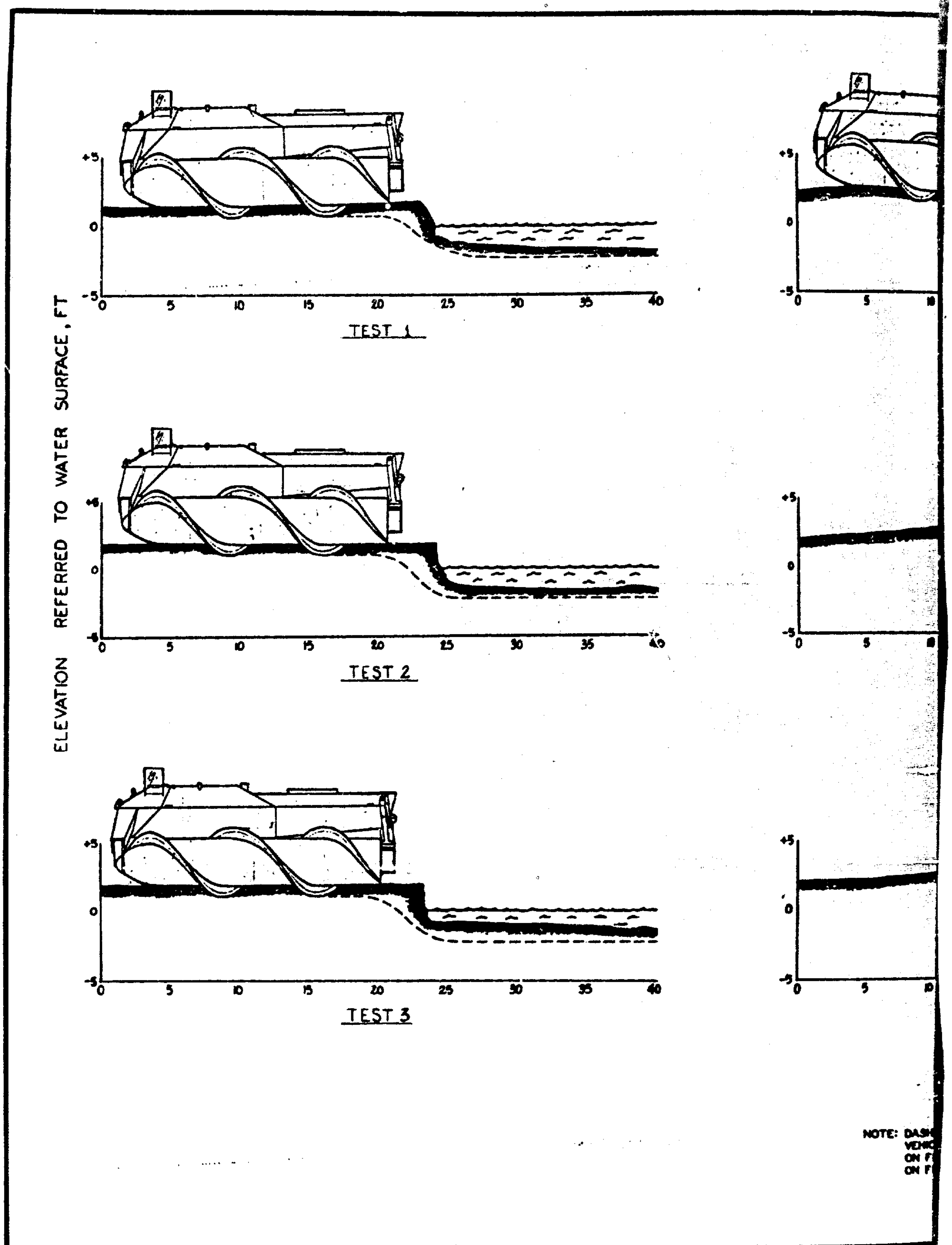
LEGEND

O SLALOM TEST
Δ ROLL TEST

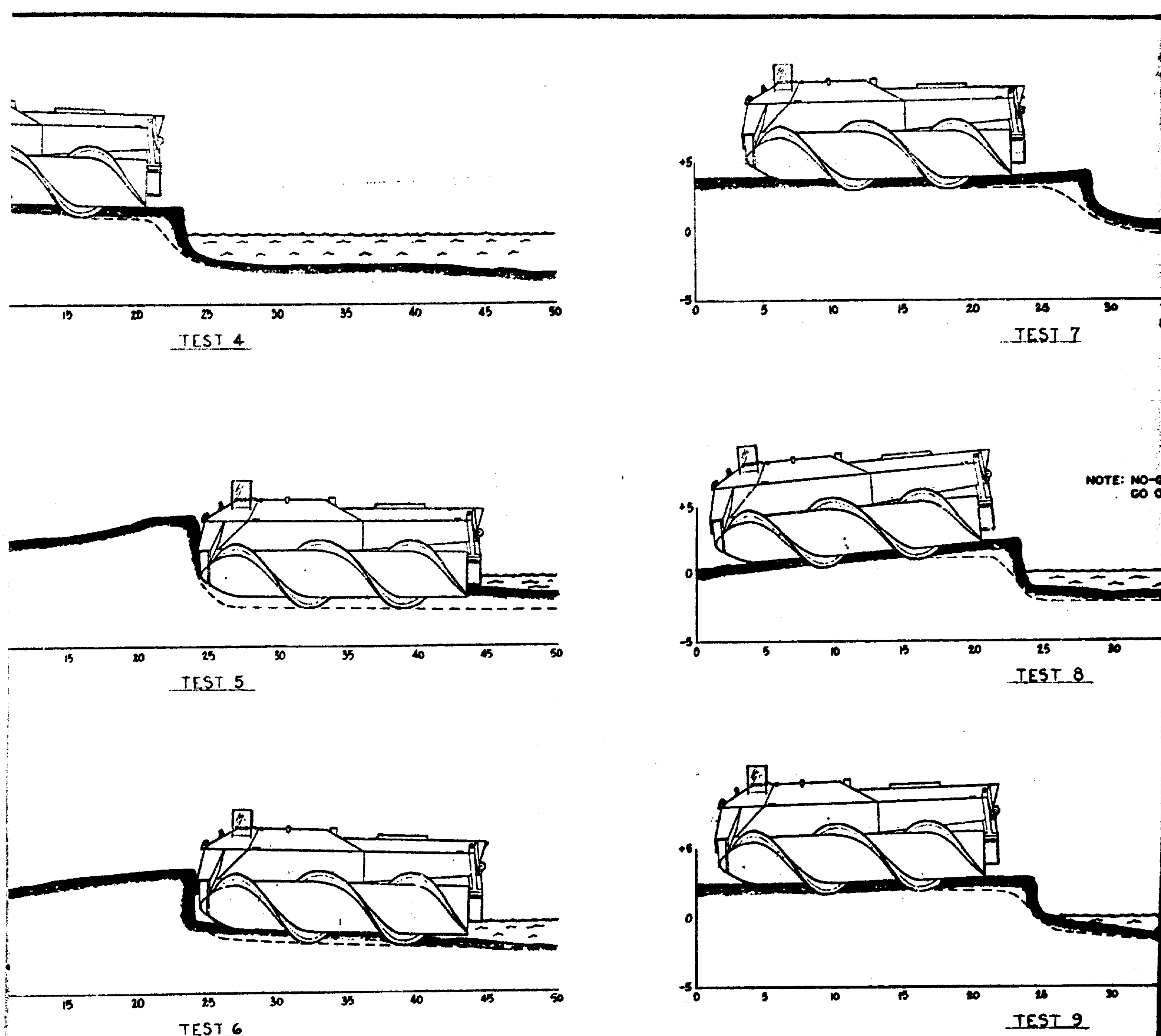
NOTE: TEST 9 INDICATES MAXIMUM MANEUVER SPEED IN WATER. RCI DATA ARE FROM TABLE 1. SPEED DATA ARE FROM TABLE 3. NUMBERS BESIDE PLOTTED POINTS ARE TEST NUMBERS.

MAXIMUM MANEUVER SPEED VS SOIL STRENGTH

PLATE 6


ELEVATION REFERRED TO WATER SURFACE, FT
+5
0
-5
0 5 10 15 20 25 30 35 40
TEST 1
TEST 2
TEST 3
NOTE: DASH
VEHIC
ON F
ON F

A

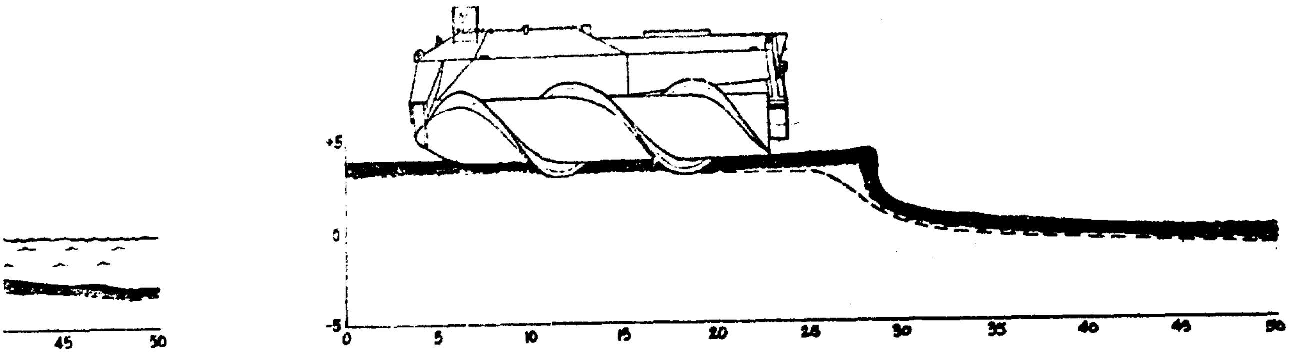


DISTANCE, FT

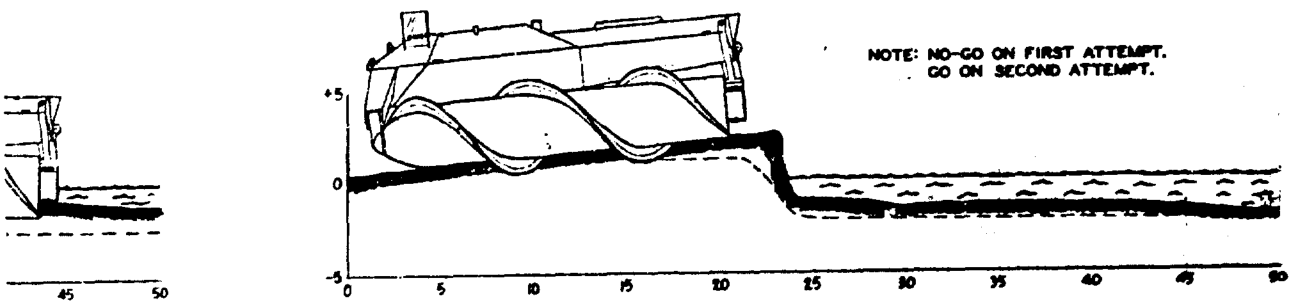
ED LINE INDICATES RUT PROFILE AFTER COMPLETION OF TEST.
LE IN POSITION ON PROFILE TO LEFT OF BANK INDICATES GO
RST PASS, IN POSITION TO RIGHT OF BANK INDICATES NO-GO
RST PASS (EXCEPT AS NOTED IN TEST 8).

WATER-EX

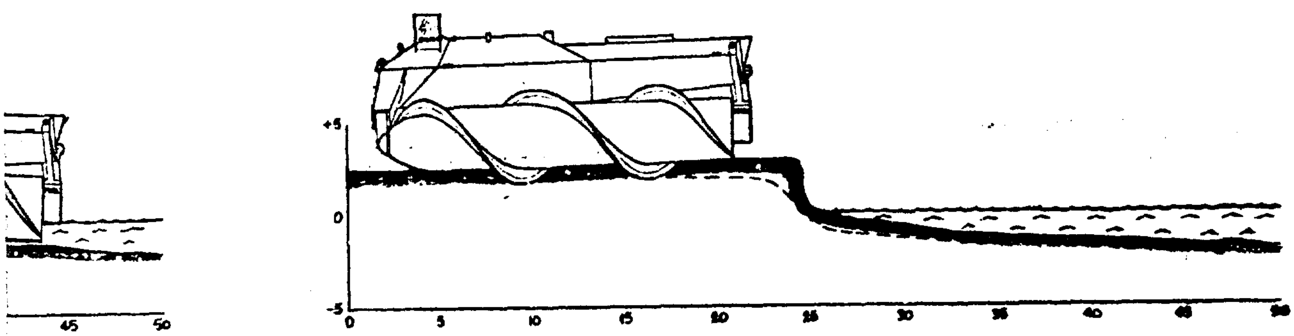
BAYOU



TEST 7



TEST 8



TEST 9

WATER-EXIT TEST PROFILES

BAYOU DU LARGE, LA.

APPENDIX A: COMPARISON OF SELECTED MEKONG DELTA AREA AND MOBILITY TEST COURSE TERRAIN TYPES

Background

1. This appendix was extracted largely from Appendix C of Technical Report No. 3-808, "Evaluation of the Performance of the XM759 Logistical Carrier," and was used primarily to compare those terrain types tested during the RUC field program with those identified in selected sections of the Mekong Delta, South Vietnam.

Purpose and scope

2. The purpose of this appendix is to present: (a) a system for defining, measuring, and identifying terrain types and (b) comparisons of terrain types found along the mobility test courses and terrain types identified in six areas of the Mekong Delta. Readily available information (maps and reports) on South Vietnam were analyzed. Due to the enormity of the Mekong Delta and the limited amount of time available to devote to the study, it was necessary to limit detailed analysis to six selected sample areas (fig. A1). The terrain types found in these sample areas are considered representative of the terrain types that would be found throughout the Mekong Delta. Selected areas in south Louisiana were visited, and terrain types were measured to determine their general analogy with Mekong Delta terrain. Results of this analogy enabled the selection of mobility test courses in accessible areas of south Louisiana that would compare favorably with inaccessible areas of the Mekong Delta.

Definitions

3. Terms used in terrain factor identification are defined below.

Terrain type. An area throughout which a specific assemblage of factor values occurs.

Vegetation. Vegetation includes all attributes of plant structure either as individual plants or as complexes or associations of plants. Stem diameter and stem spacing were used for this study.

Hydrologic-vegetation association. An association of vegetation with stems less than 1 in. in diameter usually found associated with surface water.

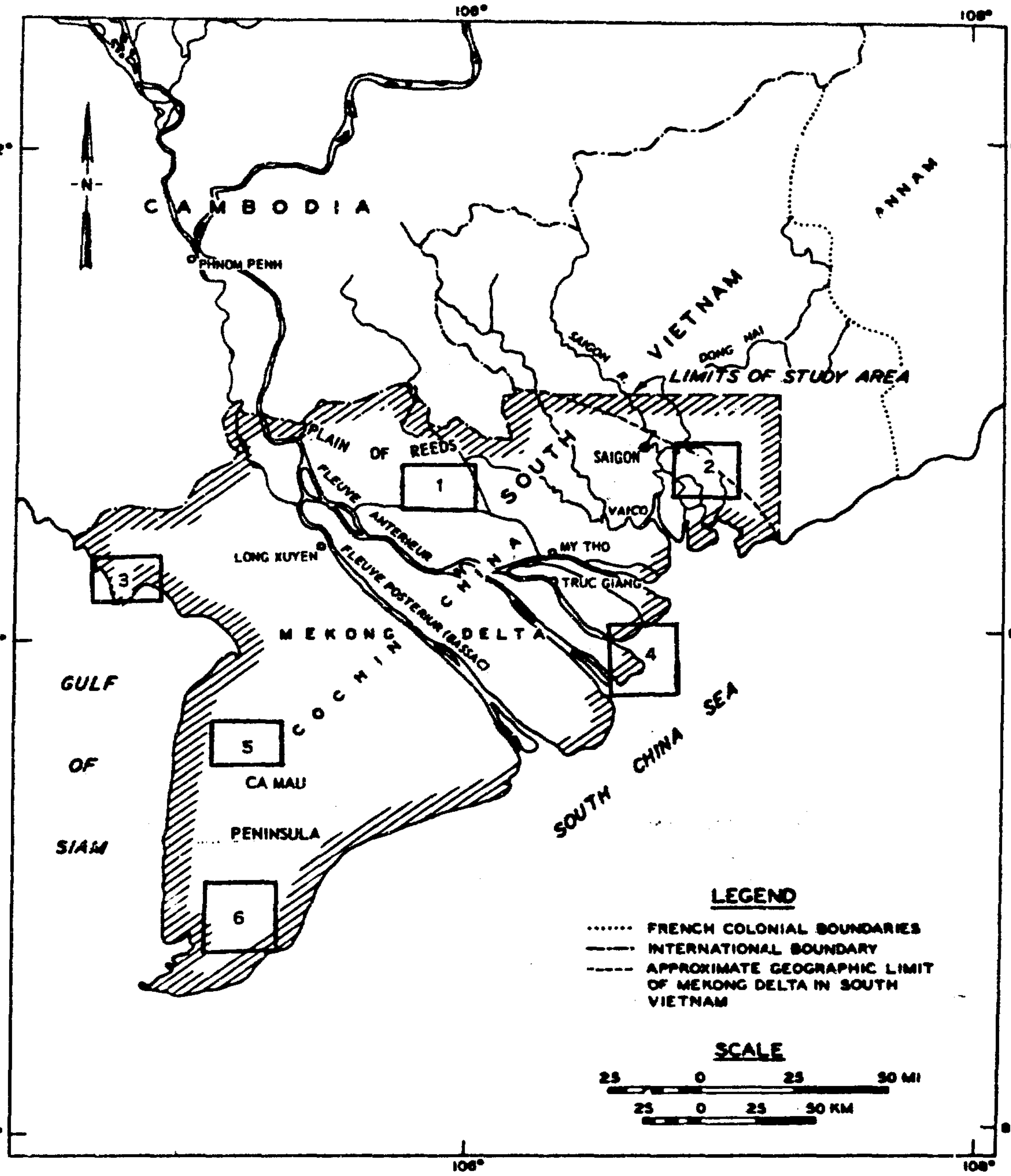


Fig. A1. Study areas in Mekong Delta, South Vietnam

Surface geometry. Surface geometry is the three-dimensional configuration of a ground surface on which a ground contact vehicle operates.

Surface composition. Surface composition is concerned with the engineering properties of the earth's surface (chiefly soils, in terms of soil mass strength).

Terrain factor. A specific attribute of a terrain (which can be defined either quantitatively or in semiquantitative or qualitative fashion) that forms an exclusive category.

Factor class. A specific category within a terrain factor defined as having a specific range of size, configuration, strength, and/or other property.

Vertical obstacle. Irregularities on the ground surface that force a vehicle to move in a vertical plane (i.e. up and down).

Step height. The vertical distance between the bottom and the top of an obstacle.

Terrain approach angle. The angle formed by the contact plane of a vehicle and the slope of an obstacle.

Obstacle spacing. The minimum distance between vertical obstacles.

Terrain Factors

4. Terrain factors that affect ground mobility have been placed into four groups or families: (a) vegetation, (b) surface geometry, (c) surface composition, and (d) hydrologic geometry. A hydrologic-vegetation association was utilized in this study where vegetation stems were less than 1 in. in diameter.

Factor classes

5. The factors identified in both delta regions and ranges of values (factor classes) used to qualitatively describe each factor are discussed in the following paragraphs.

6. Vegetation. Two aspects of vegetation where the stem diameters are greater than 1 in. that were considered are: (a) stem diameter and (b) stem spacing. Where stems were less than 1 in. in diameter, the hydrologic-vegetation association was described by the water depth and plant characteristics.

a. Vegetation classes are tabulated as follows:

Factor	Class Range 1	2	3	4
Stem diameter, in.	>1	>2.5	>5.5	>8.5

Factor	Class Range a	b	c	d
Stem spacing, ft	0-8	8.1-15	15.1-25	>25

b. Hydrologic-vegetation associations are as follows:

(1) Water depth classes are:

Class 1, less than 3 ft
Class 2, 3 to 4.5 ft
Class 3, greater than 4.5 ft

(2) Plants are described by a number-letter-number system as follows:

1 Water lily (floating flat leaves rooted)

2 Water hyacinth (floating masses 1 to 2 ft above the water to 1 to 2 ft below the water)

3 Graminoids (grasses, sedges, rushes, cattails)

a Tall (>3 ft in height)

(1) Nontussock

(2) Tussock

b Short (<3 ft in height)

(1) Nontussock

(2) Tussock

7. Surface geometry. The surface geometry parameters selected to describe the surface features are: (a) step height, (b) approach angle, (c) obstacle spacing, and (d) slope. The class ranges are shown below.

Factor	Class Range 1	2	3	4	5
Step height, in.	<12	12-20	>20		
Approach angle, deg	<135	135-150	>150		
Obstacle spacing, ft	<50	50-150	>150		
Slope, deg	<1.5	1.5-4.5	4.6-10	10.1-17	>17

Note: Surface geometry types, e.g. 1331, indicate factors of step height, approach angle, spacing, and slope and are always designated in that order. The class ranges for each factor are listed under the identification unit.

8. Surface composition. Soil conditions were evaluated in terms of soil mass strength in ranges of CI values for the 6- to 12-in. layer. These classes are shown below.

Classes	Range of CI
1	0-15
2	16-25
3	26-60
4	61-100
5	>100

9. Hydrologic geometry. In this report, hydrologic geometry is concerned only with bodies of water 3 ft deep or more. Bodies of water less than 3 ft deep are described by surface geometry classes. Hydrologic geometry factors that were identified include: (a) contact approach angle, (b) water depth, and (c) channel width. Class ranges for these factors are shown below.

Factor	Class Range 1	2	3
Contact approach angle, deg*	<150	150-165	>165
Water depth, ft	<3	3-4.5	>4.5
Channel width, ft	<20	20-60	>60

* Contact approach is defined under two conditions: (a) where the water depth is between 3.0 and 4.5 ft, and (b) where the water depth is greater than 4.5 ft. The contact approach angle under condition (a) is the angle between the bed and bank of the water body; under condition (b) it is the angle formed by a line parallel to and 4.5 ft below the water surface and the bank of the water body.

Terrain type

10. To portray the total terrain conditions, all the factors were synthesized into a single identification, referred to as a terrain type. Each terrain type is identified by an array of numbers. The first group describes vegetation. If two numbers or a number and number-letter-number combination are used, vegetation is described as a hydrologic-vegetation association. If four numbers or number-letter combinations are used, the

vegetation is described in terms of stem size and spacing. The second group describes geometry. Four numbers or number combinations describe surface geometry and the factors include step height, approach angle, obstacle spacing, and slope. If three numbers or number combinations are used, they describe hydrologic geometry and the factors include approach angle, water depth, and channel width. The last number describes surface composition in terms of cone index. For example, in table A1 the first terrain type in the Mekong Delta column is symbolized as 1,3b(2)-2,2,2,1-1. The first group describes the vegetation as a hydrologic-vegetation (HV) association (number and number-letter-number combination), the next four numbers describe surface geometry (SG), and the last number describes the surface composition (SC). The factors and classes designated by these numbers are as follows:

Factor Family	Factor	Class	Description
			Hydrologic-Vegetation Association
HV	Water depth	1	Less than 3 ft
	Plant description	3b	Graminoids (grasses, sedges, rushes, and cattails). Short (<3 ft in height)
	Plant description	(2)	Tussocks
			Surface Geometry
SG	Step height	2	12-20 in.
	Approach angle	2	135-150 deg
	Spacing	2	50-150 ft
	Slope	1	Less than 1.5 deg
			Surface Composition
SC	Cone index (6- to 12-in. layer)	1	0-15

11. For comparison purposes this system was used to identify 134 terrain types in the Mekong Delta and 23 terrain types along the mobility test courses. It is to be noted that the above-described system identified surface composition only in terms of CI in the 6- to 12-in. layer. In the evaluation of actual performance of the RUC, the system used to identify

surface composition along the test courses incorporated soil type and rating cone index. For this reason the numbers of terrain types identified by each system differ somewhat.

Development of Analog Criterion

12. The determination of analogous terrain types in two noncontiguous areas was made by comparing the terrain type identified in one area with that of another area. The criterion used in determining the degree of analogy was based upon the number of factor classes used to describe a terrain type that was in agreement. The relation of factor classes to the degree of analogy used is given in the following tabulation.

Number of Factor Classes in Agreement				
(6 Total)	(7 Total)	(8 Total)	(9 Total)	Degree of Analogy
6	7	7-8	8-9	Analogous
5	5-6	5-6	6-7	Highly analogous
3-4	3-4	3-4	4-5	Moderately analogous
1-2	1-2	1-2	1-3	Slightly analogous
0	0	0	0	Not analogous

Comparison of Terrain Types

13. Table A1 is a comparison of the Mekong Delta and mobility test course terrain types and the degree of analogy assigned. Of the 134 terrain types identified in the Mekong Delta, 7 were analogous, 55 were highly analogous, 55 were moderately analogous, and 17 were slightly analogous to one or more terrain types identified along the mobility test course.

Table A[illegible]

Comparison of the Mekong Delta and Mobility Test Course Terrain Types

Terrain Types						
Mekong Delta			Mobility Test Course			
V* or HV	SG	SC	V or HV	SG	SC	Degree of Analogy
1,[illegible](2)	2,[illegible],2,1	1	1,1a(1)	1,3,3,1	1[1]	Moderately analogous
			1,2b(1)	1,3,3,1	1[1]	
1,3b(2)	1,2,2,1	[illegible]	1,3a(1)	1,3,3,1	1[1]	Highly analogous
1,3b(2)	[illegible],2,3,1	[illegible]	1,3a(1)	1,3,3,1	1[2]	Moderately analogous
1,3b(2)	[illegible],1,3,1	[illegible]	1,3a(1)	1,3,3,1	1[1-P]	Moderately analogous
1,3b(2)	1,2,2,1	1	1,3b(1)	1,3,3,1	1[1-P]	Analogous
1,3b(2)	2,2,1,1	1	1,3b(1)	1,3,3,1	1[2]	Highly analogous
1,3b(2)	3,1,2,1	1	1,3b(1)	1,3,3,1	1[1]	Highly analogous
1,3b(2)	[illegible],2,2,1	2	1,3a(1)	1,3,3,1	2[2]	Moderately analogous
1,3b(2)	1,2,3,1	2	1,3b(1)	1,3,3,1	2[2]	Analogous
1,3b(2)	2,2,3,1	2				Highly analogous
1,3b(2)	2,2,2,1	3	1,3a(1)	1,3,3,1	3[4]	Moderately analogous
1,3b(2)	2,2,2,1	4				Moderately analogous
1,3b(2)	2,1,2,1	[illegible]				Highly analogous
1,3b(2)	1,2,2,1	3				Highly analogous
1,3b(2)	1,2,3,1	3				Analogous
1,3b(2)	1,2,2,1	4				Moderately analogous
1,3b(2)	1,2,3,1	4				Highly analogous
1,3b(2)	1,3,2,1	4				Highly analogous
1,3b(2)	3,1,1,1	3				Moderately analogous
1,3b(2)	3,1,1,2	4	1,3b(1)	1,3,3,1	3[4]	Moderately analogous
1,3b(2)	3,3,1,1	2	1,3b(1)	1,3,3,1	3[2]	Highly analogous
1,3b(2)	3,3,2,1	2	1,3b(1)	1,3,3,1	3[3]	Highly analogous
1,3b(2)	2,2,3,1	3				Moderately analogous
1,3b(2)	2,2,3,1	4				Highly analogous
1,3b(2)	3,1,2,1	4				Moderately analogous
1,3b(2)	3,1,3,3	4				Moderately analogous
1,3b(2)	3,2,2,1	3				Moderately analogous
1,3b(2)	3,2,2,1	4				Moderately analogous
1,3b(2)	3,3,2,1	4				Moderately analogous

(Continued)

Note: The underlined factor classes shown in the Mekong Delta terrain type column indicate that these factor classes also occurred as a part of the mobility test course terrain type to which one comparison was being made. Under the columns headed V or HV a number-letter-number combination, i.e. 1,3a(1) indicates a hydrologic-vegetation association. A four number-letter combination, i.e. 1d,2d,3d,4d indicates vegetation. Two numbers separated by a slant in the approach angle factor of terrain geometry indicate that the approach angle on one side of the terrain type is in a different class range from the approach angle on the other side.

* V = vegetation.
HV = hydrologic-vegetation association.
SG = surface geometry.
SC = surface composition.

Table A1 (Continued)

Terrain Types						
Mekong Delta			Mobility Test Course			
V or HV	SG	SC	V or HV	SG	SC	Degree of Analogy
1,3b(2)	1,1,2,1	5				Moderately analogous
1,3b(2)	1,2,2,1	5				Moderately analogous
1,3b(2)	1,2,3.1	5				Highly analogous
1,3b(2)	1,3,3,1	5	1,3a(1)	1,3,3,1	5[5]	Highly analogous
1,3b(2)	2,2,2,1	5				Moderately analogous
1,3b(2)	2,2,3,1	5				Moderately analogous
1,3b(2)	2,3,3,1	5				Highly analogous
1,3b(2)	3,3,2,3	5				Moderately analogous
1a,2a,3b,4d	1,3,3,1	1				Highly analogous
1a,2a,3b,4d	1,3,3,1	2				Highly analogous
1a,2a,3b,4d	1,3,3,1	3				Highly analogous
1a,2a,3b,4d	3,3,1,1	3				Moderately analogous
1a,2a,3b,4d	3,3,2,1	3				Moderately analogous
1a,2a,3b,4d	1,3,3,1	5				Highly analogous
1a,2b,3b,4b	1,3,3,1	5				Highly analogous
1a,2a,3c,4d	1,3,3,1	2				Highly analogous
1a,2a,3c,4d	1,3,3,1	3				Highly analogous
1a,2a,3c,4d	3,1,1,3	3				Slightly analogous
1a,2a,3c,4d	3,3,2,1	3				Moderately analogous
1a,2a,3c,4d	1,3,3,1	5				Highly analogous
1a,2a,3c,4d	1,3,3,4	5				Moderately analogous
1a,2a,3c,4d	1,3,3,5	5				Moderately analogous
1a,2a,3c,4d	2,2,3,1	3				Moderately analogous
1a,2a,3c,4d	3,1,2,1	3				Moderately analogous
1a,2b,3c,4d	1,2,3,1	5				Moderately analogous
1a,2b,3c,4d	1,3,1,1	5	1a,2d,3d,4d	1,3,3,1	3[3]	Moderately analogous
1a,2b,3c,4d	1,3,2,1	3				Highly analogous
1a,2b,3c,4d	1,3,3,1	3				Highly analogous
1a,2b,3c,4d	1,3,3,1	5				Highly analogous
1a,2b,3c,4d	1,3,3,5	5				Moderately analogous
1a,2b,3c,4d	1,3,3,1	2				Highly analogous
1a,3b,3c,4d	1,3,3,4	2				Moderately analogous
1a,2b,3c,4d	2,2,2,1	3				Moderately analogous
1b,2c,3d,4d	2,2,2,1	3				Moderately enaologous
1b,2c,3d,4d	2,2,3,1	3				Moderately analogous
1b,2c,3d,4d	2,3,3,1	3				Highly analogous
1b,2c,3c,4d	1,3,3,1	2				Moderately analogous
1b,2c,3c,4d	1,3,3,1	3				Highly analogous
1b,2b,3b,4d	1,3,3,1	5				Moderately analogous
1b,2c,3d,4d	1,2,2,1	5				Moderately analogous
1b,2c,3d,4d	1,3,2,1	3				Highly analogous
1b,2c,3d,4d	1,3,3,1	3				Highly analogous
1c,2c,3c,4c	1,3,3,1	5				Moderately analogous
1c,2c,3c,4d	1,3,3,1	5				Moderately analogous
1a,2b,3c,4d	1,3,2,1	1				Moderately analogous
1a,2b,3c,4d	1,3,3,1	1				Highly analogous
1b,2c,3c,4d	1,3,3,1	1				Highly analogous
1b,2c,3d,4d	1,3,3,1	1	1d,2d,3d,4d	1,3,3,1	1[1]	Highly analogous
1d,2d,3d,4d	1,3,3,1	1				Analogous
1d,2d,3d,4d	1,3,3,1	4				Analogous
1a,2a,3c,4d	1,3,3,1	1				Highly analogous

(Continued) (2 of 3 sheets)

Table A1 (Concluded)

Terrain Types						
Mekong Delta			Mobility Test Course			
V or HV	SG	SC	V or HV	SG	SC	Degree of Analogy
1a,2a,3b,4d	1,3,2,1	4				Moderately analogous
1a,2a,3b,4d	1,3,3,1	4				Highly analogous
1a,2a,3b,4d	1,2,3,1	4				Moderately analogous
1a,2a,3c,4d	1,2,3,1	4				Moderately analogous
1a,2a,3c,4d	1,3,3,1	4				Highly analogous
1a,2a,3c,4d	1,2,3,1	5				Moderately analogous
1a,2a,3c,4d	2,2,2,1	4				Slightly analogous
1a,2a,3b,4d	2,2,2,1	5				Slightly analogous
1a,2a,3c,4d	2,2,3,2	5				Slightly analogous
1a,2b,3b,4b	3,2,2,2	5				Slightly analogous
1a,2a,3d,4d	3,2,2,2	5				Slightly analogous
1a,2a,3c,4d	3,3,2,3	5				Slightly analogous
1a,2b,3c,4d	1,3,3,1	4	1d,2d,3d,4d	1,3,3,1	4[5]	Highly analogous
1a,2b,3c,4d	2,2,3,1	4				Moderately analogous
1a,2b,3c,4d	3,1,1,1	5				Slightly analogous
1a,2b,3c,4d	3,2,3,1	4				Moderately analogous
1a,2b,3c,4d	3,3,2,3	5				Slightly analogous
1a,2b,3c,4d	2,2,2,1	5				Slightly analogous
1b,2c,3d,4d	2,2,2,1	4				Moderately analogous
1b,2c,3d,4d	1,3,2,1	4				Highly analogous
1b,2c,3d,4d	1,3,2,1	5				Moderately analogous
1b,2c,3d,4d	1,3,3,1	4				Highly analogous
1b,2c,3d,4d	1,3,3,1	5				Highly analogous
1b,2c,3d,4d	1,3,3,5	5				Moderately analogous
1a,2a,3b,4d	3,2,2,1	1				Moderately analogous
1a,2a,3b,4d	3,2,2,1	2				Slightly analogous
1a,2a,3b,4d	1,1,2,1	5				Slightly analogous
1a,2a,3b,4d	1,2,2,5	5				Slightly analogous
1a,2a,3b,4d	3,3,2,3	5	1d,2d,3d,4d	2,2/3,3,3	1[1]	Moderately analogous
1a,2a,3c,4d	3,1,1,1	2				Slightly analogous
1a,2a,3b,4d	2,2,2,1	1				Slightly analogous
1a,2b,3c,4d	2,2,2,1	1				Slightly analogous
1a,2b,3c,4d	3,1,3,1	1				Moderately analogous
1a,2b,3c,4d	3,2,2,1	1				Slightly analogous
1d,2d,3d,4d	1,1,1	--				Highly analogous
1d,2d,3d,4d	1,2,1	--				Highly analogous
1d,2d,3d,4d	1,2,2	--				Highly analogous
1d,2d,3d,4d	1,3,1	--				Highly analogous
1d,2d,3d,4d	1,3,2	--				Highly analogous
1d,2d,3d,4d	1,3,3	--	1d,2d,3d,4d	1,3,3**	1[2]	Analogous
1d,2d,3d,4d	2,1,1	--	1d,2d,3d,4d	1,3,3**	3[2]	Moderately analogous
1d,2d,3d,4d	2,2,1	--				Moderately analogous
1d,2d,3d,4d	2,2,2	--				Moderately analogous
1d,2d,3d,4d	2,2,3	--				Highly analogous
1d,2d,3d,4d	2,3,1	--				Highly analogous
1d,2d,3d,4d	2,3,2	--				Highly analogous
1d,2d,3d,4d	2,3,3	--				Highly analogous
1d,2d,3d,4d	3,1,1	--				Highly analogous
1d,2d,3d,4d	3,2,1	--				Highly analogous
1d,2d,3d,4d	3,2,2	--	1d,2d,3d,4d	3/1,3,3**	2[2]	Highly analogous
1d,2d,3d,4d	3,2,3	--	1d,2d,3d,4d	3,3,3**	1[1]	Highly analogous
1d,2d,3d,4d	3,3,1	--				Highly analogous
1d,2d,3d,4d	3,3,2	--				Highly analogous
1d,2d,3d,4d	3,3,3	--				Analogous

** Hydrologic geometry factor classes.

(3 of 3 sheets)

APPENDIX B: SOIL PROFILE DESCRIPTIONS ALONG MOBILITY TEST COURSES

Station	Depth in.	Description
		Bayou du Large, La., Mobility Course 1
0+00 to 1+02	0-5	Light brown mostly organic material with small amount of clay; pencil-size roots in abundance with some small roots and fibers
	5-20	Highly organic clay, brown, with an abundance of small roots and fibers
	20-36	Organic clay, gray, with a few fibers
1+02 to 5+41	0-5	Light brown mostly organic material with some clay; pencil-size roots with some small roots and fibers
	5-17	Highly organic clay, brown, with an abundance of small roots and fibers
	17-36	Organic clay, gray, with a few fibers
5+41 to 7+42	0-5	Brownish fine roots and fibers and some pencil-size roots; considerable amount of organic clay
	5-14	Gray organic clay with a considerable amount of fine roots; no pencil-size roots
	14-22	Gray clay with some fine roots
	22-36	Gray clay mottled with brown
7+42 to 8+55	0-6	Organic clay, brown, with an abundance of fine roots and fibers; some pencil-size roots
	6-14	Organic clay, gray, with some fine roots
	14-32	Organic clay, gray, with few fine roots
	32-36	Gray clay mottled with brown
8+55 to 9+23	0-3	Gray clay mixed with an abundance of fine roots; one or two roots of pencil size
	3-24	Gray clay with several fine roots
	24-36	Gray clay mottled with brown; no roots

(Continued)

Station	Depth in.	Description
		Bayou du Large, La., Mobility Course 1 (Continued)
9+23 to water to 13+27	0-3	Gray clay mottled with brown; some organic material
	3-36	Gray clay mottled with brown
13+27 to 15+49	0-13	Brown, highly organic clay with an abundance of small roots and fibers
	13-36	Gray organic clay with a few small roots and fibers
15+49 to 16+60	0-10	Brown organic clay with a few small roots and fibers
	10-36	Gray clay with some organic material
16+60 to 19+80	0-8	Light brown mostly organic material with small amount of clay; densely packed, abundant, pencil-size roots with some small roots and fibers
	8-27	Brown organic clay with some small roots and fibers
	27-36	Gray clay with slight amount of organic material
		Bayou du Large, La., Mobility Course 2
0+00 to 0+77	0-5	Brown organic material with small amount of clay; densely packed mixture of pencil-size and smaller roots and fibers
	5-13	Brown organic clay with some small fibers
	13-36	Gray clay with small amount of organic material
0+77 to 2+09	0-5	Brown organic material with some clay; densely packed small roots and fibers
	5-36	Gray clay with some organic material
2+09 to 2+52	0-36	Gray clay; no vegetation
2+52 to 4+53	Water	
4+53 to 5+23	0-36	Gray clay mottled with brown

(Continued)

Station	Depth in.	Description
		Bayou du Large, La., Mobility Course 2 (Continued)
5+23 to 5+85	0-36	Gray clay
5+85 to 7+85	0-3	Brown organic material with some clay; abundance of roots and fibers
	3-36	Blue-gray clay mottled with brown
		Minors Canal, La., Mobility Course 3
0+00 to 2+61	Water	Covered with mass of floating lily pads. Highly organic muck under water
2+61 to 5+10	0-7	Dark brown highly organic material with small amount of clay; numerous small roots and fibers
	7-30	Light brown highly organic material with small amount of clay; numerous small roots and fibers
	30-36	Dark brown fibrous muck with very little clay
5+10 to 5+54	0-7	Medium brown clay with some fine roots and fibers
	7-15	Dark brown clay with numerous fine roots and fibers
	15-36	Medium brown clay with numerous fine roots and fibers
5+54 to 6+59	Water	
6+59 to 6+92	0-9	Brown organic clay with some roots and fibers
	9-18	Dark brown mostly organic material with some clay; numerous roots and fibers
	18-36	Brown mostly organic material with some clay; numerous small roots and fibers
6+92 to 9+03	0-12	Brown highly organic clay; numerous small roots and fibers
	12-25	Medium brown highly organic clay with numerous small roots and fibers

(Continued)

Station	Depth in.	Description
		Minors Canal, La., Mobility Course 3 (Continued)
6+92 to 9+03 (Continued)	25-36	Light brown highly organic clay with numerous small roots and fibers
9+03 to 10+26	0-5	Dark brown highly organic material with some clay; numerous small roots and fibers
	5-18	Light brown highly organic material with small amount of clay; numerous small roots and fibers
	18-32	Dark brown fibrous organic muck
	32-36	Gray clay with some organic material
		Morgan Island, La., Mobility Course 4
0+00 to 1+67	0-36	Light gray clay with traces of sand
1+67 to 2+64	0-9	Reddish brown clay
	9-14	Gray clay, mottled with reddish brown
	14-36	Gray clay, mottled with reddish brown, with some fine sand
2+64 to 3+52	0-4	Reddish brown clay with a few small roots
	4-15	Reddish brown clay
	15-25	Gray clay, mottled with reddish brown, with fine sand
	25-36	Gray clay
3+52 to 5+17	0-3	Gray clay, mottled reddish brown, with some fine fibers
	3-13	Gray clay, mottled with reddish brown with few fine fibers
	13-36	Gray clay
5+17 to 6+43	0-15	Grayish brown clay
	15-36	Grayish brown clay with small amount of organic fibers

(Continued)

Station	Depth in.	Description
		Morgan Island, La., Mobility Course 4 (Continued)
6+43 to 7+55	0-5	Light brown clay with some fibers
	5-13	Gray clay with some fine fibers
	13-36	Gray clay with abundant fibers

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13. ABSTRACT Tests were conducted at four riverine sites in south Louisiana in November 1969 to evaluate the performance of the Riverine Utility Craft (RUC). The RUC is an amphibian that employs a locomotion concept based on the Archimedean screw. It moves by two counterrotating rotors that give forward and backward thrust; the rotors also serve to float the craft. The RUC is powered by two 380-hp engines and is designed to carry a payload of 2000 lb; the gross weight of the RUC is 13,000 lb. Specific purposes of the tests were to (a) develop performance-soil strength (rating cone index) relations in terms of maximum straight-line speed, maximum maneuver speed, and minimum time required to turn 180 deg, (b) determine water-exit capabilities, (c) determine the speed attained in a variety of test courses and terrain types commonly found in wetland marshes, and (d) determine the degree of analogy of the terrain types tested with terrain types at selected areas of the Mekong Delta, South Vietnam. The specific purposes of the test program were satisfied. Test results indicate that, in general, the RUC can operate in the riverine environments for which it was designed. The craft's performance is most effective in water and wet marshes of low soil strength. The RUC also has a performance capability in areas considered restrictive or even inaccessible to boats and other amphibious craft. Appendix A discusses the comparison of terrain types tested during the RUC program with those identified in selected areas of the Mekong Delta. Appendix B presents detailed descriptions of soil profiles along the Louisiana test courses.

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Archimedean screw						
Military vehicles						
Riverine utility craft						
Screws						
Terrain						

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